Benchmarking sustainability practices in Indian Small and Medium Enterprises(SMEs): A Data Envelopment Analysis based framework

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Abstract

Small and Medium Enterprises(SMEs) face issues in supply chain sustainability. Sustainable supply chain Performance measurement is necessary to assess the efficiency of SMEs. Although there are studies on larger organizations, studies on Indian SMEs' sustainability of supply chain are scant. The purpose of this paper is to assess and improve the sustainability of Supply Chain of Indian SMEs. The proposed framework can be used for assessing and improving supply chain sustainability for group of SMEs and also individual SME. The proposed framework has been validated by Indian case studies. The managers of individual SMEs can get suggestions on their improvement measures.

Keywords Small and Medium Enterprises, sustainable supply chain, Data Envelopment Analysis

Introduction

Small and medium sized enterprises (SMEs) make up around 90% of the world's businesses (Head, ISO) and they employ 50-60% of the world's population (Organisation for Economic Cooperation and Development Staff, 2000). The total number of SMEs in the UK is 5.4 million, and they employ approximately 15.6 million people (almost one fourth of population) (PARP, 2014). Similarly, Indian SMEs in the manufacturing sector contribute significantly to GDP. Indian manufacturing SMEs contribute to 45% of India's manufacturing output and 17% of India's GDP. It gives employment to approx. 40% of India's workforce (Dubal, 2016).

While it is widely accepted that SMEs play a significant role in the economic development of any country, they also exert considerable pressure on the environment collectively (Speier, Mollenkopf, & Stank, 2008). It is estimated that SMEs contribute up to 70 percent of global pollution collectively (Hillary 2000). SMEs contribute significantly to environmental damage and GHG emissions (Whitehead, 2013).

Achieving sustainability all through the products / services life cycle is the major concern of any business. Sustainability could be achieved through most appropriate trade-off among economical, environment and social pillars (Tajbakhsh & Hassini, 2015). SMEs businesses are challenging from both demand and supply sides. In the demand side in one hand original equipment manufacturers are very demanding and competitive. In the supply side, adoption of new technology, retaining manpower, adhering to various regulations and managing procurement are challenging. Therefore, SMEs tend to be more economical focused without showing much concern on environmental and social aspects for survival unless environmental and social measures provide higher cost saving. SMEs supply chain sustainability is driven by external pressure like stakeholders, customers' needs and legislation. Hence sustainability needs to be considered across SMEs entire supply chain.

The Supply chain sustainability performance needs to be measured for assessing the competitive advantage of the SMEs (Qorri, Mujkić et al. 2018). The available supply chain sustainability performance measurement approaches fail to integrate all the Supply Chain members (Ahi and Searcy 2015). The available focus in recent publication has shifted from individual competition to competing against each other supply chains (Qorri, Mujkić et al. 2018). Additionally the studies on sustainable supply chain performance measurement are for larger organizations. However, SMEs exhibit different characteristics that differentiate their performance measurement from larger organizations. Thus, there is a need to establish relevance of the existing model with that of SMEs to measure the Sustainable SMEs Supply Chain performance. Moreover, studies on SMEs supply chain sustainability performance measurement is scant. This study tries to bridge the gap by suggesting a holistic measurement framework for Indian SMEs Sustainable Supply Chain. The proposed framework intends to improve the sustainable supply chain performance both collectively and individually.

The aim of this research is to make Indian SMEs' supply chain sustainable through developing a supply chain sustainability performance measurement framework. It will enable SMEs to assess the performance and suggest improvement measures. The rest of the paper is organised as follows. In the study we critically analyse contemporary models for measuring sustainable supply chain performance and identify knowledge gaps. We state the methodology of this research. After that we demonstrate the data collection, analysis, and results, which include the proposed performance measurement model. The study concludes with discussion and future scope of work.

Literature Review
Indian SMEs employ approximately 40% of India's workforce and contributing 45% to India's manufacturing output(Economic Times). SMEs face issues in supply chain sustainability. The SMEs are a critical part of the supply chain of the bigger companies (Seuring, Sarkis, Müller, & Rao, 2008). A bigger organisation transfers the pressure of sustainability on to its suppliers who are majorly SMEs, thus sharing both risk and

responsibility (Dey & Cheffi, 2013). The operational and economic aspects of the SMEs are the essential targets to produce goods and to gain revenue. However environmental and social performance, as well as their economic efficiency tend to conflict in their nature of contribution of sustainability (Tajbakhsh & Hassini, 2015).

