Measuring the sustainability of logistics in small island nations in the Pacific

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Julian Gilbert Joy

Abstract

This thesis examines the factors which small island nations in the Pacific could consider measuring as indicators when monitoring and reporting on the sustainability of supply chain management practices, focused on the logistics elements.

A theoretical framework is derived from a review of appropriate literature to guide the research, which employs a case study methodology. The case study provides a cross sectional view of the reporting environment for early 2015, focused on the small island developing states (SIDS) that are members of the Pacific Islands Forum. Governmental regional organisations are the core participants for the development of the research, due to the nature of the political and business environment in these Pacific nations. One private company and one academic institute are also included as possible triangulation validations.

The research finds that no effective measuring or reporting is currently being conducted in relation to assessing the holistic sustainability levels of logistics in the region. The lack of past adequate cross sectional or other methodology of data capture and reporting by the nations, has consequently resulted in a lack of adequate longitudinal data sets. Such data is needed to reliably inform and enable effective decision and policy making on logistics activity and investment in the region.

The research finds that monitoring and reporting systems would operate effectively at the regional government level, with data disaggregation to national and indicator level. The Global Reporting Initiative (GRI) method of reporting fits within the political environment, and the research finds that this, linked with the UN Sustainable Development Goals (SDG) indicators, which are to apply from 2015 to the year 2030, could provide a suitable monitoring and reporting framework. This would enable a consistent longitudinal data capture.

The research's recommended methodology will enhance the monitoring value and improve the opportunity for effective further research for the sustainability levels of logistics and other related societal functions in the small island nations.

Acknowledgements

The advice and guidance supplied by the Massey University supply chain team, led by Paul Childerhouse, and my supervisors Jersey Seipel and Alan Win has been critical to the completion of this research. Undertaking the research for this paper has flowed from my work in the Pacific Islands for various projects with NZAID and other organisations. However, analysing the situation in a rigorous academic environment meant that a significant directional focus was required in defining the research question to enable effective analysis.

Particular acknowledgements for assistance must go to John Hogan and his dedicated team at the Economic Development Division of the Secretariat of the Pacific Community in Suva. The names of the team members are listed in the Appendices. Their input into assisting to organise interviews, and discussing data availability was invaluable. They may or may not agree with all the comments or findings of the research but they are committed to the development and management of the small island nations group, and are an inspiration for all.

On the technical side I acknowledge the work of Bartholomew Joy in introducing me to, and patiently tutoring me in, the software TeXstudio for LaTeX, and associated graphical programmes. I find these very valuable software packages for significant professional and academic document production.

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Glossary

AOSIS	Alliance of Small Island States, a global organisation of all small island states
APICS	American Production and Inventory Control Society; now simply branded as APICS
APICS SCC	APICS Supply Chain Council (APICS & SCC merged in 2014)
CSF	Critical success factor
CSO	Community service obligation
CSR	Corporate social responsibility
EE	Ecological economics
ERL	Environmentally responsible logistics
EVI	Economic vulnerability index
GHG	Greenhouse gases, principally carbon dioxide, methane, nitrous oxide, and fluorinated gases such as hydroflourocarbon
GISR	Global Initiative for Sustainability Ratings
GRI	Global Reporting Initiative
GRIG4	Global Reporting Initiative G4 version, the latest version, implemented 2014
GSCM	Green supply chain management
GVSM	Green value stream mapping
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
IUCN	International Union for the Conservation of Nature
KPI	Key performance indicator

LCA	Life cycle analysis; relating to sustainability, means the total effect on the environment of the product from design to disposal
MDG	Millennium development goals
MSC	Marine Stewardship Council
NMDI	National minimum development indicators
ODA	Official Development Assistance
PIC	Pacific Island countries
PICT	Pacific Island countries and territories; members of SPC
PIDF	Pacific Islands Development Forum
PIF	Pacific Islands Forum, Pacific Islands Forum Secretariat; a political grouping of the nations in the area, with secretariat based in Suva
PNA	Parties to the Nauru Agreement, a fishing licensing agreement for a group of PICTs
PRDR	Pacific Regional Data Repository, for Sustainable Energy for All (PRDR SE4ALL)
PRISM	Pacific Regional Information System; a project of the statistics division of SPC
PSIDS	Pacific SIDS
PSSA	Particularly sensitive sea areas; an IMO activity
SASB	Sustainability Accounting Standards Board
SCOR	Supply chain operations reference model, managed by APICS
SDG	Sustainability Development Goals
SDSN	Sustainable Development Solution Network (a UN organisation)
SEEA	System of environmental and economic accounting (a UN system for valuing the natural capital of a nation)
SIDS	Small island developing states

SPC	Secretariat of the Pacific Community; an operational and research organisation with a role to implement the policies of the PIF; corporate management based in Noumea with some operational management in Suva
SPSCs	Sustainability performance of supply chains
SRPP	Socially responsible public procurement
SSI	Sustainable shipping initiative
SuSCM or SSCM	Sustainable Supply Chain Management
TBL	Triple bottom line
TEU	Twenty foot Equivalent Unit, the standard shipping container unit used in this region
UN-OHRLLS	UN office of the high representative for the least developed countries, landlocked developing countries, and small island developing states
UNCTAD	UN conference on trade and development
UNEP	UN Environment Programme
VSM	Value stream mapping
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

Chapter 1

Introduction

1.1 Introduction

The purpose of the research is to examine the methods used for quantifying and analysing the levels of sustainability that currently exist for logistics functions in small island nations of the Pacific. The focus of the study is on the logistics functions of the supply chain, including considering all transport modes. Existing models for sustainability metrics used in industrialised areas such as Europe are reviewed, and a conceptual research model constructed in order to assist the investigation process.

Chapter 1 outlines the focus of the topic, the research question, the purpose of the research and its conceptual framework. In Chapter 2 a range of significant current and recent literature on the topic is reviewed, and the definitions of concepts involved and the boundaries of the research are elaborated. Further, a conceptual model for the research is developed. In Chapter 3 the research methodology adopted is defined, the epistemological and ontological perspectives are examined and appraised, and the data capture and analysis concepts discussed. Chapter 4 describes the research as conducted, and presents and analyses the information and data obtained. Chapter 5 discusses further the practical implications of the research findings. A possible model to fulfil the research question is offered. In Chapter 6 conclusions are reached where appropriate, and research gaps requiring or enabling further research are identified.

1.2 The research topic and question

The research question is:

> What factors may be used to reliably measure current levels of sustainability of logistics in the small island nations of the Pacific?

The question is divided into three further sub-questions to assist the definitive analysis and measurement to guide the research:

1. What models and metrics are currently being used for analysis of logistics sustainability levels in the region?
2. Is there a model for analysing sustainability levels that is more appropriate for the region?
3. How sustainable is current logistics in the region considered to be, using the current and proposed models?

Pacific nations in general have in recent years adopted a vocal ‘green’ or ‘sustainable’ approach on the political level. However, although they are themselves generally small producers of greenhouse gases and associated pollutants, ESCAP (2012) points out that they appear to have taken little effective modifying action within their own nations.

At local and regional levels, formal and informal organisations press for the adoption of ‘green’ technologies, including those for transport. However, the available data appears to be inadequate for effective decision making and comparisons on a holistic longitudinal analysis of sustainability, rather than being based on emotive issues around global warming and greenhouse gases.

1.3 Objective of the research

The research question and sub-questions are designed to develop insights into the use of current measurement models and systems relating to the sustainability of logistics. The measurements and data from these models are then to be analysed relevant to the decision making needs of the small island nations of the Pacific.

The research seeks to examine the models being used for the measurement of sustainability currently being achieved in the island nations' logistics processes, to establish the models' effectiveness and relevance, and to open discussions regarding potential improved models.

1.4 Research scope and boundaries

The research is conducted on a case study basis focused on a selected group of small island nations in the Pacific. All modes of transport are included, and no distinction is made between type of product or persons as the subject of the logistics process.

