

Executive Summary of Project Entitled “Development of a Green Innovations Framework for Manufacturing Sector”

1. The world is moving towards greener production to achieve environmental sustainability and most of the countries have acknowledged this and taken up as their challenge to bring in better environmental sustainability.
2. In India, Manufacturing industries are among the most polluting and among them automotive and earthmoving segments offer huge scope to exhibit better environmental measures through green manufacturing techniques.
3. The earthmoving and automotive segments being one of the major contributors to Indian economy among the manufacturing segment have not been assessed or studied in terms of their green manufacturing methods.
4. Among them, there are companies that are pioneers in green manufacturing methods and they are on a journey towards green innovation by adopting incremental or greater changes to green manufacturing methods.
5. The automotive and Earthmoving sectors are influenced by best practices due to governmental regulations and competition. In and around Bengaluru, there are a number of small and medium enterprises in these two sectors along with large scale mature companies (OEMs) who are following Green manufacturing practices. This provides us an ample opportunity to compare companies who are following green manufacturing practices and those who are not following (this would include both Indian and foreign companies operating from Bengaluru and surrounding region).
6. Initial qualitative pilot studies amongst automotive and earthmoving sectors in and around Bengaluru revealed that there is a mixed group among those companies that follow green manufacturing practices. Some companies are ahead in their green manufacturing practices while some are lagging

behind. This opportunity offered a scope for an in-depth analysis of this phenomenon so that results of this study could be shared across many companies in India for a larger and broader benefit.

7. Given these, it was essential to survey and assess the current status of cooperative/ standalone framework for innovations in green manufacturing practices: Automotive and earthmovers in and around Bengaluru, to categorise companies based on innovations in green manufacturing practices and do a comparative study, to evaluate critical factors that impact practices of green innovation in automotive and earthmover sector, to develop green innovation framework for automotive and earthmovers, to recommend a phase wise roadmap for cooperative green innovations, and to Create a platform through a shared approach which can benefit larger number of stakeholders.
8. The scope of this study is confined to manufacturing companies in automotive and earthmoving in and around Bengaluru. Many of these companies are concentrated in areas of Peenya Industrial area, Bidadi Industrial area, Hoskote Industrial area and a few other areas in and around Bengaluru.
9. A total of 120 automotive parts companies and 94 earthmoving parts companies in Small and medium sector and Original Equipment Manufacturers (OEM) were identified using various sources like Peenya Industrial Association, Hosur Industrial association, OEM's listed in internet sources, Confederation of Indian Industry (CII), Indian Construction Equipment Manufacturers Association (ICEMA), Automotive Component Manufacturers Association of India (ACMA) and a few other sources, companies were identified that belonged to the targeted sampling group.
10. Out of the companies identified, a total of 90 companies (60 – automotive and 30 – earthmoving) were contacted and out of which, 70 companies agreed to provide data and provided the data. The data was collected from 44 automotive companies and 26 Earthmoving companies. Companies included suppliers of parts and OEM. Companies included suppliers of parts and OEM. Of the 70 companies, 16 of them were large companies, and they had to be studied as they were perceived to be advanced in quality systems. The other 54 companies belonged to Small and Medium sector.

11. The respondents for questionnaire were leaders/ plant heads/ managers in production and were the ones who led green manufacturing or who were well aware of green manufacturing practises in their companies.
12. Standalone Frameworks as per this research is described as a quality framework being adopted in a company but not through a cooperative platform (by collaborating with peer group). They could be ISO certifications, TS and others.
13. Out of total 70 companies surveyed, 69 companies (98 %) had standalone frameworks. Out of which 43 were automotive companies and 26 were Earthmoving suppliers. One company did not have any standalone framework. This meant that 97.7% of automotive companies surveyed and 100 % of Earthmoving companies surveyed followed quality standards.
14. The descriptive analysis indicated, of the companies that exhibited standalone framework (total = 69), 75.36 % of the companies were more than 10 years, 50.72 % were having a turnover of more than INR 700 lakhs and 43.47 % were having an employee strength of more than 200. This meant that among the companies that followed Standalone framework, there were more companies that were older, having a higher sales turnover and higher workforce.
15. Cooperative Framework was tested based on response to the following questions: a) how often the companies participated on a cooperative platform to exchange green manufacturing ideas with other manufacturing units? b) their opinion on - if companies should share their green manufacturing knowledge with others?
16. Of the 70 companies surveyed, there are more number of companies that participate on cooperative framework (34.28 %) than those that do not participate (28.5%). Most companies (90 %) believed that companies should share green manufacturing knowledge with others. Companies that were more than 16 years in existence exhibited a positive response to frequent participation in cooperative frameworks and they constituted 27.1 %. Companies that had employees of more than 150 exhibited a positive

response to frequent participation on cooperative platforms and they constituted 24.28 %. Companies that have a turnover of more than INR 700 Lakhs exhibit a positive response to frequent participation on cooperative platforms and they constituted 22.85 %.

