Impact of greening the supply chain on economic performance and competitiveness of manufacturing companies in Sri Lanka

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***Abstract*—The main objective of this research is to find out the economic impact of adopting green practices to the supply chains of manufacturing companies in Sri Lanka and the competitiveness gained through it. Greening the supply chain is looked at from three perspectives in this research namely, greening the inbound function, greening the production function and greening the outbound function where the final outcome presents the correlation between each of these with the improvement of economic performance and competitiveness when it comes to the manufacturing companies of Sri Lanka.**

The population of the research is the ISO 14001 (Environmental Management System) certified manufacturing companies in Sri Lanka. Data was collected through a survey done involving all the ISO 14001 certified manufacturing companies where environment management representatives of the firms were targeted through online questionnaires. A four point likert scale was used to obtain responses. Exploratory factor analysis and structural equation modeling (SEM) was used to analyze data regarding the five variables.

The research concludes with a statistically proven result that greening the inbound, production and outbound functions of a supply chain individually as well as collectively leads to improved economic performance while competitiveness can be improved by greening the inbound function of a supply chain.

Keywords— economic impact; competitiveness; greening; supply chain; ISO 14001; SEM.

I. INTRODUCTION

A supply chain is a network of different components that gets involved in a product or a service in the areas of producing, handling and distributing. "A supply chain can be quite complex. It is usually defined as a set of interdependent organizations that act together to control, manage and improve the flow of materials, products, services and information, from the point of origin to the delivery point in order to satisfy customer needs at the lowest cost to all members" [1].

Green supply chain management is increasingly becoming a popular feature in the current supply chains and has become a trend in the leading organizations in the world. It has been implemented by organizations as a philosophy to improve the profitability and market share through reducing environmental risks and impacts and at the same time to efficiently contribute to the ecological wellbeing [2], [3], [4].

A. Purpose of the research

Greening the supply chains has its own benefits in several areas and multiple sub sectors are likely to be benefited from it. Only a handful of researches have been done focusing on the relationship between green supply chains, green innovation, environmental performance and competitiveness [5], [6]. Reference [6] suggests that a proper in depth analysis is lacking when it comes to the green supply chain management and supply chain performance. As for [7], for an organization to adopt green supply chain practices, it is a necessity for it to identify the financial and operational benefits that are likely to result in, due to the green practices.

This research will be contributing towards filling the gap by analysing the relationship between greening the main phases of a supply chain, economic performance of a company and competitiveness of a company in the Sri Lankan context.

The objective of the research is to answer the following questions. Thus, they will act as the research questions.

- Do green supply chains lead to better economic performance of companies in Sri Lanka?
- Do green supply chains lead to improved competitiveness of companies in Sri Lanka?

B. Significance of the research

While green supply chains are becoming a must for most of the companies throughout the world, when it comes to Sri Lanka, the organizations are still in their infancy regarding green practices.

Reference [8] suggests that since 1970, the cost of environment protection mechanisms has increased significantly and is expected to rise in the future. Being a developing country, Sri Lankan companies are more focused towards the cost impacts of their operations and therefore are resistant to change their current practices or to adopt new practices without a guarantee regarding the impacts such changes are likely to have on them. If the green supply chain concept is to be established in Sri Lanka, it is a must that a positive impact on economic performance and competitiveness to be demonstrable with the adoption of green practices.

978-1-4799-1740-2/15/$31.00 ©2015 IEEE

II. LITERATURE REVIEW

A. Introduction

With the industrial revolution, companies around the world have contributed a huge portion towards the environmental damage done within the past few decades leading to many environmental regulations imposed to protect the environment. The growing concern of the customers regarding environment has also made it a necessity for organizations to meet the eco standards set by various organizations. Reference [9] suggests that the customers are becoming aware of the environmental concerns of the products they consume and are forcing the suppliers to minimize the usage of hazardous and toxic substances. 'Over the last few years, there has been an upsurge in environmental awareness of consumers in general. Clearly a growing number of corporations are developing company-wide environmental programs and green products sourced from markets around the world [10]. Due to this, 'green supply chain management as a form of environmental improvement is an operational initiative that many organizations are adopting to address such environmental issues' [2]. For many organizations, it has also become a way to demonstrate their commitment to sustainability [11]. 'Many realize that customers and other stakeholders do not always distinguish between a company and its suppliers. If an organization has environmental liabilities, stakeholders may often hold the lead company in a particular supply chain responsible for the adverse environmental impacts of all organizations within a specific supply chain for a particular product' [2].