1.5 Importance of the research

The research has importance as – although various data sets and monitoring systems may exist or are developing regarding sustainable logistics and supply chains – the use of these in the Pacific area does not appear to have been adequate:

> . . . the progress made with implementation of the PIFACC [Pacific Islands Framework for Action on Climate Change] was difficult to judge due to the lack of established monitoring and reporting procedures. (SPREP, 2015)

The above quotation indicates that there needs to be be an improved acceptance of the value of quantitative monitoring to inform the national decision processes. Some of the international databases such as the World Bank and IMF databases do not show data for these Pacific areas because of the small quantities involved and the lack of statistical evidence.

The stakeholders for the research include the government organisations as well as private companies, because in most of these nations a mixed ownership and operational model with significant government involvement in transport and logistics exists. Consequently, the government organisations have a significant influence, either through direct government ownership of assets or through contracted community service obligations (CSO) of private organisations. In addition, academic institutions will be enabled to further broaden and develop their research base.

1.6 Research method overview

The research is developed within a conceptual framework established from concepts into an operational plan. Veal (2005) categorises this style of research as descriptive in style, which in this case is mainly of a quantitative nature. A possible outcome for further research could involve evaluative qualitative considerations, as many of the items being measured may have a KPI metric that has been set using a subjective rather than an objective basis. This research however uses a quantitative data based system, as developing a suitable model requires quantitative and discrete elements that are readily measurable by observation or calculation.

1.7 The research contribution

The research contributes some additional directional guidance for the measurement of sustainability in the logistics sectors in general, but in particular does so related to the researched geopolitical grouping. This enables more transparent decision making for businesses and policy makers, and contributes to the open questioning and enquiry development process in sustainable logistics. Part of the process is to establish a method that is practical and has a sound basis. Three fundamental manners for displaying supply chains, as discussed by Acquaye, Genovese, Barrett and Koh (2014), are listed below. The appropriateness of each viewpoint and weighting is examined and a suitable combinations for the research area sought:

- GIS-based methods that allow for a geographical representation of the supply chain.
- Network-based methods, allowing for representing flows across the supply chain, thanks to a node-edge perspective. This is mainly utilized in the operational research literature for setting and solving supply chain optimization problems.
- Value stream methods that allow for identifying value creation hot-spots within the supply chain, usually used in reducing waste and idle time. (Acquaye et al., 2014)

These methods are established, relevant, and suitable for the analytical purposes of mapping the supply chain structure, interrelationships, and operation; however the measurement of the level of ‘sustainability’ in supply chains, which fits within the value stream analysis, is a complex and developing process involving a wide spectrum of criteria. As Schaltegger and Burritt point out when discussing the sustainability performance of supply chains (SPSCs):

> SPSCs is thus connected with impact levels, improvements and side effects and requires a full spectrum of measurement scales which as yet are under-researched. Furthermore, the introduction of multiple and offsetting or conflicting goals leads to complexities in measurement methods requiring simplification for the practice of sustainability management and would find integration to single metrics unproductive.
>
> (Schaltegger & Burritt, 2014, Page 235)

1.8 The research limitations

The research focuses on the sustainability of logistics functions within the South Pacific islands areas, and is particularly focused towards the smaller developing island nations or states (SIDS). Significant geographic, economic and societal differences occur between the nations in the region, and a model that encompasses this spectrum is required. No historical longitudinal view is adopted in the research – the existing 2014/15 supply chain features of trade logistics in the region are accepted as a base as required.

Chapter 3 examines the selection of the geopolitical groupings that are included in the research. Due to the small quantities of some of the data elements, a national basis is adopted rather than an individual industry sector. This requires significant aggregation of data with the limitations associated with that, particularly in the Pacific administration environment. This difficulty is discussed by ESCAP:

> Sustainable development requires integrated planning, management and monitoring across sectors. . . . Countries expressed concerns about the statistical capacities needed to monitor the SDGs. Monitoring and reporting on the MDGs was already a challenge for many. Disaggregation and quality of data

> were some of the issues encountered. Currently, there are inadequate investments and financial resources for national statistical systems - essential elements to acquire the tools for conducting work and maintaining a skilled and motivated work force. The production of data is important, but so, too, is the utilization of data to inform policy and enhance service delivery of development efforts. In the Pacific, there is a need to get value for money in data collection. In this regard, the fewer, simpler and more streamlined the indicators of the SDGs, the better. (ESCAP, 2014, page 5)

In the following Chapter, ‘Literature review’, significant current and recent literature contributions to the topic are reviewed, necessary definitions are developed from the literature, and the boundaries of the research are elaborated. From this literature analysis, the conceptual model for the research is developed.

Chapter 2

Literature review

2.1 Introduction

This literature review is an examination of recent significant contributions to the topic of sustainable supply chain networks and the role of logistics and transport within those supply chains, particularly focusing the attention towards the economic, societal and environmental aspects of the logistics and transport elements. Definitions that are important to the research are detailed, and the spatial and conceptual research boundaries are developed and discussed.

The relationship of sustainability and 'green' metrics to transport is defined according to recent authors, and is then related to the small island nations of the Pacific. Following the defining of the boundaries and concepts, a conceptual model of the research is explained, and research gaps are identified.

2.2 Important contextual definitions for the research

Several terms are in need of definition for boundary-setting within the context of the research in order to ensure the research is conducted in a controlled manner. The general structure of the main topic areas of the research is diagrammatically outlined in Figure 2.1, and the associated definitions together with other related terminologies are examined in subsequent sections of the literature review.

The main topic areas within the general structure of the research are delineated as:

1. International societal concepts, relating to logistics supply & demand
2. Pacific nations' societal concepts, relating to logistics supply & demand
3. The Pacific area's physical and geographical environment
4. Logistics' role in the supply chain
5. Logistics and 'sustainability'

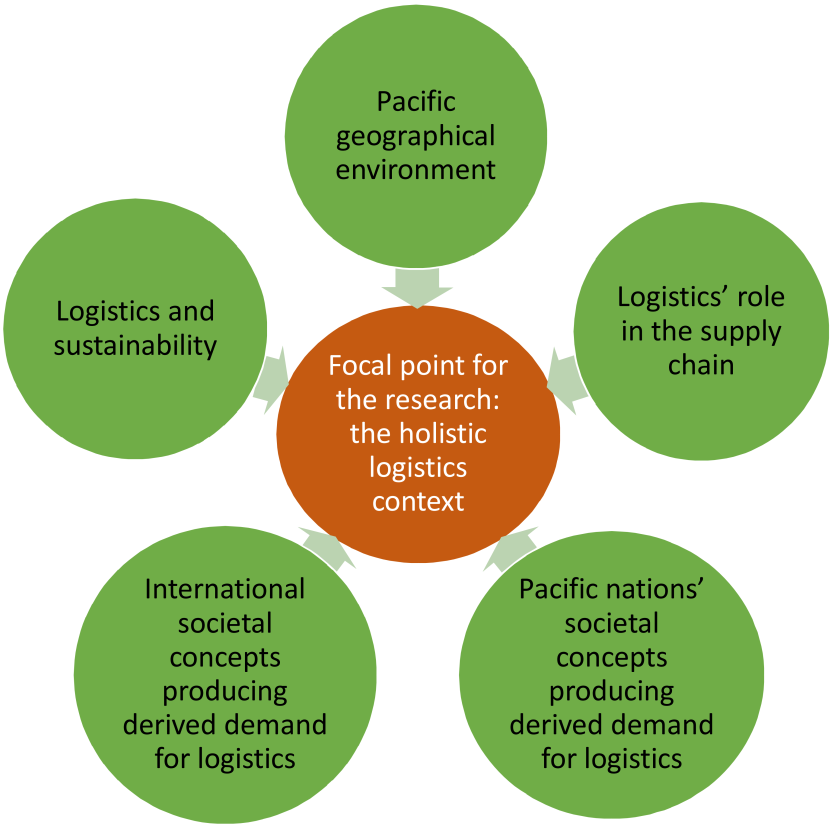


FIGURE 2.1: General structure of the research topics, showing the holistic focus adopted.

In Figure 2.1 the central area where the five element groups merge is the focal point for the research. Some elements are referred to as external drivers of logistics features, and some internal. A useful discussion on external drivers, such as public pressure and globalisation, and internal drivers, such as employee involvement and profit opportunities, is included in the examination of current supply chain sustainability trends by Tsoulfas and Pappie (2012, page 341).

