

Corporate Response to Carbon Emissions: Focusing on Scope 3

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***Abstract:** Carbon emission is considered as a major cause for climate change over the world. The purpose of this study is to assess the influence of a new ground of carbon emissions which is Scope 3 emissions in Japanese companies and to have a perception whether Japanese companies are concerned about considering and calculating Scope 3 emissions. Three types of analyses of different sample sizes have been conducted in this study from 2011 to 2015 and the data source is CDP. This study finds that the influence of Scope 3 emission in Japanese companies is very alarming because Scope 3 is responsible for major portion of carbon emissions. Japanese companies are very conscious about climate change but they mainly focus on total carbon emission rather than Scope 3 emissions. This study appears to be the first to provide evidence about the influence and consciousness of Scope 3 emissions in Japanese companies.*

***Keywords:** Carbon emissions, CDP, Climate change, Scope 3.*

1. Introduction

Global warming indicates continuous increase in the average temperature of the world's atmosphere which causes permanent change in the earth's climate. The amount of carbon dioxide and other greenhouse gases (GHGs) are increasing every day which are the main sources of global warming (Liesen et al., 2015). Therefore, the motivation of this study is to reduce world-wide GHGs emission and help corporations to run green business. Thus, the importance of a very new arena of carbon emission which is Scope 3 emissions has been analyzed in this study.

An extensive number of studies have been conducted regarding the factors affecting carbon disclosure of firms, sustainability, and carbon emissions (Zhao and Schroder, 2010; Liesen et al., 2015; Luo et al., 2012) and it is noticeable that most of the previous

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studies (Rankin et al., 2011; Matisoff et al., 2013) consider scope 1 (Direct emissions released from sources directly controlled or owned by the reporting entity) and scope 2 emission (indirect emissions from electricity use). While scope 3 (emissions from product lifecycle, supply chain, and distribution) emission is frequently recorded as a discretionary supplement to the compulsory Scope 1 and Scope 2 emissions. But an effective corporate climate change policy necessitates a detailed understanding of a company's GHG. Otherwise, it's difficult to take into account all the emission- related risks and opportunities and focus on company's greatest GHG impacts.

Hence, this study tries to conduct an extensive analysis regarding the tendency of scope 3 emissions and an attempt has been made to justify the influence of scope 3 emissions over total emitted carbon in Japanese companies. Because in Japan, Carbon dioxide was major and responsible for more than 94% for total GHG emission among 6 different gases classified as GHG emission during 1990-2008 period and this percentage has started to increase from 91% in 1990 to 95% at the end of year 2008 (Huang & Nagasaka ,2011). Moreover, Japan's greenhouse-gas emissions rose to the second-highest on record in the year ended March 2014.

Thus the climate change data of Japanese companies provided by CDP has been analyzed in this study basically to focus on the influence of scope 3 emission. CDP is a not-for-profit organization that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts. It has been working since 2002 and created a system that has resulted in supreme engagement on environmental issues internationally.

Therefore, analyses of this research have been divided into three categories having particular objective of each analysis. The first research objective is to find out the influence of Scope 3 emission over total carbon emission by assessing the general trend of scope 3 emissions along with the industries' effect over Scope 3 emissions in Japanese companies.

Second research objective is to have an idea about the awareness of Japanese companies regarding carbon reduction. Hence, descriptive analysis for the management and stakeholder engagement related questions and responses of the Japanese companies provided by climate change questionnaire of CDP have been conducted. Thereafter, the directions of changes in the amount of 3 scopes of emissions individually and in total carbon emission have been calculated from 2014 to 2015.

Third and final objective of this study is to analyze the relationships of Scope 3 emission and total carbon emission with the management and stakeholders' engagement in Japanese companies. Thus, third analysis examines the relationships of the components of management and stakeholder engagement with Scope 3 carbon emission and total carbon emission by cross tabulation analysis using Chi-Square test.

The findings of this study demonstrate that the influence of Scope 3 emissions over total carbon emission is very alarming as Scope 3 shows increasing trend from 2011 to 2015. Secondly, the results of the industry analysis determine that material sector is mostly responsible for producing Scope 3 emissions in Japanese companies. The outcome of the analysis regarding Japanese companies' carbon performance concludes that Japanese companies are very aware of climate change as many companies respond to CDP questionnaire with positive viewpoint. In addition, Japanese companies are more conscious about total carbon emission reduction rather than managing Scope 3 emissions only.

Thus, contribution of this research comprises considerable significance to the world's climate change and especially to the carbon related literature as there is lack of comprehensive study relating to scope 3 emission in previous literature. Hence, this study will provide a solution for the dearth of scope 3 emission research and will add value to the quality of world's carbon literature.

Therefore, the rest of this paper is structured as follows: Next section describes about GHG protocol Scope 3. Literature review has been explained in section 3. Section 4 describes the research design of this study. Results and explanations of all the analyses of this study have been described in section 5. Section 6 concludes the study describing a bit implication of this research.

2. GHG protocol Scope 3

Through the development of the "GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard", the GHG protocol has responded to the requirement for an internationally accepted method to support GHG management of companies' value chains. The Greenhouse Gas Protocol (GHG Protocol) is a multi-stakeholder partnership of business, non-governmental organizations (NGOs), governments, and others organized by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). Launched in 1998, the mission of the GHG Protocol is to develop internationally accepted greenhouse gas (GHG) accounting and reporting standards and tools, and to foster their implementation in order to achieve a low emission economy worldwide.

The Corporate Value Chain (Scope 3) Accounting and Reporting Standard was first launched in 2001 and revised in 2004. This standard has been accepted as the international standard for developing and reporting businesses' GHG inventory. Moreover, this standard categorizes a corporation's direct and indirect GHG emissions into three scopes and exposes that substantial amount of carbon emissions and related

risks and opportunities arise from supply chain activities (Scope 3) which are not detained by Scope 1 (direct emission from owned and controlled sources) and Scope 2 (indirect emissions from the purchased energy consumed by the reporting entity).

It is noted that Scope 1, Scope 2 and Scope 3 are mutually exclusive for the reporting entity as if no double counting of emissions concerning the scopes. To explain more, a company's scope 3 list does not comprise any emissions already accounted for Scope 1 or Scope 2 by the same company and a company's combined Scope 1, Scope 2, Scope 3 emissions represent the total GHGs emissions related to that company.