According to [2] 'Environmental management encompasses diverse initiatives to reduce or minimize the adverse environmental impacts of an organization's operations. These efforts aim to improve environmental performance, reduce costs, enhance corporate image, reduce risks of non-compliance and improve marketing advantage'. Nevertheless, 'many organizations still look upon green initiatives as involving trade-offs between environmental performance and economic performance' [12]. As for [2], it implies that greening different phases of a supply chain will directly or indirectly lead to improved economic/ financial performance even though it looks like it will only have an impact on the environmental performance. They also emphasize on the fact that it is not necessarily true that greening the supply chain should directly lead to better economic performance.

B. Inbound Function

Inbound function acts as the most critical phase when it comes to greening the supply chain. Most of the other phases of a supply chain will have a direct or an indirect effect from the inbound function. The process of making this phase an environmentally friendly one would be costly at times but is likely to reward with benefits in return. As for [13], there are several dimensions that should be looked at when it comes to greening the inbound function. He suggests that if a firm is to enhance environmental purchasing, factors such as materials used in product design, the design process, improving supplier processes, evaluating the suppliers and the inbound logistics should be considered.

C. Production Function

Production phase is the easiest to monitor and control since it is within the boundaries of the organization. This will again be a critical function as it is the image that a company will have to maintain. A direct relationship is visible between this function and the organizational contribution towards environment. Reference [14] makes it a point that the environmental innovation in this phase could be a result of it being the most internally focused function of the operational cycle which allows the organizations to observe the impacts of implementing new technology and innovative procedures.

The production function will have a huge influence over the out bound function as well. The factors such as volume, tonnage, packaging and handling requirements will be derived from the production phase which will create the necessity for warehousing, distribution, space utilization etc. [14].

Reference [15] reveals that the organizations are innovative in the fields of reducing waste and pollution and this commitment leads to green manufacturing.

D. Outbound Function

Green marketing, environmentally friendly distribution and packaging come under the out bound function. In this research, the reverse logistics will also be considered as a sub function of the out bound phase.

Out bound phase will also be critical as it will be one of the areas that is visible to the end customers and is likely to create an impact on the brand image of organizations. It is also an area which is highly influenced by the inbound phase and the production phase so that higher control measures will have to be taken in order to green this phase of the supply chain.

When it comes to reverse logistics, it contains both the remains of a used product and also unused products which are sent back for claiming warrants, or as returns. Possible strategies to be used for these would include reuse, remanufacture, recycle and dispose [14].

Reference [16] identifies packaging design and warehousing as the most critical functions of the out bound phase. As for them, standardized containers, smooth warehousing facilities, package designs and information flows are likely to contribute towards smooth functioning of the outbound phase and at the same time towards environmental soundness. Transportation will also play a crucial role in the out bound function in contributing towards greenness.

E. Competitiveness

Competitiveness arises due to increased customer attraction towards a particular product or a service and so, unless the customers are concerned about the environmental impacts of it, greening would be useless. Luckily with the increased awareness of the customers, it is becoming a must for the products and services to have their share of environmental performance integrated within.

Reference [17] shows that by uplifting the green corporate image of a company, it can unveil new business opportunities and can improve the competitive advantage in order to gain the

edge over its competitors. Reference [18] came up with a correlation between environmental performance and the competitiveness in the North American context.

'Companies should work closely with, and even integrate their business processes with their upstream and downstream suppliers to achieve environmental goals and to relieve the pressure on the buyer's requirements. More business opportunities may then be generated by these organizations than by their competitors in the global market' [5].

F. Economic performance

Economic performance contributes the highest share when the companies are making a decision in the current business landscape regarding whether to implement green practices or not. Reference [7] indicates that the differentiation between following green supply chain management practices or not depends on whether it will gain both financial and operational benefits or not.

Implementing green practices can affect an organization in two ways. It can be costly to implement such standards but also can gain benefits if properly implemented. Reference [19] mentions that the cost undertaken can be covered up by the productivity improvements due to green supply chain management. Reference [20] found out that by taking environment related initiatives, organizations can reduce production costs and achieve higher levels of economic efficiencies.

G. Relationship between greening the supply chain, economic performance and competitiveness

An empirical research was done for the South East Asian region (Malaysia, Philippines, Indonesia, Thailand, and Singapore) by [21] to find out the correlation between greening the phases of a supply chain and the impact of it on the economic performance and competitiveness. However, no correlation was found by him between these factors in this attempt. Again [2] did a similar research to the same region and found out that the economic performance and the competitiveness of a firm has a positive impact due to green supply chain management. This research was done in line with [20] which showed that environmental initiatives will reduce the production costs which will lead to higher economic efficiencies. Reference [2] suggests that the future researches should be done considering different countries to find out the relationship suggested by them in order to enable comparative studies.

