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5.3 Drivers and barriers to implement sustainable manufacturing concepts in Sri Lankan manufacturing sector

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Abstract
Sri Lanka promotes manufacturing sector without much concern on environmental and social problems as one of the driving forces for the economic prosperity. This has aggravated number of issues and this has lead to adapting of some sustainability related initiatives in local manufacturing sector. However, majority of them function independently with fix boundaries. Conversely, there are some hindrances to implement the sustainable manufacturing concepts as a one comprehensive solution. This research intends to investigate the motivators and barriers to adapt sustainable manufacturing concept to overcome current issues faced by the manufacturing industry. An evaluation criterion was developed based on some of the popularly used guidelines and sustainability options available in number of sub domains. Results highlights the main motivators plus common and cluster specific barriers to implement sustainable manufacturing in local industry. These outcomes can be easily considered for the policy development purposes in developing countries in future.
Keywords:
Drivers and barriers for Sustainable Manufacturing, Policy making, awareness of sustainability, manufacturing plant sustainability, triple bottom line in sustainability

1 INTRODUCTION

With the opening up of its economy in the early 1980's, Sri Lanka as a country has been striving to develop its manufacturing industry as one of the main foreign income earners and to provide employment for the locals. In order to facilitate this policy, successive governments have even developed separate industrial and export processing zones, with most of the infrastructure facilities needed for the manufacturing sector. Although successive governments facilitated to develop manufacturing sector over the years, they could keep apply stringent measures to minimize environmental and social impacts, which are common problems associated with the development and expansion of the industry. Environmental pollution, industrial waste management, and exploitation of workers and health and safety of workers are some of the emergent problems. Since policy makers prime objective is to provide employment for locals and to promote foreign direct investments for establishment of industries, they often do not pay due concern to environmental and social problems which arise as a consequence of these initiatives.

Conversely, due to the lack of awareness of the community there is not much resistance or protest towards poor management of these industries or even to pressurize policy makers to adapt stringent measures to scrutinize the sustainability issues of the manufacturing sector. However, few manufacturing industries have adapted certain sustainability options within their organizations, with the awareness they receive from foreign business partners or due to the market pressure from environmentally conscious customers of foreign countries. Further, there are several promotions initiated again from foreign donor agencies, which motivate certain industries to align their practices towards Sustainable Manufacturing (SM) directions. These initiatives are becoming famous among the industrialists due to the recognitions they can gain in the form of annual awards (NCPC awards [1], Geo Cycle awards [2] etc.) The same strategy is currently being adopted by government authorities as well, with the aid of foreign funding to give some recognition annually in the form of green reporting initiatives (Green awards CEA [3]). However, both of these initiatives are limited to the environmental domain of sustainability as their mode of evaluation and do not consider specially the social aspects into account. Further, these schemes only look at the problems surfacing and do not go into the manufacturing processes when they evaluate organizations for these awards. When considering about sustainable manufacturing options (SMO), it is very rare to find any ministry or authority related to industries having a separate and dedicated unit to promote these concepts. There is also no evidence that relevant government authorities are aware of the concept "Sustainable Manufacturing". In addition, most of the local tertiary education programs do not have separate subjects such as Sustainable Manufacturing. However, certain industries have been changing their processes towards green energy options mainly due to the economic benefits than social and environmental benefits. Even government has taken steps to establish a separate unit (Sri Lanka Sustainable Energy Authority [5]) to popularize renewable energy among the industrialist in the recent past.

Although there are a few published researches in some of the sub-domains of sustainable manufacturing in the recent past [6, 7, 8 and 9] it is very rare to find any research in the direction of SM. Further, there is no research or any government or privately involved project to investigate the pros and cons or motivating and de-motivating factors to move in the direction of sustainable manufacturing. This

research is carried out In order to fill this gap and thereby to develop a generic model to evaluate plant SMO, and it can be used to bring in potential SMO's to surface in addition to filling the present vacuum available within the country. Further this study will be useful when developing future policies not only for the Sri Lankan context but for most developing countries as well. The rest of the paper is arranged as follows; Section 2, explains the methodology used in this research, followed by the case study and the results in Section 3. Discussion on the outcomes of the research is presented in Section 4 while conclusion is given in the Section 5.

