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A META-ANALYSIS ON SUSTAINABLE SUPPLY CHAIN MANAGEMENT: AN ANALYTICAL APPROACH

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ABSTRACT: *Sustainability in Supply Chain is a key area in business that great attention is being looked into by academicians and practioners in recent times. The literature of sustainable supply chain management is still scant and several literature review has been conducted to investigate the state of the art knowledge of sustainable supply chain management. The field of text mining is rapidly evolving but little has been done on the techniques used in the study of sustainable supply chain management. The major objective of the study was to conduct a meta–analysis of the literature review studies in the area of sustainable supply chain management. Specifically the objective of the study was to find out the state of the art knowledge in sustainable supply chain and to use text mining techniques to derive the most frequent used words in keywords, abstracts and conclusion of the literature review papers on sustainable supply chain management. Major trends and current research topics in sustainable supply chain management were identified. A total of 57 papers were identified, the process was iterative involving many hours of reading, additional collection of literature, synthesis and refinement. The leading peer reviewed journals, universities, and authors were identified as well. The study adopted meta-analysis and content based qualitative approach of published literature for assessing the appropriateness of the framework presented in the research articles. More specifically the alignment between keywords, abstract and conclusion was studied. Finally, suggestion and recommendation was provided for the research agenda in the field of sustainable supply chain management*

KEYWORDS: Supply Chain, Sustainability, Sustainable Supply Chain, Text Mining

INTRODUCTION

The literature of SSCM is still scarce and scanty (Seuring and Muller 2008) and several literature reviews have been conducted to investigate the state of the art knowledge of sustainable supply chain management (SSCM). Pagell and Shevchenko (2014) commented that in the intervening two decades, sustainable supply chain management (SSCM) has moved from being an outlying topic that many practioners were actively discouraged from studying, to the mainstream. Pagell and Shevchenko,(2014) also asserts that the existence of SSCM as a separate stream of research means that while it is now mainstream enough to have its own tracks in conferences and departments in journals, SSCM is still somehow a novelty or a nice to have, not the focus for the typical researcher. Inquiry in understanding the roles, management, tools, and mechanisms for sustainable supply chains must be increased in order to help meet these challenges (Seuring *et al* .,2008).

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Supply chain sustainability as an area in business is receiving a lot of special issues (Seuring *et al*., 2008) and attention by practioners and academicians in the recent decade (Yawar and Seuring.,(2015),Seuring *et al* .,(2005),Sarkis *et al* ., (2011), Taticchi *et al*., 2015).The environmental and social problems caused by governmental, industrial, services, profit and non-profit establishments will continue to exist (Seuring *et al*., 2008) and the origin and management of these environmental and social burdens is not the single responsibility of one organization; whole supply chains and networks of supply chains must be involved. .Globalization of businesses considers sustainability as an increasingly key strategic goal (Closs *et al*., 2011). Increased attention to the environment and resource consequence of organization products and processes (Kleindorfer *et al*., 2005), offshoring and transferring of manufacturing companies to developing countries is a characteristic of today's business world. Businesses at large need to balance the economic, social and environmental dimensions of its supply chains to remain competitive as advocated by Carter and Easton (2011).

LITERATURE REVIEW

Sustainable development as presented by (Lumley and Armstrong, 2003) is a term that became popular after the 1987 publication of *Our Common Future*, also known as the Brundtland Report, by the World Commission on Environment and Development (WCED, 1987). The WCED defined sustainable development as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987:43). Giunipero *et al*., (2012) presented the themes in sustainability literature giving a time frame evolution of sustainability from 1960's to year 2000 and concluded that there is a lack of consensus in the definition of sustainability but provided a broad landscape comprising the sustainability evolution. Narrowing sustainability to supply chain management, Sustainable supply chain management is defined by Seuring and Müller(2008a), p.1700, as "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development ,i.e., economic, environmental and social, into account which are derived from customer and stake holder requirements" while Hassini, Surti, and Searcy (2012), p.70), defined SSCM as: '…the management of supply chain operations, resources, information, and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impact and maximizing the social well-being'. SSCM encompasses the triple bottom line concept (Elkington; 2003).An organization should be able to balance between Economic (profits), environmental and social aspects of the entire business and its upstream suppliers and downstream customers to be truly sustainable.