In definition, Scope 3 emissions arise from sources owned or controlled by other entities in the value chain (e.g., materials suppliers, third party logistics providers, waste management suppliers, travel suppliers, lessees and lessors, franchisees, retailers, employees and customers). The GHG protocol Scope 3 Standard describes 15 distinct categories as Scope 3 which are divided into 2 groups: 1) Upstream emissions are indirect GHG emissions related to purchased or acquired goods and services. 2) Downstream emissions are indirect GHG emissions related to sold goods and services.

Hence, businesses can account for all scope 3 emissions as defined in the above list and should reveal and explain any exclusion. But companies should follow the principles of relevance, completeness, accuracy, consistency and transparency when deciding whether to exclude any activity from the scope 3 inventory. Companies should not exclude any action that would comprise the relevance of the reported inventory and should ensure the scope 3 inventory properly reflects the GHG emissions of the company.

3. Literature Review on carbon disclosure and carbon management

Up to the present time, most of the researches on CDP have concentrated on accelerating the disclosure of carbon information (Freedman and Jaggi, 2005; Rankin et al., 2011,). Luo et al. (2012) examine the data of 291 companies published in CDP 2009 and their study shows that larger firms prefer to disclose carbon information voluntarily even in the absence of a required accounting and reporting standards because they are aware of social responsibility. Moreover, Liesen et al., (2015) finds that the percentage of making GHG emissions disclosures by EU companies has risen from 52 percent in 2005 to 71 percent by 2009, they added.

Apart from the studies related to carbon disclosure, there are many previous researches which focus on carbon and environment management practices particularly. Haslam et al. (2014) focus on the nature of carbon footprint treatment for society utilizing numbers and narratives to explore changes in carbon footprint. Their analysis suggests that there are reasons to be optimistic about reducing carbon usage as carbon emissions reported by the FTSE62 group of firms have remained flat in recent years.

Eccles et al., (2012) finds that non-monetary incentive for management has positive associations with the lower carbon emission and monetary incentives hold for higher carbon emission. This finding is derived by both in cross-sectional and time-series analysis, they added. Correspondingly, Zhao and Schroeder (2010) documented that the driving forces for high urban ecological footprints are per capita energy consumption, CO₂ emissions and carbon footprints. They also state that in most Asian countries per capita emissions are still below world average.

Feng et al., (2009) conduct a study to analyze how several socio-economic factors contribute to spread CO₂emissions overtime period. Their analysis concludes that the two key driving forces for the changes in CO₂emissions in the pre-reform period (until 1978) which are growing population and industrial structure change.

Lodhia and Martin (2012) analyze 105 public submissions on the NGER policy paper issued by the Australian Department of Climate Change. Their study finds a positive association between the NGER process and a future emissions trading scheme. Their study also suggests to pay close attention on the advancement of tool for setting carbon price. Nakamura et al. (2001) conduct a study about Japanese companies and their study concludes that manufacturers of consumer products in Japan face little market pressure to integrate green policies as advertising intensity has limited influences on companies' environmental responses.

Matisoff et al., (2013) talked a little bit about scopes of carbon which concludes that firms have been increasingly likely to employ a standardized accounting methodology and report numerical data in response to Scope 1, 2, and 3 emissions queries separately. But no major or specific analysis has been conducted regarding scope 3 emissions in that study.

To summarize, previous researches have exhibited wide variations in strategic decision-making of firms related to carbon performance and disclosure as well. Larger firms prefer to disclose more GHG information without any mandatory regulation and there is a positive association between complete GHG disclosure and improved climate change performance. Another finding is that non-monetary management incentives have positive association with lower carbon emission. It is also evidenced in previous studies that due to population growth, technological advancements have not been able to offset the increase of carbon emissions. Hence, in spite of having lots of researches regarding carbon or climate change, a gap of conducting analysis with scope 3 emission is apparent. This has opened a new arena for this study to focus on scope 3 emission. Thus, this study will add value to previous studies examining the influence of Scope 3 emission over total carbon emission in the companies of Japan.

4. Research Design

4.1: Framework

Research design of this study is structured in 3 parts of analyses and every analysis has some segments. To clarify, first analysis has been conducted to explain the trend of carbon emission and industrial effect. Therefore, first analysis has two parts. In first part of analysis 1, the trend of 3 scopes (Scope 1, Scope 2, Scope 3) of carbon emission have been determined to find out the influence of Scope 3 carbon emission from the year 2011 to 2015 and second part of analysis 1 depicts the industrial effects for the year 2015.

Analysis 2 is all about studying 112 Japanese companies' carbon performance. There are 2 parts in analysis 2. First part of analysis 2 comprises descriptive analysis of the Japanese companies' carbon management and second part of analysis 2 is to find out the direction of changes in the amount of carbon emission from 2014 to 2015.

The third and final analysis of this study is to examine whether management and stakeholder engagement have any association with Scope 3 emissions and total carbon emission which has been examined by cross tabulation analysis using Chi-square test. So analysis 3 has two parts. First part of analysis 3 is to assess the relationship between management and Scope 3 emission as well as total carbon emission. Subsequently, second part of analysis 3 examines whether Scope 3 emissions and total carbon emission are associated with stakeholder engagement for climate change. It is noted that all the tables in the study have been made by the author using the data of CDP.

4.2: Sample and Data

The sample of this study has been selected based on the type of analysis. For the part 1 of analysis 1, CDP data disclosed by the 652 companies (only those companies who must disclose scope 3 carbon emission along with Scope 1&2) of Japan from 2011 to 2015 and for the part 2 of analysis 1, CDP data disclosed by the 159 companies of Japan only in 2015 have been considered. Subsequently, for analysis 2 and 3, the CDP data of 112 Japanese companies of 2014 and 2015 have been selected (**Please see Appendix 1**).

5. Results and Interpretations

5.1: Trend of carbon emission in four countries and industrial effect

CDP requests companies to provide data about Scope 1, Scope 2 and Scope 3 emission in metric tonnesCO₂e. Different countries use the different standard, protocol or methodology to calculate the amount of carbon emission. Thus the data provided by CDP has been used in analysis 1 to find the percentages of 3 scopes of carbon emission over total carbon emission over the years and in 10 different industries. The main objective of this analysis is to find out the influence of Scope 3 emission over total carbon emission based on time and industry.

