Sustainable logistics and supply chain management: a holistic view through the lens of the wicked problem

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Abstract: This study takes a holistic perspective of sustainable logistics and supply chain management (SLSCM), exploring the interdependencies among sustainability, financial strength and customer performance in logistics and supply chain management. Firms often struggle to understand when sustainable performance is improving and most importantly, what it costs them in terms of financial and customer performance. The theoretical lens of the wicked problem provides a framework to understand why sustainability performance shows mixed results. Hypotheses that investigate aggregate-level links between sustainable practices of global companies are tested with regression analysis and firm-level data from three widely used databases. Efforts to improve SLSCM can have a positive impact on performance; however, it comes at a price. For example, we find that firms that achieve the highest sustainability recognition have a lower return on assets (ROA) and that a leadership position in sustainability performance requires resources and a long-term view of return on investment.

Keywords: supply chain management; sustainability; wicked problem; Dow Jones; green brands; return on assets; ROA; stakeholders; logistics.


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1 Introduction

“Whoever attempts to tame a part of a wicked problem but not the whole is morally wrong.”
–Churchman 1967

While the term ‘wicked problem’ may sound like a play on words, it is actually a theoretically substantiated lens that focuses on complex problems with many interdependencies – problems that are organic in nature. Managing tradeoffs to achieve sustainability in supply chains is complex and wicked in nature. For more than two decades, companies have pursued the triple bottom line, only to find that improvement in one area detracts from improvements in other areas. Tradeoffs are prevalent and investigating the complexity of sustainable logistics and supply chain management (SLSCM) requires simultaneous examination of many moving parts and a long-term orientation. Everything about achieving SLSCM is complex. Firms have struggled to develop means to measure their sustainability impacts and to determine when they have achieved SLSCM and at what cost. To address this wicked problem, we use multiple long-term databases to consider the costs and benefits of pursuing SLSCM from both a financial and brand recognition standpoint. The literature supports the use of mixed approaches to research wicked problems. Martens (2015) suggests that wicked problems
are broad and require mixed methods to gain appropriate knowledge. Chapin et al. (2008) suggest an early stage exploring the ‘wickedness’ of the problem and that it can be explained by determining linkages among processes. In this research, by using both financial and brand recognition data at the aggregate level, the linkages among processes and their resulting impact on financial performance are detected.

Just as the epigraph suggests, the wicked problem of SLSCM is exacerbated by the interdependencies among supply chain partners, and not considering all stakeholders of a supply chain is morally wrong. Influential companies are able to motivate sustainability progress by encouraging suppliers to improve the sustainability of products and packaging. For example, Walmart influences suppliers to limit their use of specific ingredients such as palm oil to avoid deforestation. Walmart also challenges textile suppliers to provide more products that use ‘cold wash’ cycles, reducing the energy use of the customers (Stanford Graduate School of Business, 2010). Another retailer, IKEA stresses that their long-term supplier contracts and their code of conduct contain guidelines to help manufacturers reduce the impact of their activities on the environment (Lu, 2014). These examples show the interdependence of supply chain partners in achieving SLSCM, but at what cost and who bears the cost? To develop knowledge of how to achieve SLSCM, we pursue the following research question: “Taking a holistic view of supply chain sustainability performance, what are the organic interdependencies that drive sustainability, financial and customer performance in logistics and supply chain management?”

In the balance of this paper, literature from five leading logistics and supply chain management journals is reviewed, the theoretical framework of the wicked problem is used to develop hypotheses and linear regression analysis is used to test hypotheses. Aggregate-level findings are discussed and management implications are set forth.