When it comes to the South East Asian region, 'If they green their supply chains not only would firms achieve substantial cost savings, but they would also enhance sales, market share, and exploit new market opportunities to lead to greater profit margins, all of which contribute to the economic performance of the firm' [2]. Even though the situation is such when it comes to the South East Asian region, a proper research is not available specifically analysing the situation in Sri Lanka. The social behaviour, cultural impacts, economy, thinking patterns and many other factors are likely to have a major impact on this situation when it comes to Sri Lanka.

III. RESEARCH METHODOLOGY

This research was designed in such a way where at the end of the analysis, the correlation between each of the following was achieved.

- Correlation between greening the recognized phases of a supply chain.
- Correlation between greening each of the phases of a supply chain and economic performance of a firm
- Correlation between greening each of the phases of a supply chain and competitiveness of a firm

This was in line with the two research objectives. Five latent constructs were used in the research and to capture those latent constructs, several indicator variables that represent the underlying constructs were used. The population of this research is the manufacturing companies in Sri Lanka that have implemented green practices in their supply chains.

A. Sample design

Selection of the sample is crucial since results acquired and the outcome should represent the entire population. Exploratory factor analysis has been used to extract the factors. This method requires a minimum of 30 responses to provide valid results [22] and so, the selected sample size had to be at least 30. All the ISO 14001 certified manufacturing companies in Sri Lanka were used as the sample. The list of companies was extracted from the Sri Lanka Standards Institution (SLSI). This was the only set of companies to be recognized for implementing eco-friendly standards in Sri Lanka.

B. Data collection- questionnaire

The questionnaire was developed to extract data regarding the variables considered in the research. Its base structure is that of [2] and was altered to match the needs of this research. The questionnaire consists of five main questions with sub questions categorized under the following latent variables.

- Greenness of the inbound supply chain
- Greenness of the production supply chain
- Greenness of the outbound supply chain
- Competitiveness gained through greening the supply chain
- Impact on economic performance of greening the supply chain

The responses were recorded on a four point likert scale ranging from strongly agree (represented with 4) to strongly disagree (represented with 1). The reason for using an even number for the likert scale is to avoid central tendency bias.

Before sending out the questionnaires to be filled by the target sample, a pilot survey was done using few industry experts. The initial questionnaire did not have to be altered since most of the questions were those which were already tested at large in the South East Asian context [2].

An online questionnaire was sent to the environment management representatives of the identified companies via e-mail. Four waves of emails had to be used with a gap of 1 week between the waves to acquire the data and the companies who had not responded were reminded over the phone. A total of 49 questionnaires were sent to companies and 30 valid responses were received. Hence the response rate stands at 61%.

C. Data analysis methods

The analysis was done in several steps. As the first step of analysing, the data was screened out to remove any missing data and unengaged responses using Microsoft excel 2010. Skewness test and Kurtosis analysis were done to identify any abnormalities of the collected responses.

An exploratory factor analysis was done using principal axis factoring (PAF) in order to narrow down the large set of variables into a more focused narrow set of variables. As a general variation, the N: p ratio stays within 3:1 to 20:1 [23], where N stands for the number of participants and p stands for the number of variables. In this case, there were 31 responses for 5 variables so that the N: p ratio is close to 6:1 which is well within the acceptable range. "As long as communalities are high, the number of expected factors is relatively small, and model error is low (a condition which often goes hand-in-hand with high communalities), researchers and reviewers should not be overly concerned about small sample sizes." [24].

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy index is used to measure the suitability of using factor analysis for a particular data set and above 0.50 is considered to be a match [23]. Bartlett's Test of Sphericity is the other value used to test the suitability of using factor analysis and it has to be significant ($p<0.05$) for factor analysis to provide valid results [23]."Strong data" in factor analysis means uniformly high communalities without cross loadings, plus several variables loading strongly on each factor. [25].

Critical ratio was used to measure the significance of the correlation between the selected latent variables and a value that exceeds 1.65 was considered to be significant. The fitting method used to identify the factor loading was Principle Axis Factoring (PAF). The reason for using PAF was that this method generates valid results even if the assumption of normality is violated [22] and it is less likely to produce improper solutions. IBM SPSS Statistics 20 was the software used to conduct the exploratory factor analysis. Cronbach's alpha test was conducted afterwards and the required adjustments were done to improve the reliability of the scale.

