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Do Carbon Management Practices create an immediate impact?

A case study on cut and sew apparel manufacturing companies in Sri Lanka

Asanka Waruni Thiranagama[1#] and W.M.P.S.B. Wahala[2]

[1]Department of Business Management, Faculty of Management Studies, Sabaragamuwa University of Sri Lanka, Belihuloya 70140, SRI LANKA

[2]Department of Tourism Management, Faculty of Management Studies, Sabaragamuwa University of Sri Lanka, Belihuloya 70140, SRI LANKA

[#]Corresponding Author:
Tele: (94) 71 9492615; E-mail: waruni@mgt.sab.ac.lk

ABSTRACT

Carbon management practices are actions to reduce Carbon Footprint. The question is whether these Carbon Management Practices reduce the Carbon Footprint of organizations. This study investigates the impact of Carbon Management Practices on the organizational Carbon Footprint by categorizing companies based on the level of implementation of Carbon Management Practices and the variations of specific Carbon Footprint among apparel manufacturing companies in Sri Lanka. Dimensions of Carbon Management Practices (policy, measurement, implementation & decision making, disclosure) were measured using a structured questionnaire, and GHG inventory data were obtained to investigate the reduction of Carbon Footprint. 77.7% of companies were categorized into the "Beginner" cluster with a low implementation of Carbon Management Practices and 22.2% into the "Emerging" cluster. The specific CF of the emerging cluster was observed as 0.057 $KgCO_{2e}$, and the beginners' cluster was 0.059 $KgCO_{2e}$. Specific Carbon Footprint for both clusters shows a decreasing trend with the increase of monthly earned minutes, and there was no noticeable short term reduction in organizational Carbon Footprint caused by Carbon Management Practices in apparel manufacturing companies in Sri Lanka.

Key words: *Carbon Footprint, Carbon Management Practices, Green House Gas, Apparel Manufacturing, Sri Lanka*

1. Introduction

The apparel industry has been a major industry in the global market since the industrial revolution and remains the same in using natural resources in the industry at a considerably higher level. With these rapid changes, a growing number of concerns have raised regarding the industry's environmental issues, such as the use of hazardous chemicals, extensive use of non-renewable resources, and generation of waste (Allwood, Laursen, Malvido & Bocken, 2006; Fletcher, 2008). The new trend of Fast Fashion, which is rapid acquisition and disposal of apparel, led to the increased use of resources to produce wearing apparel creating a significant impact on the environment.

The apparel manufacturing industry contributes significantly to increase global GHG emissions by approximately 6.7% in 2018 due to their operations by burning fossil fuels to produce energy, generating waste, and other operational processes (Quanits, 2018). Carbon Footprint (CF) Assessment is an effective tool that can measure and manage the organizations' GHG emissions that capture all aspects of emissions related to an organization or a product. Carbon footprint is usually calculated, including all greenhouse gases, expressed in tones of CO2 equivalent (tCO_{2e}) (Carbon Trust, 2008).

Measurement of CF will pave the way to reducing and managing CF in organizations. Responding to the rising societal pressure about GHG emission, possible climate change impacts, and regulatory provisions, companies have started to act on reducing GHG emissions (Okereke 2007, Jeswani, Wehrmeyer & Mulugetta, 2008, Goworek 2011, Tippura et al 2016, Thorisdottir & Johannsdottir 2019) (Gouldson & Sullivan 2007; Hill & Lee 2012; Weinhofer & Busch 2013; Cavender & Lee 2018).; however, the majority of the companies are still in preface phase (Kolk and Pinkse, 2005). Those actions aiming to reduce the Carbon Footprint of the organizations are termed as "Carbon Management Practices" (CMP) (Doda, Gennaioli, Goundson, Grover & Sullivan, 2015). Moreover, the sectoral differences exist in regions or countries implementing those carbon reduction initiatives (Jeswani et al., 2008).

CMP can be classified differently (Jeswani, Wehrmeyer & Mulugetta, 2008; Weinhofer & Hoffmann, 2010; Doda et al., 2015), and companies can be categorized into different clusters based on their level of application of the carbon management practices (Jeswani et al., 2008). Studies have been conducted to investigate the implementation of explicit practices of carbon management on changes in the use of energy or carbon emissions yet, and few studies have done with some exceptions quantitatively (Theyel, 2000; Bloom, Genakos, Martin, & Sadun, 2010; Bloom &

Van Reenan 2010; Matsumura, Prakash & Vera-Munoz, 2011). However, these CMP might have been implemented by apparel manufacturing organizations as a superficial and misleading adaption, which is called "Greenwashing" rather than aiming at a result of positive effect to reduce the negative impact (Testa, Boiral & Iraldo, 2018). As well it is argued that these actions might be measured and disclosed to the public to create an affirmative impression about the organization's activities, but without any association of real changes in operations (Symbolism) rather communicating about how the operational changes have impacted which are more reliable with the expectations of the society (Kim, Bach & Clelland, 2007; Hrasky, 2011).

