

Study on implement of green technology and industry revolution 4.0 for organisational development to manufacturing industries in Nashik

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Abstract

This study examines the implementation of green technology and Industry 4.0 for organisational development in manufacturing industries in Nashik, Maharashtra. The primary objective is to assess the awareness, adoption, and implementation of green technology and Industry 4.0 technologies in manufacturing processes and to understand their contribution to cost savings, environmental sustainability, operational efficiency, employee competency, and production quality. The study also aims to identify the need for employee training, continuous monitoring, and capacity building to support sustainable industrial development.

The research adopts a qualitative, survey-based approach using structured questionnaires to collect primary data from manufacturing industries located in the Ambad and Satpur industrial areas of Nashik district. The study reports the selection of 110 manufacturing units through simple random and stratified sampling methods. The questionnaire covers organisational and respondent profiles, awareness and implementation of green technology, and awareness and implementation of Industry 4.0. The collected data were tabulated and analysed using Microsoft SPSS, with descriptive statistical analysis employed to interpret the responses.

The findings indicate a generally positive response towards green technology adoption. Most respondents agreed that green technology contributes to significant cost savings, has been implemented in manufacturing processes, and requires employee training and regular evaluation. Similarly, the results indicate considerable awareness of Industry 4.0 concepts and the integration of related technologies into manufacturing operations. Respondents also reported improvements in production quality associated with Industry 4.0 implementation. However, the findings highlight continuing challenges, including limited technological capabilities, financial constraints, inadequate infrastructure, and shortages of skilled personnel. Some organisations also require stronger employee training programmes and more effective monitoring and evaluation systems.

The study concludes that integrating green technology and Industry 4.0 can support organisational development, sustainable manufacturing, environmental responsibility, and improved operational performance. Manufacturing industries should strengthen employee development, technological infrastructure, and systematic performance evaluation to maximise these benefits. A coordinated approach to sustainable production and digital transformation can help manufacturing organisations improve their competitiveness while addressing environmental and operational challenges.

Keywords: Nashik, green technology, industry 4.0, organisational development, manufacturing industries, sustainable manufacturing, environmental sustainability, technological innovation, employee training, operational efficiency

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Introduction

The paradigm change in policy towards a green economy is causing businesses to take green projects seriously. Businesses, especially those in the manufacturing industry, need to be preventative rather than responsive. UNEP estimated in 2011 that the industrial sector drank 35% of all power used worldwide and was responsible for 20% of all damaging CO₂ emissions. Given these considerations, it seems like an ideal moment to do empirical research on green manufacturing and to put green manufacturing frameworks into place, especially in countries like India, which is quickly becoming one of the world's top manufacturing centers alongside China. Before

diving into the topic of "green manufacturing," it's important to understand development of environmentally friendly production methods.

Factors Influencing Green Manufacturing

Multiple companies have already started incorporating green efforts into their regular tasks. Five factors that are contributing immensely to these initiatives are given as follows (Masson *et al.*, 2018)^[13].

- Increasing the cost of energy and inputs.
- Increasing customers appeal for green products.
- Regulatory constraints are increasing as policymakers

enact new and more stringent environmental and waste management laws.

- New business opportunities created by innovative advancements.
- The need to increase differentiation from the competition, particularly for early adopters or those who can avoid the trade-off between higher expenses in the short-term and many long-term advantages (e.g., brand premium, new client groups).

Developments of Green Manufacturing

The industrial revolution may have been impetus for the development of Green Supply Chain Management (GSCM). Increased awareness of the harmful consequences of mechanical and other waste on the environment, however, has brought moral concerns to the fore in recent years. The widespread use of Supply Chain Management (SCM) has led to greater supplier and customer integration, as well as the development of sophisticated supply and transportation logistics networks for the distribution of goods. Because of these environmental concerns, businesses have started include elements in their supply chain foundation that deal with the recycling, reusing, and repurposing of waste materials and energy. Large industrial companies throughout India need assistance in establishing regional hubs to reduce their use of energy, water, hazardous materials, and trash. The number of eco-friendly buying companies in India is growing quickly. Similarly, there is a wide variety in the propensity to tout eco-friendly practices from sector to sector.

Introduction of Industry 4.0

Numerous manufacturing businesses have introduced cutting-edge production methods in response to the heightened uncertainties of today's global market in effort to boost productivity, profitability & competitiveness. The notion of Industry 4.0 represents a new phase for the manufacturing sector, and several companies in this sector have already begun implementing it under various names. Organizational success and longevity depend on a culture of continuous development. Industries should listen to their customers and adjust their methods to improve reliability and efficiency. The goal of the industry 4.0 idea is to increase the efficiency and output of intelligent factories by means of cutting-edge production techniques and methods. When items, machines, and technology are all linked together, production can run more efficiently, expenses can be cut, and profits may be increased. Alcácer and Cruz-Machado (2019) ^[14] and Vaidya *et al.* (2018a) ^[15] state that Industry 4.0 made it possible for dynamically adaptable mechanisms to change production functions, providing high granularity and precision procedures for self-decision and real-time operation and equipment selection.

Materials and Methods

This study is based on qualitative research. This type of

research methods involves describing in details specific situation using research tools like interview, surveys and observations. The researcher has selected 110 manufacturing units by using simple random and stratified sampling method. Actual sample for the study surveyed 110 units of the manufacturing industry and as such data obtained is presented and used for arriving at conclusions and testing the research hypotheses. The empirical data has been collected from the manufacturing industries in the Ambad and Satpur of Nashik district through the questionnaires with the company representative. The research also specified the source of data and procedure for data collecting. Questionnaire can be used to collect both quantitative and qualitative data. As mentioned in the research type it is survey type or qualitative research. To conduct survey from the various manufacturing industries made structured questionnaire. Questionnaire is widely employed tool for data collection in research. To collect the primary data, researcher used structured questionnaire, which is made by covering all the aspects/topics of the study. Questions are frame so that objectives of the research are going to fulfill. Questionnaire has been divided into six parts.