2 Literature review

Fifty studies on SLSCM published from 1995 to 2014 in International Journal of Logistics Management, International Journal of Physical Distribution and Logistics Management, Journal of Business Logistics, Journal of Supply Chain Management and Transportation Journal were identified and reviewed. The reason for focusing on these particular journals was to identify specific logistics and supply chain related studies. These studies surfaced when using the search words sustainability, environment, corporate social responsibility (CSR) and ISO 14000. The majority of them were limited in scope; for example, studying only a few companies in one isolated country. The studies provided a useful start in exploring SLSCM and also illustrated the challenges of conducting research that provides both specific results and generalisability. Table 1 summarises the 50 studies with respect to subject area, general themes, authors and publication year; and by doing so illustrates the wickedness of the SLSCM problem in the range of issues raised and hypotheses tested in the research over the past 15 years.
<table>
<thead>
<tr>
<th>Journal</th>
<th>Total number of articles</th>
<th>Sustainability/environment</th>
<th>CSR</th>
<th>ISO 14000/Green</th>
<th>General theme of articles</th>
<th>Author and year of publications</th>
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</thead>
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<td>Journal of Business Logistics</td>
<td>9</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>CSR in logistics and purchasing. Reverse logistics and packaging. Values and drivers of sustainable SCM.</td>
<td>Brockhaus et al., 2013; Ehrgott et al., 2013; Tate et al., 2011; Kinra and Kotzab, 2008; Filbeck et al., 2005; Mollenkopf et al., 2005; Carter and Jennings, 2004; Richey et al., 2004; Kicely et al., 2004; Carter and Jennings, 2002.</td>
</tr>
<tr>
<td>Journal of Supply Chain Management</td>
<td>12</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>Framework for CSR in SCM, practices and case studies on SSCM. Management and barriers for implementing SSCM industrial cooperation and SSCM in a global perspective.</td>
<td>Rauser and Kaufmann, 2015; Theillen et al., 2014; Golicic and Smith, 2013; Paulraj, 2011; Foerdel et al., 2010; Tate et al., 2010; Andersen and Skjøtt-Larsen, 2009; Balse and McKnight, 2009; Knashe et al., 2009; Pagell and Wu, 2009; Pullman et al., 2009; Tan, 2002; Montabon et al., 2000.</td>
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<tr>
<td>Total</td>
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<td>37</td>
<td>8</td>
<td>5</td>
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</table>
In studies where hypotheses are tested or propositions are put forward, it is clear that constructs that could be tested based on available data are narrow, but nonetheless contributing in terms of their advancement of understanding SLSCM. In the areas where propositions are presented, there are insights regarding the correlations of specific sustainability variables. For example, in Brockhaus et al. (2013) propositions assert sustainability implementations are mandated by strong members of the supply chain, inferring that strength of presence in the industry can drive action on sustainability. Brockhaus et al. (2013) go on to assert propositions that suggest a lack of communication and an imbalance of risks and rewards among supply chain partners where these mandated sustainability efforts occur. Many stakeholders with different values and priorities (Camillus, 2008) create a wicked problem situation, where focusing on meeting sustainability requirements in one area can create performance issues in other areas. Another study by Tate et al. (2011) asserts propositions regarding CSR reports and their role in managing institutional pressure to meet stakeholder demands. An assertion in this work is that US firms view responding to this pressure as part of risk management whereas European and Japanese firms view it as part of community integration, highlighting differing views of sustainability in different business cultures. One study that tested hypotheses was presented by Carter (2005) and focused on purchasing social responsibility (PSR). This study found that PSR is positively related to organisational learning and supplier performance. The study also finds that organisational learning is positively related to supplier performance and supplier performance is positively related to cost reduction (Carter, 2005; Gualandris et al., 2014). This is a wicked problem situation where the roots of sustainable supply chain management are complex and tangled (Camillus, 2008).

A study by Hazen et al. (2011) examined the green reverse logistics chain and hypothesised that consumer perception of quality would be negatively affected for products that were reused, remanufactured and recycled. The test of their hypotheses revealed a negative perception from reused and remanufactured products, compared to new products. However, there was no perceived quality difference between products made with recycled materials and new products, and there was no negative affect from the use of recycled materials. The authors note that their study suggests some green supply chain management initiatives may not lead to competitive advantage and firms need to consider other dimensions such as low price and service on which to compete. While the study points problem solvers in a direction, it is a wicked problem in that there is nothing to indicate the right answer to the problem (Camillus, 2008).

Using archival databases to glean information on this complicated problem was undertaken recently by Wang and Sarkis (2013). In their research, they sample from the top 500 green companies ranked by Newsweek; and similar to research in this article, they use some of the latest available information from databases on environmental, social and governance metrics to investigate the fundamental question of whether sustainable supply chain practices relate to financial performance. Wang and Sarkis (2013) also indicate that external supply chain management is positively associated with return on assets (ROA).

In the past, logistics and supply chain management has traditionally focused on upstream social risks, such as working conditions, child labour and minimum wages. As evidenced by the literature reviewed here, more recently the concept has expanded to include a broader range of economic, environmental and social issues across the entire value chain (RobecoSAM, 2013). Supply chain management plays an increasingly
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impactful role as companies strive to improve their sustainability performance and green image. Supply chains are the origin of many companies’ environmental and social impacts and reputational risks (RobecoSAM, 2013). At the same time, companies rely on their supply chains for steady, undisrupted supplies of products and services to remain profitable into the future; that challenge is heightened when sustainability goals need to be met. Recognition of the multi-faceted role of supply chains in making products available to customers, practicing environmental stewardship and contributing ROA was the impetus for this study. We found this to be a wicked problem (Camillus, 2008) and one worth delving into to improve overall firm performance.