5.1.1: Trends of the amount of carbon emission over the years

In the part 5.1.1, the percentages of all 3 scopes of emission to total carbon emissions have been calculated over the years and presented in the following table to find out the influence of scope 3 emissions over total carbon emission. Here the amount of scope 1, 2 and 3 carbon emission have been calculated per company and afterward, total amount carbon emission per company has been calculated. Finally, the percentages have been determined.

Table 1: Trend of 3 scopes of carbon emission in Japan from 2011 to 2015:

Scopes Dates	Scope 1 emissions	Scope 2 emissions	Scope 3 emissions
2011	21.83%	10.14%	68.03%
2012	14.71%	6.19%	79.10%
2013	11.78%	6.40%	92.42%
2014	7.90%	3.54%	88.56%
2015	6.09%	3.59%	90.32%

In Japan, both in Scope 1 and Scope 2 emissions, a decreasing trend is noticeable over the years as in 2011 the percentage of Scope 1 emissions was 21.83% and falls to 6.09% in 2015 which reveals more than 3times less carbon emission compared to 2011. Accordingly, Scope 2 emission has decreased as almost 3 times compared to 2011 (10.14%) to 2015 (3.59%).

But Scope 3 emission always shows a high percentage having a little bit fluctuation in 2014 as it falls to 88.56% from 92.42% in 2013. Still an increasing trend of Scope 3 emission is noticeable in Japanese companies from the year 2011 (68.03%) to 2015 (90.32%).

As the main focus of this study is Scope 3 emission, therefore we can see that in 2011, the percentage of Scope 3 emissions is 68.03% which rises to 90.32% in 2015. So companies in Japan are progressing much to count and disclose Scope 3 emissions in recent years compared to previous days.

To summarize analysis 5.1.1, it can be said that Scope 3 emissions cover the maximum portion of total carbon emission compared to Scope 1 or Scope 2 emissions and it has been showing growing trend since 2011 till 2015 as exhibited by the above analyses of the 652 sample companies of Japan. So influence of Scope 3 emissions to GHGs in Japanese companies is very concerning.

5.1.2: Industrial effect over carbon emission

Analysis 5.1.2 is accomplished to justify the industrial effect over scope 3 emissions meaning which industry sectors are primarily responsible for Scope 3 emissions. Following table shows the accumulation of the information of total scope 1, scope 2 and scope 3 emissions by 10 different industry sectors categorized by Global Industry Classification Standard (GICS) of 159 sample companies in Japan for the year 2015.

The abbreviate forms of the 10 industry sectors have been used in the tables. So the words are explained as: Consumer Discretionary= C.D, Consumer Staples= C.S, Energy= Enr, Financials= Fin, Health Care =H.C, Industrials=Inds, Information Technology= I.T, Materials=Mtrl, Telecommunication Services= T.S, Utilities= Utl. For each industry sector of each scope of carbon emission, the amount per company has been shown in percentages.

Table 2: Total of scope 1, 2 & 3 carbon emission in Japan 2015

Industry Scope	C.D	C.S	Enr	Fin	H.C	Inds	I.T	Mtrl.	T.S	Utl.
S1	2.1%	1.6%	48.0%	0.2%	0.4%	9.4%	0.7%	16.1%	0.3%	21.3%
S2	15.2%	8.2%	6.6%	1.7%	1.8%	8.5%	7.8%	19.1%	25.8%	5.4%
S3	2.2%	9.2%	13.4%	1.0%	2.7%	1.3%	0.2%	52.0%	5.6%	12.4%

Table 2 displays that in Japan, Material sector (52.0%) and Energy sector (13.4%) are responsible for producing maximum Scope 3 emissions. Energy sector (48.0%) is also producing maximum Scope 1 emissions but major portion of Scope 2 emits from telecommunication services (25.8%). Moreover, figure 1 demonstrates that in 2015, more than 80% carbon of Japan's total industry sector is discharged from Scope 3 emissions. Surprisingly only 2% carbon of total industry is caused by Scope 2 emissions while 14% of Japan's total industry sector in 2015 emits from Scope 1.

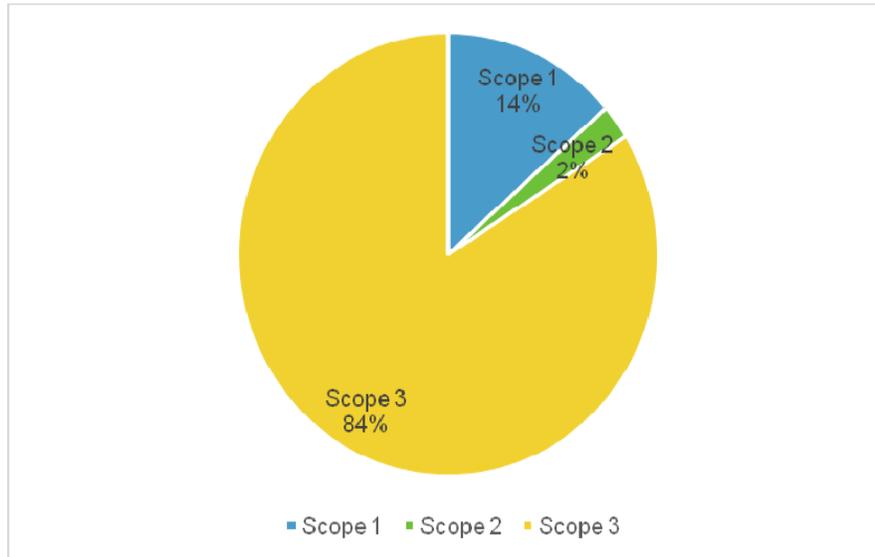


Figure 1: Proportion of 3 scopes of Carbon emission in industry sectors of Japan

To summarize analysis 5.1.2, it can be anticipated that in Japan, Material sector is responsible for maximum Scope 3 emissions (52.0%). Therefore, companies in Japan of material sector like chemical or paper making companies are mostly responsible for Scope 3 emissions. Thus, government may pay attention to the carbon reduction target of chemical or paper making companies in Japan.

5.2: Analyzing 112 Japanese companies' carbon emission

Second focus of this study is to analyze 112 Japanese companies' carbon emission for the year 2015. Therefore, analysis 2 has been divided into 2 parts. First part is all about a descriptive analysis which will represent the level of Japanese companies' consciousness regarding climate change and carbon emission specially by analyzing responses of Japanese companies' to CDP climate change questions. Calculation of the amount of 3 Scopes of carbon emission, total carbon emission for the years 2014 and 2015 will be performed to determine the direction of change in the amount of carbon emission in 2015 which will be conducted in second part of analysis 2 of this study.