- **Section A:** General Demographic information of Data.
This section deals with demographic and general information about name of organization, types of industries, gender, address, phone no, etc.
- **Section B:** Awareness and Implementation of Green Technology.
The deals with information related to implementation on green technology, and awareness in industries etc.
- **Section C:** Awareness and Implementation of Industry 4.0.
Deals with information related to implementation on Awareness and Implementation of Industry 4.0 etc.

The main purpose of data collection is to select the data from the total population which has been decided from the research area. Questionnaire tool is used for data collection. Sufficient copies of questionnaire were prepared. Then researcher visited all the selected companies and collects the data. Most of the companies responded positively by filling up and returning the same. The experience was encouraging during the discussion between researcher and representative of the company data were collected about role & impact of information & communication technology in the manufacturing industries in the Ambad and Satpur MIDC area of Nashik. The researcher selected 110 manufacturing companies by using random sampling method from the of Nashik district. Collected data was tabulated by using Microsoft SPSS.

Analysis and Interpretation

This section deals with demographic and general information about the organisational profile it is including Name of the organisation, location of organisation, types of manufacturing organisation, years in organisation operation, and numbers of employees in organisation etc.

Table 1: Descriptive statistical analysis of organisational profile

Variable	Category	Frequency (N)	Percentage (%)
Location of Manufacturing Organisation	Ambad	62	56.36
	Satpur	48	43.64
Type of Manufacturing Organisation	Automobiles and Auto Components	87	15.96
	Engineering Goods	143	26.24
	Pharmaceuticals and Chemicals	31	5.69
	Electronics and Electrical	107	19.63
	Packaging Materials	112	20.55
	Others	65	11.93
Years in the Organisation Operation	0-5 years	32	5.87
	6-10 years	164	30.09
	11-15 years	173	31.75
	Above 15 years	176	32.29
Numbers of Employees in Organisation	Less than 50 (Micro)	36	6.61
	50-100 (Small)	241	44.22
	100-500 (Medium)	229	42.01
	More than 500 (Large)	39	7.16

Respondent Profile

This section deals with demographic and general information about the respondent profile it is including number of

respondents, gender, age of respondent, education, and experience in organisation etc.

Table 2: Descriptive statistical analysis of respondent's profile

Variable	Category	Frequency (N)	Percentage (%)
Location of Respondents	Ambad	282	51.74
	Satpur	263	48.26
Gender	Male	380	69.72
	Female	165	30.28
Age of the Respondents	Less than 35 years	105	19.27
	36-45 years	246	45.14
	46-55 years	159	29.17
	Above 55 years	35	6.42
Education of Qualification Respondent	Graduate	178	32.66
	Post Graduate	161	29.54
	Professional Qualification	174	31.93
	Others	32	5.87
Experience in the Current Organization	Less than 5 years	40	7.34
	5-10 years	260	47.71
	10-20 years	197	36.15
	More than 20 years	48	8.80

Section B: Awareness and Implementation of Green Technology. For each of the following statements, please

indicate your level of agreement by selecting one of the following options.

Table 3: Awareness and implementation of green technology

Statement	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Total
The use of green technology has led to significant cost savings.						
Statement 1	236	177	86	32	14	545
We have implemented green technology solutions in our manufacturing processes.						
Statement 2	265	179	78	23	00	545
Our employees are trained to use green technology effectively.						
Statement 3	263	183	73	24	02	545
We regularly monitor and evaluate the impact of green technology in our operation.						
Statement 4	269	174	73	29	00	545

Section C: Awareness and Implementation of Industry 4.0.

Table 4: Awareness and implementation of industry 4.0

Statement	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Total
Our organization is knowledgeable about Industry 4.0 concepts.						
Statement 5	235	170	105	35	00	545
We have integrated Industry 4.0 technologies into our manufacturing processes.						
Statement 6	246	196	82	30	00	545
Employees are adequately trained to handle Industry 4.0 tools & techniques.						
Statement 7	256	175	76	30	08	545
Industry 4.0 has significantly improved our production quality.						
Statement 8	245	195	83	19	03	545

Conclusion

- These finding suggest that the selected manufacturing industries have a high level of awareness and adoption of the green technology, reflecting their commitment to the sustainable manufacturing practices and environmental responsibility.
- These finding suggest that selected manufacturing industries have adopted environmentally friendly technologies & sustainable production practices. Indicating that some of the organizations are still in the early stages of implementing green technology or face challenges in adoption.
- Organizations still need to strengthen their employee training and development programs related to green technology.
- The most manufacturing industries have established mechanisms to assess the environmental and operational outcomes of green technology implementation also continuous monitoring helps organizations identify areas for improvement, ensure compliance with environmental standards, and enhance sustainable manufacturing performance. However, 5.32% of respondents disagreed or strongly disagreed, suggest some organizations need to strengthen their monitoring & evaluation system for green technology.
- Organizations still require greater awareness and capacity-building initiatives to fully understand and adopt Industry 4.0 technologies.
- Indicating some organizations continue to face challenges in adopted & integrating Industry 4.0 technologies due to factors such as financial constraints, technological limitations, or lack of skilled personnel.
- Indicating that some organizations still need to strengthen their training and skill development initiatives to fully realize the benefits of Industry 4.0 technologies.
- Organizations may not yet have realized the full quality benefits of Industry 4.0 implementation due to limited adoption, inadequate infrastructure, or insufficient technical expertise.

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