Conversely, CF studies in Sri Lanka have conducted with relevant to a quantification of a product, process or an organization and calculated and identified the emission sources specifically (Avanthi & Navarathna 2010) (Kumanayake, Luo & Paulusz 2018; Abeydeera, Mesthrige, & Samarasinghalage 2019). (Kumara, Munasinghe, Rodrigo & Karunaratna 2016). (Gunathilaka & Gunewardena 2014) (Gunathilaka & Gunewardena 2015). (Uddin, Bidisha & Ozturk 2016). (Munasinghe, Jayasinghe, Ralapanawe & Gajanayake 2016). Muthukumarana, Karunathilake, Punchihewa, Manthilake and Hewage (2017), (Pathirana & Yarime 2018). (Ranasinghe, Jayasooriya & Fernando 2018). None of the studies have conducted comparing or including emissions of a sample of manufacturing facilities which leaves a gap in identifying variations, patterns and trends in emissions and investigating the impact of carbon management on reducing CF in apparel manufacturing industry.

Consequently, the answer to whether carbon management practices of apparel manufacturing organizations reduce the organizational carbon footprint should yet be discovered in the Sri Lankan context. Hence this study was focused on investigating the impact of carbon management practices on organizational carbon footprint. Three objectives were established to carry out the study relevant to the research phenomenon as (1) To categorize the apparel manufacturing companies in Sri Lanka based on the Carbon Management Practices (CMP), (2) To examine the variations in specific organizational Carbon Footprint (CF) of apparel manufacturing companies in Sri Lanka and (3) To investigate the impact of Carbon Management Practices (CMP) on organizational Carbon Footprint (CF) of apparel manufacturing companies in Sri Lanka.

2. Materials and Methods

2.1 Scope of the study

Sri Lanka is an assembling country in the apparel industry's global value chain (Athukorala & Ekanayake, 2017). Therefore, the study focused on the assembling phase, which includes all the sub-processes from cutting fabrics until gathering cut components into a finished garment and dispatch from the manufacturing facility. The current study's process boundary excludes the dyeing & washing of a garment as not every type of garment produced requires dyeing & washing, which leaves a typical assembly process for most apparel manufacturing companies. The sub-processes considered under process boundary are the phases completed in one facility in many cases. The study did not consider emissions from the entire value chain of the apparel industry. However, the direct and indirect emissions of specific manufacturing facilities (Manufacturing/Assembly stage in the life cycle stages in apparel manufacturing) were included for the period under consideration.

2.2 Selection of the sample

The companies that manufacture wearable apparel were considered as the population of the study specifically, companies which includes cut to sew operations. A list of 226 companies registered under the "Apparel" category in the Export Development Board was obtained, and out of that, 153 companies (67%) were selected, which produce only wearable apparels. Preliminary investigations conducted based on companies' information revealed that only 19.6 % of registered wearable apparel manufacturing companies have engaged with carbon management activities and measured their carbon footprint; which was selected as the sample of the study. Companies have changed their typical operations since the pandemic during the past couple of years. Thus 2018 was the last year as they engage business operations as usual which is a critical factor for this study.

All the selected apparel companies are large scale companies in terms of number of employees worked and the classification is in accordance with the World Bank definition of enterprise size in Sri Lanka (Ponnamperuma, 2000). The number of employees was ranged from 327 to 3200. Companies produce diverse range of wearable apparel products to different export markets. Even though the sample displays heterogeneous characteristics, the impact was normalized for the comparison purposes in data analysis. Approach to normalize the heterogeneity is explained under the section 2.4.3 (Analysis of the variations of organizational carbon footprint).

Due to the non-disclosure agreements made with the companies selected to obtain the data, samples were coded with a unique sequence number as APSBU01 (Ex. Apparel Strategic Business Unit – sample one). The calendar period from January 2018 to December 2018 was considered to collect CMP and CF data.

2.3 Data collection

After reviewing available three measurement scales of CMP (Jeswani et al. 2008, Weinhofer & Hoffmann, 2010, Doda et al., 2015), the scale developed by Doda et al. (2015) was selected to measure the CMP. All three scales provide similar areas underlying the concepts yet with different names or labels for dimensions. The selected scale was the latest upgraded one, which is the most fitted one for the study context. The questionnaire was developed with modifications to comply with the original dimensions proposed by Doda et al. (2015). The modified questionnaire consists of 23 questions covering four dimensions, namely; Policy, Measurement, Implementation, Decision Making, and Disclosure. The questions were measured on a 5-point Likert scale ranging from 1 – "Strongly Disagree" to 5 – "Strongly Agree" in many cases, and specific options were developed as required, which is appropriate for the questions as mentioned in the Table 1 (Ex: Completeness of the GHG inventory - Scope 1, Scope 2, Scope 3,). The developed questionnaire was sent to experts in the fields of Carbon Management, Carbon quantification & verification for their expert opinions, and the questions were revised based on the comments received. The dependent variable, Carbon Footprint/Activity data, were obtained from the CF (GHG) inventories internally prepared verified from respective companies.

Table 1: Operationalization of the variables on Carbon Management Practices and Carbon Footprint with dimensions and items used in the questionnaire to measure the respective variables, modified by authors from the original work of Doda et al. (2015)

Variable	Dimension	Items in the questionnaire
Carbon Management Practices (CMP)	Policy	Organization is completely aligned to the corporate GHG management policy
		Organization has set emission reduction targets to be achieved in a specific time frame
	Measurement	Organization has a highly efficient emissions data gathering process/procedure

