

Define KPIs for Balanced Scorecard to Measure Eco-Sustainable Performance at Container Terminals in Sri Lanka

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Abstract

A port or a terminal is always associated with various adverse environmental impacts. Therefore, it is a pressing need to have a comprehensive environmental performance management tool to improve ecological sustainability. There are different tools and standards to measure environmental performance; such as ISO 14001, ISO 14031, EMAS and SDM. These are so general that it becomes impractical for small terminals to adapt them directly. Incorporating environmental sustainability into the Balanced Scorecard gives comprehensive, internally-developed environmental performance management tool to improve ecological sustainability.

Focused interviews were conducted to identify existing environmental issues at container terminals (JCT/UCT, SAGT and CICT), which revealed issues such as emission, waste management, energy conservation etc. Based on findings from interviews and the literature survey, a set of key performance indicators (KPIs) were developed. Analytical Hierarchical Process (AHP) was the base tool to rank the defined KPIs, using a questionnaire survey. Finally a Strategy Map was drawn for the extended Eco-BSC.

The developed model will provide a comprehensive tool for environmental performance management, which will help measure and mitigate adverse environmental impacts, and improving ecological sustainability at the container terminal.

Introduction

The growth of international trade has given rise to maritime and port activities worldwide, for majority of the global trade happening through sea transport. However, with the increase of business in ports and terminals, the harmful environmental impacts also increase. In ports almost all the elements which can be associated with environmental impact are found: waste water, emissions of gas or particles into the atmosphere, noise, soil contamination, dredging, waste production, accidental releases into water or air, etc.¹ Of all the maritime trade, containerized trade amounts up to 35.4%.² Hence, as the world economy grows, the undesirable environmental impacts by container terminals will also increase.

Along with economic development, many stakeholders are becoming more and more conscious of the need for environmental sustainability of ports and terminals. Since they are identified as a major source of pollution, external pressure on reducing the environmental impacts of ports is growing. Therefore Port Authorities and Terminal Operators can no longer turn a blind eye to the damage they are causing on the surrounding environment.

There are several measures internationally recognized to mitigate these environmental issues. International Maritime Organization (IMO) have strict rules for pollution prevention from ships, but none for ports

and terminals. International Organization of Standardization (ISO) has a separate class, ISO 14000, as a tool for environmental management, but it is purely voluntary and not specific for the maritime sector. Eco-Management and Audit Scheme (EMAS) is another such measure. There are several tools available, specific for ports and container terminals, such as Self Diagnosis Method and Green Port Guidelines. They too are voluntary and not internal measures. On the other hand, the Balanced Scorecard by Kaplan and Norton³ is one of the most popular concepts of performance measurement in a business unit. Therefore it is suggested that the best approach to measure environmental performance of a container terminal, as well as other operational aspects, would be to integrate environmental sustainability into the Balanced Scorecard.³

This study was carried out to develop a set of Key Performance Indicators from the Ecological perspective for an extended Balanced Scorecard to measure environmental performance at container terminals in Sri Lanka.

Research Objectives

The main research problem addressed in this research was "How the Eco Balanced Scorecard can be applied to improve the environmental performance in container terminals."

Based on the above Research Problem, the objectives of the research can be stated as follows:

- Identify the Ecological Balanced Scorecard (Eco-BSC) approach
- Identify environmental issues within the container terminal that need to be addressed to improve sustainability
- Identify ISO, IMO and EMAS standards regarding environmental sustainability of a container terminal, and environmental standards set by other Port Authorities and terminals around the world
- Develop KPIs to measure the eco-sustainability of container terminals in Sri Lanka in accordance with the Eco-BSC and prioritize them using the Analytical Hierarchical Process (AHP).

Literature Review

Environmental performance refers to the environmental results realized whenever the environmental aspects of activities, processes, products, services, systems, and organizations are managed and controlled.⁴ It is improved when adverse environmental impacts are reduced and beneficial environmental impacts are produced.