3 Theoretical framework: the ‘wicked problem’

The connection of SLSCM to the wicked problem is illustrated in a study conducted among Dutch logistics service providers participating in a ‘Lean & Green’ program to promote sustainability within the logistics chain in the Netherlands. The authors concluded that sustainable physical distribution is a wicked problem, that the stakeholders still do not have a shared common view of what sustainable physical distribution means and that they have conflicting interests and demands (Pieters et al., 2012). A tool for tackling wicked problems in supply chain management is proposed by Peterson (2009) who suggests a so called transformational supply chain governance, creating new knowledge in the context of a broad stakeholder network. Another suggested approach for public managers facing a wicked sustainability problem is to stop looking for the perfect solution and instead seek a satisfying response. The authors suggest an iterative, analytic, adaptive and participatory process (Balint et al., 2011).

The thing that links these methods together is that they are based on trying to structure a complex issue into a clarifying, understandable system, and that they seem time consuming. This can deter many stakeholders in the SCM system who all have little time for labour intensive theoretic work aiming at improving a holistic good for the efficiency of the supply chain, compromising the priorities of their own organisation. However, it is this myopic view that contributes to what Havenga (2015) notes as an unchecked global economic growth paradigm raising concerns of natural resource depletion, ecological instability and systemic financial and monetary failures. It is not the complex models’ fault that nature is complex. Considering these several issues, Conklin (2001) warns of trying to make a tame (solvable) problem out of a wicked problem. It will lead to sub-optimisations and the wicked problem simply reasserts itself, perhaps in a different guise, as if nothing had been done.

SLSCM fits the theoretical definition of as a wicked problem originally described by Rittel and Webber (1973) and characterised by Camillus (2008) as having five key attributes:

1. many stakeholders with different values and priorities
2. roots that are complex and tangled
3. a problem that is difficult to come to grips with and changes with every attempt to address it
4. a challenge that has no precedent, and
5 there is nothing to indicate the right answer to the problem.

These five attributes are a useful theoretical framework for dissecting the problem of SLSCM and are explored in the following paragraphs.

Attribute 1 There are many stakeholders with different values and priorities. SLSCM has stakeholders at every tier in the supply chain. Customers care about sustainability to varying degrees and increasingly use sustainability factors as a component of their buying decision. Consequently, manufacturers are considering sustainability in their product and service offerings. Manufacturing and service firms have transferred these values to suppliers by requiring similar practices as part of their decision to work with a particular supplier or not. Beyond these core supply chain organisations, stakeholders also include governments of countries around the world, non-government organisations that lobby for sustainable practices and of course the environment itself.

Attribute 2 The roots of sustainable supply chain management are complex and tangled. ‘Tangled’ or interdependent roots is observed by companies struggling with the trade-off of financial investment and environmental and social improvements. This research investigates these interdependencies by considering the progress on sustainability initiatives in the Dow Jones sustainability index (DJSI) and Interbrand Green Brands databases. We then weave in the financial impact using Compustat financial data to track ROA.

Attribute 3 It is difficult to come to grips with and it changes with every attempt to address it. The reason SLSCM is difficult to come to grips with is because there is mixed confidence in the validity of the problem. Stakeholders present opposing and controversial views that drive short-term actions to achieve economic, social and environmental performance. There are conflicting and contradictory research findings attesting to the negative impact of companies who neglect environmental and social issues yielding to economic gain (Hazen et al., 2011). The problem of SLSCM does change with every attempt to address it because every change presents a new frame of the problem with new approaches and areas to study, but only short sighted solutions.

Attribute 4 It has no precedent. How to make something inherently renewable depends on the nature of the ‘thing’, which is ever evolving and organic. There are several examples in the supply chain management literature on how initiatives to improve productivity and human welfare have resulted in drawbacks in other parts of the natural system, sometimes rising decades after the initial plans were made (Balint et al., 2011; Thornton et al., 2013). One example is when the Florida Everglades were made into arable land growing sugar cane and fruit, only to experience environmental issues decades later. During this time, South Florida became prosperous, millions of people moved in, found work and made the economy strong. However, decades later, environmental backlashes were discovered – the loss of freshwater supply for Miami and the necessary foundation for endangered
wildlife. This resulted in a need in the 1980s to expend effort and money to recover the Everglades (Balaint et al., 2011).