5.2.1: Japanese companies' behavior for carbon emission.

Descriptive analysis has been conducted to analyze how many companies respond 'YES' and how many companies respond 'NO' to each particular climate change question. Basically the questions have been selected from the management and stakeholder engagement portion of CDP questionnaire 2015. The percentage for each type of response has been shown also alongside the number of companies.

1) Incentives for managing climate change (CC)

Table 3: Number of companies providing incentives for managing climate change issues

Response	Number of companies (percentage)
YES	108 (96%)
NO	4(4%)
Total	112

Table 3 represents that among 112 Japanese companies, only 4 (4%) companies don't provide any incentives for managing climate change issues and 108 (96%) companies provide monetary, recognition reward or other non-monetary incentives to the management as incentive for managing climate change issues.

2) Risk Management procedures for climate change

Table 4: Number of companies having risk management procedures regarding climate change risks and opportunities

Response	Number of companies (percentage)
YES	109(97%)
NO	3(3%)
Total	112

Risk management procedure regarding climate change is an important initiative to cut emission progressively. So the responses of companies having risk management procedures regarding climate change risks and opportunities have been shown in table 4. But still 3 companies don't have any risk management technique while 109 (97%) companies have so.

3) Integrating climate change into Business Strategies

Table 5: Number of companies who integrate climate change into their business strategy?

Response	Number of companies (percentage)
YES	109 (98%)
NO	2 (2%)
Total	111

Table 5 represents that 109 (98%) companies integrate climate change into business strategy. The two companies who don't integrate climate change into their business strategy are Advantest Corporation and Kurita Water Industries Ltd.

4) Internal Price of carbon

Table 6: Number of companies who use an internal price of carbon?

Response	Number of companies (percentage)
YES	22 (21%)
NO	82 (79%)
Total	104

As declared by CDP that only 22 (21%) companies use an internal price of carbon while 82 companies (79%) don't use any internal price of carbon among 112 companies in Japan which is shown in table 6. It is noted that in total, only 35 (19%) companies use an internal price of carbon in Japan according to CDP 2015 which suggests that using internal price of carbon is very new issue in Japan.

5) Engagement with Policy makers

Table 7: Number of companies engaging with policy makers.

Response	Number of companies (percentage)
YES	63 (57%)
NO	48 (43%)
Total	111

Table 7 describes that 63 (57%) companies engage with policy makers that could either directly or indirectly influence public policy on climate change and 48 (43%) companies don't engage with policy makers.

6) Emission Reduction Initiatives (ERI)

Table 8: Number of companies who have emissions reduction initiatives

Response	Number of companies (percentage)
YES	111 (99%)
NO	1(1%)
Total	112

Table 8 represents that except one company, the rest 111 sample companies have emission reduction initiatives which is a hopeful aspect of Japanese companies to contribute to carbon reduction measures. The company which does not have emissions reduction initiatives is Yamato Holdings Co., Ltd, a company of air Freight transportation and Logistics industry.

7) Publishing climate change Information other than in CDP

Table 9: Number of companies who publish information regarding climate change and GHG emissions performance other than in CDP.

Response	Number of companies (percentage)
YES	107 (96%)
NO	5(4%)
Total	112

Table 9 comprises the responses of the Japanese companies whether they publish information regarding climate change and GHG emission performance other than in CDP. It is found that almost all the companies 107 (96%) disclose their climate change data not only in CDP but through reports while only 5 (4%) companies don't do so.

8) Identifying Inherent climate change risk

Table 10: Number of companies identifying inherent climate change risks.

Response	Number of companies (percentage)
YES	109(97%)
NO	0(0%)
Total	109

Among 109 respondent companies, 100% (109) companies have identified inherent climate change risks that have the potential to generate a substantive change in their business operations, revenue or expenditure as derived by the table 10.

9) Participation in Emission Trading Scheme (ETS)

Table 11: Number of companies participating in emissions trading schemes (ETS)?

Response	Number of companies (percentage)
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Response	Number of companies (percentage)
YES	52(46%)
NO	60(54%)
Total	112

It is found from the table 11 that less than half of the 112 Japanese companies participate in ETS as only 52 (46%) companies have 'YES' response and 60(54%) companies don't participate in ETS. But some companies don't participate in ETS now though but they are anticipating doing so in the next 2 years.

10) Engagement with Customers about climate change strategies

Table 12: Number of companies engaging with customers about climate change strategies.

Response	Number of companies (percentage)
YES	59 (53%)
NO	52 (47%)
Total	111

Table 12 shows that 59 (53%) companies engage with their customers in value chain about GHG emissions and climate change strategies while 52 (47%) companies don't engage with their customers in value chain.

11) Engagement with Suppliers regarding climate change strategies

Table 13: Number of companies engaging with suppliers regarding climate change strategies.

Response	Number of companies (percentage)
YES	74 (67%)
NO	37 (33%)
Total	111

Among 111 respondent companies 74 (67%) companies engage with suppliers on their value chain and only 37 (33%) companies don't engage with their suppliers regarding GHG emission or climate change strategies.

To summarize the part 1 of analysis 2, the responses of Japanese companies to management and stakeholders' engagement related questions of CDP have been scrutinized well in the above 11 tables. It is found out from this analysis that majority of the companies in Japan are concerning much to manage climate change and reduce carbon emission by applying strong strategic policies or engaging with their stakeholders.

5.2.2: Trends in the amount of carbon emission.

Analysis 5.2.2 includes to present the direction of changes in 3 Scopes of emission from the year 2014 and 2015 of 112 Japanese companies. The directions of changes have been differentiated in increase, decrease and no change. Please see **Appendix 1** for details.