Focusing these elements provides the measurement and monitoring lens through which the research question is investigated. The component topics, together with other related parameters and terminologies relevant to the research, are examined in the following sections.

2.2.1 International societal concepts, relating to logistics supply & demand

The demand for logistics is increasing globally, with pressure on logistics companies to deliver more varied goods with shorter lead times at lower costs. ‘Globalisation’ of manufacturing, and practices such as ‘Just in Time’ supply chain operations, have increased logistics demand and complexity significantly. The complex logistics systems that enable international passenger air travel are taken as routine and normal by many of today’s global residents, and high levels of service expectations have developed. Courier business growth illustrates the demand for short lead times for the delivery of goods. The research does not develop or examine these individual topics further; they are however accepted as external driving influences on the derivation of demand for logistics services in the research area.

No nation or supply chain exists in isolation, and the effect of events in global societies certainly have effects on the Pacific nations. Some community groups of the residents of the island nations have always travelled and worked extensively, and increasingly so in recent years. For some of the smaller nations, more of the residents live outside the nation, such as in New Zealand or Australia, than on the islands. An extreme example of this is represented by Niue, where Statistics Niue (2015) reports that about 20,200 Niueans live in New Zealand, and about 1,600 live on the island of Niue.

It is inevitable, due to the travel and residence mobility of some population groups, that global demands, expectations, and other relationships can be considered as influencing the decision makers in these nations.

2.2.2 Pacific nations' societal concepts, relating to logistics supply & demand

The research does not attempt to examine the differing societal related political structures within the area. Residents of the research nations are however influenced by global activities in a variety of manners, and where relevant to the logistics process, these are considered in the research. An example of influence is the demand for international air transport from the resident's island and nation for social, employment, and political reasons. Many of the political organisations have staff travelling extensively, and this experience affects the demand and expectations for goods and services, including travel, and possibly not always in a positive manner. As Hughes points out, when examining the involvement of the SIDS as individual members of the United Nations:

> Servicing international obligations individually leads to travel and stints in New York, but eats up money and scarce trained manpower. (Hughes, 2003, page 4)

Many residents work internationally or have family that do so, such as for example working as seafarers on ships or seasonal work in the nearby New Zealand and Australia. Many study in other nations on scholarships funded by aid programmes or other funding projects. This work and travel inevitably influences personal expectations. It does not necessarily mean a *greater* demand for consumer goods and services; for example the researcher was visiting a small island, with a population of under 50, and several residents had travelled internationally for work, including to New Zealand and other parts of the world. This island had a no-alcohol policy and did not wish for large capital developments, as it would spoil the island. In contrast, other islands may demand features of a 'Western' modern lifestyle on their island. Both of these options have a direct influence on logistics and associated infrastructure requirements.

2.2.3 The research area's physical and geographical environment

The nations covered by this research are included in two main geo-political groupings:

1. Pacific Island Countries & Territories (PICTs), which are the Secretariat of the Pacific Community (SPC) member nations.

2. Small Island Developing States (SIDS).

The PICTs group of nations that are members of SPC include:

1. A group of four large nations with historical and current significant political involvement in the region: Australia, New Zealand, USA, and France.
2. A group of twenty-two island nations:

   American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.

   - Within the twenty-two island nation group, there is a sub-group of fourteen nations classified as Small Island Developing States (SIDS):

     Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.

Small island developing states are not isolated to the Pacific; there are 52 in total, and they are in three main groupings: 23 nations in the Caribbean, 20 in the Pacific, and 9 in the group scattered around the Atlantic and Indian Oceans, and Mediterranean and South China Seas. The UN describes the features of SIDS as follows:

> Small Island Developing States (SIDS) is a term [sic] first appeared during the 1992 United Nations Conference on Environment and Development (UNCED) to focus the attention of the international community to the unique characteristics of the small, ecologically fragile, and economically vulnerable island states, including but not limited to the following:
>
> - Volatility and susceptibility to external global economic factors, including economic and natural shocks beyond domestic control;
> - Lack of economies of scale;
> - Excessive dependence on international trade;
> - Relatively high costs for transportation and energy services;

> - Limited human, institutional, and financial capacities to manage and use natural resources on a sustainable basis;
> - Increasing demographic (small but rapidly growing population) and economic pressures on fragile, vulnerable, endemic natural resources and ecosystems. (UN DESA, 2013, page 3)

The research does not consider specific issues relating to the effects of increasing populations or any demographic influences on the islands resources, unless specifically related to logistics.

The effect that climate change may have on the low-lying islands is frequently discussed by the nations' politicians in international arenas. Scientists' views vary on the past, recent, and predicted geomorphic processes regarding the quantity and causation of land and sea changes in the region. These issues are discussed for SIDS and LDCs by Bruckner (2012) in relation to the effect that changes may have on the Economic Vulnerability Index (EVI) for the nations. Kench, Thompson, Ford, Ogawa and McLean (2015) conducted research on Tuvalu which found that there has been a 7.3% increase in net island area over the past century, not a decrease as in some popular statements. This evidence supports the researcher's empirical and unofficial observations that a significant proportion of island land and coastal damage is caused by increased population and significant construction of structures such as buildings and roads on the low lying islands, thereby inevitably altering the natural local geographic processes. These are consequential effects of the increasing demographic and societal changes, and are considered in the research where they affect the logistics processes.

The major existing geographic, climatic, and topographic features of the islands influence the transport and logistic practices that may be appropriate, and as Simchi-Levi, Kaminsky and Simchi-Levi (2008) point out, whether in developed or undeveloped countries the geography significantly affects the supply chain decisions. A study conducted in central Europe is considering significantly different environmental and economic characteristics and parameters compared to one conducted in the Pacific. These features directly influence the research, but any longitudinal change in those influences with time is not considered. This could be a subject for further research.

Thus, when considering metrics and indicators for logistics and transport use in the research region, analysis needs to be included regarding modal alternatives available and other institutional features relating to the current overall spatial environment, including population and resource distribution. In Switzerland for example, a relatively greater involvement with terrestrial logistics than with maritime logistics would be expected to be observed in the nation's logistics data, and the reverse would be expected for Nauru.

The ratio of EEZ area to land area can be used as one broad indicator of how significant the ocean may be compared to the land for the nation's domestic and international transport infrastructure considerations. Table 2.1 shows some sample nations in the Pacific area, and the data shows that New Zealand has a ratio of EEZ ocean area to land area of 16; Fiji's ratio is 70, Cook Islands is 7,721, and Tuvalu has the largest ratio at 34,620, having a land area of 26 km^2 (spread over 9 islands), and an EEZ of 900,000 km^2.

Some Pacific nation's relative land and sea areas

Nation	**Land area** km^2	**EEZ** km^2	**EEZ/land area**
Australia	7,692,000	6,363,000	1
New Zealand	268,700	4,300,000	16
Fiji	18,330	1,290,000	70
Samoa	2,935	120,000	41
Kiribati	811	3,550,000	4,377
Cook Islands	237	1,830,000	7,721
Marshall Islands	181	2,131,000	11,770
Nauru	21	320,000	15,240
Pitcairn Islands	47	836,000	17,790
Tuvalu	26	900,000	34,620

Table 2.1: Relative land and sea areas of a sample of Pacific nations. The relationship of ocean area (EEZ) to land area illustrates the importance of the ocean to the island nations. Values are rounded where appropriate.

The map Figure 2.2 also illustrates this, showing the EEZ areas for the member states of SPC, and this highlights some of the particular geographic and political features of the study area when compared to Europe or other major areas. The research data analysis includes the categorisation of the selected nations according to criteria such as population, transport facilities available, service connectivity, land and sea territory size, and other data considered of significance to the logistics analysis.