Attribute 5 *Nothing to indicate the right answer to the problem.* You need to understand the question before you can effectively answer it. The nature of the wicked problem of SLSCM is that there are multiple questions stemming from the many stakeholders. This might indicate why companies, although focused on improving sustainability, continue to focus primarily on the profitability aspects of their respective businesses and secondarily pursue sustainability initiatives when those initiatives are also profitable. Since we will never really know if we are ‘solving’ the sustainability problem, we continue to ‘pursue’ the problem and continue to focus on profitability with medium and short-term measures (Peterson, 2009).

Theory supports that the wicked problem must be examined from multiple angles concurrently, such as understanding the impact on multiple stakeholders or the impact on alternate performance measures (Stahl, 2014; Whyte and Thompson, 2012; Balint et al., 2011; Ritchey, 2011; Peterson, 2009; Potter et al., 2010; Camillus, 2008). Churchman (1967) speaks of the wicked problem by noting that neglecting to study the individual pieces concurrently, or solving one piece of the problem as solving the whole is morally wrong. Furthermore, ‘feasibility’ is a continuous struggle with the wicked problem, which drives us to explore and develop heuristics in the uncertain environment surrounding SLSCM and all its constructs (Churchman, 1967). This approach is particularly important given the contradictory nature of the research findings to date in the area of sustainability. Therefore, our hypotheses are designed to look at aggregate global data and determine relationships between alternate measures of SLSCM, namely financial results (i.e., ROA), actual sustainability initiatives (i.e., DJSI), and customer perception (i.e., Interbrand). By hypothesising this research in the following way we seek to understand the relationships between aggregate SLSCM performance indicators. The results of this analysis can be used by business managers to more accurately develop corporate sustainability strategy in line with their business goals. The hypotheses in our study test the relationship among DJSI performance, ROA and the Interbrand rank. Specific hypotheses to be tested in this study are as follows:

H1 Firms that achieve the highest sustainable performance, as represented by DJSI medal designation have a lower ROA.

H2 Firms that achieve the highest sustainable performance as represented by DJSI medal designation have a higher Interbrand rank.

H3 Firms that achieve the highest sustainable performance as represented by the Interbrand rank have a lower ROA.

H4 Firms with higher Interbrand gap scores have a higher ROA.

4 Methodology

To begin examination of the wicked problem of SLSCM, we chose three broadly encompassing databases: one that provides financial and accounting information (i.e.,
Wharton Research Data Services), one that provides actual sustainability performance (i.e., Dow Jones sustainability index) and one that provides customer perception (i.e., Interbrand Best Global Green Brands index). The Wharton Data Services database was selected because it contains reliable financial and accounting data for global companies. The Dow Jones sustainability database was selected because it represents all industries, all regions of the world, and is used by both managers and investors. The Interbrand database was selected because it examines the perception of value of sustainable practices that consumers associate with each of the world’s major brands. Using this data, we were able to examine a large cross section of firms across three years of data.

4.1 Data sources

- **Wharton Research Data Services.** The Compustat database provided by Wharton Research Data Services was used to acquire the financial and accounting data for the global companies in our study. Annual data such as net income, total assets and revenue was measured in US dollars.

- **Dow Jones sustainability index.** The DJSI is based on an analysis of corporate economic, environmental and social performance, assessing issues such as corporate governance, risk management, branding, climate change mitigation, supply chain standards and labour practices. An industry specific questionnaire featuring approximately 80–120 questions on financially relevant economic, environmental and social factors is the starting point for the annual assessment. For each industry, the company with the highest score is named the industry leader, and is considered to be the company within its industry that is best prepared to seize the opportunities and manage the risks deriving from economic, environmental and social developments. Companies whose score is within 1% of the industry leader’s score receive the gold class award, companies receiving a score within a range of 1% to 5% from the score of the industry leader receive the silver class distinction, and companies whose score is within a range of 5% to 10% from the score of the industry leader receive the bronze class distinction (RobecoSAM, 2013). The actual scores that each company receives from the DJSI are sustainability performance scores in general, but they include the logistics and supply chain related activities of each corporation. For firms with complex supply chains and logistics (the firms in our sample), the DJSI assessment includes specialised logistics analysts and evaluates: corporate efforts to reduce carbon emissions, customer relationship management, operational eco-efficiency, distribution, standards for suppliers and corporate strategy to improve access to products.