The field of text mining or knowledge discovery from textual database is gaining acceptance in business studies. The phrase "text mining" is generally used to denote any system that analyzes large quantities of natural language text and detects lexical or linguistic usage patterns in an attempt to extract probably useful (although only probably correct) information (Sebastian, 2002). Text mining is about looking for patterns in text .The pioneers of text mining such as Freinerer *et al*., (2008), Hornik and Meyer (2008) and Freinerer (2015) described text mining infrastructure in R software provided by tm package which helps in extracting interesting information or patterns from documents. Words usually give a lot of information that managers need for decision making. In research and academics, comparing frequencies counts over texts or corpora is an important task in many applications and scientific disciplines

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(Kilgarriff (2001).The field of text mining is rapidly evolving but its techniques have not been used in study of sustainability in supply chain management.

Research Objectives

This study therefore conducts a meta-analysis of the literature review studies in the area of sustainable supply chain management with the following objectives:

1. To find out what is the state of the art knowledge in sustainable supply chain management.
2. Use text mining techniques to derive the most frequent used words in keywords, abstracts and conclusions of the literature review papers on SSCM.

Significance of the Study

This study will be significant to academicians and researchers in terms of big data and predictive analytics. The use of text mining techniques and word profiling to know which are the most frequent words in any academic writing helps in finding interesting words that helps to discover new knowledge. The supply chain management profession will benefit by adding knowledge on dimensions of sustainability so that supply chain managers have an idea on how to balance the three dimensions of sustainable supply chain management and is the actual gap in sustainable management. The study will also be beneficial to policy makers whereby proper policies relating to environment, social and financial issues will be put in place.

RESEARCH METHODOLOGY

This study adopted Meta-analysis and content based qualitative approach to study literature reviews papers on SSCM. According to Glass (1976) "Meta-analysis is a statistical analysis of a large collection of results from individual studies for the purpose of integrating findings. It integrates and summarizes the findings from a body of research". Meta- analysis study involves pooling of data to set the effectiveness of the results. Content based analysis on the other hand is defined as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" by (Hsieh & Shannon, 2005, p.1278).This study espoused Mayring (2008), (cf. Kassarjian, 1977; Krippendorff, 1980; Mayring, 2000) procedure on content based analysis which comprises the following four major steps: material collection, descriptive analysis, category selection and material evaluation.

The methodological procedure for the research included the literature sample comprised of English speaking peer reviewed literature review paper on SSCM covering 10 year period from 2005-2015.The study excluded a number of articles published in gray literature such as commercial publishers, conference proceedings, project reports, abstracts, book reviews, non-academic papers and industry reports. Literature review papers were searched using the keywords "sustainability", "supply chain", "green", "reverse logistics", "closed loop supply chain", "green purchasing", "green supplier selection" and "literature review". Major databases were used to search for the related articles such as those provided by major publishers or library services. Those papers with title that was beyond the scope of this review were removed including those that did not mention that the study is a literature review. All the papers were

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filtered according to the quality of journals .The analysis considered only those journals included in the Association of Business Schools (ABS) ranking.(Harvey *et al* .,2010)The journal of cleaner production was included as an exception to ABS ranking because there are significant volume of papers published on sustainability.

Material search was conducted with intensive rigor and dedication, exhausting all the possible avenues of literature review papers. To increase reliability of the research, journals and individual papers were checked by the other three researchers. Reading the papers ,counter checking and updating the database until no other literature review papers was found ensured validity of the research. A total of 57 papers were identified, this is after the four researchers came to a consensus that no other paper on literature review and supply chain sustainability could be found.

The process was iterative involving many hours of reading, additional collection of literature, synthesis and refinement with the other researchers .A database of all relevant articles from the search was created in excel. These articles were keyed in by year, authors, university, research methodology, sustainability dimension, barriers, triggers, sustainability functions and critical analysis of the each article. During these review a number of themes emerged which formed the basis of the study.

RESEARCH FINDINGS

State of the Art Knowledge in SSCM

The allocation of the publications in the researched period was (2005-2015). The first published paper on supply chain sustainability literature was in 2005 and is used as the starting point for the SSCM. High number of publication was found in the year 2012 but the number dropped in the year 2013 and 2014. About 74% of the research articles have been published in the last 4 years (2012-2015), and the year with the highest frequency (23%) has been the year 2015.This shows the wide acceptance of the topic among researchers. The results show that five journals concentrate almost 50% of the literature reviews on SSCM. The top five journals include; *International Journal of Physical Distribution and Logistics management with 7 papers,* the reason being reverse logistics and closed loop supply chains have been studied and published in logistics journals. Such studies include Govindan *et al*.,(2015), Agrawal *et al.,* (2015), Phokharel S and Muthab A (2012),Jayant *et al.,* (2012),Jamal forte (2008) and Meade *et al* .,(2007). *International Journal of Cleaner Production* ties with *Supply Chain Management: International Journal* with 6 papers each. *International Journal of Production Economics and Journal of purchasing and Supply Management* published 5 and 3 papers respectively. The rest of the papers are distributed across a range of other journals. This shows the topic of sustainable supply chain management is published across a wider range of journals.