		Organization measures the emissions with a consistent frequency
		Emissions data gathered from the organization is accurate and in a high quality level
		Organization achieves set emissions reduction target/s
		Completeness of the GHG inventory (Scope 1, Scope 2, Scope 3)
	Implementation & Decision Making	The highest responsibility in the organization hierarchy which is responsible for GHG Management is lies at,(Top Level/Middle Level/Lower Level)
		The responsible person for GHG Management in the organization is highly committed
		Organization's performance appraisal procedure is linked with monetary incentives for meeting GHG management goals/targets
		Organization efficiently implements the operational activities for energy efficiency (Relate with technology/process/human/etc)
		Organization efficiently implements the operational activities for GHG reduction
		Organization efficiently incorporates technology for GHG reduction
		Organization has improved/redesigned its processes for GHG reduction
		Organization encourage employees to take initiatives for GHG reduction
		Organization implements GHG Management for Marketing/Reputational/Brand Image
		Organization implements GHG Management for anticipating future legal/regulatory requirements
		Organization implements GHG Management for Customer/Investor/Partner/Supply chain demands

		Organization implements GHG Management as voluntary initiative
	Disclosure	Organizations emissions are verified (Third party independent, Internal, Not verified)
		Completeness of the disclosure (Scope 1, Scope 2, Scope 3)
		Reputability of the assurance process used to verify the emissions of the organization
*Organizational Carbon Footprint (CF)		Direct and Indirect emissions of the organization

2.4. Data analysis

2.4.1 Cluster analysis

Two-step Cluster Analysis was performed to identify the correct number of clusters for the data set and categorize companies based on their CMP level. Based on the results of the Two-step cluster analysis, K-means cluster analysis was performed. Companies were categorized into clusters using dimension wise CMP scores and overall CMP score. These analyses were performed using SPSS Statistics Version 21.

2.4.2 Cluster labelling

Jeswani et al. (2008) proposed four main clusters in which companies can be classified based on their CMP level.

(1) "Indifferent" cluster, which is not concerned about the issues and regulations on the environment, does not have taken the initial steps required for a climate change strategy such as establishing a policy, preparation of inventories of emissions. Also not engaged in any external activities in carbon management, yet very few internal carbon management activities have been carried out mostly to reduce the cost and do not have any formal carbon management system, certified or verified.

(2) "Beginner" cluster has initiated some of the operational activities in carbon management but is in the early stage of managing those activities. They have to set up their carbon management programs where management allocates minimum resources for carbon management; thus, the company has focused on low-cost activities such as energy efficiency projects.

(3) "Emerging" cluster is better than the" Beginner" cluster but is not up to the perfect carbon management level. They have implemented a carbon management system but are not verified externally. Actions of the organization are limited to the legal requirements though they are aware of the options for improvements. Setting Carbon management policy, preparation of GHG inventory, benchmarking of emissions has been carried out for carbon management. Specifically, these organizations engage in external activities such as fulfilling regulatory requirements to reduce emissions, participating in emission trading, and disclosing their emissions.

(4) "Active," the superior cluster is the opposite of the "indifferent" cluster where its carbon management system has wholly developed and integrates with other business strategies. Engage with various operational activities such as shifting the use of fossil fuels to renewable sources (wind, solar, biomass). In this cluster, companies have usually prepared their complete GHG inventories, conduct assessments, identified the opportunities for improvements, and externally verified and disclosed their emissions. Management has considerably invested and committed to carbon management activities.

2.4.3 Analysis of the variations of organizational carbon footprint

One–way ANOVA with Tukey's pairwise comparison using Minitab® 17.1.0 statistical software was performed to analyze the variations of apparel manufacturing companies' specific carbon footprint based on different criteria. Operational category (Embroidery/Product Development/Knitting, Printing, Sewing/Packing & Finishing, Storing/Cutting/Sewing/Packing & Finishing, and Washing), time (Monthly and Quarterly variation of a total carbon footprint per earn minute), and Level of CMP was considered.

In order to compare the CF between above factors, Tthe variations caused for CF of the organizations due to its size, production capacity and product type were normalized using monthly earned minutes of the organization to calculate specific CF. The monthly earned minute is a key performance indicator used by apparel manufacturing companies. It is the ratio between the Standard Actual Hours (SAH) against the revenue of a month. The calculation of SAH includes time taken to complete one operation of an apparel which is standard for an operation, number of pieces produced and converted into an hourly rate. Production capacity would be change based on the product type but normalizing it using SAH would capture the variations of production capacity and product type. Hence Monthly Earned Minutes would be a good indicator to determine the specific CF of organizations.

Standard Actual Hours (SAH) = (SAM of Operation ×Garments produced)/60 (1)

Monthly Earned Minute = Standard Actual Hours (SAH)/Monthly Revenue (2)

2.4.4 Polynomial regression analysis

Polynomial regression analysis was performed between the specific carbon footprint (per earn minute) versus monthly earned minutes using Minitab® 17.1.0 statistical software.

2.4.5 Association and impact of CMP and CF of companies

In the past literature of carbon management, a few studies have quantitatively studied the phenomena yet concluded with positive and negative outcomes contrary to the expectations. Jeswani et al. (2008) stated that a significant drop in GHG emissions is needed in quite a short period to avoid the threat formed by climate change. Thus, it is recommended that companies with good practice of carbon management at present will also have to go further on the continuum to be more proactive and innovative with appropriate and clear goals to reduce their carbon emissions. It represents the ability to reduce emissions by implementing carbon management practices. Further, Boiral, Henry, and Talbot (2012) conclude that examining GHG performance determinants needs to examine the actual commitment these companies put forward. Consequently, it is suggested that companies' GHG performance is determined by their level of commitment, which leads to significant changes in organizations. Further, in their study, it was found that 27.1% of the GHG performance variance could be explained through GHG commitment (which refers to Carbon Management in this study); thus, it could be associated significantly and positively with GHG performance in Canada. Fu & Su (2020) has found that pollution prevention and waste management (PPWM) practices reduce the GHG emission yet not thoroughly examined the size of the impact. On the other hand, Doda et al. (2015) found slight compelling evidence that general carbon management practices reduce emissions for those particular companies they have studied, yet it cannot be generalized for every company. Thus, to understand the Sri Lankan context's reality, the association and impact of the CMP and CF were tested in the study.