2 METHODOLOGY

The main obstacle to identify motivational and de-motivating factors towards implementing sustainable manufacturing practices in the local industry arises in a situation of how to recognize potential options depend on the nature of the industry. There are significant deviations available from different manufacturing sectors with respect to one SM option. Therefore, it is very important to first identify all possible SM options irrespective of the sector considered, and later to develop a generic model consisting of all the SM options. In turn, this type of model will assist to identify reasons behind implementing or not implementing SM options if we go by the SM options available in the generic model for manufacturing plant sustainable Manufacturing options (SMO). Therefore, initially, a generic model was developed to specify all possible SMO's that is applicable for any manufacturing plant. It is somewhat difficult to find generic models specifically developed to evaluate SMO's applicable to manufacturing plants in the literature. However, there are a number of studies done with respect to the sustainability options at the product design stage [10, 11]. Their main focus was to define a product sustainability index by considering sustainability options in three different bottom lines of sustainability; economics, social and environmental aspects. However, when local manufacturing industry is concerned, most organizations do not have their own systematic product design and development process, and some are dependent on the designs given from foreign business partners. Therefore, even though the model proposed in [10] is comprehensive, we cannot use it straightaway for our own evaluation of plants. Hence, the plant specific SM generic model was developed aligning with the triple bottom lines to identify sustainability options in environmental, social and economical aspects. The plant related factors were categorized based on the total life cycle of the product. This includes, supply chain related aspects, product focus issues, built environment of the plant and manufacturing process related aspects.

The motivational factors for implementing SMO's and barriers to implement SMO's were identified by tracing against the generic model with existing plant manufacturing practices. The main motivators and barriers for implementation of SMO's were identified first, and later, appropriate course/reason behind it was done against each relevant SMO of the respective plant. Manufacturing plants selected for evaluation included diverse manufacturing sectors with different scales of economies, ownership, product and market category etc.

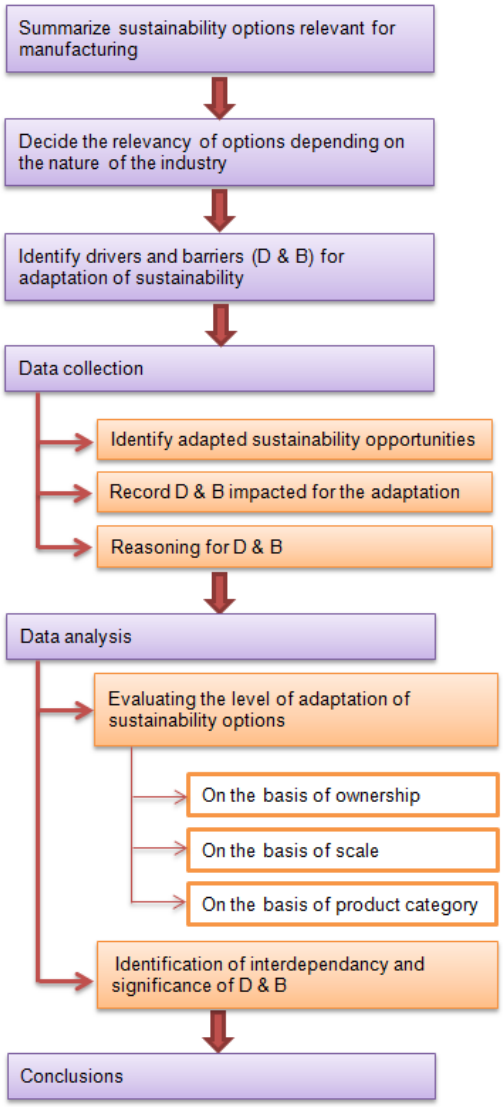


Figure 1: Methodology.