Table 15: Direction of changes in CO2 emission of Japanese companies from 2014 to 2015

Directions Scopes	Increase	Decrease	No change
Scope 1	51 (46%)	60 (53%)	1
Scope 2	75(67%)	37 (33%)	0
Scope 3	71(64%)	40 (35%)	1
Total	82 (73%)	30 (27%)	0

The number of companies according to increase, decrease and no change in the amount of each scope of carbon emission and total carbon emission from 2014 to 2015 have been shown in the table 15. It is determined that among 112 companies in Japan, in 51(46%) companies, the amount of scope 1 emissions increases in 2015 from 2014, in 60 (53%) companies, the amount of scope 1 emissions decreases and only 1 company shows that there is no change in its amount of scope 1 emissions from 2014 to 2015. Totally reverse result is noticed in case of scope 2 emissions. As in case of scope 1 emissions, the number companies for decreased amount were more than the number of companies of increased carbon emission.

But among 112 Japanese companies 75 (67%) companies reveal that their amount scope 2 emissions increase from 2014 to 2015 and only in 37 (33%) companies, amount of

scope 2 emissions decreases. Same result is evident in case of scope 3 emissions because only in 40 (35%) Japanese companies, amount of scope 3 emissions decreases from 2014 to 2015. On the other hand, 71 (64%) companies disclose that amount of scope 3 emissions increases from 2014 to 2015 in their companies and there is no change in the amount of scope 3 emissions only in 1 company.

Finally, in case of total carbon emission, only 30 (27%) companies show that there is a decrease movement in the amount of total carbon emission where in 80 (73%) companies, increase direction is noticed. So maximum companies (73%) in Japan cannot afford to cut total carbon emission and Scope 2, Scope 3 emissions as well. But many companies (53%) have been able to cut carbon emission in case of activities directly controlled or owned by the reporting entities which are known as Scope 1 emissions.

5.3: Association of management and stakeholders' engagement with carbon emission

5.3.1 Relationship between management and carbon emission.

The relationships between some determinants related to management and direction of change in Scope 3 emissions along with direction of change in total carbon emission have been examined by cross tabulation analysis using Chi-square test in 5.3.1. The variables are Management Incentive, Risk Management, ERI (Emission Reduction Initiative), Publishing Information other than CDP, Identifying Climate Change Risk, participation in emission trading scheme (ETS), having internal price of carbon, integrating climate change into business strategy and directly engagement with policy makers.

The objective of this analysis is to find out whether management has any impact over Scope 3 emissions or total carbon emission and exactly which determinants of management have associations with Scope 3 emissions. Findings of the results of analysis 5.3.1 have been displayed in the table 16.

Table 16: Significance level of the relationship of management with Scope 3 and total carbon emission.

Type of emission Variables	Scope 3 emissions	Total carbon emission
Management Incentive	Not Significant	Significant***
Risk Management	Not Significant	Not Significant
Emission Reduction Initiatives	Not Significant	Not Significant

Publishing Information other than CDP	Not Significant	Significant**
Climate Change Risk	Not Significant	Not Significant
Emission Trading Scheme	Not Significant	Significant***
Carbon Price	Significant**	Not Significant
Business Strategy	Significant*	Not Significant
Engagement with policy makers	Not Significant	Not Significant

Significance at p value < 0.1*, p value < 0.05**, p value < 0.01***

Table 16 shows the results of the impact of management over both Scope 3 emissions and total carbon emission. The detailed information of this analysis has been shown in **Appendix 2**. When we look at the overall scenario, we can see that there are 3 determinants which are management incentive, publishing information other than CDP and participation in ETS are related with the increase and decrease of total carbon emission. This result signifies that if management is given monetary or non-monetary reward for attaining certain climate change targets, that has an extensive effect over the changes in the amount of total carbon emissions in Japanese companies. Additionally, companies in Japan are more likely to be transparent to their stakeholders as the companies try to report on the increased amount of emission voluntarily through several medias other than CDP. Moreover, companies with increased amount of emissions are more likely to participate in ETS. The probable reason behind this finding is that companies with increased amount of emissions frequently need to trade emissions with other companies in order to ensure that the carbon savings are made as cheaply as possible.

On the other hand, two variables which are carbon price and integrating climate change with business strategy have relationship with the increase and decrease of Scope 3 emissions in Japanese companies. All the relationships are negative, meaning companies with increased amount of emissions have relationships with the determinants of the management.

5.3.2: Relationship between stakeholders' engagement and carbon emission.

The associations between the elements of stakeholders' engagement and direction of change in Scope 3 emissions along with direction of change in total carbon emissions have been examined by cross tabulation analysis using Chi-square test in part 5.3.2. In this analysis, two main parts of stakeholders are considered which are engagement with

suppliers and customers. This analysis aims at finding out whether stakeholders' engagement has any association with Scope 3 emissions or total carbon emission.

Results of analysis 5.3.2 have been exhibited in the table 17. Detailed analyses are shown in **Appendix 3**.

Table 17: Significance level of stakeholders' engagement over Scope 3 and total carbon emission.

Variables \ Type of emission	Scope 3 carbon emission	Total carbon emission
Suppliers	Not Significant	Significant ***
Customers	Not Significant	Not Significant

Significance at p value < 0.01***

Table 17 shows that stakeholders' engagement does not have any association with the increase or decrease of Scope 3. This finding implies that although many companies in Japan engage with customers or suppliers for reducing carbon but it might not result in any influence over the increase or decrease in Scope 3 emission.

On the other hand, engagement with suppliers have relationship with increase or decrease of total carbon emission while engagement with customers does not have any association. This finding can be interpreted that in order to keep long term business relationship, suppliers try to implement the p strategies for reducing carbon emission as no supplier wants to lose any client. Conversely, customers don't have any relationship over total carbon emission because customers may not care to implement all the strategies to reduce carbon taken by the companies as customers might not feel to keep long term relationship with the companies.

6. Conclusion and Implication

The main intent of this study is to examine the impacts of Scope 3 emissions over total carbon emissions in current business field along with finding out the awareness of Japanese companies regarding carbon management. Focusing on a sample of 652 companies of Japan disclosing their information in CDP over the period from 2011 to 2015, this study finds that a substantial proportion of carbon emits from Scope 3 and an increasing trend is noticed in the companies of Japan from 2011 to 2015. This finding implies that companies are progressing gradually to calculate and disclose Scope 3 emissions but have not been able to reduce the emissions.

Furthermore, analysis of carbon emission in 10 industry sectors in Japan demonstrates that more than 50% of total carbon releases from Scope 3 inventories and material sector is producing maximum Scope 3 emissions. Thus Scope 3 emissions have greater impacts over the global GHGs emission and climate change.