Finally, structural equation modelling was done to test and confirm the measurement model using maximum likelihood estimation. SEM allows for variables to correlate while regression adjusts for the variables in the model. The ability of SEM to account for error [26] plays a crucial role compared to regression which assumes that perfect information is provided. Mediations will also be found simultaneously with the use of this model which will further strengthen the outcomes. The analysis was done using AMOS Graphics for Windows Version 22. To evaluate the validity of the model, many factors were used including p-value, chi-square test, Goodness of fit test (GFI), adjusted goodness of fit index (AGFI), degree of freedom and root mean square residual (RMSR).

IV. RESEARCH FINDINGS

30 valid responses were collected from the entire population where, from all the received responses, 2 had to be rejected as a reason of being unengaged.

The KMO ratio of sampling adequacy was 0.614 which suggests that the sample is mediocre adequate to provide valid results. Barlett's Test of Sphericity has a Sig. value less than alpha. According to these outcomes, it suggests that the variables considered have correlations which makes it appropriate for factor analysis. All the communality values after adjustments were above 0.6 with a minimum of 0.67 and a maximum of 0.960. This concluded that all the variables which remained, fits well with the factor solutions.

To extract the factors, several adjustments had to be done to the initial set of variables, and to reach a proper extraction without cross loadings, some observed variables had to be dropped. Reference [27] suggests that it would be appropriate to have at least three observed variables per factor but still two observed variables per factor would produce a valid result.

According to the results, five underlying factors could be identified which were in line with the initial conceptual design. The Cronbach's alpha test which was conducted to test the reliability of the scale showed positive outcomes as all the alpha figures were above 0.7 which acts as the rule of thumb.

TABLE I. EXTRACTED FACTORS FROM THE EXPLORATORY FACTOR ANALYSIS

Factor 3 (Greening the inbound function)	Holding awareness seminars for suppliers
	Guiding suppliers to establish their own environmental programs
	Informing suppliers about the benefits of cleaner production and technologies
	Urging/ pressuring suppliers to take environmental actions
Factor 1 (Greening the production function)	Substitution of environmentally questionable materials
	Taking environment criteria into consideration
	Use of cleaner technology processes to make savings
	Recycling of materials
Factor 5 (Greening the outbound function)	Taking back packaging
	Change for more environmentally-friendly transportation
Factor 4 (impact on competitiveness)	Improved efficiency
	Quality improvement
	Productivity improvement
Factor 2 (Impact on economic performance)	New market opportunities
	Product price increase
	Sales
	Market share

A. Structural Equation Modelling

TABLE II. COVARIANCE MATRIX EXTRACTED BY CONFIRMATORY FACTOR ANALYSIS

	Est.	S.E.	C.R.	P
Production<>Economic	.089	.052	1.694	.090
Production<>Competitiveness	.090	.056	1.610	.107
Economic<>Inbound	.115	.065	1.781	.075
Economic<>Competitiveness	.097	.061	1.577	.115
Economic<>Outbound	.123	.073	1.685	.092
Inbound<>Competitiveness	.126	.071	1.767	.077

All the factor loadings as for the confirmatory analysis were significant except 2 factors which were still around an acceptable loading. The CFI value was 0.944 which is marginal for a good model fit while CMIN/DF was 2.26 where the rule of thumb states it to be between 1 and 3 to be accepted as a valid model. PCLOSE value was not significant, confirming the validity of the selected model to analyze the data. RMSEA value was more towards the cautious range but still acceptable. GFI was 0.73 and AGFI was 0.65 which is again in the border line of accepting the model where [28] suggests that there is no specific value for the GFI and AGFI to be accepted but still, a higher value would provide better validity. All the latent variables were tested for correlations individually and the results suggested that they were sufficiently linear to be tested using covariance based structural equation modeling.

Critical ratios between the latent variables were considered in order to determine whether a significant relationship exists at a significance of 0.10 where the C.R was above 1.65. The output of the covariance matrix from AMOS Graphics was analysed to recognize these latent variables as shown below.

V. CONCLUSIONS AND RECOMMENDATIONS

According to the critical ratios, the results suggested that there is a significant impact on economic performance from the three latent variables; greening the inbound function, greening the production function, and greening the outbound function. The only factor which results in increased competitiveness is greening the inbound function. No significant relationship can be seen between greening the inbound, production and outbound functions. Neither the economic performance nor competitiveness seems to be having a significant impact on each other at a significance of 0.1.

Even though a significance level of 0.1 was considered when arriving at the final result, two other relationships are also shown in the diagram, represented by broken lines which do not qualify when the significance levels are considered but are closely following. Fig.1. shows the path diagram.