The information was gathered with consultation of Manufacturing or Plant engineers who are qualified graduates in Engineering (Production or Mechanical & Manufacturing specializations) to maintain the homogeneity of the awareness of SMO's and to get expertise feedback from the industries towards this research. The overall frequency of occurrences of different type of motivating factors and de-motivating barriers were counted against each SMO. Based on the analysis of the gathered information, cyclic reasoning models behind all motivating and de-motivating factors were developed for future policymaking purposes towards end of the research. The schematic model of the different phases of the research is given in Figure 1 and the generic SMO model is given in Table 1.

Table 1: Generic model for manufacturing plant sustainability options.

		Industry Focus			
		Supply Chain	Product	Built Environment	Process
Sustainability Focus	Environmental	Raw material extraction method	Eco design	Rain water harvesting	Substitution with green energy
		Supplier compliance towards green material	LCA analysis	Blue, green water saving	Water efficiency
		Transportation related emissions	Green reporting schemes	Substitution with green energy	Resource efficiency
		Inventory/storage reduction		HVAC optimization	Adaptation of technologies free of hazardous waste
		Chemical leasing		Energy saving options	Responsible production
		Elimination of unwanted packaging			Eco indicators and sustainable aspect calculations
		packing material			Environmental friendly technology
					Acquiring of standards (ISO 14001 etc.)
					Efficiency in material handling
	Economical	Original shape of raw material	Resource efficiency	Selection of the location	Energy Efficient options
		Transportation/Distribution optimization	Usage of recycle material	Centralized facility location	Positive attitudes for energy saving
		Milk run		Day light harnessing (sky light)	Raw material Conversion factor
				Behaviour (switch on off policy)	Process improvement and innovation
					Process visualization
					Product quality standards (ISO 9001)
					Technology Needs Assessment
	Social	Ergonomics raw material extraction, storage loading and transportation	Design for social needs	Indoor air quality	Health and safety
			Reduce packaging	Ergonomics in workstation design	Welfare of the workforce
		Health and safety in raw material extraction and transportation		Health and safety in work	Ergonomics in Process design

3 CASE STUDY AND RESULTS

A case study was done in order to investigate the current situation of local manufacturing sector in Sri Lanka. Of many manufacturing plants, a sample was selected to carry out the survey by considering the nature of products, market segment, ownership etc. Later, based on the generic SMO guideline shown in Figure 2, each of the selected plant's SMO's were evaluated by interviewing the engineer/s overall plant maintenance and manufacturing operations to check the level of implementation and motivation behind it and vice versa. There were multiple number of reasons behind one SMO in some situations when completing the information gathering. The overall motivational factors and barriers for SMO were analyzed for main and sub issues.

Based on the analysis, level of adaptation of SMO's with respect to previously stated categories are shown in Figure 2. The summarized version of motivational factors and barriers for implementing SMOs of all selected plants are given in Figure 3.

Based on the results and the analysis, it is evident that, when implementing SMOs, majority of manufacturing plants owned by foreigners have adapted about 60 % while the manufacturing plants owned by locals have implemented about 45 % of options available in the generic SMO shown in Table 1. Further, large scale manufacturing plants have implemented SMOs than their medium scale counterparts and respective percentages are 53 % and 42% respectively. When the nature of manufacturing plants are concerned, FMCG sector have adapted majority of SMOs when compared to heavy and assembly sector and apparel sector. FMCG has scored 62% while its closest contender, the apparel sector, has scored 54 % and heavy and assembly sector scored only 41%.

When variations of SMO implementation are concerned, it is evident that awareness towards SM plays a pivotal role. Many developed countries or newly industrialized countries are currently very much aware of SM and the advantages of moving towards that direction. Therefore, they have been self motivated to implement some SMOs. Further, it can be seen that majority of large scale manufacturing organizations too are successful in implementing SMO than their counterparts since they have more exposure to foreign markets and may afford to spend money for foreign consultancy etc. Conversely, locals own most of the medium scale manufacturing organizations and mostly with single ownership category. Majority of them have been developed over the years to cater to the local market and level of awareness of the modern manufacturing related concepts are less.