The balanced scorecard³ is a performance measurement tool introduced by Kaplan and Norton. Its applicability in measuring environmental performance is not unknown; but rare in the maritime industry. From an environmental perspective, one advantage of BSC is that it shows the relationship

between long-term resources and capabilities, including sustainability issues, and short-term financial outcomes.⁵ There are 3 different approaches in integrating environmental concerns into the balanced scorecard to measure the sustainability.⁶

Integrating environmental metrics into the existing four perspectives

Adding an additional perspective that is concerned with environment (extended BSC)

Formulating a specific environmental scorecard (thematic BSC)

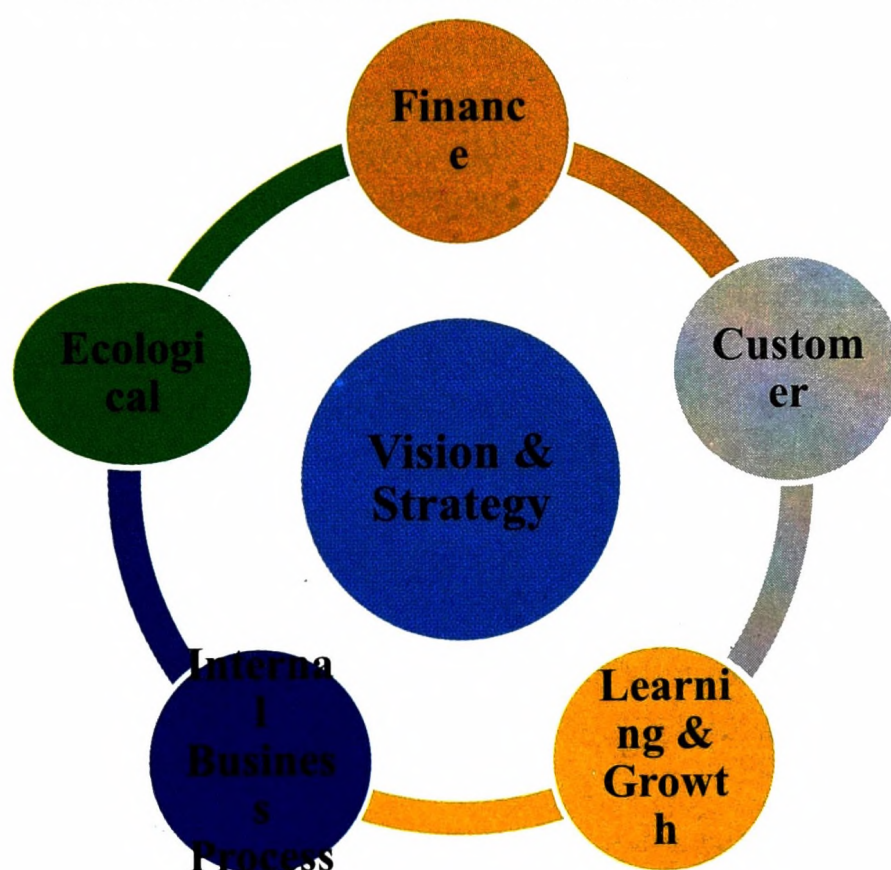
Of them, the derived BSC represents only a second step and the initial step should always be to integrate environmental aspects into the core BSC.⁶ Selecting the best out of the first two approaches must be based on the characteristics of the organization. If the strategically relevant environmental objectives can be integrated to the conventional scorecard, the first method is appropriate. If not, an additional non-market perspective needs to be included to extend the original scorecard.⁶

Research Methodology

The following methodology was followed to achieve the research objectives:

Data collection methods includes two approaches as primary data collection and secondary data collection. Out of this, the secondary data collection is done in the literature review. The primary data required is collected in 2 steps: the initial focused interview and the questionnaire survey.

FIGURE 1 ECOLOGICAL BALANCED SCORECARD



The initial literature review highlights the need of environmental performance measurement for the port sector and the common sustainability concerns at ports and terminals. It looks into the applicability of the sustainability-balanced scorecard in different industries and provide the base of selecting the approach to integrate environmental concerns to the BSC. Further, the literature review consists of the different tools and standards in existence to measure environmental performance of a company, such as ISO 14000, EMAS, Self-Diagnosis Method and Green Port Guidelines. The Key Performance Indicators to measure environmental sustainability that has been adopted by different ports and container terminals worldwide are also discussed.