- **Interbrand Best Global Green Brands index.** Interbrand publishes the annual Best Global Brands report that determines the world’s 100 most valuable brands. One category of this report is the best ‘green’ brand. To make the top 50 Best Global Green Brands, organisations must perform well in terms of both sustainability performance and customer’s perception of sustainability. The Interbrand data that is used to determine the Best Global Green Brands is determined following a three step process. First, the actual sustainability performance score is calculated using a methodology developed by Deloitte. A brand’s green performance score is composed of 83 metrics upon which each brand is ranked. The metrics evaluate companies’
disclosures and assess environmental performance across six pillars: transportation and logistics, supply chain, operations, products and services, governance and stakeholder engagement. Notice the strong focus on SLSCM metrics (Interbrand, 2014). Second, Interbrand examines how a brand’s sustainability efforts are perceived by consumers across another six pillar assessment: authenticity, relevance, differentiation, consistency, presence and understanding (Interbrand, 2014; Business Wire, 2014). Each brand’s perception score is determined through a consumer study covering over 10,000 respondents, over 1,000 in each of the 10 largest economies. The Interbrand perception score provides a proxy for the social opinion of the ‘greenness’ of a brand and the company’s environmental performance. Third, a composite measurement, the Interbrand gap score, is calculated by taking the difference of the actual performance score minus the perception score.

4.2 Variables

- **ROA**: ROA is used as a relative measure of logistics performance. ROA is the primary measurement ratio used as the basis in the strategic profit models (Coyle et al., 2008) and is commonly used in logistics management. ROA was selected over ROE because it measures the return on the assets such as inventory, distribution centres and transportation equipment rather than just the capital invested.

- **DJSI_ANY**: This is a dummy variable that is flagged in the years that a company receives any medal awarded by the DJSI company rankings.

- **DJSI_G**: This dummy variable is flagged in the years that a company receives a gold medal awarded by the DJSI company rankings.

- **DJSI_S**: This dummy variable is flagged in the years that a company receives a silver medal awarded by the DJSI company rankings.

- **DJSI_B**: This dummy variable is flagged in the years that a company receives a bronze medal awarded by the DJSI company rankings.

- **IB_RANK**: The Interbrand rank is a top 50 ranking award each year for green brand performance awarded by Interbrand. The Interbrand rank, which is calculated in cooperation with Deloitte, is used as a variable to account for the actual sustainable practices by each company.

- **IB_GAP**: The Interbrand gap represents the difference between the actual sustainability performance of a company (brand) and the perception of its sustainability performance by consumers. Interbrand data from 2012–2014 was used. The gap number is the actual activity score minus the perception score. If the perception is higher than the actual investment, the gap is negative.

4.3 Models

To test our hypotheses, ordinary least squares regression was used to examine the relationships between financial performance (i.e., ROA), sustainability performance (i.e., DJSI) and customer performance (i.e., Interbrand rank and Interbrand gap). Several linear regression models are used to test the significance and signs of the relationships between.
Model (1a) measures how financial performance changed according to whether or not the companies are noted for their sustainability efforts (designated by receiving any DJSI medal).

\[ ROA = \beta_1 DJSI\_ANY + e \]

Model (1b) measures how financial performance changed according to gold, silver and bronze medal winners. This model is used to test hypothesis H1.

\[ ROA = \beta_1 DJSI\_G + \beta_2 DJSI\_S + \beta_3 DJSI\_B + e \]

Model (2) measures the relationship between sustainability performance and customer performance. This model is used to test hypothesis H2.

\[ IB\_RANK = \beta_1 DJSI\_ANY + e \]

Model (3) measures the relationship between sustainability performance and financial performance. This model is used to test hypothesis H3.

\[ ROA = \beta_1 IB\_RANK + e \]

Model (4) measures the relationship between customer performance and financial performance. This model is used to test hypothesis H4.

\[ ROA = \beta_1 IB\_GAP + e \]

5 Hypotheses testing

In this section, we revisit our four hypotheses and delineate how the results of our hypotheses tests answer our research question. Table 2 includes descriptive statistics and variable correlations and Table 3 summarises the results of regression models (1a), (1b), (2), (3) and (4).

H1 Firms that achieve the highest sustainable performance, as represented by DJSI medal designation have a lower ROA.

H1 is supported as determined by the negative coefficient in models (1a) (–0.034**) and (1b). If we expand the model to include variables for medal (e.g., gold, silver and bronze) [model (1b)] we see that attaining a gold or a bronze medal (silver is not significant) have negative signs and therefore have lower ROA than companies that do not attain an award. Therefore, being the ‘most’ sustainable (i.e., getting an award) does not improve ROA. This supports a generally acceptable notion that sustainability will cost something. Note that, as expected, companies that attain gold status perform slightly better than bronze companies.