Subsequently, study of Japanese companies' responses to climate change concludes that companies in Japan are very aware of climate change as almost all the sample companies respond to CDP climate change questions.

However, the assessment of management and stakeholders' engagement of 112 Japanese companies for the years 2014 and 2015 for affecting Scope 3 and total carbon emission finds that having internal price of carbon and integrating climate change into business strategies have relationship with the increase or decrease of Scope 3 emissions while total carbon emission has relationship with management incentives for climate change strategies, publishing GHGs emission data other than in CDP, participating in ETS and engagement with suppliers for reducing carbon emission.

This finding suggests that companies in Japan basically formulate their climate change strategies focusing on total carbon emission not considering Scope 3 emissions only. The probable reason might be that Scope 3 emission is very new issue and companies might be planning some management strategies for calculating Scope 3 emissions but those strategies might have not been executed yet.

To conclude, this research is motivated to reduce global GHGs emissions and required to establish the various themes of carbon management mainly focusing on Scope 3 emissions. There are extensive number of previous studies based on carbon emission but this study improves prior literature in two significant ways. Firstly, this study reveals the importance of Scope 3 emissions from actual data of corporations which is very important to consider as a large portion of carbon emission of the businesses are released from Scope 3 inventories and there is dearth of study concentrating on Scope 3 emissions in previous carbon literature.

Secondly, companies, policy makers and researchers can have idea from this study about the importance of Scope 3 emissions looking at the emissions trend and industrial representation concerning Scope 3 emissions and can take proper steps to control carbon emissions.

The limitation of this study is that the sample firms are from CDP where all the companies have not been considered. Hence, future research may consider all the companies of a particular country or several developed countries for comparing the similarities and dissimilarities of the determinants influencing Scope 3 emissions. Such an investigation can extract more insights about corporate carbon management and

mitigation strategies.

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Appendix 1: Description of the sample of analysis 2 and 3

Table 1: Sample companies of analysis 2 and 3 along with the detailed calculation of part 5.2.3

Serial No.	Organization	Direction of change in Scope 1 (metric tonnes)	Direction of change in Scope 2 (metric tonnes)	Direction of change in Scope 3 (metric tonnes)	Direction of change in total emission (metric tonnes)
1	Advantest Corporation	1531.18	2549.79	-51.72	4029.25
2	Aeon Co., Ltd.	-152367	-1697076	274197	-1575246
3	Ajinomoto Co.Inc.	126020	-112089	407550	421481
4	Anritsu Corporation	13.52	2167.2	857.31	3038.03
5	Asahi Glass Co., Ltd.	50000	120000	5000100	5170100
6	Asahi Group Holdings, Ltd.	45128	25971	63188	134287
7	Asahi Kasei Corporation	62956	3156	5699074	5765186
8	Asics Corporation	175	6173	-42975	-36627
9	Astellas Pharma Inc.	-12181	7179	212354	207352
10	Azbil Corporation	-831	-967	372469	370671
11	Canon Inc.	48810	131092	129389	309291
12	Dai Nippon Printing Co., Ltd.	-24100	-6800	-20800	-51700
13	Daiichi Sankyo Co., Ltd.	-83447	-220322	-6413	-310182
14	Daikin Industries, Ltd.	142565	15950	46673398	46831913
15	Dainippon Sumitomo Pharma Co., Ltd.	12404	6755	-1979322	-1960163
16	Daito Trust Construction Co., Ltd.	-8515.28	2095.09	-160508.66	-166928.85
17	Daiwa House Industry Co., Ltd.	4848.23	37241.67	361062	403151.9
18	Daiwa Securities Group Inc.	-317.7	38745	-795	37632.3
19	Dentsu Inc.	3633.25	39561.68	38200.99	81395.92
20	DISCO Corporation	-5639	6289	281538	282188
21	FP Corporation	-79	30683	-34021	-3417
22	Fuji Electric Co., Ltd.	9126	-4264	10232	15094
23	Fuji Xerox Co., Ltd.	-2184	-7021	42648	33443
24	Fujikura Ltd.	-1527.3	-3085.96	-2661014.4	-2665627.65

Serial No.	Organization	Direction of change in Scope 1 (metric tonnes)	Direction of change in Scope 2 (metric tonnes)	Direction of change in Scope 3 (metric tonnes)	Direction of change in total emission (metric tonnes)
25	Fujitsu Ltd.	-18600	-32800	-374109	-425509
26	Furukawa Electric Co., Ltd.	60778	414340	2019835	2494953
27	GS Yuasa Corporation	6591	34976	-1198	40369
28	Hitachi Chemical Company, Ltd.	3500	11800	8100	23400
29	Hitachi Construction Machinery Co., Ltd.	-1637.77	4275.87	20678381.3	20681019.35
30	Hitachi, Ltd.	-55256	-23542	20371210	20292412
31	Honda Motor Company	-33000	66000	-3901000	-3868000
32	Ibiden Co., Ltd.	-89800	154700	-4100	60800
33	IHI Corporation	6530	13232	5981307.74	6001069.74
34	Inpex Corporation	-76209	8854	-61042116	-61109471
35	Japan Tobacco Inc.	-8213	-1629	-92837	-102679
36	Kajima Corporation	-36638	5223	-22121	-53536
37	KAO Corporation	29000	21000	208300	258300
38	Kawasaki Heavy Industries, Ltd.	-11622.7	44494.83	-2523628	-2490755.84
39	Kawasaki Kisen Kaisha, Ltd.	649221	16046	-275939	389328
40	KDDI Corporation	757.38	227657.64	1204534.25	1432949.27
41	Kintetsu Corporation	28	-576	76241	75693
42	Konica Minolta, Inc.	7405	-10770	-33891	-37256
43	Kubota Corporation	38800	15600	15666800	15721200
44	Kurita Water Industries Ltd.	1938	33159	-78	35019
45	LAWSON, Inc.	500	3000	722200	725700
46	Lion Corporation	-3188	-244	720593	717161
47	LIXIL Group Corporation	-31771	-24685	-6509	-62965
48	Mazda Motor Corporation	-7980	26230	-1723593	-1705343
49	Mitsubishi Chemical Holdings Corporation	-311000	-203000	10687000	10173000
50	Mitsubishi Heavy Industries, Ltd.	83700	98200	-5286	176614
51	Mitsubishi Materials Corporation	122060	-23032	-3297	95731
52	Mitsubishi UFJ Financial Group, Inc.	-1162	37332	-3443	32727