Initial focused interviews were conducted with selected personnel from the 3 main container terminals (JCT, SAGT and CICT) in Sri Lanka, to identify the existing environmental issues in their respective container terminals. Addressing the findings of this semi-structured interview, and based on the literature survey, a set of KPIs is defined for the container terminals in Sri Lanka.

Key Performance Indicators that have been developed were tested using a questionnaire survey. It is done using a pair-wise comparison, where the respondent selects the more important aspect of a given pair, and the degree of importance of one criteria over the other. The responses were analyzed using Analytical Hierarchical Process (AHP), a multi criteria decision making tool.⁷ Comparisons indicated in a pair-wise comparison matrix are normalized in the next step to obtain the Priority Vector or the Performance Score of each criteria. Consistency calculations are done to check the consistency of the responses. Group decision making technique,⁸ using the Consistency Ratio (CR) value was used whenever combining the different responses given by the various respondents. The final result would be a prioritized set of KPIs for each of the container terminals.

In the next phase, a Strategy Map was drawn for the Balanced Scorecard, to show which of the KPIs in the Ecological perspective is critically influencing the other four perspectives of the BSC. In such a map, all sustainability aspects which have been identified as strategically relevant are presented in the hierarchical network of cause-and-effect chains.⁶

Analysis and Findings

Following the steps described under Methodology, the analysis was carried out.

Before developing the Key Performance Indicators to the Eco Balanced Scorecard, existing environmental

issues in the container terminals were identified. This was through focused or semi-structured interviews with selected personnel from the three main container terminals (JCT, SAGT and CICT) in Sri Lanka. The questions asked were open ended and the interviewee was free to express their own ideas. In order to identify environmental issues at JCT and UCT, the former head of the Sustainability Team of SLPA, who was well aware of environmental issues at the container terminals, the Health, Safety and Environment Manager at SAGT and a Manager from the Operations Division of CICT were interviewed.

The initial focus interview findings revealed that in JCT and UCT, the main environmental issues were air pollution caused by burning fuel, inefficient material usage, lack of sorting, reusing and recycling waste, water pollution, and the unavailability of an internal environmental management system. At SAGT, the emissions from vehicles and equipment, waste accumulation, and electricity usage were the key problems. Further it was revealed that the management at SAGT was working towards obtaining ISO 14001 certification. In SAGT, there are monthly debriefing sessions conducted to educate the employees on how they can contribute to reduce impacts on the environment. For CICT, the main issues were air pollution due to emissions, garbage collection and lack of recycling. All three terminals are under obligation to the Central Environmental Authority to comply with regulatory requirements.

The issues identified from the focus interview are summarized in Table 1.

The defining of Key Performance Indicators (KPIs) was done based on the focus interview findings and the literature survey. The base tool used was a revised version of "Green Port Guidelines" by the Sydney Ports Corporation, as given in Fig. 2. It identifies eight key environmental areas under two main concerns: resource consumption and environment quality.⁹ In each of the areas recognized, KPIs were defined, up to a total of 25.

As explained in Methodology, the prepared questionnaire was distributed to an expert group of top and middle level managers at each container terminal, and 6 responses were obtained (JCT/UCT 4, SAGT 1 and CICT 1). The data collected from the respondents were analyzed using the AHP tool.

The analysis of the data collected by the Analytical Hierarchical Process technique have given a ranking of the KPIs defined earlier in the Literature Review.