Association for the CMP and CF was tested for both dimensions (Policy, Measurement, Implementation and Decision Making, Disclosure) and overall CMP value. Pearson correlation analysis using SPSS Statistics Version 21 software was performed to identify the association between the companies' CMP and CF. Following hypotheses were tested.

H_0: There is no relationship between the Dimensions of Carbon Management Practices and Carbon Footprint of the apparel manufacturing companies

H_1: There is a relationship between Dimensions of Carbon Management Practices and Carbon Footprint of the apparel manufacturing companies.

Simple regression analysis using SPSS Statistics Version 21 software was performed to identify whether the CMP reduces organizational CF to investigate the significance of CMP's impact on CF. Overall, the CMP score was considered as the independent variable, while the Absolute CF value was considered as the dependent variable. The following hypotheses were tested.

H_0: Carbon Management Practices does not impact on Organizational Carbon Footprint of apparel manufacturing companies

H_1: Carbon Management Practices impact on Organizational Carbon Footprint of apparel manufacturing companies

3. Results

3.1 Categorization of organisations based on the level of CMP

The CMP data obtained from the apparel manufacturing companies were analyzed to categorize the companies, and the response rate was 63%. Two-step Cluster Analysis was revealed that the optimal number of clusters based on the four dimensions (Policy, Measurement, Implementation & Decision Making, Disclosure) was two. Based on that, K-means cluster analysis was performed after that for grouping the companies into two clusters. In this categorization, one company was removed from the data set due to its influential nature to the results. Table 2 shows the final cluster centres for four dimensions of CMP. The mean value represents the average score of a particular dimension of CMP, ranging from 1 to 5. Lower the mean value; lower the score for a particular dimension in CMP. Since the optimal number of clusters for this study is two, the two sets of lowest and highest mean values were considered to identify the clusters.

Table 2: Final cluster centres based on dimensions of CMP of wearable apparel manufacturing companies

Final Cluster Centres		
	Cluster Label	
	1 - Beginner	**2 - Emerging**
Policy	2.07	2.75
Measurement	1.86	2.38
Implementation & Decision Making	4.61	4.75
Disclosure	3.50	3.50

Cluster 1 consists of the lowest mean values for all three dimensions, and the disclosure mean value is equal in both clusters. Based on the mean values of the dimensions, cluster 1 was labelled as "Beginner" (companies which have initiated some of the operational activities in carbon management but are in early-stage in managing those activities) and cluster 2 as "Emerging" (companies which are better than the" Beginner" category but are not up to the perfect level in carbon management) on the level of implementation of CMP. The number of companies falls in each cluster is shown in Table 3.

Table 3: Number of companies in each cluster according to the level of implementation of CMP

Number of Cases in each Cluster		
Cluster	1 (Beginner)	14.000
	2 (Emerging)	4.000
Valid		18.000
Missing		.000

According to table 3, cluster 1 consists of 14 companies (77.7%) of the sample, while cluster 2 consists of only four companies (22.2%). According to the dimension wise

analysis, the majority of the companies in the sample belongs to the "Beginner" category where those companies show an average level (Mean value 2.07) of setting policies and targets for carbon management, low level of effectiveness, accuracy, and completeness in data gathering and calculation process of emissions (Mean value 1.86). However, implementation and decision making and the disclosure appeared at a higher level in the cluster with higher mean values of 4.61 and 3.50, respectively, which indicates the high level of efficiency and effectiveness in the implementation process of carbon management, a broad delegation of responsibility and good behaviour in making decisions regarding carbon management, an acceptable level of completeness, external verification, and disclosure among the companies in the cluster.

"Emerging" cluster consists of 22.2% of the companies and shows the highest mean values for all four dimensions. Cluster shows a higher level (Mean value 2.75) of setting policies and targets for carbon management than the Beginners, the average level of effectiveness, accuracy, and completeness in data gathering and calculation process of emissions (Mean value 2.38). Moreover, implementation and decision making and the disclosure dimensions appeared at a higher level in the cluster with higher mean values of 4.75 and 3.50, respectively, which indicates the high level of efficiency and effectiveness in the implementation process of carbon management, a wide delegation of responsibility and good behaviour in making decisions regarding carbon management, high level of completeness, external verification, and disclosure among the companies in the cluster.

3.2 Variations in organizational carbon footprint

Variations of organizational carbon footprint were analyzed using carbon footprint inventories of organizations to assess whether these CMP have produced the expected result of a reduction in CF or make any impact on it. Operational category, time (Monthly and Quarterly), and Level of CMP were considered to analyze the variations in absolute and specific carbon footprints in apparel manufacturing companies.