It is believed that the environmental damage caused by SMEs will grow unless innovative strategies are devised. There are a number of barriers that prevent SMEs from achieving such innovative strategies and these include: a lack of information on the cost-benefits of improving environmental performance, weak external pressure / incentives, lack of internal capacity (e.g. financial resources, human resources, technologies, business processes and R&D activities), weak supporting frameworks and in many cases political indulgence by policy makers (Zhu & Sarkis, 2004; Dey & Cheffi, 2013).

There are many analytical models and the indices present to measure performance of sustainable supply chain of the organization (Tajbakhsh & Hassini, 2015). Generally critical Indicators are designed to measure the supply chain performance of the organization. The traditional method of measuring the supply chain efficiency is "spider", "radar" or "z" chart (Wong,2007). The technique is graphical based so it leads to an inconvenience in cases of multiple input and output. Another method is formulation of ratios but it is difficult to capture all the set of ratios into one judgement (Shen,2013). Supply chain characteristics requires a multi factor performance measurement model. Multi criteria decision making (MCDM) approach has been used for evaluating the performance of the supply chain but the method neither be used for assessing and improving the sample set of organisation. Balanced Score Card and SCORE model has been used to measure the efficiency of the supply chain (Brewer,2000). All the above methods have not being looked into with regard of practices and performances of the organisation. These approach have a shortcoming of not bringing in together all aspects of sustainability, strategy, and stakeholders (Qorri, Mujkić et al. 2018).

Multi-objective programs have been developed with focus on economic impact considered as single objective, with others parameters like environmental, and social impacts jointly as multi objective function (Oliveira et al. 2014; Radulescu et al. 2014). Few mathematical model has been developed to study the combined effect of social and environment aspects have been modelled by the mixed-integer linear program (Chaabane et al., 2012). The existing models consider specific cases in the model formulation however the collective consideration performance measurement of the SMEs supply chain sustainability is lacking. While the existing model provide different perspectives to the research in supply chain sustainability, none of them provides an integrative, comprehensive approach of economic, social, environment and operational aspects in practices and performances. Above models also need accurate data for each measurement. SMEs do not have all data reported. Again accurate data cannot be always made available as all the Supply chain members cannot be measured. (Shepherd & Günter, 2010). Qorri, Mujkić et al. (2018) compares all the methods and techniques used in sustainable supply chain performance measurement.

Data Envelopment Analysis (DEA), has been used to assess sustainable supply chains performance (Cooper, Seiford, & Zhu, 2011). In DEA the input output model is to be designed such that the ratio of weights does not ask for the exact weight of each criteria. Taticchi et al. (2015) developed the performance measurement for the sustainable supply chain for the big companies and decision tools was designed. DEA has been used to

measure the sustainability of the supply chain networks for big companies (Tajbakhsh & Hassini, 2015). Very less has been discussed on the sustainable supply chain performance measurement of the SMEs. The SMEs supply chain performance is to be appropriately measured and based upon their business practices the appropriate solution is to be suggested. Thus there is a need for development of a framework for SMEs performance measurement sustainable supply chain (Qorri, Mujkić et al. 2018). Additionally it is required to measure the performance of the sustainable supply chain of the organization and to find a framework integrating strategic and a generic, holistic approach which will incorporate all the aspects of sustainability for SMEs supply chain.

The supply chain characteristics of SMEs vary from that of the large organisations. Large organisation supply chain performance measures are decided by perfect delivery, order fill rate, inventory turnover etc. while that of SMEs are more focused on the internal failures, inventory costs, customer services, productivity etc. (Thakkar,2007). SMEs supply chain face frequent changes in their order and has comparative shorter lead time. SMEs have more flexibility in their process which poses as their advantage over the large organisation. As the supply chain characteristics are different for SMEs, the conventional large organisation supply chain performance measurement model cannot be used for SMEs supply chain performance measurement.