Environmental Issue	JCT	SAGT	CICT
Air pollution/Emission	X	X	X
Equipment use – TTU and yard cranes	X	X	
Waste collection	X	X	X
High and inefficient material usage	X		
Recycling issues	X		X
Water pollution	X	X	
Internal environmental management policy	X	X	X
Lack of good housekeeping		X	
Energy conservation		X	X

Table 1. Environmental Issues of Container Terminals

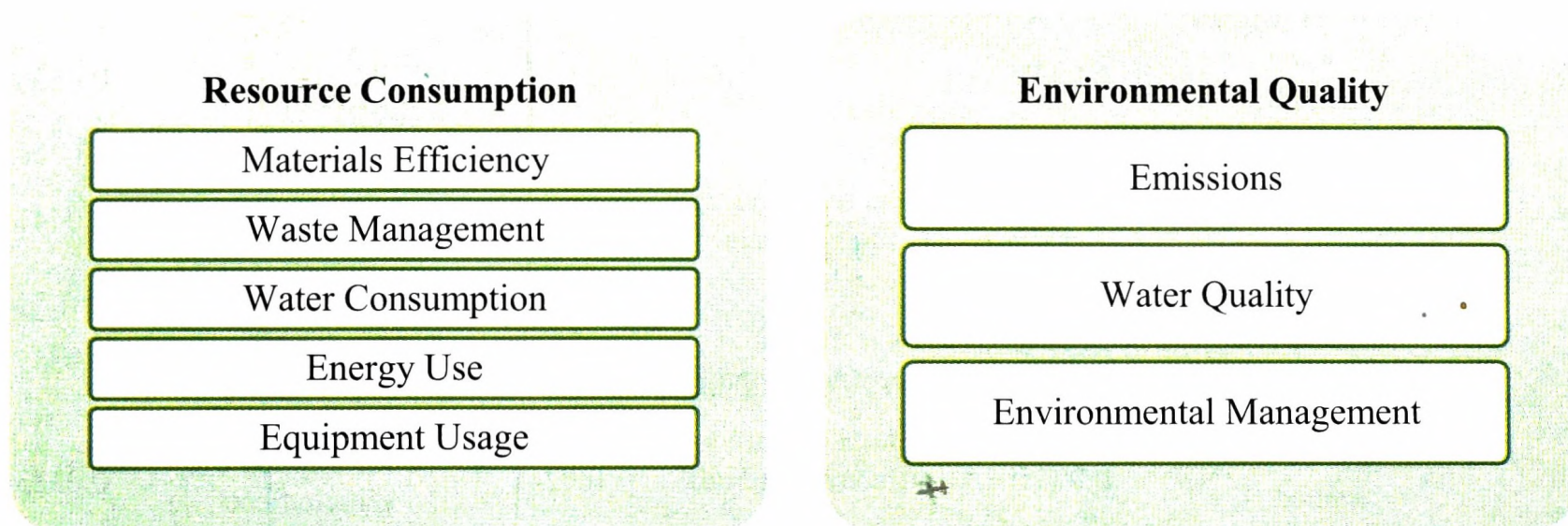


Fig. 2. Revised Key Environmental Issues: Green Port Guidelines

In this research, the KPIs of the three different container terminals have not been aggregated, since the 3 terminals are operating under different authorities and their environmental issues are varied. Therefore, the output of the AHP is unique to each container terminal, with some similarities. All three terminals have ranked the main category “Resource Consumption” to be higher than “Environmental Quality”. Under the former, the two sub-categories “Energy Use” and “Equipment Usage” are within the top 3 ranked in all three terminals. Further, the KPIs “Quay crane and yard crane diesel consumption” and “Total annual energy consumption” are among the top 5 in the global ranking of all container terminals. Finally, a sample Strategy Map has been drawn up for SAGT to illustrate the relationship between 10 KPIs in the Ecological perspective and the four other perspective.

Conclusions

Environmental issues associated with the maritime industry are high, especially in ports and terminals. Stakeholders now are becoming more and more attentive on environmental sustainability, to measure and mitigate impacts on the environment.

The objective of the research was to identify environmental issues in container terminals in Sri Lanka, and develop a set of environmental performance indicators for Ecological perspective in the extended Balanced Scorecard to improve environmental sustainability.

An initial literature survey revealed the different tools in use to measure environmental performance. A preliminary focus interview conducted with one person from each container terminal (JCT, SAGT and CICT) who was familiar with the environment, revealed existing environmental issues such as emission, waste management, energy conservation lack of internal environmental management policy, etc..