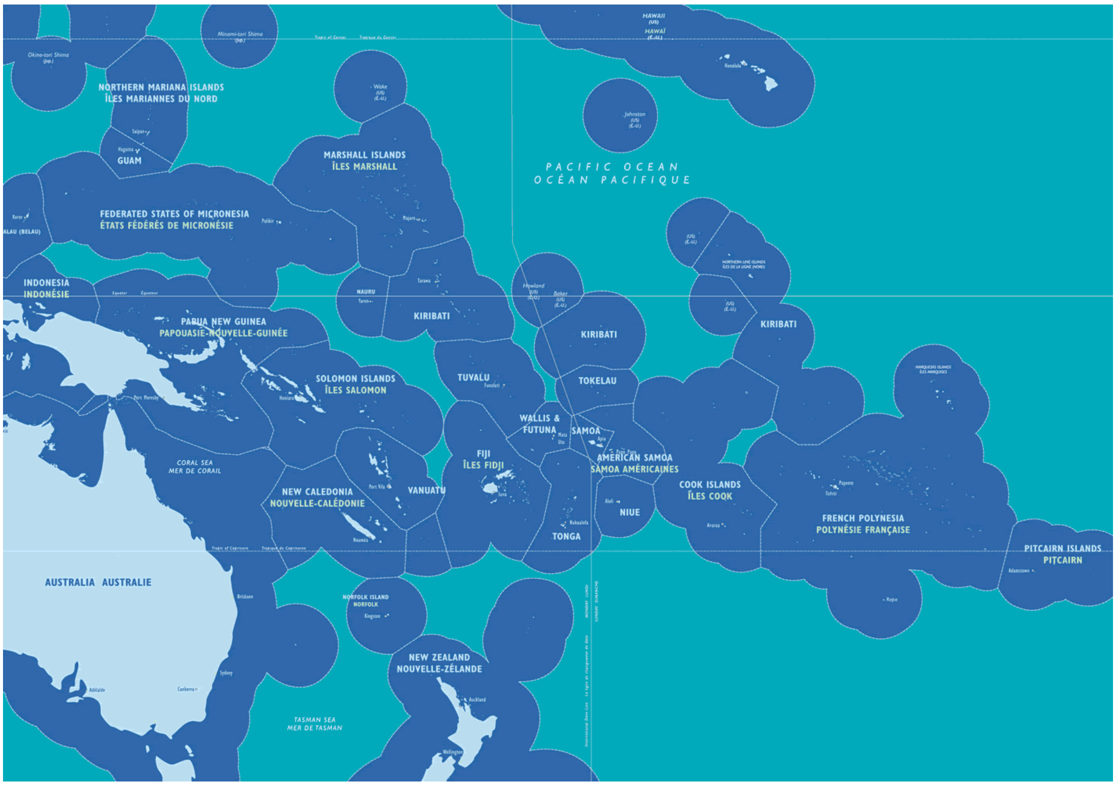


FIGURE 2.2: Map showing SPC membership coverage, including NZ and Australia. The dark blue areas are the EEZs for the nations in the region, including non-SPC members such as Hawaii. Source: SPC

2.2.4 Logistics in the supply chain

The definition of supply chain management, together with its relationship with logistics, has been developing over recent years. As the research is aimed at a conceptual and operational level, and relates to the management of the business and government logistics environments, the definitions selected are those at management level. Current definitions can be accepted as similar to that of the Council of Supply Chain Management Professionals (CSCMP) which defines 'supply chain management' in some detail:

> Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies. (CSCMP, 2014)

Similarly, the CSCMP defines the 'logistics management' function within the supply chain:

> Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements. (CSCMP, 2014)

Within these definitions, the research focuses on logistics management, of which transport is a significant component. This encompasses the physical movement of the product, including any storage that is associated with the transport sector but not with the product processing. It is also important to note that in the research, the terms 'goods', 'product', and 'cargo', or similar expressions used regarding the item that the transport logistics process is storing or moving, includes a person or passenger (but not crew), because for the logistics process a passenger is simply a product with particular characteristics, as is correctly pointed out by Fawcett (2000).

No supply chain network is completely separate from other chains, and intersection is necessary, common and often planned – 'supply chain integration' is the study of planning this intersection feature – and a common place of intersection, but by no means the sole place, is a transport element. The transport element of the supply chain is undoubtedly significantly important in managing the current global trade environment; Oakden and Katia (2011, page 21) point this out when they state that 'the logistics strategy of the enterprise is informed by the current structure of the supply chains that interact with the business.' A typical intersection transport element could be, in the geographical area being considered, a cargo ship carrying products sourced from a variety of supply chain networks around the world, being transhipped for example from the regional hub port of Suva in Fiji to the local hub port of Funafuti in Tuvalu, for further local distribution.

Figure 2.3 visually represents the linkage concept between logistics elements of supply chains with common transport sectors; such linkage is common in the area of the research. In the diagram, three typical products may move in three separate supply chains to an export area hub port (such as Los Angeles), then to a Pacific hub port (such as

Suva) and local hub ports (such as Honiara and Funafuti), and then to a final island destination and the end of the physical supply chain. A consignment would commonly be moved on two or three different ships or aircraft or combination thereof.

Direct shipping container service connectivity has significantly increased over the past few years for Fiji, Palau, and Solomon Islands, but reduced elsewhere in the region, reflecting the increased role of these nations as local hub port bases for the smaller island nations (UNCTAD, 2014). Therefore, a key development area for the smaller island nations in the Pacific continues to be efficient feeder service operations from these main hub port areas, through local hubs to the small islands and atolls.

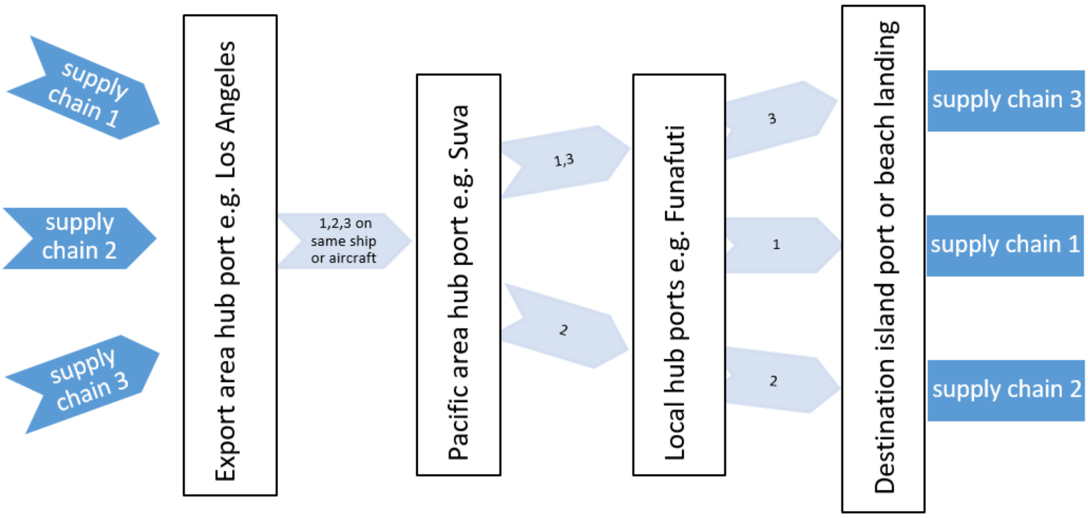


FIGURE 2.3: Representation of supply chain intersections at transport focal points. Note that a port can be either a sea port or an air port.

2.2.5 Logistics and sustainability

‘Sustainability’ is a derived noun from the verb ‘sustain’, and has a range of evolving meanings. The Oxford English Dictionary defines ‘sustain’ and ‘sustainable’ with a few variations according to the context. Current modern meanings selected as appropriate to the research are:

sustain : To support, maintain, uphold. (Oxford English Dictionary, 2014a)

sustainability : The quality of being sustainable at a certain rate or level. An example specifically of a meaning in recent use: The property of being environmentally

> sustainable; the degree to which a process or enterprise is able to be maintained or continued while avoiding the long-term depletion of natural resources. (Oxford English Dictionary, 2014b)

Evolved from these dictionary meanings, a definition of 'sustainability' for possible use in a societal and economic context relevant to the broad concepts of this research environment is used by the United Nations:

> Sustainability calls for a decent standard of living for everyone today without compromising the needs of future generations. (UN, 2015c)

The terms 'sustainable' and 'green' are relatively recent in business supply chain terminology. Sustainability of the business supply chain has developed as a management topic significantly in the past decade. Ballou (2004) for example mentions the term 'environment' only briefly, as was common at that time, and his environmental consideration was mainly concerned with supply chain waste and reverse logistics. By comparison, a new wave of research has developed in recent years, and for example the journal 'Supply Chain Management: An International Journal', 2014, published Volume 19 issue number 3 as a special issue on the research topic of measuring and managing sustainability performance of supply chains (Emerald, 2014, 3). Several of the papers in that issue are referenced in this research.