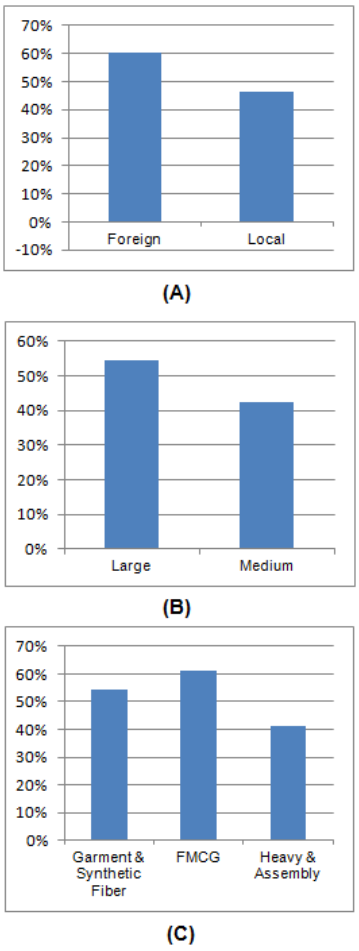
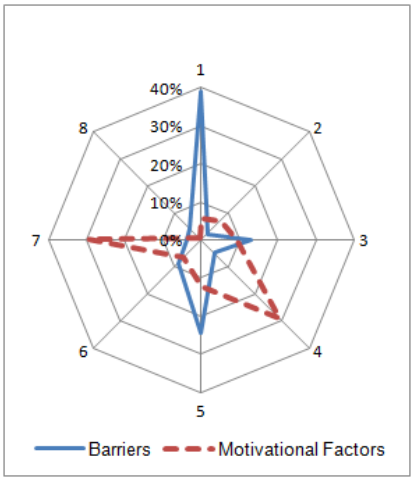


Figure 2: Cluster-wise (A-Ownership, B-Scale, C-Manufacturing sector) SMO adaptation in Sri Lankan manufacturing sector.



Main categories of Barriers

1. Lack of awareness sustainability concepts
2. No tax benefit or other rewards from government
3. Lack of awareness programs conducted in locally
4. Lack of awareness of local customers in green products
5. Negative attitudes towards sustainability concepts
6. Less support from the employees
7. Lack of funds for green projects
8. Difficulty for operation and maintenance

Motivational Factors

1. Pressure from market
2. Potential to use as a marketing tool
3. Government promotions and regulations
4. Awareness of the top management
5. Limitations in existing process improvement techniques
6. Success stories of SM in other organizations
7. Economical benefits
8. Availability of funds for green projects

Figure 3: Percentage representation of motivational factors and barriers for implementing SMOs

The main reason behind FMCG's success in adapting SMOs is partially due to the stringent regulations they are subjected to. In addition, a fair share of these companies includes multinational companies. With all these findings, it can be easy to justify the variations shown in the spider diagrams shown in Figure 3; since there are number of loosely coupled relationships that can be seen with respect to the clustering based analysis.

Based on the spider diagrams, the main barrier for SMO implementations is lack of awareness about SMOs or how to recognize those options. This issue accounts for nearly 40% of the cases. This can be even evident from the cluster/category wise comparison done previously as well. The next frequent barrier encountered in the research is the negative attitudes towards SMOs. This issue again inter-links with previous statements. Very lower percentage was due to lack of tax benefits, lack of awareness of local customers on green products and difficulty to operate and maintenance. However, the second largest barrier for SMO implementation is due to the negative attitudes towards sustainability.

When considering the drivers behind SMO adaptation, 40% each were scored by two factors; awareness and commitments of top management and for economical benefits. The least percentages were scored for availability of funds for green projects, success stories on SMOs, government regulations etc. None of the plants highlighted that lack of funding for green initiatives. However, it is difficult to find any strong relationship between barriers and motivational factors shown in Figure 3. Therefore, it can be seen that one motivational factor or barrier leads to one or more factors in this study. Hence, these variations can be shown with a loosely connected relationship chart which is given in Figure 4.