Table 2. Top 10 KPI according to Global Rankings

Rank	JCT/UCT		SAGT		CICT	
	1	Energy consumption per TEU	0.1506	Quay Crane and Yard Crane Diesel consumption	0.0975	Total annual energy consumption
2	Total annual energy consumption	0.0955	Percentage from renewable energy sources	0.0960	Energy consumption per TEU	0.1323
3	Hours of preventive maintenance	0.0819	Total annual air emission	0.0484	Quay Crane and Yard Crane Diesel consumption	0.0828
4	Quay Crane and Yard Crane Diesel consumption	0.0809	Total annual water consumption	0.0479	Hours of preventive maintenance	0.0777
5	Average fuel consumption of vehicle fleet/ equipment	0.0562	Total annual energy consumption	0.0369	Electricity consumption	0.0686
6	Amount of water untreated water released to soil/sea	0.0482	Time spent idling	0.0355	Total annual emissions of GHG per TUE	0.0506
7	Electricity consumption	0.0457	Electricity consumption	0.0336	Total annual air emission	0.0506
8	Percentage from renewable energy sources	0.0298	Hours of preventive maintenance	0.0332	Amount of waste recycled: Cubic meters of solid waste or litres of liquid waste	0.0447
9	Wastewater discharged per TEU handled	0.0238	Noise measured at specific receptor	0.0286	Time spent idling	0.0355
10	Number of employees trained	0.0231	Annual quantity of different materials used	0.0248	Average fuel consumption of vehicle fleet/ equipment	0.0323

It was the platform in defining the KPIs. These were ranked using AHP and finally, a Strategy Map was drawn to realize cause-and-effect relationship between the Ecological perspective and the other four perspectives.

The study showed that the extended Balanced Scorecard is a good technique to incorporate environmental sustainability into a company's performance matrix. The followed methodology gave a prioritized set of KPIs for the Ecological perspective of the extended BSC. It showed that the results were difficult to be generalized, and unique to the container terminal.

By implementing this model, management of container terminals will have a comprehensive tool for environmental performance management, which will be the key for measuring and mitigating adverse environmental impacts, and improving ecological sustainability at the container terminal.

References

1. R. M. Darbra, A. Ronza, J. Casal, T. A. Stojanovic and C. Wooldridge, The Self Diagnosis Method, *Marine Pollution Bulletin*, 2004, pp. 420-428.
2. UNCTAD, *Rev. Maritime Transport*, 2014, UNCTAD
3. R. S. Kaplan and D. P. Norton, The Balanced Scorecard - Measures that Drive Performance, *Harv. Bus. Rev.*, 1992, 9
4. Paraxiom Research Group Limited, ISO 14001 2015, <http://www.praxiom.com/iso-14001-definitions.htm>, 2015, accessed 28 12 2015.
5. A. Moller and S. Schaltegger, The Sustainability Balanced Scorecard as a Framework for Eco-efficiency Analysis, *J. Industry Ecol.*, 9, 4.
6. F. Figge, T. Hahn, S. Schaltegger and M. Wagner, The Sustainability Balanced Scorecard - Theory and Application of a Tool for Value-Based Sustainability Management, *Bus. Strategy Environ.*, 2002, 11, 269-284.

7. T. L. Saaty, Decision making with the analytic hierarchy process, *Intl. J. Services Sciences*, 2008, 1 (1), 83-98.
8. Z. Srdevic, B. Blagojevic and B. Srdevic, AHP based group decision making in ranking loan applicants for purchasing irrigation equipment: A Case Study, *Bulg. J. Agri. Sci.*, 2011, 531-543.
9. Sydney Ports Corporation, Green Port Guidelines - Sustainable Strategies for Port Developments and Operations, Sydney, 2006.
10. M. H. Hakam, Nordic Container Port Sustainability Performance - A Conceptual Intelligence Framework, *J. Service Sci. Management*, 2015, 8, 14-23
11. R. S. Kaplan and D. P. Norton, Having Trouble with Your Strategy? Then Map It, *Harv. Bus. Rev.*, 2000, 78, 167-176