3.2.1 Variation of a total carbon footprint per earn minutes between different operational categories

The highest mean of a total carbon footprint per earn minute was recorded in the printing category as 0.3246 Kg CO_{2e} (SD±0.0399), followed by washing as 0.1780 Kg CO2e (SD±0.01822) and Embroidery/Product Development/Knitting as 0.1103 Kg CO2e (SD±0.0418). Cutting/Sewing/Packing & Finishing was recorded as 0.0340

Kg CO2e (SD±0.04708). The lowest was recorded in the Sewing/Packing & Finishing as 0.0195 Kg CO2e (SD±0.00529) (Figure 1). Printing, washing, and Embroidery/Product Development & Knitting operation categories were significantly different from each other, and the other two categories of Cutting/Sewing/Packing & Finishing and Sewing/Packing & Finishing. However, Cutting/Sewing/Packing & Finishing and Sewing/Packing & Finishing Results were not significantly different from each other (P <0.05).

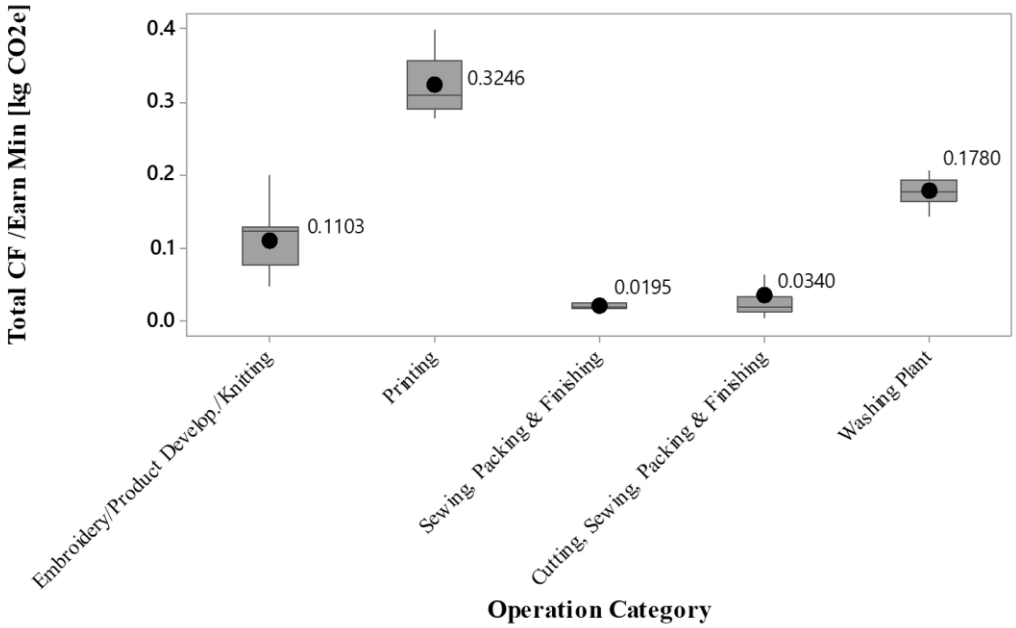

Figure 1: Variation of a total carbon footprint per earn minutes between different operational categories. (●) represents the mean value. The box represents the middle 50% of Carbon Footprint data. The line through the box represents the median of the Carbon Footprint. The whiskers extending from the box represent the upper and lower 25% of the Carbon Footprint data.

3.2.2 Monthly average variation of a total carbon footprint per earn minute for all strategic business units

The highest mean of a total carbon footprint per earn minute was recorded in September as 0.0672 Kg CO_{2e} (SD±0.0988), and the lowest mean was recorded in January as 0.0519 Kg CO_{2e} (SD±0.0768) (Figure 2). There was no significant difference in mean values between the months (P < 0.05).

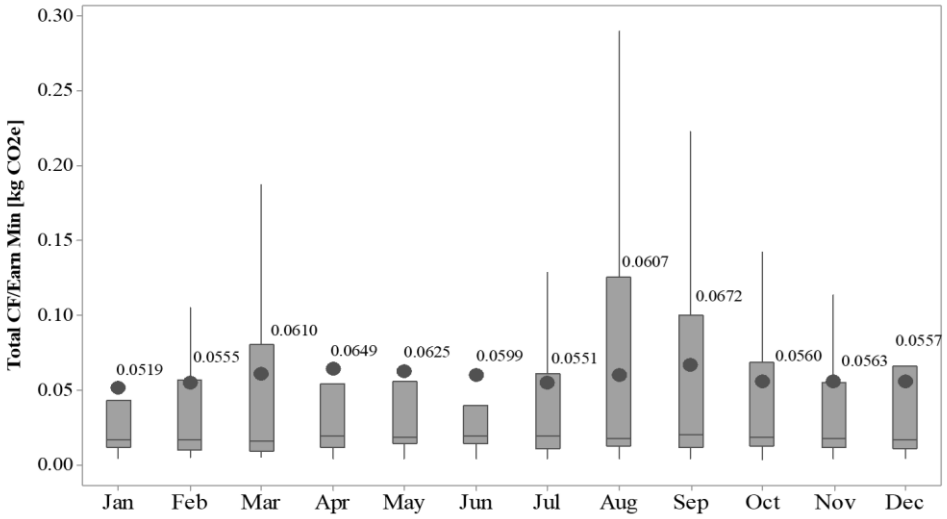

Figure 2: Monthly average variation of Total carbon footprint per Earn Minute for all strategic business units. (●) represents the mean value. The box represents the middle 50% of Carbon Footprint data. The line through the box represents the median of the Carbon Footprint. The whiskers extending from the box represent the upper and lower 25% of the Carbon Footprint data.

