

Can lean lead to green? Assessment of radial tyre manufacturing processes using system dynamics modelling



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ABSTRACT

Even though tyre sector within rubber industry has been recognised to be the major contributor towards environmental pollution, hardly any study has been done to assess the processes involved and its associated wastes to reduce the detrimental impact on the environment. In addition, with the challenges and competitions existing in Indian manufacturing system, domestic tyre manufacturers are struggling for their competitive sustenance. This situation is particularly severe in the radial tyre manufacturing unit, which involves very complex manufacturing process, thereby increasing the volume of wasteful activities. Therefore, tyre manufacturing units are struggling for both their economic and environmental sustainability. Using the well accepted lean manufacturing principles, this paper investigates the processes and the associated wastes of radial tyre manufacturing. The paper presents a novel approach for assessing the wastes using a system dynamics model and validates the model in a radial tyre manufacturing case organisation in India. Scenario analysis by varying the level of employee skills, manpower availability, and machine availability is conducted. The model in addition to showing the overall performance of the radial tyre manufacturing unit assessed, throws light on the amount of greenness attainable by the organisation through the implementation of lean thinking. Wastes which had a substantial impact and subordinate impact on improving the lean and green performance are identified. The study is unique in studying the highly polluting sector which has received the least attention in both OM researcher's and practitioner's literature. The study is also novel in adopting system dynamics modelling to answer the research questions raised and provide implications for theory and practice.

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1. Introduction

Ministry of Environment, Forest and Climate Change, Government of India launched the Charter on “Corporate Responsibility for Environmental Protection (CREP)” to set targets and develop action points for pollution control of various categories of highly polluting industries including the rubber product manufacturing industry (CREP, 2003). The rubber product manufacturing industry in India is basically divided into two major sectors, namely the tyre and non-tyre sector. The tyre sector produces all types of automotive and non-automotive tyres and has been a key supplier to

the automobile industry. Non-tyre sector produces high technology and sophisticated products and comprises the medium scale, small scale and tiny units. In terms of production of natural rubber during the year 2012, India stood fourth among all countries accounting for meeting 9% of the global demand during the year (Indian Rubber Statistics, 2013). Fig. 1 plots the production of natural rubber in major consuming countries across the world. Fig. 2 plots the consumption of rubber in the auto-tyre sector and other general rubber goods sector in India during 2011–12 and 2012–13. In 2012–2013, India is the second largest consumer of natural rubber after China (Indian Rubber Statistics, 2013). From Fig. 2, it is clear that more than two-third of total rubber consumption in India is by the auto-tyre sector. In this study, we test the applicability of lean manufacturing principles in this highly prominent auto-tyre sector and study how lean principles can improve the greenness level of the tyre manufacturing firm. In the subsequent

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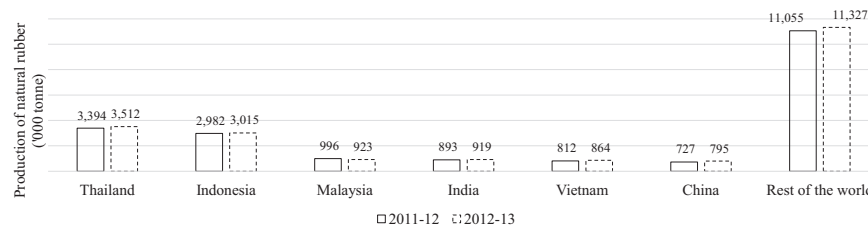


Fig. 1. Production of natural rubber in major consuming countries across the world during 2011–12 and 2012–13.

