

Material and Resource Efficiency within Manufacturing Industry: A study of strategic differences in material efficiency strategies based on size of enterprises and their location.

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Popular Summary

Global production has been on the rise due to rapid industrialisation and growing population throughout the world. This leads to the rise in consumption of natural material resources to meet the demand of the materialistic world. Metal is one such naturally occurring resource whose accessibility has increased over time and industries today do not greatly consider the rate at which known, naturally occurring metal reservoirs are depleting. To tackle and spread awareness of the issues regarding the unsustainable natural resource consumption the UN released a set of sustainable development goals (SDGs) amongst which SDG 12 sets targets for industries to ensure sustainable resource consumption. Large (L), Medium (M), Small (S) and Micro (XS) sized manufacturing enterprises are equally accountable due to the impact each of them have on the material consumed and waste generated. Similarly, industries in developed countries need to comply with several strict environmental policies sworn in to making the production system more sustainable unlike the developed countries where monetary profits and economic development leads to more lenient policies and approach to monitoring the compliance of the industry. Hence, looking into the possibility of the location of the country having an impact on the degree of sustainable practices used within the industry is one of the intentions of this thesis. Similarly, assessing the current state of material efficiency strategies in each of these enterprise types is key to provide future solutions based on the current level of application of material efficiency strategies.

Based on this, the following research questions were formulated which looked into (i) the current industrial practices to reduce raw material consumption and increase raw material value retention (ii) raw material consumption and in-process material behaviour tracking methods used in industries (iii) impact of the size of the industry on the material efficiency practices (iv) driving factors to implement material efficiency strategies (v) barriers to implementing material efficiency strategies (vi) role of the status of developing or developed country in an industries push towards efficient use of material resource.

In this thesis, the material efficiency strategy used within the industry and the research questions are assessed using parameters such as Key Performance Indicators (KPIs) for raw material consumption used in the industry, in-process data collection techniques used in industries, waste reduction tools used and recycling practices within the industry, drivers, barriers faced by industries to implement material efficiency strategies found through the literature search. Due to these parameters being indicators of quality, the best way to analyse these parameters was through a qualitative and a descriptive analysis. The data on the current industrial practices was collected through the online survey based on the research parameters mentioned above. The responses were then analysed by grouping them based on the type of industry and the raw material used to provide a microscopic understanding of the practices. Based on the type of primary raw material used the responses were divided into “core metal fabricating industries” (industries which used metal as a primary raw material) and “chemical

industries with machining workshops” (industries which primarily used chemicals as raw materials but had machining workshops which mimicked small or micro manufacturing industries). Through the literature search, key strategies such as zero waste, circular economy, and net-positive philosophies to reduce overall material consumption throughout the different stages of material product life cycle were discussed.

The survey had 19 participants with a response rate of 29.231%. Out of the 19 participants, 16 of them were L, 2 were XS and 1 was M. After analysing their responses to 27 questions which were divided between 3 sections, i.e., section 1 enquired upon the information on the participating industry (No. of employees, No. of production locations, raw materials, and raw material shape form), section 2 based on the research parameters, section 3 enquired the drivers, barriers and advantages experienced by the industries upon implementing material efficiency strategies. Upon analysing the responses, the research questions were answered as below:

Application of both waste prevention and waste management activities in manufacturing industries is an encouraging sign to reduce raw material consumption and retain its value. KPIs have been historically used to track the system performance and similar trend is seen even to this date. The use of KPIs to track environmental performance of the material is neglected and could be improved upon, however, input and scrap quantity generated were regularly tracked. The KPI of actual to planned scrap ratio was minimal and increasing its use can assist industries in fine-tuning their processes to minimize waste. Manual data collection and PLC is still heavily relied upon in industries despite the errors associated with it, however, the use of modern sensor-based data collection techniques coupled with Industrial Internet of things (IIOT) is still at its early stages. A highly effective waste minimization tool i.e., Value Stream Mapping was rarely used whereas 5S and Root Cause Analysis were often used.

Large Manufacturing Industries have a greater responsibility to mindfully consume raw materials, and according to the survey they do take greater accountability in consuming raw materials when compared to Medium and Micro enterprises. However, there are large variations amongst the large manufacturing industries based on the use of KPIs, in-process data collection techniques and waste reduction tools used opens a scope of uniformity to increase their potential in mindful raw material consumption. The Micro enterprises need to use higher number of KPIs and in-process data collection techniques.

Implementing material efficiency actions and strategies was mainly driven by the rising raw material costs, therefore one can say that industries use material efficiency as a cost reduction tool and not as an environmental enhancement tool. Similarly, the common industrial perception of high investment costs and slow return on investments hindered its application.

The possibility of developed countries implementing material efficiency strategies effectively is better when compared to developing nations as the Swedish industries that took part in this study on an average used higher number of KPIs, data collection techniques, waste reduction tools when compared to Indian industries. However, this part of the survey requires further research as the difference in the sample sizes between Indian responding industries and Swedish responding industries is very large.