H2 Firms that achieve the highest sustainable performance as represented by DJSI medal designation have a higher Interbrand rank.

H2 is supported as revealed by the negative coefficient (–6.902**) on DJSI\_ANY in model (2). Note that higher Interbrand ranks are lower numbers (e.g., number 2 in the ranking is a higher ranking than number 5 on the list).
Theoretically, we know that having a green brand is costly and likely investing additional resources to have the highest ranked green brand by investors and customers may require significant resource utilisation with undetermined return on that resource investment. Therefore, we expect that the most highly recognised green brands, those that top the rankings for investors and customers will be associated with a lower return. This leads us to H3.

**H3**  
Firms that achieve the highest sustainable performance as represented by the Interbrand rank have a lower \textit{ROA}.

H3 is supported. The positive coefficient of IB\_RANK (0.002*** ) means a lower \textit{ROA} is observed for firms that rank higher.

Increasing perception of sustainability is costly and \textit{being perceived} as the most sustainable brand does not result in higher \textit{ROA}. By examining model (3), we see that the higher Interbrand rank (number one being the highest) is associated with a lower \textit{ROA}.

To be comprehensive, we have to consider both the actual sustainability performance (as measured by the \textit{DJSI\_ANY} and \textit{IB\_RANK}) and consumer perception of sustainable performance concurrently to determine the net effect on SLSCM. This leads us to consider that the customer’s perception in relation to the actual sustainability performance is important for achieving the highest return on resource investments.

\textit{IB\_GAP} is used as a variable to account for the perception of the sustainability efforts because we hypothesise that sustainability may be composed of not just actual sustainability performance but also the perception (or reputation) of how sustainable companies are. We further expect that when the gap score is higher the sustainability efforts are less noticed and provide less benefit (lower \textit{ROA}) to the company. If the gap score is negative, then the company is credited with sustainability efforts they have not actually done. So, we hypothesised that:

**H4**  
Firms with higher Interbrand gap scores have a higher \textit{ROA}.

H4 is not supported, because \textit{IB\_GAP} in model (4) is negative (–0.003***).

\textit{IB\_GAP} measures the difference between the actual resources that companies invest in sustainability minus the customer perception of those sustainable efforts. The gap score ranges from 19 to 21 in our dataset. In model (4), we find that as the gap increases (i.e., firms are conducting better sustainability efforts than they are perceived to be conducting) \textit{ROA} decreases. Also, as the gap score decreases (i.e., firms are perceived as conducting sustainability initiatives better) \textit{ROA} increases.

### 6 Findings and analysis

The correlations, descriptive statistics and four regression models were used to initially isolate and understand the characteristics and behaviors of the parts of the wicked problem and subsequently allow researchers to consider the interactions of the elements of the wicked problem. This is important for understanding the organic (as is) interactions, rather than putting all elements in one mathematically tractable model, which would detract from the ability to assess the organic nature of the interactions.
Table 2

<table>
<thead>
<tr>
<th></th>
<th>RONA</th>
<th>DJSI_ANYMETAL</th>
<th>DJSI_GOLD</th>
<th>DJSI_SILVER</th>
<th>DJSI_BRONZE</th>
<th>INTERB_RANK</th>
<th>INTERB_GAP</th>
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<td>0.116279</td>
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<tr>
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<td>0.360308</td>
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</table>
Table 3  Regression results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1(a)</th>
<th>Model 1(b)</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RONA</td>
<td>RONA</td>
<td>IB_RANK</td>
<td>RONA</td>
<td>RONA</td>
</tr>
<tr>
<td>C</td>
<td>0.085***</td>
<td>0.0851***</td>
<td>0.1058***</td>
<td>0.034*</td>
<td>0.088***</td>
</tr>
<tr>
<td>H1 DJSI_ANY</td>
<td>0.002***</td>
<td>-0.034**</td>
<td>-6.902**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJSI_G</td>
<td>-0.032**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJSI_S</td>
<td>-0.009n.s.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DJSI_B</td>
<td>-0.054**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2 IB_RANK</td>
<td></td>
<td></td>
<td></td>
<td>0.002***</td>
<td></td>
</tr>
<tr>
<td>H3 IB_GAP</td>
<td></td>
<td></td>
<td></td>
<td>-0.003***</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.059</td>
<td>0.092</td>
<td>0.058</td>
<td>0.062</td>
<td>0.061</td>
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<tr>
<td>F-stat</td>
<td>5.471**</td>
<td>2.904**</td>
<td>5.798**</td>
<td>8.260***</td>
<td>8.157***</td>
</tr>
<tr>
<td>n~</td>
<td>90</td>
<td>90</td>
<td>97</td>
<td>128</td>
<td>128</td>
</tr>
</tbody>
</table>

Notes: *p < 0.1*; **p < 0.05**; ***p < 0.01***; ~some observations were lost when using the lagged term TS(1).