3.2.3 Quarterly variation of a total carbon footprint per earn minute for all strategic business units

The highest mean of total carbon footprint (Kg CO_{2e}) per earn minute was recorded in the second quarter of the year as 0.0631 Kg CO_{2e} (SD±0.0939), followed by the third quarter as 0.0611 Kg CO_{2e} (SD±0.0867) and the first quarter as 0.0559 Kg CO_{2e} (SD±0.0848). The fourth quarter's lowest mean was recorded as 0.0558 Kg CO2e (SD±0.0826) (Figure 3). However, there was no significant difference in mean values between the four quarters of the year ($P < 0.05$).

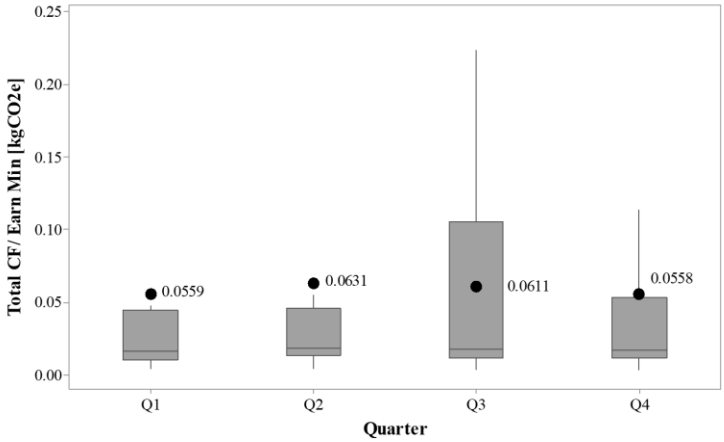

Figure 3: Quarterly average variation of Total carbon footprint per Earn Minute for all strategic business units. (●) represents the mean value. The box represents the middle 50% of Carbon Footprint data. The line through the box represents the median of the Carbon Footprint. The whiskers extending from the box represent the upper and lower 25% of the Carbon Footprint data.

3.2.4 Variation of specific carbon footprint (per earn minute) between the level of carbon management practices

The two clusters, Beginners and Emerging, which was determined from the previous cluster analysis (Refer Table 2 and Table 3), were used as the basis for this analysis. Among the two clusters, the highest mean specific carbon footprint was recorded in the Beginners cluster as 0.0594 Kg CO_{2e} (SD±0.08671). Emerging recorded 0.0569 Kg CO_{2e} (SD±0.0570) (Figure 4). The beginner cluster's mean specific carbon footprint was higher than the emerging cluster, but it was not significant ($P < 0.05$).

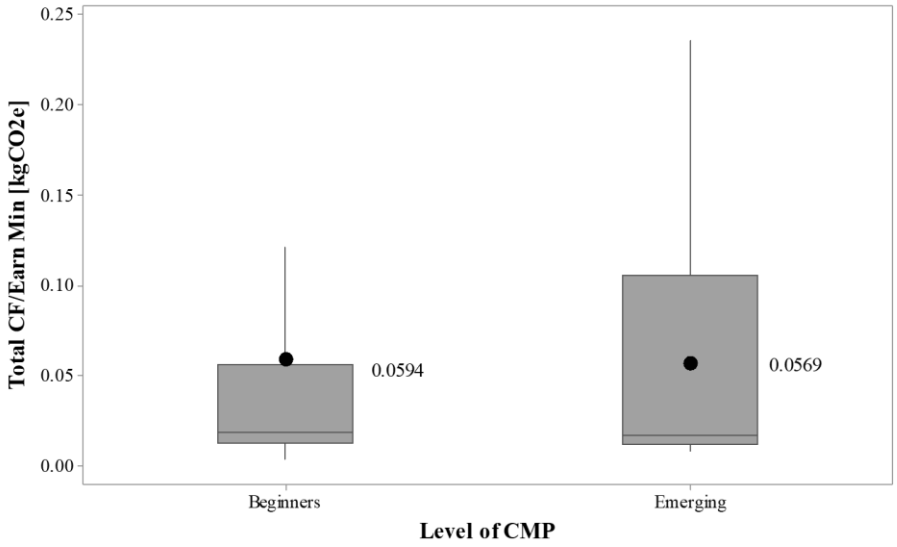

Figure 4: Variation of specific Carbon Footprint (per Earn minute) between levels of carbon management practices (Beginners and Emerging). (○) represents the mean value. The box represents the middle 50% of specific Carbon Footprint data (per earn minute). The line through the box represents the median of the Carbon Footprint. The whiskers extending from the box represent the upper and lower 25% of the Carbon Footprint data.

3.3 Polynomial regression analysis of specific carbon footprint (per earned minute) versus monthly earned minutes

Figure 5 shows the regression analysis between specific carbon footprint and monthly earned minutes. A decreasing trend was recorded in a specific carbon footprint with an increase of earned minutes. Specific carbon footprint shows a decreasing trend up to 3 million earned minutes and a slight increase up to approximately 5 million and yet again a decreasing trend afterwards.