Serial No.	Organization	Direction of change in Scope 1 (metric tonnes)	Direction of change in Scope 2 (metric tonnes)	Direction of change in Scope 3 (metric tonnes)	Direction of change in total emission (metric tonnes)
53	Mitsui O.S.K. Lines Ltd	992889.6	-460674.16	-1921330	-1389114.6
54	Mizuho Financial Group, Inc.	-75.4	39156.27	9441764.69	9480845.56
55	Mori Building Co, Ltd.	-924	-4251	27761.36	22586.36
56	MS&AD Insurance Group Holdings, Inc.	-1536	11823	536938	547225
57	Murata Mfg. Co.	-1100	174800	1017600	1191300
58	Nabtesco Corporation	-795	4131	117304	120640
59	Nankai Electric Railway Co., Ltd.	1246	-320	72162.41	73088.41
60	NEC Corporation	-1671.72	42234.42	1945420	1985982.7
61	NGK Spark Plug Co., Ltd.	-6307	70414	581345	645452
62	Nikon Corporation	-1041	-306	3163894	3162547
63	Nippon Express Co., Ltd.	-63898	-30381	525346	431067
64	Nippon Kayaku Co., Ltd.	45	-2005	51609	49649
65	Nippon Yusen Kaisha Line	-379729	-4762.98	-187449.7	-571941.63
66	Nisshinbo Holdings Inc.	5525	8026	-3936	9615
67	Nitto Denko Corporation	27820	101455	352	129627
68	Nomura Holdings, Inc.	151	-4480	31537	27208
69	Nomura Research Institute, Ltd.	-156.51	-3852.11	143681.91	139673.29
70	NSK Ltd.	5141	23803	3009217	3038161
71	NTT Data Corporation	-61	3898	1141497	1145334
72	NTT DOCOMO, INC.	-10132	76801	3998551	4065220
73	NTT Urban Development Corporation	986.9	-9813.3	139501.41	130675.01
74	Olympus Corporation	-6244	6810	29000	29566
75	OMRON Corporation	16423	18752	5035910	3542294
76	ORIX Corporation	-51191	22416	16367	-12408
77	Panasonic Corporation	-142755	-351765	-4896000	-5390520
78	Pioneer Corporation	-1638.33	153.39	65253.75	63768.81
79	Ricoh Co., Ltd.	-2471	29942	-36811	-9340
80	Rinnai Corporation	6603.07	5915.73	-1254	11264.8
81	Rohm Co., Ltd.	-85851.7	14909.46	386462.2	315520.01

Serial No.	Organization	Direction of change in Scope 1 (metric tonnes)	Direction of change in Scope 2 (metric tonnes)	Direction of change in Scope 3 (metric tonnes)	Direction of change in total emission (metric tonnes)
82	Sapporo Holdings Limited	-1530.08	26429.2	-241688	-216788.88
83	Secom Co., Ltd.	-781.69	-939.15	142255.4	140534.56
84	Sekisui Chemical Co., Ltd.	8175.03	6321.63	245443.43	259940.09
85	Sekisui House, Ltd.	-15715.9	-6404.23	597519	575398.85
86	Seven & I Holdings Co., Ltd.	-24864	115809	19217262	19308207
87	Seven Bank, Ltd.	0	194	-14196	-14002
88	Shimizu Corporation	-24972	5373	-519675	-539274
89	Shiseido Co., Ltd.	-645	7726	1099045	1106126
90	Sumitomo Chemical Co., Ltd.	509000	3284000	963980	4756980
91	Sumitomo Forestry Co., Ltd.	-7312.84	12456.2	-140059.37	-134916.01
92	Sumitomo Heavy Industries, Ltd.	1352.48	5709.2	258130.55	265192.23
93	Sumitomo Rubber Industries, Ltd.	15983	132306	-3684919	-3536630
94	Taisei Corporation	70078	26238	11597974.5	11694290.52
95	TDK Corporation	833.16	76858.13	429006	506697.29
96	Teijin Ltd.	-182601	14836	469940	302175
97	Terumo Corporation	30083	76276	4727.26	111086.26
98	The Dai-ichi Life Insurance Company, Limited	12574.57	114684.72	-1840.73	125418.56
99	The Hachijuni Bank, Ltd.	1219.41	4208.67	11617.15	17045.23
100	Toda Corporation	1926	-1460	4276627	4277093
101	Tokio Marine Holdings, Inc.	-1070	11678	-264	10344
102	Tokyo Electron Ltd.	-1468	-9080	-83490	-94038
103	Tokyo Gas Co., Ltd.	-111000	31000	-4252800	-4332800
104	Toray Industries, Inc.	99075	-28378	10308931	10379628
105	Toshiba Corporation	-29000	290000	63051700	63312700
106	Toto Ltd.	4595	7051	1746416	1758062
107	Toyo Ink SC Holdings Co., Ltd.	-644	4555	1049	4960
108	Toyota Industries Corporation	-51682.8	-4095.6	48146392.2	48090613.8
109	Toyota Motor Corporation	15000	217000	374329000	374561000
110	West Japan Railway Company	1400	-10000	1652490	1643890

Serial No.	Organization	Direction of change in Scope 1 (metric tonnes)	Direction of change in Scope 2 (metric tonnes)	Direction of change in Scope 3 (metric tonnes)	Direction of change in total emission (metric tonnes)
111	Yamaha Corporation	-617	-1444	-53.23	-2114.23
112	Yamato Holdings Co., Ltd.	-8152	-51040	1386756.2	1327564.2

Appendix 2: Cross tabulation analysis of part 5.3.1

Detailed descriptions of part 5.3.1 have been described in the tables A to R. The associations of management variables with scope 3 emissions and total carbon emission have been examined by following cross tabulation analysis using Chi-square test. In each analysis, degree of freedom (df) is 1. Specific abbreviated forms for some words are used in the tables. For example,

Scope 3 = S3, Management incentive =M.I., Risk management procedures =R. M. P, Emission reduction initiatives = ERI. Publishing information =PI, Inherent climate change risks =ICCR, Business strategy =B. S, Policy makers =P.M, Trade association =T.A. and Emission trading scheme= ETS.

Table A: Relationship between scope 3 emissions and management incentive (M.I.)