The analysis of the geographic position of the contributing authors institutional reveals that Universities from Europe(55) is leading in publication on supply chain sustainability literature reviews, North America (43) is the second, North America (14) and Asia (11).Africa is least represented showing a great concern of involvement of African countries on sustainability research.

On content analysis of the literature review papers, the top three topics studied in sustainability literature include Sustainable supply chain evolution and future direction, Green supply chain

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management, and Reverse logistics and closed loop supply chains with about 20%, 8% and 11% respectively. This shows that Sustainable supply chains subject areas are varied ranging from metrics, use of theories to study sustainable supply chain management, Management of social issues, Performance measurement and decision support in supply chains, Product innovation and manufacturing facility location. On analysis of the number of papers reviewed per study, most number of papers range between 0-100 papers with a percentage of 28.07% among all the publications. There is no study that generated 901-1000 papers for their study. Other studies reviewed enormous number of papers such as the study by Schniederig T *et al* (2012) with 8516 papers and 23946 papers by Mollenkopf *et al* (2010).

The use of Environmental management systems such ISO 14001 and corporate social responsibility SA 8000 is used to study Supply chain sustainability with a percentage of 40.35 %. 59.64 % of the studies did not mention the use of these tools. From the analysis it can be deduced that the Environment and social dimension has been mentioned severally in literature review papers accounting for 17 papers, followed by economic dimension which occurred 10 times. Other dimensions of sustainability discovered include stakeholder, volunteer, long-term focus and resilience.

Results of Text Mining; Key Words, Abstract and Conclusion

Word frequency query was run in R tm package to determine the extent of research in various themes. The result is shown below in tables and word cloud. The size of each word represents its relative frequency.

Analysis Of Key Words And Key Word Cloud

Table 1: Frequency of key words

WORDS	FREQUENCY
Supply	57
Chain	48
Management	47
Sustainability	29
Review	20
Green	18

Table 1 shows the frequency of key words and figure 1 shows the key word cloud from the R tm package results. In Keywords “Supply” was used mostly with 57 frequency ,”Chain” had 48 appearances and “management” appeared third with 47.This shows that literature review papers, the most used key words used are ‘supply’, ‘chain’, ‘management’, ‘sustainability’, ‘review’ and ‘green’ in that order.

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Key Word Cloud

Figure:1 Key word cloud

Analysis of Abstract And Abstract Cloud

Table 2: Abstract frequency

WORD	FREQUENCY
Supply	152
Research	147
Chain	107
Literature	107
Management	92
Sustainability	79
Paper	64
Review	63

The findings highlights that in abstracts the word "supply" is frequently used with 157 occurrences ,"Research" has 147 rate and The word "chain" and "Literature" ties with 107 presences.it can be deduced that in literature review papers on SSCM the most used words in abstract writing is 'suppy','research','chain','literature','management','sustainability','paper' and 'review' in that order.

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Abstract Cloud

Figure 2: Abstract cloud

Conclusion Frequency

Table 3: Conclusion Cloud

CONCLUSION WORDS	FREQUENCY
Research	422
Supply	340
Chain	215
Sustainability	189
Management	140
Green	115
Sustainable	121
Literature	87

As table 3 depicts, in writing conclusion the frequent used word is “Research” followed by “supply”, then “chain” and “sustainability”.

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Conclusion cloud

Figure 3: Conclusion cloud

Test of Hypothesis

A chi-square test was conducted to test the study hypothesis. Pearson's chi-square test is based on the assumption that a text or a corpus can be modeled as a sequence of independent Bernoulli trials. The study is guided by the following hypothesis:

Hypothesis 1

H_O: There is no association between words in keywords (K) and Abstracts (A)

The result of the test is as follows:

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Table 15: keywords and Abstracts