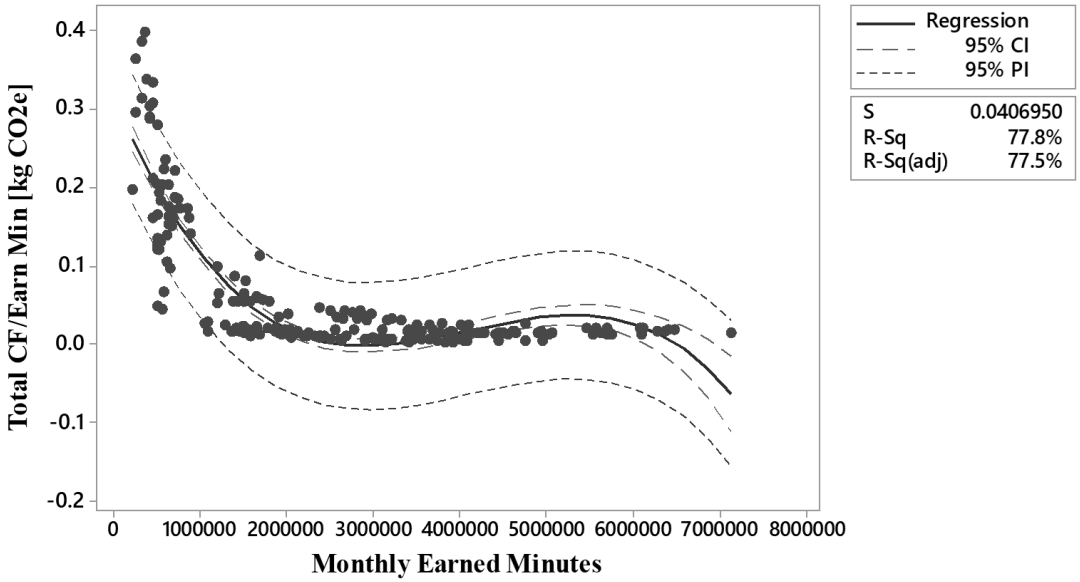

Figure 5: Regression analysis of specific carbon footprint and monthly earned minutes. (S) represents the standard distance data values fall from the regression line; (CI) represents the confidence interval; (PI) represents the prediction interval, defined by lower and upper limits, calculated from the confidence level and the prediction's standard error.

The derived regression equation is given as follows;

Specific CFP Monthly Earned Minutes = 0.3188-0.000000 MEM (3)

The fitted model explained 77% of variation in specific CF by monthly earned minutes ($R^2 = 0.778$, Adjusted $R^2 = 0.775$).

3.4 Association between CMP and CF of companies

Pearson correlation analysis was performed to identify the association between the CMP and CF of companies, and the results are presented in Table 4. Significant correlations were observed with a 99% confidence level. According to Table 4, the output p-values for policy (0.134), measurement (0.181), and implementation (0.750) was higher than the 0.05 level. Hence there is no evidence to reject H0 (H0: There is no relationship between dimensions of Carbon Management Practices and Carbon Foot Print of the apparel manufacturing companies, H1: There is a relationship between dimensions of Carbon Management Practices and Carbon Foot Print of the apparel manufacturing companies). Correlation for disclosure was not calculated in the test as it was at an equal level for all companies in the sample; hence it was

considered a constant. Thus, it can be concluded that there is no relationship between dimensions of CMP and CF of apparel manufacturing companies in Sri Lanka.

Table 4: Correlation analysis of CF and dimensions of CMP

		CF
Policy	Pearson Correlation	.367
	Sig. (2-tailed)	.134
	N	18
Measurement	Pearson Correlation	.330
	Sig. (2-tailed)	.181
	N	18
Implementation	Pearson Correlation	-.081
	Sig. (2-tailed)	.750
	N	18
Disclosure	Pearson Correlation	.a
	Sig. (2-tailed)	.
	N	18

a. Note: It cannot be computed because at least one of the variables is constant.

Further correlation between CMP and CF's overall value was tested, and the results are presented in Table 5 below.

Table 5: Correlation between CMP and CF's overall value

		CF
CMP	Pearson Correlation	.305
	Sig. (2-tailed)	.218
	N	18

According to Table 5, the output p-value of CMP and CF (0.218) is higher than the 0.05 level; hence there is no enough evidence to reject H_0 (H_0: There is no relationship between Carbon Management Practices and Carbon Footprint of the apparel manufacturing companies, H_1: There is a relationship between Carbon Management Practices and Carbon Footprint of the apparel manufacturing companies). Therefore, it can be concluded that there is no correlation between CMP and CF of apparel manufacturing companies in Sri Lanka.

3.5 Impact of CMP on CF

Simple regression was performed to analyze the impact of CMP on CF (Table 6 shows a summary of the simple regression analysis) based on the proposed hypothesis, which is H1: Carbon Management Practices' impact on Organizational Carbon Footprint of apparel manufacturing companies.

Table 6: Outputs of simple regression analysis

Coefficients a						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	.407	.326		1.249	.230
	CMP	-.087	.089	-.239	-.986	.339

a. Dependent Variable: CF

Table 6 shows that the output P value (0.339) is higher than the critical P-value of 0.05. hence there is no enough evidence to reject H0 (H0: Carbon Management Practices does not impact on Carbon Footprint of apparel manufacturing companies) at a 95% confidence level, and it is evident that Carbon Management Practices do not influence the reduction of Carbon Footprint of apparel manufacturing companies in Sri Lanka.