The consideration of sustainability as an influencing factor for business profitability rather than a simple cost has been developing for some time. For example Pullman, Maloni and Carter (2009) researched this for the food industry businesses, and found positive direct and indirect impacts on business performance when social and environmental factors were included into a business's operational framework.

A summary of the development of 'green' logistics terms and associated research is discussed by McKinnon, Browne and Whiteing, and they reach a significant conclusion that 'green logistics is now regarded as good business practice and something that can have a positive impact on many financial and operational metrics' (McKinnon et al., 2012, page 19).

Similarly, Oakden and Katia (2011) conclude that 'sustainability is therefore not a fringe issue, but a strategic business concern'. In addition, Frota Neto, Bloemhof-Ruwaard, van Nunen and van Heck (2008) adopted a wide supply chain view, demonstrating the principle that the objective in the design of logistic networks has changed from one of simple cost minimisation, to one of both cost and environmental impact minimisation.

All these references demonstrate that the environmental and wider societal components of the logistics elements of a supply chain must be considered, as they are no longer invisible economic externalities for a business organisation. It is equally apparent from the literature that the term sustainability means more than simply 'green' for the environment, and this more complex definition is needed for this research. The wider definition used by Morana (2013) for sustainable supply chain management is therefore workable for the research; it sums up the overall situation and also ensures that the required deliberate decision making process is acknowledged:

> Sustainable Supply Chain Management can be understood as the management of the flows of materials, information, capital, people, and intelligence with an economic, environmental and social/societal purpose. As a strategic management approach, it is found in the quite deliberate set of intra- and inter- organisational connections, with a view to the long-term performance of each company and of its supply chain. (Morana, 2013, page xv)

Although an increasing number of papers has been written about the topic of sustainability and green transport in recent years, there has been less about how to effectively measure sustainability and what valid actions can be taken once those measurement units are agreed. The reasons for this would require research but would include the complexity of the data and its use, as Jury, Kalchschmidt and Ruggero point out:

> Sustainability performance, being a multidimensional concept, is not directly measurable and requires a set of indicators to be assessed. (Jury et al., 2014, page 259)

A comparison of the Pacific island area data with that of other regions of the world using the standard core metric of CO_2 emissions is shown in Table 2.2. These limited and broad data elements are included for the purpose of illustrating the context of the geopolitical area in the research; part of the purpose of the research is to develop a model establishing the validity, reliability, relevance and usefulness of such measures. Clearly, broad indicative global average data values are applied in the table, whereas there will be significant variations between modal balances in the different regions of the world. For example, New Zealand's domestic transport emissions for the year 2013 constituted approximately 20% of the total emissions (compared to 22% indicative average), but 91.2% was produced by land transport (compared to 75% indicative average), 6.1% by aviation (compared to 15% indicative average), and 2.7% by maritime transport (compared to 10% indicative average) (NZ Ministry of Transport, 2015).

In the research region, the proportion of CO_2 produced by transport ranges significantly around the average of 22%; the limited data available indicates it is closer to 50% in Fiji, possibly due to the lower level of emissions from other sources such as factories and power production that are large emitters of CO_2 in larger nations. This aspect is examined in Chapter 4.

Comparison of CO_2 emissions per capita in sample regions of the world

Country or regional group of countries	**All sources, Tonnes CO_2 per person**	**All transport modes** (22% of all sources) Tonnes CO_2 per person	**Maritime transport** (10% of all transport) Tonnes CO_2 per person	**Airborne transport** (15% of all transport) Tonnes CO_2 per person	**Land transport** (75% of all transport) Tonnes CO_2 per person
World, all countries averaged	**4.90**	**1.08**	**0.11**	**0.16**	**0.81**
USA	17.60	3.87	0.39	0.58	2.91
OECD members	10.10	2.22	0.22	0.33	1.67
Caribbean states	9.90	2.18	0.22	0.33	1.63
China	6.20	1.36	0.14	0.21	1.02
East Asia & Pacific	4.90	1.08	0.11	0.16	0.81
PICTS	**1.10**	**0.24**	**0.02**	**0.04**	**0.18**

Table 2.2: Indicative CO_2 emissions per capita for selected sample of world regions and transport modes; data sourced from IEA databases and global average percentages from IPCC (2014); calculations by researcher applying the global average percentages.

Synthesising the definitions covering the logistics, transportation, and the geopolitical societal environment is a complex scenario with a variety of viewpoints as to method. Schiller, Bruun and Kenworthy (2010) clearly point this out:

> Sustainable transportation involves taking many dimensions of transportation and land use planning into account simultaneously, as well as public visioning processes aimed at describing the future we desire, and then taking the steps necessary to attain that vision. Sustainable transportation is essentially a societal, rather than strictly technical, process that depends upon planning, policy, economics and citizen involvement. (Schiller et al., 2010, page xxi)

Schiller et al. also point out that one direct way to increase sustainability of the freight transport system is to reduce the length of travel, thereby reducing the global supply chain complexity. To achieve this in the Pacific research area would require increasing purchasing from local PICTs and nations in the nearby Pacific basin areas, including Australia and New Zealand, thereby decreasing sourcing from Europe and North America. This process is indirectly currently in progress, with efforts for increasing the trade relationships within the region, as outlined in Pacific Island Forum Secretariat (2014) and subsequent activities.

SPC in its Strategic Plan 2013 – 2015 notes that sustainable development of the member countries must be underpinned by three sustainability measurements: economic, human and social, and natural resource and environment (SPC, 2013). Similarly, the Pacific Islands Forum Secretariat incorporates the broader sustainability concepts in its annual planning process (PIF, 2012). In the research the general terms of ‘economic, environmental, and societal’ are used for the three sustainability measurement categories.

One element of the sustainability issue to therefore be aware of for the small island nations in the Pacific is to ensure that the differing needs of industry and societal sectors are not confused. The frame of reference in which focus is established needs to be clearly defined.

Clearly, for example, using solar and possibly wind power technology to avoid the use of imported fossil fuels is an effective use of modern technologies for land based communities such as the urban or rural areas. Solar power infrastructure for lighting in villages, for maritime navigation lights, and for many other purposes is already making significant benefits to standards of living on small islands and atolls. However when considering applying such energy technology features to the transport unit, the needs for the safety of life and reliability of the ship and aircraft operation take on much higher priorities than simply the carbon footprint, and a model for the decision making process needs to be able to quantify these priorities.

Nuttall (2013) has principally focused on the propulsion method of maritime transport, and this focus, together with the use of historical rather than current data, has resulted in an unbalanced view of maritime transport sustainability in the region. A more holistic approach investigating sustainable maritime transport in the region is taken by SPC (2014c) in a paper authored for them by the researcher.

In the global maritime sector, the International Maritime Organisation (IMO) adopted the UN's 'sustainable development' principles, concluding that this required, among other things for the maritime transport sector, the following:

> . . . a Sustainable Maritime Transportation System requires coordinated support from the shore-side entities intrinsic to shipping, such as providers of aids to navigation, oceanographic, hydrographic and meteorological services, search and rescue services, incident and emergency responders, port facilities, trade facilitation measures, and cargo-handling and logistics systems. (IMO, 2013, page 9)

The clear requirement from this is that managing sustainability of the maritime logistics component of the supply chain does not mean simply examining the fuel used, the GHG emitted, or other physical transport aspects. This principal of requiring inclusion of all associated infrastructure in any analysis, is fully applicable to all the transport modes - land, sea, and air – and this research adopts that approach.

One of the most significant transport problems for the small island nations in the Pacific is reported still to be a low level of reliability and predictability of schedules, with several studies such as ESCAP (2013) reporting this finding. Therefore, in analysing the priorities for sustainable logistics in the small island nations of the Pacific it is apparent, as examined in SPC (2013), that the requirements of service reliability, predictability, availability and affordability make the management and governance issues of greater significance than the transport mode and fuel used. The research examines the measurement of these features and any possible causal linkages as they relate to sustainability.