WORDS IN KvsA	TEST
Supply	we reject the Null
Chain	we reject the Null
Management	we reject the Null
Sustainability	we reject the Null
Green	we reject the Null
Sustainable	we reject the Null
Performance	we reject the Null
Social	we reject the Null
Chains	we fail to reject the Null
Logistics	we reject the Null
Reverse	we reject the Null
Environmental	we fail to reject the Null
Responsibility	we reject the Null
Economic	we fail to reject the Null
Environment	we reject the Null
sscm	we fail to reject the Null
gscm	we fail to reject the Null
Closed-loop	we fail to reject the Null
scm	we fail to reject the Null
Triple	we fail to reject the Null
Network	we reject the Null
Development	we reject the Null
supplier	we fail to reject the Null
Literature	we fail to reject the Null
Review	we reject the Null
Purchasing	we reject the Null
Research	we fail to reject the Null
Theory	we fail to reject the Null
Measurement	we reject the Null
Indicators	we reject the Null

Hypothesis 2

H_O: There is no association between words in keywords (K) and conclusions(C)

The result is shown below:

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Table 16: keywords and conclusion table

WORDS IN KvsC	TEST
Supply	we reject the Null
Chain	we reject the Null
Management	we reject the Null
Sustainability	we reject the Null
Green	we reject the Null
Sustainable	we reject the Null
Performance	we reject the Null
Social	we reject the Null
Chains	we reject the Null
Logistics	we reject the Null
Reverse	we reject the Null
Environmental	we fail to reject the Null
Responsibility	we reject the Null
Economic	we fail to reject the Null
Environment	we reject the Null
Sscm	we fail to reject the Null
Gscm	we fail to reject the Null
Closed-loop	we reject the Null
Scm	we reject the Null
Triple	we fail to reject the Null
Network	we fail to reject the Null
Development	we reject the Null
Supplier	we reject the Null
Literature	we reject the Null
Review	we reject the Null
Purchasing	we fail to reject the Null
Research	we fail to reject the Null
Theory	we fail to reject the Null
Measurement	we reject the Null
Indicators	we reject the Null

Hypothesis 3

The last hypothesis is abstract and conclusion and is stated as follows;

H_O: There is no association between words in Abstracts (A) and conclusions (C)

The result is as shown below;

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Table 16: Abstract and Conclusion

WORDS IN AvsC	TEST
Supply	we reject the Null
Chain	we reject the Null
Management	we reject the Null
Sustainability	we fail to reject the Null
Green	we reject the Null
Sustainable	we reject the Null
Performance	we fail to reject the Null
Social	we fail to reject the Null
Chains	we fail to reject the Null
Logistics	we fail to reject the Null
Reverse	we reject the Null
Environmental	we fail to reject the Null
Responsibility	we fail to reject the Null
Economic	we fail to reject the Null
Environment	we fail to reject the Null
Sscm	we fail to reject the Null
Gscm	we fail to reject the Null
Closed-loop	we reject the Null
Scm	we fail to reject the Null
Triple	we fail to reject the Null
Network	we fail to reject the Null
Development	we fail to reject the Null
Supplier	we fail to reject the Null
Literature	we reject the Null
Review	we reject the Null
Purchasing	we fail to reject the Null
Research	we fail to reject the Null
Theory	we fail to reject the Null
Measurement	we fail to reject the Null
Indicators	we fail to reject the Null