17. The 16 large companies had the following characteristics – 13 companies were more than 20 years old, one company was between 16 and 20 years, one was between 11 and 15 years and one was between 6 to 10 years. All the 16 companies had an employee strength of above 200 employees. 13 companies had a turnover of more than INR 1000 lakhs, one had a turnover between INR 700 and 1000 lakhs, one had a turnover between INR 300 and 700 lakhs, and one had a turnover between INR 100 and 300 lakhs.
18. Companies were categorized based on summated score of the scaled variables used that indicated their value on the proposed green innovation index. The process of categorization was achieved by adding all the scores obtained by respective samples across their scaled questions that measured their journey from green awareness towards Green Innovation.
19. The variables considered for categorization were selected based on feedbacks taken from industry experts and academic experts. These variables essentially measured the awareness about green innovations, budgets allocated for green manufacturing policy, extent of design towards green aspects, usage of renewable energy for manufacturing processes, extent of reuse, recycle, support to / from stakeholders for recycling, recovery management, proportion of green value chain (raw materials to shipping of finished goods), energy audits, budgets for green manufacturing, alignment of strategy for green manufacturing, participation on green platforms and knowledge sharing.
20. The minimum score achieved by a company was 112 and maximum score was 217. The minimum score indicated that company had the lowest value of green innovation index and maximum score indicated the highest value of green innovation index. This range provided a continuum of scores achieved by companies on the proposed Green innovation index. The median value of 168 was taken as the mid-

point for categorising the companies into two groups. Hence Companies that scored more than 168 were categorized as those that were more innovative in green manufacturing and was grouped under '1' (also called 'Leaders') for the purpose of this research. Companies that scored equal to and less than 168 were grouped under '2' (called 'followers') for the purpose of this research.

21. The key variables that differentiated the 'leaders' from 'followers' are - Recycling policy to take back products from customers, Encouragement to suppliers to use recycled materials, Support to Suppliers in Green Initiatives, Alignment of Strategies towards Green Initiatives, Extent of Economic advantage due to green manufacturing practices.
22. This meant that the leaders in green manufacturing emphasized more on recycling aspects, encouraged their suppliers in green initiatives, aligned their business strategies towards green initiatives, and derived economic advantage through their green initiatives.
23. This also pointed to the fact that if companies have to successfully move towards green manufacturing innovation, they have to align their strategy towards green manufacturing and support their stakeholders like suppliers to a greater extent.
24. Eleven Important factors explained the phenomenon of green manufacturing innovations and they are - Green Value Chain, Recyclability, Green design, Recovery Management, Cost and resource assessment, Green Stakeholder support, Strategic Alignment towards Green manufacturing, Green Commitment of Employees, Refurbishment, Re-use and 3R implementation.
25. The factors directly point towards importance of economic gains to be acquired by adopting green manufacturing practices followed by factors that require alignment of systems, strategy and people with green manufacturing practice. Hence while propagating green manufacturing across the community of manufacturers, it is necessary that they be made aware of economic gains and then how to align systems, strategy and people with green manufacturing.

26. Linear regression brought out the relative importance of factors. Calculated Green Index value was considered as the dependent variable and the factors scores were considered as independent variables. Factors in order of importance are - Recyclability, Recovery Management, Green Stakeholder support, Green Commitment of Employees, Green Value Chain, Cost and Resource measurement, Green Design, Strategic alignment towards green manufacturing, Reuse and 3R implementation.
27. This study has made an important contribution to research in terms of identifying the important factors that explain the green manufacturing innovations among the Automotive and Earthmoving sector and proposing a framework based on these factors.
28. Considering the factors identified, the green Innovations framework has been proposed using three stages – Green Commitment, Green Systems and Green culture and excellence.
29. Green commitment: In this stage, importance is given to creation of awareness of advantages of green manufacturing and seeking commitment of stakeholders towards creation of green manufacturing policy.
30. Green Systems and Practices: This stage involved establishment of Practices, tools and techniques for green manufacturing. A well-defined system that focuses on green manufacturing system will have measurement system (KPIs), tools and techniques, standards and reporting mechanism.
31. Green Culture and Excellence: Green culture emphasizes on green practices as a part of organisational culture. Green excellence is a journey towards becoming best in class and guide to others towards a sustainable business enterprise both economically and ecologically.
32. In order to implement the green innovations framework, the proposed roadmap was discussed with manufacturing units and has the following stages of journey: Green Commitment, Green Practices, Green systems, Green culture and Green Innovation.

33. Our University – M S Ramaiah University of Applied Sciences actively supports research and has established various research centres. Among them is Innovation and entrepreneurship research centre. Under this centre, we propose to establish a centre for excellence in Green Innovations.
34. The aim of the proposed Centre is to provide a strategic inputs to conduct and disseminate research in Green manufacturing and Green Business. It is expected that the proposed research centre will create a viable platform to showcase M S Ramaiah Group’s research contribution towards its Mission of becoming an entity of International Stature and Global Relevance.
35. This centre will bring all stakeholders across all categories of green innovation maturity to participate in knowledge sharing workshops and will involve in dissemination of research. It plans to bring in global experts from industry and academia, to share the platform with Indian experts and novices in Green manufacturing and services and foster green innovation and sharing of green manufacturing ideas in the process.
36. Policy recommendations have been arrived at: to identify the companies that are willing to participate on cooperative platforms for knowledge sharing. Based on green manufacturing framework developed, a phase wise road map can be developed for such companies that are willing to embark on journey of green innovations with support coming from various stakeholders like leading companies in green manufacturing, green manufacturing experts and researchers, industry bodies and the Government. Our University will be able to host a research centre to facilitate the same