2.3 Sustainability indicators and measurements

In order to establish any levels of sustainability monitoring and measurement, it is necessary to define measuring and reporting processes and a set of criteria or indicators that can be used. Several international organisations are involved in this process, including for example the Global Reporting Initiative (GRI, 2014), the Supply Chain Operation Reference Model (SCOR) (Supply Chain Council, 2014), and the ISO 9000, 14000 and 26000 series known as the triple bottom line grouping of economics, quality, and environment (ISO, 2014). These systems are samples of processes aimed at recording, reporting, and globally benchmarking sustainability actions in business and government organisations. However these standards have a reputation of being expensive to operate and maintain, and would be unsuitable for a low value economy; a sample of ISO compliance costs for example is discussed by Yiridoe and Marett (2004) as relating to small agriculture-based businesses.

The selection, measurement and calculation of the metrics to enable reliable data capture and benchmarking is a variable factor possibly specific to each industry and location. The principles involved in the development of indicators are discussed by Kuei and Lin and also by J. Wu and T. Wu and other authors in Madu and Kuei (2012):

> For an indicator to be useful, there ought to be an established reference, benchmark, or threshold that represents a normal state, desired behaviour, or goal to be achieved. (J. Wu & T. Wu, 2012, page 69)

A general system flow for the development of a model is as follows, based on analysis and discussion in McKinnon et al. (2012, Chapter 3):

1. Set objectives and build a process map
2. Select the calculation approach and define metrics and boundaries
3. Collect data
4. Conduct calculations and analysis
5. Verify and disclose

Each of the common monitoring and reporting models include standard procedures for these system steps. Some of the principles of dynamic systems relating to feedback and analysis, as discussed by Sterman (2000) and Grossler and Strohhecker (2012), may also be usefully incorporated into a model's construction. The research analyses a comparison of available processes and reporting as they relate to sustainability within the research boundaries and locations, and covering the three key sectors of economic, environmental, and societal features.

An important part of the research is establishing what factors need measurement in order to obtain the desired result covering the three key sectors; what operational definitions must be established and what empirical data must be obtained in order to flow back to the conceptual hypothesis of sustainability. For example, does the commonly quoted CO_2 measurement give an adequate index of sustainability, or do other data sets need to be included? Relationships around this process, and the related issues of reliability and validity of data, are thoroughly discussed by Neuman (2006). Neuman also compares the use of scales and indices for data comparison, and the use of an appropriate set of these is considered as part of the research.

The validity of these metrics to the maritime sector is usefully discussed in Panayides and Song (2012) particularly by Lindstad, Asbjornslett and Pederson (2012), where the lifecycle analysis comparison and other related inputs are discussed in an attempt to obtain a more focused model than a simple model based on CO_2 calculations from fuel consumption; however, although the discussion is useful, it does not produce any conclusion that is definitive for this research.

Schaltegger and Burritt (2014) discuss the conceptual question of measuring sustainability in supply chains, and examine the possibilities from the aspect of a risk management or an opportunity process. They consider the difference in metrics that may be needed according to the approach selected and the outcomes desired for management action. There is ongoing development in publications in this research area as political awareness develops. For example, in June 2015 the UN published 'Indicators and a Monitoring Framework for the Sustainable Development Goals - Launching a data revolution for the SDGs' (UN Sustainable Development Solutions Network, Leadership Council, 2015), which contributes significantly to the development of appropriate indicators of sustainability in the region.

The challenge of this is developed into the conceptual model for the research.

2.4 Conceptual model of the research

The literature review has demonstrated that the research can be reasonably divided into major topic representations for analysis and modelling. The significant topic areas as detailed in Figure 2.1 and discussed in Section 2.2 of this chapter are expanded and linkages developed in the following groupings:

1. Societal considerations regarding sustainable logistics concepts within a supply chain, regardless of geographic location.
2. Societal considerations regarding sustainable logistics concepts within a supply chain in the Pacific area.
3. The effect of geographic location and characteristics of the Pacific islands in the research area on the logistics processes and options available.
4. The roles of the transport infrastructure, modes and nodal facilities such as ports in the logistics process.
5. The quantifying, monitoring and reporting of the 'sustainability' and 'green' features of logistics units, using measurements such as GHG emissions and other environmental and societal metrics for public and political use.

These are visually demonstrated in Figure 2.4, a visual conceptual model of the research showing the research question linkages. On the conceptual model diagram the above five topic areas are summarised and linked into the holistic process.

Separated from the direct lines of effect, the research has no influence on the operational decisions made. Additionally, as it is not based on 'action research', it has no direct or causal influence on the data – participants do not modify their behaviour during the observation and data gathering period.

The concepts of the research are operationalised through the process of system and data analysis, as outlined by David and Sutton:

> Operationalization is the process of turning abstract theoretical concepts into observable and measurable entities. (David & Sutton, 2011)

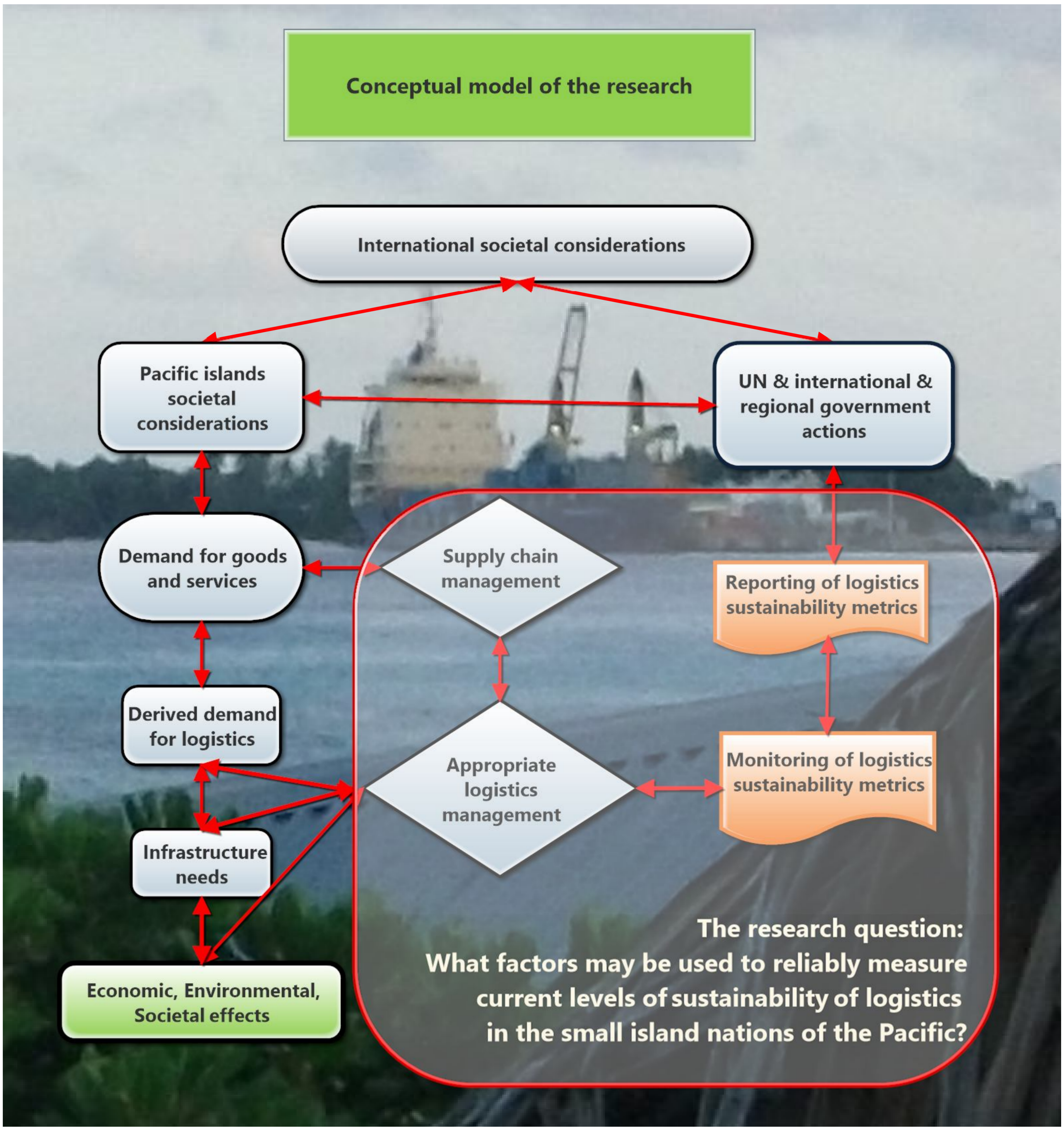


FIGURE 2.4: Conceptual model of the research. Background image is MV Southern Pearl berthed at the wharf in Funafuti, Tuvalu.