As a result of the literature review it was identified that there is a lack of literature on SMEs to assess the performance evaluation of the supply chain sustainability of the organisation. There is a research gap on the need to measure the efficiency of Indian SMEs on considering social and environmental practices. The paper tries to propose an innovative sustainable supply chain performance measurement framework to assess the supply chain performance and provide improvement to the SMEs.

The research question is i)how to assess the performance of the SMEs and study their performances on adoption of environmental and social aspects of the practices ii) how to measure the sustainable supply chain performance and how to segregate the efficient and inefficient SMEs to propose appropriate improvement and solutions. The SMEs performance on the adoption of environment and social practices is to be studied. The main aim of the paper is to assess the efficiency of the SMEs and provide them appropriate solutions.

 Methodology:
 Thirty five specific case studies have been conducted on the SMEs based in the Eastern part of India and the nature of products manufactured by the company. The data was collected by interviews, case study and by historical records. The case study was made by visiting companies, and getting the data filled up by the interview considering the adequate sample size (2-4 managers in top management) of respondents. The data was processed into the excel sheet. The qualitative data was collected on the Likert scale and converted in the range of 1-10 to arrange in the form of input and output for the DEA assessment model. The data sheet was used to run the sustainable supply chain performance model. Data Envelopment Analysis (DEA) was used to benchmark the company's performance and to identify the efficient and inefficient SMEs. The data was analysed by DEA Modelling software DEA Excel Solver. The companies efficiency were studied by the score values. The efficient and inefficient SMEs were identified. The sensitivity analysis was done on the collected data to study the variation in efficiency when different sets of inputs and output variables are considered. The sensitivity analysis

done is hence helpful for the SMEs to study the variation in their efficiency as the practices and performances vary. The DEA model helped in assessing the efficiency of the SMEs. The efficient SME's focus was for growth of their business. The companies who were identified as the inefficient SMEs were benchmarked with their appropriate peers and given improvements.

The various steps of DEA methodology for Supply chain sustainability used in this paper are discussed below:

Step 1. The CSFs for Supply chain sustainability through extensive literature review and case study has been identified based on the judgment of multiple (2-4 respondents in top management in each SME) experts.

Step 2. The relevant CSFs are considered to develop the DEA based supply chain sustainability performance measurement model.

Selection of variables: DEA efficiency main consideration is of the variables selected for input and output for the efficiency analysis. The sustainability performance as output variable has been considered based upon the Critical Success Factor of SMEs identified during case study. Table 1 represents the constructs taken for the study

SMEs suffer from resource constraint, lack of resources, lack of formalised planning, and difficulty in attracting finance which prevents them from engaging in the innovation process. SMEs characteristics are different than larger organisation because they have different organisational structure. Supply chain sustainability of SMEs is different than that of large organisation. Sustainability Performance of the SMEs can be measured by Economic Performance, social performance, environmental performance and operational performance. The constructs are:

Step 3: Developing interview questions to capture the characteristics discussed in Step 2

Step 4: Formulation of DEA-based supply chain sustainability performance measurement model

The Data Envelopment Analysis (DEA) assessment model was run on the data collected from the case study. The efficiency is compared and benchmarked of the 35 SMEs in Eastern Part of India. The case study was designed to collect the input practices and output performances of the DEA model. The model was run and the efficiency (VRS) of all the company-DMUs was obtained. As the model is run the SMEs efficiency get benchmarked and compared. From DEA Analysis, SMEs who achieve score 1, are efficient and with fractional values less than 1 are inefficient. Figure 1 represents the methodological framework for the sustainable supply chain performance measurement of SMEs.

Step 5 & 6 : Identify & undertaking SMEs for conducting Case Study on SMEs. The proposed DEA model has been applied in 35 Indian manufacturing SMEs in order to demonstrate its efficiency.

Step 7 : Process data to be fed into DEA model: based upon the case study interview, the excel sheet attached in the Appendix A is filed up.

Step 8 : Run the DEA model and derive the supply chain sustainability performance of the participating SMEs. Figure 1 represents the methodological framework for undertaking the study.