4. Discussion

Concerning the Green House Gas Management, most apparel manufacturing companies (77.7%) in Sri Lanka come under the "Beginner" category, where companies in their preliminary stages in applying carbon management practices. According to Jeswani et al. (2008), the beginner category corresponds to the companies which have initiated some of the operational activities in carbon management but are in the early stage of managing those activities. Beginner companies have to set up their carbon management programs with minimum resource allocation and focus on low-cost activities such as energy efficiency projects. However, based on the sample, none of the companies was categorized under the "Indifferent" cluster (companies which are not concern about the issues and regulations on the environment and not have taken the initial steps required for a climate change strategy such as establishing a policy, preparation of inventories of emissions). The reason could be the selected sample (based on the preliminary survey) consists of the companies who calculated the CF. They have already implemented some specific CMPs which may transfer organizations from indifferent categories to beginners or emerging categories. The emerging category represents the lower percentage from the sample. According to Jeswani et al. (2008), the emerging category consist of companies that are better than the" Beginner" category but are not up to the level of "Active" companies. Emerging companies follow the leaders but not the first movers in carbon management. They have implemented a carbon management system but are not verified externally. The organization's actions are limited to the legal requirements though they are aware of suitable options for improvements. Setting Carbon management policy, Preparation of GHG inventory, benchmarking of emissions has been carried out concerning carbon management. Specifically, these organizations engage in external activities such as fulfilling regulatory requirements to reduce emissions, participating in emission trading, and disclosing their emissions. With the findings of this study, Sri Lanka still has a significantly less number of organizations implementing their Carbon Management Practices up to a considerable level, which is required to impact the organization's environmental performances in terms of carbon. None of the company falls into the

"Active" category, which is superior among all the categories where their carbon management system has wholly developed and integrates with other business strategies, engage with a variety of operational activities such as shifting the use of fossil fuels to renewable sources (wind, solar, biomass). In this cluster, companies have usually prepared their complete GHG inventories, conduct regular assessments, identified the opportunities for improvements, and externally verified and disclosed their emissions. Management has considerably invested and committed to carbon management activities.

Few significant variations were identified in the study. High energy requirements for machinery and low earned minutes compared with the other operations could mark a high average total carbon footprint in printing operations. However, further investigations are required to make a precise conclusion on these variations between operations. Seasonal variations could affect to vary the demand for production and thereby vary the monthly emissions. High demand for production may lead to an increase the resource usage, overtime, etc. The highest value was recorded in September, and the lowest was in January. Seasonal variations (ex: Christmas) may affect to increase the production volume. In January, the completion of orders may reduce the production requirements compared to the other months. Specific carbon footprint (per earned minute) shows a decreasing trend where it can conclude that monthly earned minutes will reduce the companies' specific carbon footprint.

According to Jeswani et al. (2008), the emerging category is better than the beginner category in CMP's application. They have implemented a proper carbon management system, set up carbon management policy and targets, and prepared the GHG inventory. The assumption of this could be that better implementation of CMP should reduce the CF of the organization. After normalizing the variations caused by the production capacities, the specific carbon footprint (Kg CO2e per earned minute) of the emerging category was lower than the beginners but not significant in the study. Moreover, a significant association was not found between CMPs and CF, thereby not impact on reducing Carbon Footprint by implementing CMPs. It was evident that CMP's implementation does not produce any immediate results in the Sri Lankan context. The majority of the companies belong to the "beginner" cluster indicate the implementation of CMP is at the initial stages, which may not be sufficient to generate expected results within one year; this notifies a few things about implementing corporate CMPs, which does not reveal these practices' actual impact on GHG emissions. The implementation of CMPs may not lead to immediately observable reductions in GHG emissions. There was some evidence of this delayed impact elsewhere (Wu & Teng, 2014). Further this was supported by the finding of long-

term sustainability-related benefits is more visible than short-term value Haessler (2020).

Moreover, CMPs that are being implemented by companies may not be sufficiently impact-oriented. Corporations might be assuming that the mere presence of different CMPs reduces their GHG emissions without assessing the extent to which the CMPs are doing so. Expressed more directly, it could be that more attention should be paid not to the present but to the impact of corporate CMPs on the emissions that they are supposed to be reducing (Hrasky, 2011; Doda et al. 2015).

5. Conclusions

The majority of companies in the apparel manufacturing industry in Sri Lanka are still at their preliminary phase of implementation in Carbon Management Practices. They have initiated some operational activities, explicitly focusing on projects with low cost and less resource allocation. The absence of a regulatory requirement on emissions might encourage companies to stay focus on the minimum level of implementation in CMPs. Even though Sri Lanka does not have any regulatory requirements on emissions; few companies have voluntarily initiated and maintained the Carbon Management up to a considerable level. It is a good indicator that the Sri Lankan apparel manufacturing industry is moving towards the advancement in Carbon Management Practices. Further, it signals that most companies will possibly transform their CMPs into a better status with time. Significant variations of specific Carbon Footprint exist between the type of operations and during the year. However, the study revealed that initial stages of Carbon Management Practices do not reduce organizational Carbon Footprint in the short run.

6. Future Research Suggestions

The study does not identify specific CMPs that companies would apply which requires an in-depth investigation. Hence future researchers can focus on identifying specific CPMs and specific carbon reduction activities which companies apply where both qualitative and quantitative methods can be deployed to draw a more informative conclusion. Considering a longitudinal study that expands for several years or obtaining data for the last few years would generate more reliable findings than it would do when considering only one year. Further, there might be a reverse causality in the analysis of whether the CF's level or the level of change reduction/increase of CF drives the organization to implement CMPs (Contrary to the argument in the study whether the CMP impact on CF) in the context. Thus, investigating that possible reverse relationship is vital in future research.

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