2.5 Research gap

An increasing volume of research is, as earlier discussed, currently being published regarding the principles and metrics related to sustainable supply chains, and also of green logistics and related topics.

Beske and Seuring point out that in the ten years to 2007, 191 peer reviewed papers were published on SSCM, and that has rapidly increased to over 300 in 2011 alone. (Beske & Seuring, 2014, p. 323) The years from 2011 will almost certainly have that research trend continuing.

Most of the research papers are focused on the urbanised nations, particularly those of the northern hemisphere, and data and models appropriate for the specific logistics features of small island nations of the Pacific do not appear to exist. This gap in research is where this research fits, and will supply benefit to the logistics policy makers, decision makers and practitioners in the Pacific region.

2.6 Conceptual lens

The research is described as being in the middle range theory category, as it has medium abstraction, is integrated in a practical operation, is context specific, bridges social research, and involves a deductive process.

In the following chapter, 'The research design and methodology', the research strategy adopted and the conceptual lens involved are further explored. The data analysis methodology options are discussed.

Chapter 3

The research design and methodology

3.1 Introduction

In this Chapter the research methodology and strategy adopted is described, the data collection methodology examined, and data analysis approaches discussed. The availability of data, and its associated reliability, validity, relevance and effectiveness is considered, together with boundaries for the research. Quantitative compared to qualitative data issues are discussed in relation to the requirements of the research question, and the ethical considerations of the research are examined.

3.2 Research strategies

The overall classification of the design strategy for the research is summarised in Table 3.1, based on a table by Cooper and Schindler (2008). The italicised items are the attributes that apply to this research. The core essential attributes applicable show that the research is conducted as a descriptive cross-sectional case study in a field setting.

Research design strategic spectrum considerations			
Category of research consideration	**Strategic spectrum**		**Notes on the attribute and its effect in the research**
Degree of question crystallisation	***Formal***	Exploratory	Exploratory features may exist but the research directs the effect of these to ongoing research gaps
Data collection method	***Monitoring***	Communication	With a possible trend to Communication in latter stages as exploratory features probably develop
Control of variables by researcher	Experiment	***Ex post facto***	No experimenting is involved in the research
Purpose	***Descriptive***	Causal	Some possible causal side linkages may exist, but the research directs the effect of these to ongoing research gaps
Time dimension	***Cross sectional***	Longitudinal	A research outcome that leads to enable future longitudinal research is expected
Topical scope of the research	***Case study***	Statistical study	Case study based on a geopolitical grouping of island nations, limited statistical study
Research environment	***Field setting***	Simulation, Laboratory	No simulation or laboratory research is involved
Participants' perceptions of the activity	***Routine***	Modified	No modification of participants' behaviour is required or expected for the research

Table 3.1: Research design strategy considerations, after Cooper and Schindler. The italicised items are the applicable attributes of the research.

In reality, the strategic spectrum categories have 'fuzzy' boundaries and there is no clear-cut boundary or division of conceptual areas, because as succinctly stated by Frankel, Nasland and Bolumole:

> Logistics problems are often ill-structured, even messy, real-world problems. (Frankel et al., 2005, page 203)

The case study approach is appropriate for the research, as when comparing the research methodology to structures discussed by Frankel et al. (2005) and Veal (2005), the features of a case study fit well with the nature of the research question. Case studies have the following characteristics (not listed in any priority order):

- Place the events in social and historical context
- Have ability to treat the subject holistically and in depth
- Allow the use of multiple data sources
- Allow triangulation of methods
- Enable a manageable data collection task
- Incorporate flexibility in strategy possible as research proceeds
- Possibly avoid a need for generalisation
- Are able to uncover subtle distinctions

A longitudinal research methodology compared to a cross sectional case study, whilst undoubtedly being able to produce research results of interest and essential value in the future, would not have enabled a focus on development of metrics and systems as required in the research question.

3.3 Epistemological & ontological perspectives

The research is considered to be posing a question and a process that complies with a characterisation of 'middle range theory' as compared to being a 'grand theory'. Grand theories have high abstraction levels, with distant and universal application, whereas as discussed by Bryman and Bell (2011) and Grossler and Strohhecker (2012), the middle and lower level observational theories, such as contingency or situational theory, are grouped into the 'middle range' and are the most appropriate style for this business research.

The theory of knowledge itself is known as epistemology, which for research purposes is concerned with defining knowledge and its foundations. The epistemological belief set that fits the research and the researcher provides the core structural paradigm to the research design and its implementation process. The research question fits to a research style with a positivism epistemology and the research is a deductive process, with an associated objective ontology.

Table 3.2, based on Bryman and Bell (2011) and Veal (2005) classifies the attributes of the research's epistemological paradigm. The italicised items are the selected attributes of the research, and the dominance of the positivism approach is clear.

Epistemological and ontological perspectives		
	The associated epistemological spectrum	
Attribute of the research and its organisation	**Positivism**	**Interpretivism**
Underlying basis of the knowledge paradigm	***Natural sciences***	Human interactions
Approach to social science	***Explanation of & generalisation of behaviour; objectivity required***	Causal explanation and interpretive understanding of human behaviour; subjectivity accepted
Subject matter	***Nature***	Social reality
Subject's actions	***Inanimate & unmotivated***	Meaningful & engaged
Data collection	***Observation, codification, measurement; tends towards quantitative***	Comprehend the perspective of the human subjects; tends towards qualitative
Research & theory	***Mostly deductive***	Strong inductive leaning
Associated ontology – the organisational nature, drivers, and culture	***Objectivism: organisation is tangible, structured with procedures; participants internalise the organisational norms***	Constructionism: organisation is formed by interactive processes, evolving negotiated order; a fluid culture that reconstructs itself through the interactions

Table 3.2: Epistemological and ontological perspectives of the research, after Bryman and Bell and Veal. The italicised items are the applicable attributes of the research.

Further investigation into the ontological paradigm of the research results in the matrix shown in Table 3.3, based on Burrell and Morgan (1979). This outlines the main categorisation of features relating to organisational research. As before, the italicised text indicates the function identified as relating to the research, and this is clearly a 'functionalist' category.

Business research paradigm considerations for the research		
	Regulatory – makes description, minor changes, no judgements	**Radical – makes judgements and suggestions**
Objectivist – views the organisation from an external viewpoint	***Functionalist – problem solving, rational (a common process in business research)***	Radical structuralist – the organisation is a product of structural power relationships
Subjectivist – believes the organisation can only be understood from an internal involvement	Interpretivist – questions organisational concepts of existence; understanding can only be from those within organisation	Radical humanist – organisation is negative social arrangement; individuals need emancipation from it

Table 3.3: Business research paradigm considerations for the research, after Burrell and Morgan (1979). The italicised items are the applicable attributes of the research.

3.4 Data measurement – qualitative and quantitative

The question as to whether a quantitative or qualitative data methodology is most valid for the research is not discretely defined, in part due to the subjective nature of some of the indicator metric attributes. It is considered important however that to enable adequately defined criteria for benchmarking, a quantitative method is adopted for the research. For example, a quantitative system is preferred in order to overcome the lack of suitable data sets that results in longitudinal trend uncertainty:

> . . . the progress made with implementation of the PIFACC [Pacific Island Forum Action on Climate Change] was difficult to judge due to the lack of established monitoring and reporting procedures. (SPREP, 2012)

The research, as explained in the previous section, is approached in an objectivist functional manner for the major data collection and analysis elements. However some categories of the sustainability element could subsequently require further research items to adopt a more subjectivist approach particularly when discussing the subsequent ‘why’ and ‘what then’ questions as in Burrell and Morgan (1979). The primary setting of metrics criteria, for example of an acceptable level of CO_2 emissions, is considered to be significantly in a qualitative area, as although the level of CO_2 can be quantitatively measured by scientists and engineers, and KPI and targets set, the acceptable levels are open to some measure of societal debate.