Table 1: DEA based Input Output measurement model

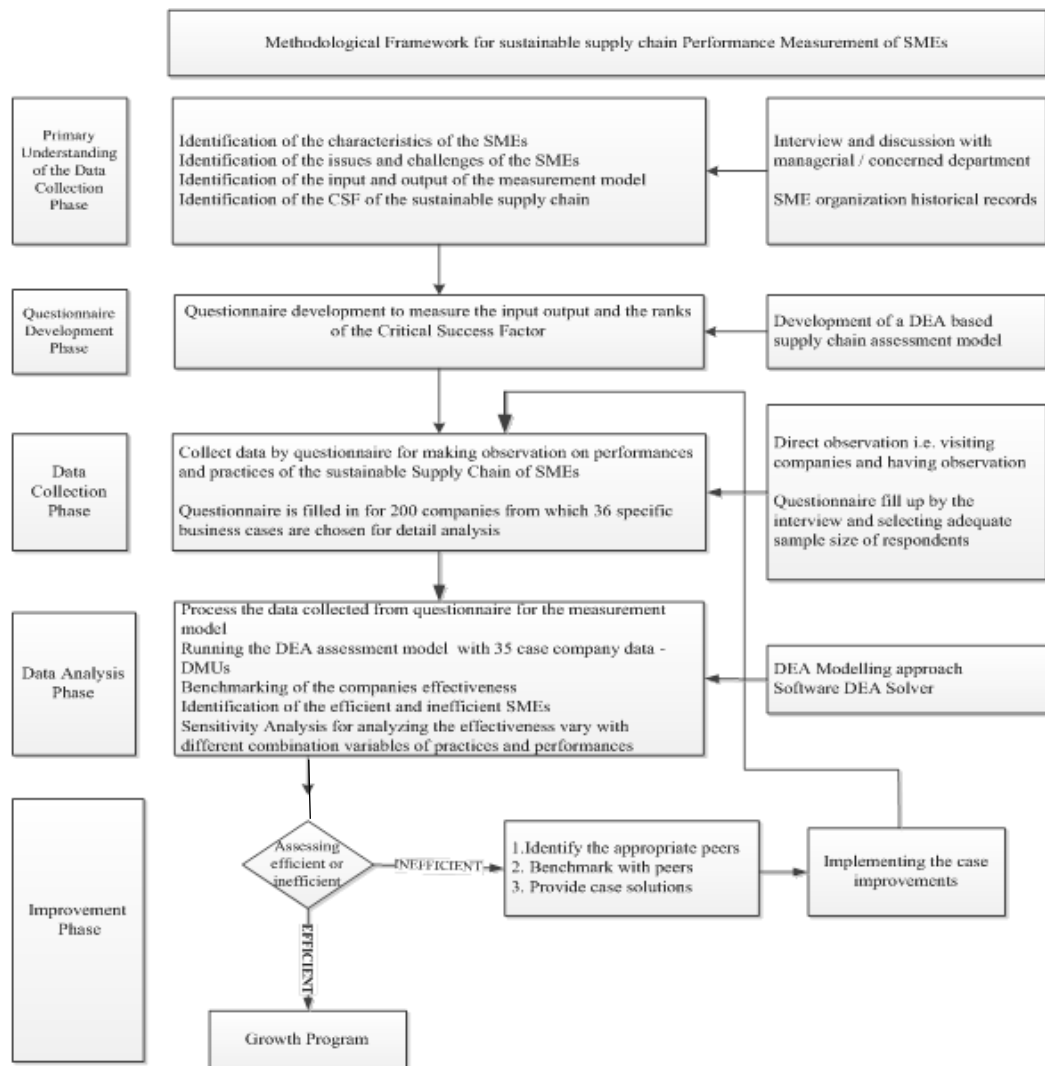| Input (Practices)				Output (Performances)			
Criteria							
Economic	Operation	Environment	Social	Economic	Operation	Environment	Social
Sub- criteria							
Infrastructure Number of Employees	Internal operations management CRM Practices SRM Practices Standardized business process Lean Practices	Environment management Adopting standardized environment system Waste management practices Energy consumption and emission control	Social Management CSR practices Health and Safety Practices	Turnover Business growth	Long term relationship with customers CRM effectiveness Demand uncertainties Long term relationship suppliers SRM effectiveness Supply uncertainties Business process effectiveness Lean effectiveness	Effectiveness of environmental system Waste reduction Reduction energy consumption and emissions	CSR performance Health and safety performance

Figure 1 Methodological framework for the sustainable supply chain performance measurement of SMEs.