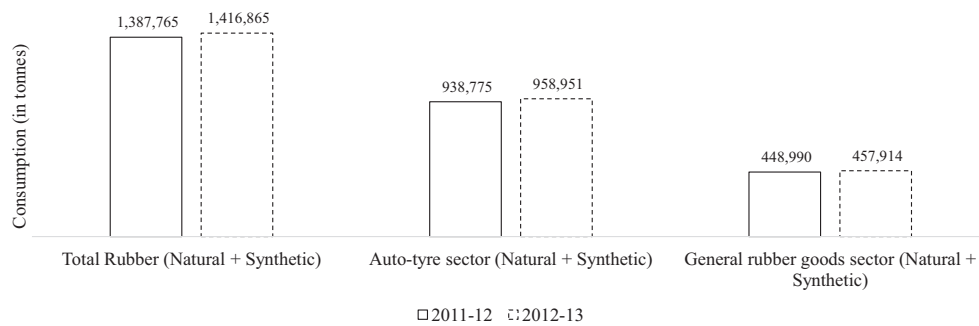


Fig. 2. Consumption of rubber in India during 2011–12 and 2012–13.

sub-sections, we discuss the need for lean and green in the Indian auto-tyre industry.

1.1. Economic status of Indian auto-tyre industry – need for lean

Automotive industry which includes the manufacturers of automotive component items like tyres is one of the leading contributors' to GDP of a nation and also to the global economy. India accounts for over 5% of the global automobile production (OICA Production Statistics, 2012). Turnover of the Indian auto component sector stood at USD 40.6 billion in FY2012–13 and the industry is expected to reach USD 115 billion by FY2020–21 (IBEF, 2014). Strong growth in demand for automotive products in India is observed due to rising income of middle class and young population. According to IBEF (2014), automobile sector in India was expected to attain a market size of \$145 billion in 2016. One of the primary reason behind this growth is that India has significant cost advantages i.e. auto firms save 10–25 per cent on operations vis-à-vis Europe and Latin America. As a result, auto-tyre manufacturers have seen a significant surge in their demand and increased competition for their products. Perceived strong demand from both automobile manufacturers (OEM) and replacement market which includes secondary sales channel such as tyre wholesalers and retailers was expected to rise the total tyre production capacity by more than 47% in 2012–13 (ICRA, 2011).

Globalisation has changed the business paradigm all over the world. Ever since deregulating its economy in 1990, Indian automotive industry has made steady progress because of the low cost of manufacturing and high demand in local market. However, the concept of attaining competitiveness on the basis of low-cost skilled labour, favourable exchange rates, low-interest rates and concessional duty structure is now becoming inadequate because of very high level of non-value adding activities in its value chain. Indian tyre manufacturers are struggling for their sustenance because of major challenges like cost competi-

tiveness due to increasing overhead expenses and raw material prices, increasing domestic rivalry amongst the tyre manufacturers, high suppliers and customers bargaining power, availability of low price imported tyres and backward integration by automobile manufacturers. Therefore, there is a great need for developing a favourable environment for the production of high-quality goods at minimal cost to ensure competitiveness on a long-term basis. This involves elimination of non-value adding activities and identification of major areas for continuous improvement where quality concerns with cost competitiveness are more important. This manufacturing philosophy is in line with lean manufacturing paradigm. Therefore, it is logical to claim that assessment of wastes and its elimination through lean manufacturing principles will assist tyre manufacturing firms to become more efficient and competitive.

1.2. Environmental status of Indian auto-tyre industry – need for green

Central Pollution Control Board (CPCB) of India developed minimum national standards for rubber product industries with regards to their effluent discharge (water pollutants), emissions (air pollutants), noise levels and solid waste (refer to Appendix I for the standards developed). The KPMG's (2012) global survey indicates that the global automotive industry, including the auto-tyre sector, of late, is concerned with environment related issues of how to increase efficiency and reduce pollution across its supply chain. Field investigations, process studies, sampling, and monitoring rubber product manufacturing industries have identified air pollutants associated with different processes (refer to Appendix II for a complete list of rubber manufacturing process pollution outputs). Fig. 3 documents more specifically the pollution outputs associated with different tyre manufacturing processes. Volatile organic compounds (VOC) and Hazardous Air Pollutants (HAP) emissions that result from use of solvents in cementing and spraying operations and scrap tyre disposal are the key pollution outputs from the tyre manufacturing process.

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