M.I.	YES	NO	Total
Direction S3			
Decrease	59	1	60
Increase	49	3	52
Total	108	4	112

$$\chi^2=1.361443495$$

$$P \text{ value} = 0.243287468$$

Table B: Relationship between total carbon emission and management incentive

M.I.	YES	NO	Total
Direction total			
Decrease	18	1	19
Increase	90	3	93
Total	108	4	112

$$\chi^2=8.100776134$$

$$P \text{ value}= 0.004424631$$

Table C: Association between scope 3 emissions and climate change risk management procedures (R.M.P.).

Direction S3 \ R.M.P.	YES	NO	Total
Decrease	24	1	25
Increase	85	2	87
Total	109	3	112

$\chi^2=0.215582973$
P value=0.64242628

Table D: Association between total carbon emission and climate change risk management procedures.

Direction total \ R.M.P.	YES	NO	Total
Decrease	18	1	19
Increase	91	2	93
Total	109	3	112

$\chi^2 = 0.58635293$
P value = 0.443832894

Table E: Relationship between scope 3 emissions and emission reduction initiatives (ERI).

Direction S3 \ ERI	YES	NO	Total
Decrease	24	0	24
Increase	87	1	88
Total	111	1	112

$\chi^2=0.275184275$
P value= 0.599875128

Table F: Relationship between total carbon emissions and emission reduction initiatives.

Direction total \ ERI	YES	NO	Total
Decrease	53	0	53
Increase	58	1	59
Total	111	1	112

$\chi^2=0.906397923$
p value =0.341071966

Table G: Relationship between scope 3 emissions and publishing information (PI) about climate change other than CDP.

Direction S3 \ PI	YES	NO	Total
Decrease	24	1	25
Increase	83	4	87
Total	107	5	112

$$\chi^2=0.016266409$$

$$p \text{ value} = 0.898513149$$

Table H: Relationship between total carbon emission and publishing information about climate change other than CDP.

Direction total \ PI	YES	NO	Total
Decrease	19	3	22
Increase	88	2	90
Total	107	5	112

$$\chi^2 = 5.400275654$$

$$P \text{ value} = 0.020133571$$

Table I: Relationship between scope 3 emissions and inherent climate change risks (ICCR).

Direction S3 \ ICCR	YES	NO	Total
Decrease	24	1	25
Increase	85	2	87
Total	109	3	112

$$\chi^2=0.215582973$$

$$P \text{ value} = 0.64242628$$

Table J: Relationship between scope 3 emissions and inherent climate change risks.

Direction total \ ICCR	YES	NO	Total
Decrease	51	1	52
Increase	58	2	60
Total	109	3	112

$$\chi^2= 0.212530385$$

$$p \text{ value} = 0.644791302$$

Table K: Relationship between scope 3 emissions and ETS participation.

ETS \ Direction S3	YES	NO	Total
Decrease	14	11	25
Increase	38	49	87
Total	52	60	112

$$\chi^2=1.185424108$$

$$P \text{ value} = 0.276254515$$

Table L: Relationship between total carbon emission and ETS participation.

ETS \ Direction total	YES	NO	Total
Decrease	10	31	41
Increase	42	29	71
Total	52	60	112

$$\chi^2_{28.42912207}$$

$$P \text{ value} = 0.00000009719$$

Table M: Relationship between scope 3 (S3) emissions and internal price of carbon.

Carbon Price \ Direction S3	Yes	No	Total
Decrease	4	35	39
Increase	18	47	65
Total	22	82	104

$$\chi^2=4.442867701$$

$$P \text{ value} = 0.035047331$$

Table N: Relationship between total carbon emission and internal price of carbon

Carbon price \ Direction total	Yes	No	Total
Decrease	5	23	28
Increase	17	59	76
Total	22	82	104

$$\chi^2=0.24967074$$

$$P \text{ value} = 0.617307015$$

Table O: Relationship between scope 3 emissions and integrating climate change into business strategy (B.S)

Direction S3 \ B.S	Yes	No	Total
Decrease	38	2	40
Increase	72	0	72
Total	110	2	112

$$\chi^2=3.615137615$$

P value: 0.057255985

Table P: Relationship between total carbon emission and integrating climate change into business strategy (B.S)

Direction Total \ B.S	Yes	No	Total
Decrease	30	0	30
Increase	80	2	82
Total	110	2	112

$$\chi^2=0.745011086$$

P value: 0.388060362

Table Q: Association between scope 3 emissions and engagement with policy makers (P.M.)

Direction S3 \ P.M	Yes	No	Total
Decrease	21	19	40
Increase	42	29	71
Total	63	48	111

$$\chi^2= 0.2856$$

P value: 0.59304077

Table R: Association between total carbon emission and engagement with policy makers (P.M.)

P.M. Direction Total	Yes	No	Total
Decrease	17	13	30
Increase	46	35	81
Total	63	48	111

$$\chi^2=0.000135$$

P value: 0.990697088

Appendix 3: Cross tabulation analysis of part 5.3.2

Tables S to V contain the detailed analyses of part 5.3.2. In each case, the influence of customer or supplier about GHG emissions and climate change strategies has been examined by cross tabulation analysis using Chi square test and degree of freedom (df) is 1.

Table S: Relationship between engagement with customers on climate change strategies and scope 3 (S3) emissions.

Customer Direction S3	Yes	No	Total
Decrease	21	19	40
Increase	38	33	71
Total	59	52	111

$$\chi^2 = 0.01071384$$

P value in Chi Square test = 0.91756004

Table T: Relationship between engagement with customers on climate change strategies and total carbon emission.

Customer Direction total	Yes	No	Total
Decrease	15	14	29
Increase	44	38	82
Total	59	52	111

$$\chi^2 = 0.14933799$$

P value in Chi Square test = 0.6991688

Table U: Relationship between engagement with suppliers concerning climate change strategies and scope 3(S3) emissions.

Supplier Direction S3	Yes	No	Total
Decrease	28	12	40

Supplier Direction S3	Yes	No	Total
Increase	46	25	71
Total	74	37	111

$$\chi^2 = .31267606$$

P value = 0.57604267.

Table V: Relationship between engagement with suppliers regarding climate change strategies and total carbon emission.

Supplier Direction total	Yes	No	Total
Decrease	22	7	29
Increase	52	30	82
Total	74	37	111

$$\chi^2 = 8.62587609$$

P value of Chi-square test = 0.00331421