Application / Results: Interpretation of the benchmarking results: Application of the proposed model to the Indian SMEs

The proposed DEA model has been applied in 35 Indian SMEs in order to demonstrate its efficiency using the data collected from case study. The response were processed to feed into the DEA model for each input and output criteria. The descriptive statistics of the 35 Indian SMEs on the four input and four output has been performed. The data ranges for economic practices in between 4.5 and 1.5 with average value 3.0 and standard deviation. Median has a value 0.6964. Similarly the other 1.5 indicators of statistics are shown in table 2. The values in the descriptive statistics indicate the overall nature of the practices and performances of the data. Descriptive statistics explains the nature of the data however it fails to benchmark the SMEs efficiency. For benchmarking, identifying inefficient SMEs from efficient SMEs. The same data has been used to run the proposed DEA model.

Discussion

Managerial Implications Figure 2 shows the comparison of the efficiency obtained. Table 2 illustrates for SME 1 as how it allows us to suggest actions for improving performance.

Table 2: The results of SME 2 from analysis

SME	Economic practice	Operation practice	Environment practice	Social practice	Economic performance	Operational performance	Environment performance	Social performance
Origin	6.000	2.650	2.833	3.500	4.500	3.900	6.000	2.650
Difference%	27.924	5.242	5.242	5.242	5.242	5.652	27.924	5.242
Projection	4.382	2.050	2.6845	3.3165	4.500	4.12	4.382	2.050

 Original value against each economic, operational, environmental and social practice and performance in line with case study responses are in row 1. It is easy to understand that we use input based BCC-DEA model so the projection is proportional expansion on four input indicators. The model manipulates the input so that the sustainability output can be optimized and improved in comparison to the considered case organization. Hence BCC-Input orientation model by DEA for benchmarking has been formulated. Therefore, we can see that the inputs are projections in outputs are 4.382,2.51,2.6845,3.3165 for the economic, operational, Environment and Social practices respectively. Analysis results depict that decrease of 27.924% decrease in economic practices, and 5.242% decrease in operation, environment, social practice leads to an improvement in 5.652% increase in the operational performance of the SME. That means the economic practices need to be substantially optimised to achieve the improved economic performances to 4.5. All the inefficient SMEs can be benchmarked with the appropriate efficient SMEs. The efficient SMEs too can try to improve their scale efficiency. DEA analysis gives weight scores which help in suggestion as how a SME must be benchmarked with relevant SME.

Sensitivity Analysis In the next scenario (sensitivity) analysis is done on the set of practices and performances of the SMEs to evaluate what will happen if the different proportion of things are tried. It is done to check the robustness of the variables/ practices of the SMEs. The practices are kept same and the outputs are varied. Managers need to understand how the performance affects the efficiency of the SMEs. A sensitivity analysis is a technique used to determine how different values of an independent variable impact dependent variable under a given set of assumptions. This is implemented by running

DEA analysis by considering DEA input output model B and C. Table 3 represents the Sensitivity analysis model
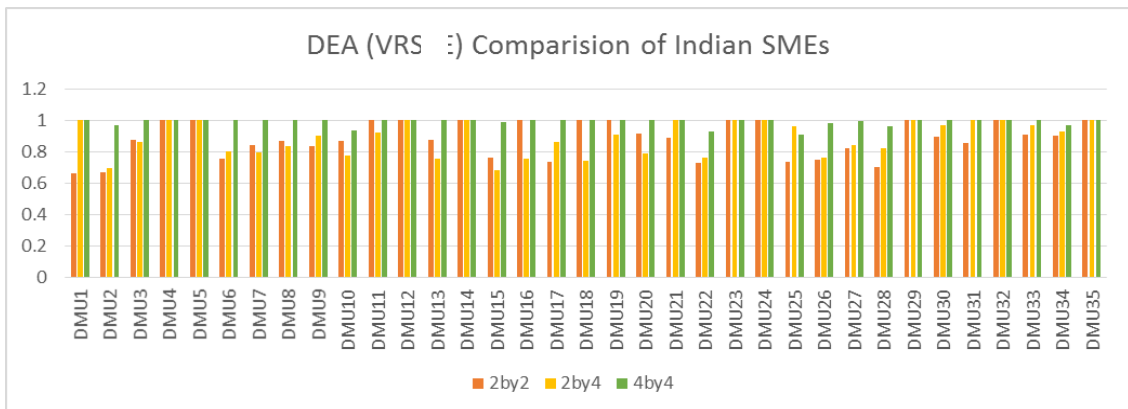