Table 2 reveals that smaller companies, measured by revenue and assets, have larger Interbrand gap scores. Since the gap score measures actual sustainable effort minus perceived efforts from the perspective of consumers, this indicates that smaller companies are not receiving the same degree of recognition for their actual sustainability efforts, at least not at a level that is consistent with their level of effort. Time and money are at the core of the assessment. We infer that the better performance of larger companies is a reflection of the amount of time and money that larger companies can afford to spend on marketing their brands and building corporate image. For both large and small companies, however, we learn that ROA improved from one year to the next indicating that the companies in our sample are profitable and doing better each year.

Also in Table 2, the correlations indicate that companies with a larger gap are more strongly correlated with earning a medal than companies with a smaller gap. This indicates two things:

1. it indicates that our two sources of sustainability data are consistent, even given the diversity and measurement methods employed by Interbrand and the Dow Jones organisations, and

2. companies that receive medals for sustainability efforts are rewarded on actual performance and not perceived performance, which has often been a criticism by the general public.

The regression models in Table 3 uncover the reality that while it is great to earn a sustainability ranking, earning that ranking comes at a price. We find that earning recognition for sustainability definitely affects ROA. Firms need to look at this as an investment with long-term implications. We determined this by our models that regress firms that get a medal from DJSI on ROA [models (1a) and (1b)].
When we look further at Table 3 we observe that attaining any medal is correlated with lower ROA, but when we look deeper at gold, silver or bronze medal recipients, coefficients of all three are still negative. The coefficient for attaining a silver medal is not significant so we cannot make determinations of the effect on this ROA. But we do learn that companies ranked with gold status for their sustainable initiatives perform better financially than other companies receiving sustainability metals. There are several inferences that we can make from observing this information. The impact is at one extreme or the other. Meaning that, companies without any sustainability efforts perform best on ROA. However, if firms are going to make sustainability improvements, in the short-term the results are negative. Also, we find that firms that invest more heavily in sustainability performance and are recognised as such with a gold medal, still have lower ROA than non-sustainable companies but they perform better than companies that invest in sustainability only partially. So, with more sustainable efforts the negative impact is less.

Overall, if we consider the Interbrand green brand scores and financial DJSI together, we start to gain insight into the interdependencies of these important aspects of the business, namely the financial health and the customer perception. In Table 3, model (2) regresses firms that get a DJSI medal on the brand ranking per the Interbrand Green Brands index, model (3) that investigates the Interbrand rank on ROA and model (4) that delves deeper into the Interbrand rank and examines how the Interbrand gap score impacts ROA.

Observing the results concurrently from the descriptive statistics and correlations in Table 2 and regression models in Table 3, we are convinced of the interrelationships of different performance measures. This is evident because measuring performance by financial, sustainability and customer perception can yield different results depending on the different levels of sustainability investment. From analysis of the data, we infer that sustainability is a long-term investment, something noted in the literature but hard to prove. Furthermore, it is not only an iterative process it is recursive. It requires both reconsideration of certain aspects and all-out mindset shifts of other variables – that is what makes it a wicked problem. We were enlightened when reviewing the Interbrand approach to measuring both perceived and actual sustainability efforts. Being perceived as sustainable and being truly sustainable might be mutually exclusive, yet both impact the bottom line. While there are true sustainability initiatives, some companies focus on perception of sustainability as much as, or more than, actual sustainability initiatives. Finally, this leads to an insight regarding the tradeoffs of achieving sustainability in the supply chain which is why we approach this as a wicked problem, and glean interim results of the impact on business performance in an effort to provide guidance to supply chain managers on how to deal with this wicked problem.