From the spider diagram shown in Figure 3, it is very clear that one barrier leads to many subsequent barriers. For example, lack of awareness on SMOs leads to four other issues and it is dependent on lack of knowledge on building awareness within society. Further, since there are no stringent policies to motivate manufacturers to adopt SMOs, they are not willing to implement SMOs. Due to that, it is difficult to see any success stories, which are available locally, and due to lack of awareness about these concepts within policy making level, even financial sector does not provide any loan schemes etc. to implement such options.

4 DISCUSSION

It is event from the above studies that there are inter dependent issues to both motivate and de-motivate the implementation of SMOs in local manufacturing sector. In order to overcome the barriers currently available in local manufacturing sector, a generic model can be designed based on the findings of previously explained analysis. The foundation of the model should be the awareness on SMOs, which is a must even for governmental officials, policy makers etc. so that they will find it easy to communicate. Once the foundation is laid, an action group should be formulated. This group should consist of academics and researchers who act as bridges to transfer knowledge from research and academic domains to industries. This group should include high-ranking

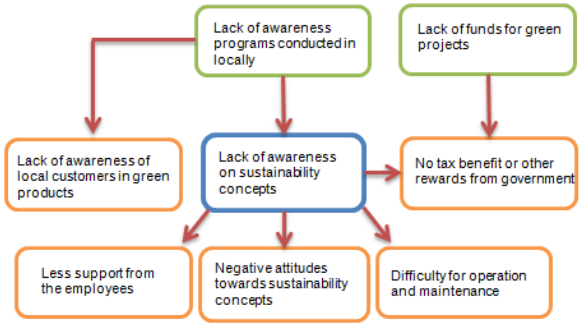


Figure 4: Interdependency of barriers for SMO implementation

governmental officials from different ministries such as ministry of industries, economic development, environment, power and energy, labour etc. When there is a new project to set up a manufacturing plant, it is necessary to make it mandatory to get necessary approval from above committee,

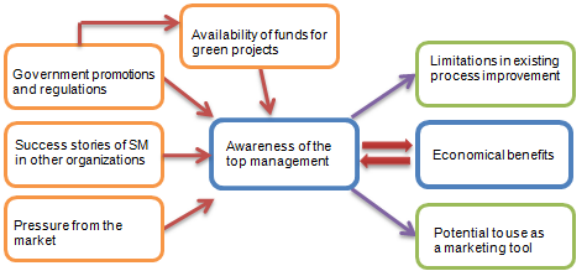


Figure 5: Interdependency of motivational factors for SMO implementation

which will look in to the implementation of SMO and thereby advise investors to adhere to their guidelines. Further, there should be a close relationship between the steering committee and financial organizations of the country, so that necessary funding can be facilitated for SMO implementations after viability of the project is studied. In addition to the interference with new manufacturing plant commissioning, this steering committee can even extend their involvement to assist existing manufacturing plants to convert their practices in line with SM. This can be assisted if the local universities are empowered with necessary human resources, especially facilitating adequate training facilities to the current academics. It is not adequate to provide assistance to implement SMOs, but a frequent monitoring mechanism is also necessary even after implementation of SMOs. In order to motivate those who practice SMOs in their plants, this committee can come up with an awards scheme based on in-depth study of the SMO already been adapted and key organizations successes can be shared in openly accessible domains so that they can be referred to as success stories. For their own development, the SM steering committee should have links with other global networks to share their experiences and development in this discipline and it is essential to organize awareness programs starting from secondary school levels to CEOs of manufacturing companies. Further, local universities can be provided funding to carry out research to develop this concept locally and to come up with customized approaches to match with local settings, especially social and cultural aspects as well.

5 CONCLUSION

This research benefitted to the knowledge from diverse directions. The generic model developed for plant level SMO, can be used to evaluate any manufacturing plants' sustainability options. In addition, this can be used to recognize indirectly the motivational and barriers with respect to SMO. The reasons behind motivational and barriers can be used to recognize where and how to address the core issue behind sustainable implementation and to make society aware of these issues. Therefore, the outcome at this research can be used to develop a policy on SM for Sri Lanka. However, based on the interdependency of different motivational and barriers for implementing SMOs, some inputs can be useful for other developing countries who want to drive their manufacturing sector in the SM direction.

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