Figure 2 Results of the efficiency analysis of Indian SMEs

Benchmarking of the SMEs help in assessing business efficiency. In this study based upon the values of the frontier analysis by DEA shown in Figure 1 and Table 2 the companies are segregated inefficient and inefficient SMEs. The companies which achieve efficiency of 1 are on the efficient frontier and hence they have been segregated as efficient SMEs. In Figure 2 the companies which achieve non-negative fractional number as score are inefficient SMEs.

Table 3: Sensitivity Analysis Model

Input (Practices)				Output (Performances)			
Model A							
Economic	Operation	Environmental	Social	Economic	Operation	Environmental	Social
Model B							
Economic	Operation	Environmental	Social	Economic	Operation		
Model C							
Economic		Operation		Economic			Operation

Figure 3: Sensitivity Analysis

In Sensitive Analysis the efficiency of the SMEs with and without the environmental and social practices were considered in Model B and C respectively. An SME in consideration can check the model results to understand their state of practice and compare it when performing sustainability practices. Figure 3 represents the results of the sensitivity analysis. The practical contribution of the proposed DEA measurement model helped in analyzing the performance of a SME as their individual practices vary. It helps SMEs to decide appropriate practices and decide future action plans.
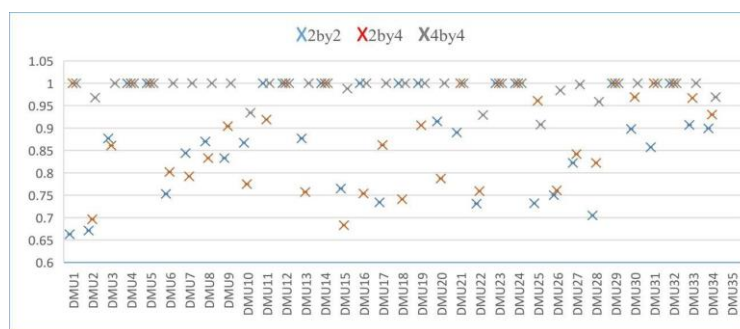
Companies identified as inefficient SMEs are further benchmarked with appropriate peers based on the lambda values, and also upon their nature of the SMEs and issues and challenges faced by them. It was benchmarked with other DMUs in same industry type with a better score(efficiency). The further business case development would provide specific improvement solutions. In comparison to the models initially proposed based on

multi criteria decision making (Gunasekaran et al. 2014), single objective function, multi objective function (Oliveira et al. 2014; Radulescu et al. 2014) the model in this study is helpful as a tool to be used by SMEs to access their sustainability practices. While the existing model provided different perspectives to the research in supply chain sustainability, they had a gap in provided an integrative, comprehensive approach of economic, social, environment and operational aspects in practices and performances for Indian SMEs. As SMEs do not have all data reported hence accurate data are not available to be furnished for the performance measurement (Shepherd & Günter, 2010). SMEs have a different characteristic and most of small enterprises have local customers. This model would be helpful in more robust approach for SMEs to analyze their practices. DEA models exists too for the supply chain sustainability but they use secondary data for efficiency measurement. This study and model uses primary data sources which results in improved, robust and more accurate performance supply chain sustainability measurement.

Conclusion The practical contribution of the paper is an innovative sustainable supply chain performance measurement framework for SMEs using DEA that enables not only segregation of efficient and inefficient SMEs but suggests improvement measures through benchmarking with most appropriate peers. The proposed model has been applied to a group of selected SMEs in the Eastern part of India to demonstrate its effectiveness. The theoretical contribution of the paper is in the theory of resource view of the organization as we test the effect of the practices on the performance of organisation, as hence, comment on the efficiency of organization. The paper contributes in the proper utilization of the practices to enhance the performance of the organisation. The framework has been used to suggest solutions to the SMEs. Caution must be taken while providing solution to the SMEs based upon their characteristics features. The future scope of work remain as similar model can be used to compare SMEs efficiency cross nations so that trend of practices and performances across nations can be observed.

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