These insights and contributions support why this research began and why the SLSCM problem is viewed as a ‘wicked problem’. The very nature of a wicked problem is that there exist several seemingly independent but ultimately interdependent components of the problem. However, the interdependencies are complex and an overall solution is elusive. Wicked problems must be managed with a long-term view of the business.
Sustainable logistics and supply chain management

Management implications

Sustainability is a truly cross-disciplinary problem and cannot be solved in a vacuum. The aggregate level correlations presented here indicate ‘how the continents are moving’ with respect to SLSCM efforts in supply chain across the globe. There are ways of improving supply chain sustainability by thinking outside the corporate box and by influencing the practices of suppliers and customers. It is well accepted that supply chain drives the core operating functions of the business. It is becoming clear, as researchers continue to unravel the sustainability problem, that sometimes subtle changes in process can have a significant effect on SLSCM outcomes. This study provided examples where a simple change in product ingredients (palm oil) or change in product use instructions (‘cold wash’) eliminate waste and undue harm that was unknowingly caused.

The sustainability problem is complex, and indeed, a wicked problem, because of the number of variables that contribute to increasing uncertainty. In supply chain management, a common goal is to reduce uncertainty to achieve solid business performance. The stakeholders, including stockholders, employees, suppliers, customers, environmental groups, governments and the general public, need to be considered as variables in any supply chain sustainability assessment. The complexity is compounded by the fact that each of the stakeholders have different methods and ways of measuring sustainable performance. Furthermore, all stakeholders have different thresholds of exactly when being sustainable is actually achieved.

Wicked problems cannot be solved – but need to be managed. The findings from this research and the literature reviews show that the trade-off between environmental concern and ROA through effective SLSCM is a wicked problem. Managers need to identify that a wicked problem exists, monitor the process, and maintain flexibility as follows:

1. **Identify that a wicked problem exists.** Do not try to turn the wicked problem into a tame problem, attractive as it might be, as tame problems have solutions and familiar tools for solving them. The wicked problem will reoccur. You have to take a holistic approach and be wary of the wickedness of the problem.

2. **Monitor the process.** Being aware is the first step to managing the wicked problem but it does not necessarily mean that all actors in the supply chain will require the same view and management approach. It means that it is possible to have a productive dialogue and open access to knowledge between involved stakeholders. Ensure that the ownership of the problem formulation is transparent and open to all actors. A holistic view is necessary to accept and respect that other stakeholders have different goals. Stakeholder involvement, commitment and coordination between organisations must be in place.

3. **Maintain flexibility.** Stakeholders in the supply chain need to accept that there is no optimal way to solve a wicked problem such as SLSCM. It is necessary to stay flexible with regard to problem solving approach. Be innovative and open to new ideas. Negotiations are necessary and stakeholders need to expect to step back from short-term demands and requests to garner the benefits for the whole system in the long-run.
Managing wicked problems requires a type of supply chain governance that creates new knowledge in the context of a broad stakeholder network (Peterson, 2009). The problem solving process continuously evolves and adapts, as does the community of stakeholders that enact it, along with their understanding of the problem and its solutions. In short, the stakeholders are the solution (Potter et al., 2010).

8 Conclusions

This research provides a unique contribution by taking a holistic view of the wicked problem of SLSCM. Most of the extant literature is granular in nature and does not take into account the multiple stakeholders and interdependent outcomes of sustainability initiatives. SLSCM is a ‘wicked problem’ for which this study begins to provide direction for managers and researchers. Regarding the research question “Taking a holistic view of supply chain sustainability performance, what are the organic interdependencies that drive sustainability, financial and customer performance in logistics and supply chain management?”, five conclusions are presented.

The first conclusion is that smaller companies are not managing stakeholder perceptions as well as large companies when they have made SLSCM efforts. Even though small companies are doing well on SLSCM, they are at a deficit in terms of perceived efforts. This could affect firm financial results. Secondly, companies that focus on sustainability can and do make improvements on SLSCM. All of the companies in our study, while progressing at different rates, are improving financially year over year while at the same time making sustainability improvements. Third, as we continued to unravel the issues, it became clear that investment in SLSCM is required to maintain a positive brand image, but significant investment in SLSCM may not be worth the financial pay-off and other reasons for pursuing sustainability must take the lead. Fourth, it is also clear that SLSCM improvement and performance both require long-term investments, something noted in the literature but hard to prove. This is one reason that we approach this as a wicked problem and attempt to glean at least interim results of several measures of sustainability performance. One final conclusion – it is difficult to optimise sustainability, profitability and brand perception concurrently. Yet, management of corporate performance requires a strategy that does just that. By using this research to glean insights among the organic interdependencies of sustainable logistics and supply chain management, researchers and managers have a better understanding of how to address this wicked problem.

We believe that more research is needed to develop an effective process management model for the wicked problem of SLSCM. We hope that this study will stand as a significant contribution for further research in this important area.

References


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