As for the model developed, it is visible that there are several relationships between each of the factors where greening of inbound, production and outbound functions act as independent variables while competitiveness and economic performance act as dependent variables.

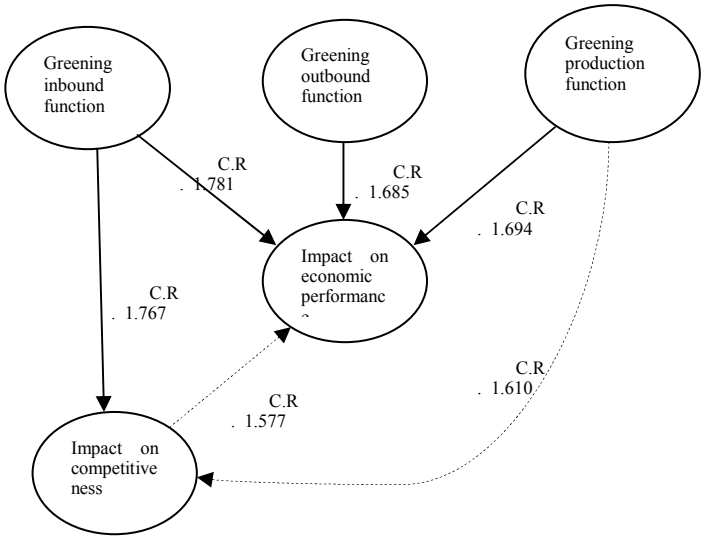

Fig. 1. Path diagram which illustrates the final model developed from the analysis

When the significance levels are considered, there were no relationships with a significance level better than 0.05 whereas the literature has evidence of such relationships between the same latent constructs considered for different regions of the country. Each of these relationships has to be evaluated thoroughly in order to get a proper idea regarding the reasons causing such relationships and to find out the reasons for lower significance levels when it comes to some of the latent constructs.

A. Conclusion

In the modern world, it is increasingly becoming a trend that manufacturing companies adopt green practices in various stages of their supply chains in order to achieve different objectives. When it comes to the same scenario in Sri Lanka, most of the manufacturing companies are reluctant to adopt green practices as there is no assurance that they will achieve benefits from greening the supply chain. Comparatively, this becomes a disadvantage to Sri Lankan companies who are importing their products rather than those who are trading within Sri Lanka as most of the countries who are exporting from Sri Lanka are concerned about eco-friendliness of the companies they are trading with. The attitude shared by most of the consumers in Sri Lanka tends to be more price sensitive and only a little concern is given on other aspects such as greenness of the brands.

The objective of doing this research was to find out whether there is a significant relationship between greening the supply chain of the Sri Lankan manufacturing companies and the economic and competitive advantages gained through it. When each of the three phases of the supply chain is considered, the research provides proof from analysis done using empirical data that all three phases will individually lead to better economic performance. It then becomes obvious that a company which adopts green practices throughout the supply chain will be benefitted economically. It can also be observed that greening the inbound function will lead to improved competitiveness of the companies. None of the other two phases prove to be contributing towards improved

competitiveness and neither does improved competitiveness seem to be contributing towards better economic performance. The relationship between greening the out bound function and competitiveness, and the relationship between competitiveness and economic performance seems to be having high critical ratios though they do not qualify for the 0.1 significance level.

B. Limitations of the study

The sample size is the main limitation in this research as only 30 responses were used when analysing the data even though when the response rate is considered, 30 valid responses out of a total of 49 companies is above par. The respondents had to be forced to send responses where four waves of emails had to be sent to arrive at 32 responses. This could have lead to non-response bias. The questionnaire responses can be subject to acquiescence bias, demand characteristics bias, extreme response bias and social desirability bias. The sample focused was the ISO 14001 certified manufacturing companies in Sri Lanka where the accreditation was done through SLSI (Sri Lanka Standards Institution). There is a possibility for companies to not have the environment management system certification issued by SLSI but to have an advanced environment management system, as the EMS certification is a voluntary certification. There could also be companies who are accredited with different standards from different standard institutions. This could result in problems when generalizing the findings from this research.

C. Suggestions and recommendations for future research

This research will act as an extension of the research done by [2] where it was done for the South East Asian region. The relationship suggested by this research should be tested in different countries to enable comparisons between different countries in different regions of the world. Future researchers can focus on larger samples which will improve the validity of the findings and will allow the results to be generalized over a larger population. The latent variables used in this research can be further broken down in order to provide a more focused output for the readers and thereby improve the usefulness of the research findings. As this research is only focusing on the manufacturing organizations, future researchers can extend the scope of this research to different organizational segments in order to compare the behavioural differences in each of them.

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