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Chi-square Test

words	**hypotheses (chisquare)**				**p-values**		
	KvsA	KvsC	AvsC		KvsA	KvsC	AvsC
Supply	85.2511583	172.521043	12.1409858		0.00E+00	0	0.00049326
Chain	90.8724258	205.455008	14.2623754		0.00E+00	0	0.00015901
Management	103.868408	307.871025	29.9561332		0.00E+00	0	4.4193E-08
Sustainability	40.9814361	76.2094289	3.98671263		1.54E-10	0	0.04586046
Green	23.2035334	67.5469399	11.8295034		1.46E-06	0	0.000583
Sustainable	17.2287221	47.2776767	10.2117501		3.31E-05	6.161E-12	0.00139549
Performance	12.0185492	28.2349534	4.41526101		5.27E-04	1.0745E-07	0.03561883
Social	15.422908	32.1294882	2.76593753		8.59E-05	1.4423E-08	0.09629026
Chains	6.34215844	14.5631676	2.83000508		1.18E-02	0.00013554	0.09251807
Logistics	19.2773202	52.3677479	4.27854688		1.13E-05	4.6019E-13	0.03859633
Reverse	17.1466628	63.3291992	9.79509974		3.46E-05	1.7764E-15	0.00174978
Environmental	1.20522523	5.38939622	5.85784583		2.72E-01	0.02025948	0.01550776
Responsibility	61.7141567	98.9445554	0.45067075		4.00E-15	0	0.5020166
Economic	0.81280604	2.49751098	1.19804794		3.67E-01	0.11402638	0.27371218
Environment	23.1062228	14.4823672	2.16363498		1.53E-06	0.00014148	0.14131006
Sscm	0.04853353	0.02241537	6.81526662		8.26E-01	0.88098741	0.00903818
Gscm	0.23875391	1.45847828	1.8033313		6.25E-01	0.2271724	0.17931028
Closed-loop	0.96526363	16.3909529	8.73420485		3.26E-01	5.1531E-05	0.00312295
Scm	0.96526363	12.5498142	6.7529245		3.26E-01	0.00039625	0.00935942
Triple	2.76021697	6.83442095	0.06745275		9.66E-02	0.00894177	0.79508234
Network	8.44258127	6.94752132	0.45735813		3.67E-03	0.00839355	0.49886125
Development	9.06988662	9.01833941	0.14503731		2.60E-03	0.00267284	0.70332373
Supplier	4.41344997	13.8700919	4.50292195		3.57E-02	0.00019589	0.03383699
Literature	6.59851325	56.9679305	63.8989465		1.02E-02	4.4298E-14	0
Review	21.9447991	101.925994	34.7861326		2.81E-06	0	3.6799E-09
Purchasing	7.98042772	3.39273067	2.05275482		4.73E-03	0.06548442	0.15193106
Research	5.19015612	4.2829166	0.8686537		2.27E-02	0.03849724	0.35132829
Theory	0.02357034	0.04800229	0.00700413		8.78E-01	0.82657664	0.93330237
Measurement	12.8695917	21.2290382	0.05176986		3.34E-04	4.0754E-06	0.82001171
Indicators	10.4596723	9.64956284	0.29623571		1.22E-03	0.00189397	0.58625197

Using p-values to test the hypothesis, the P-value is compared to the level of significance α=0.05.If the p-value is less than or equal to α, then the null hypothesis is rejected in favour of the alternative hypothesis. Otherwise if the P- value is greater than α, then the null hypothesis is not rejected.

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Hypothesized Results

		% of Words			
	α (level of significance)	K vs. A	K vs. C	A vs. C	
1	0.01	60%	70%	36.66%	Very strong association
2	0.05	80%	83.33%	53.33%	Strong association
3	0.1	70%	86.67%	60%	Association

DISCUSSION, CONCLUSION AND SUGGESTION FOR FURTHER STUDIES

This study combined systematic literature, content based analysis and text mining techniques to study sustainable supply chain management literature review studies. It combined the strengths of meta-analysis and information technology to derive conclusion about the field of sustainable supply chain management and give suggestions for further studies in sustainable supply chains.

Descriptive analysis

This study reveals literature review as a methodology to study supply chain sustainability is increasingly recognized and matured because of the increase in the number of publications over the years in this area. The wide distribution of journal publications shows that the topic of sustainable supply chains is cross-disciplinary and most journals will publish the work. The state of the art exposes that economic and environmental dimension has been the center of attention for researchers as compared to the social dimension of sustainability. In terms of regional distribution and influential work, the study concludes that studies on sustainable supply chain management are concentrated among few scholars mostly in Europe, USA and Asia. The lack of non-western and non-Asian research is noted. This calls for more African and Asian countries to make their work known, publish and get recognized in today's globalized world.

Text mining

Text mining is a multi-disciplinary field that involves extracting interesting and non-trivial patterns or knowledge from documents. From the study; keywords, Abstracts and conclusion were the main focus. The researcher's main aim was to find out if the publications in sustainable supply chains were congruent in terms of the wording used in the keywords, abstract and conclusion. The hypothesized results of the study revealed that in sustainable supply chain management research, words such as 'supply', 'management', 'sustainability', 'literature', and 'review' are the most used. In addition the study discloses that there are words in keywords and Abstracts that have no association. Noted in the study the word environmental, economic, triple and sscm are very significant yet they are not mentioned in the same intensity in the keywords, Abstract and conclusions. It is also concluded that researchers in the field of sustainability supply chain management write their keywords, abstracts and conclusions with different wordings. The study therefore recommended that when publishing sustainable supply chain research, words in keywords, abstracts and conclusion should have similarity.

Suggestion for further studies is that:

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i) When writing and publishing sustainable supply chain research the core issues dealing with sustainability such as 'environmental' economic and social should be given more priority.

ii) There is need for more research in sustainable supply chain issues in non-Western and non-Asian countries to broaden the scope of sustainability.

iii) The social dimension of supply chain sustainability is least researched in literature. Further studies should uncover more social dimensions

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