Some of the mathematical considerations and challenges involved in measuring these features are discussed within the mathematical discipline of fuzzy logic such as by Phillis and Kouikoglou (2009). These elements may evolve when further research is conducted for advanced aspects of a model.

The core of the research is therefore based on quantitative data, involving items such as levels of CO_2 and other pollutants, the frequency and affordability of logistics service, road length, together with such other items considered important for inclusion in a holistic sustainability model.

Table 3.4, compiled from information in Bryman (2012), Neuman (2006), and Bryman and Bell (2011) displays a suitable comparison of quantitative and qualitative data processing in terms of the research. The italicised text indicates the method identified as relating to the research, and this is clearly emphasising that the 'quantitative' method is appropriate.

Distinctions between the methods are not always definitive or exclusive; it is more important that the data collection and analysis techniques are compatible with the research question and its epistemological framework rather than simply nominating which method is to be used. 'Mixed method research' is common for this reason, but is not a method used significantly in this research.

The research is a cross sectional study, based on the timespan covering ten months from January to October 2015, with interview data collection on site in Fiji in April. This may be considered too static for extrapolation purposes, but the research finds that such cross sectional data sets are needed to establish the ability to develop an accumulating longitudinal data set.

Quantitative data collection is sometimes considered a linear, precise process with high quality data; however the topic and the location of the research means that some of the data from secondary sources is of a variable quality, and means of validating that data quality is not always available. Data reliability in the region is not high for a variety of reasons, and the reasons are not always purely technical:

> The fundamental reason for inconsistent and inaccurate data is that Pacific states do not value data objectively, but regard data as political weapons in

Quantitative compared to qualitative data processing for the research			
Attribute	**Quantitative**	**Qualitative**	**Notes on the research attribute**
Research observation and measurement	***Objective indicators & reliability are important; hypothesis testing***	More subjective involvement; the meaning emerges from the data	Both need to quantify data at some point for the research to be valid
Data concepts	***Distinct variables, measurable numbers***	Themes, taxonomies, generalities	For longitudinal validity, need distinct data
Data measures	***Systematically created and standardised before commencing data collection***	Often specific to the individual setting or research	Units of measurement need to be internationally standard metrics
Use of primary & secondary data	***Uses both***	Uses both, with also self-reported data	Secondary data initially, leading into need for primary data
Linearity	***Generally linear***	A process view, more complex	Distinguishing between nature & organisations can be more limited in quantitative work
Actions behind the measurements	***Behaviour***	Meaning	Logistics has a behavoural cause; meanings not researched
Causality of theory	***Often causal, deductive reasoning***	Can be causal, more inductive and abductive reasoning	Does a static view hinder a real answer?
Data analysis	***Quantified (e.g. graphs) and directed towards hypothesis***	Extracting themes to present coherent picture	Statistical data is needed and used
Replication	***Important and objective***	Not high ability, researcher is too involved, research is too specific	Objectivity is important
Generalisation	***Has predictive validity for extrapolation***	Limited predictive ability	Statistical legitimacy important
Transparency	***Important and at a high level***	Less transparent	Transparency is very important

TABLE 3.4: Quantitative compared to qualitative data processing for research after Bryman (2012), Bryman and Bell (2011), and Neuman (2006). The italicised items are the appropriate attributes of the research.

> internal debates and in their annual request for aid. Political adjustments to data are frequent. (Hughes, 2003, page 3)

In order to improve reliability and validity of data, triangulation of data is used in the research whenever possible. The case study style of research is able to use either style of data collection according to the requirements, and this is indicated in the table.

The conclusion for the research is that the quantitative data method is relevant and is the appropriate dominant method to use. There is also a possibility within the research that questions offering a qualitative solution may exist and be useful for potential triangulation and indicators of further research opportunities. It is important not to exclude these qualitative factors due to a dogmatic data approach.

3.5 Data measurement – primary and secondary

Data capture for research is developed in two main groupings – primary and secondary – relating to the purpose and availability of the information. Data for the research was gathered from principally secondary sources which include databases such as the UN, World Bank, IMF and the International Energy Agency, as well as those held by regional organisations such as SPC. Some data calculated by the researcher from available technical information is also utilised, and this may be considered as primary data collection, as are portions of the interview process.

No primary data was obtained from laboratory or related experimentation activity, and no direct measurements in the field took place. Table 3.5 summarises sources of data for the research, and shows that secondary data use dominates as the main method.

To establish the current sustainability reporting models in use, a semi-structured interview process was used. The research questions were covered largely indirectly according to the interview and working meeting process, as part of a discussion and review of the factors, as this was found to be the most practicable manner. An element of interviewee’s personal view may be included when discussing the elements within the models and how effective they are considered to be at measuring sustainability, but this was not considered to be a significant qualitative issue for the research.

Research data measurement sources – primary and secondary			
Type of data	**Features of the data**	**Example of source of data**	**Style of information**
Secondary	Obtained by other organisations; need to verify reliability; easier to obtain; questionable accuracy; good for the context and theory.	Local & regional government sources such as SPC; global sources such as UN, World Bank, ADB, IEA. Local businesses, and private research organisations	Local production of recent databases and reports; establishing current methods and data; global databases and reports, (largely historical data possibly) company information and possibly more recent data
Primary	Obtained by researcher directly; high reliability; more difficult to obtain; improved accuracy; good for specific insights.	Direct personal communications, surveys, interviews; calculations & observations. Analytical model development	Insights into current and proposed models and data systems; calculations based on raw data, obtained from other sources; establishment of revised or appropriate factors for inclusion in a revised model

Table 3.5: Data measurement sources – primary and secondary, after Ghauri and Gronhaug (2010).

The major initial data collection for establishing logistics features such as availability used secondary data gathered from government sources, regional organisations such as SPC divisions – Economic Development Division, PRISM, Statistics for Development Division – and international sources such as the UN, World Bank and the International Energy Agency (IEA) databases. Some of the data from SPC was supplied for the research from primary sources by SPC staff, and this is considered the most reliable data. This was supplemented by data from other sources and organisations and calculations, where available and necessary. Care needs to be taken regarding the accuracy and validity of much of this data and this consideration is discussed further in the research.

3.6 Further research methodology considerations

Due to the wide geographic spread of the island nations, the limited transport availability for the researcher to access local data, and varied availability of data, it was necessary to limit the number of locations studied. It is an option that one nation or area could be the subject of a case study, but the unique geopolitical arrangement in the region leaned towards a regional case study being equally appropriate and valuable, so this approach was adopted. In addition, it was necessary to ensure that academic ethical considerations were complied with, and these assisted in the decision to focus on the regional governmental organisations.

The considerations of the research nation selection, and associated decisions, are discussed in the following sub-sections.

3.6.1 Geopolitical scope of the research area

In order to obtain a representative selection, the nations were divided into categories based on the following key divisions:

SPC membership: The SPC offices dealing with logistics topics are based in Suva, Fiji. Therefore, for statistical and research support, and ease of access for interviews and data gathering, SPC membership had advantages.

United Nations listing as a 'SIDS': Nations categorised as Small Island Developing States have some common features of politics and geography, so therefore made a natural grouping. (The definition of 'SIDS' is discussed in Chapter 4).

Figure 3.1 shows the political relationships of the nations in the research. SPC members are shown, as is the United Nations classification as a Pacific SIDS. The research is focused on the group of SIDS shown that are members of the SPC organisation. Timor-Leste, near Indonesia, is classified by the UN as a Pacific SIDS but is not an SPC member state, although it has applied for membership (which is expected to be confirmed late in 2015).

The research was therefore developed with a close liaison with the Secretariat of the Pacific Community's Department of Economic Development in Suva, where that regional organisation maintains data and research personnel. The researcher has an intermittent working relationship with that organisation and has assisted with writing papers and other work. A recent report written by the researcher, which is of relevance to the

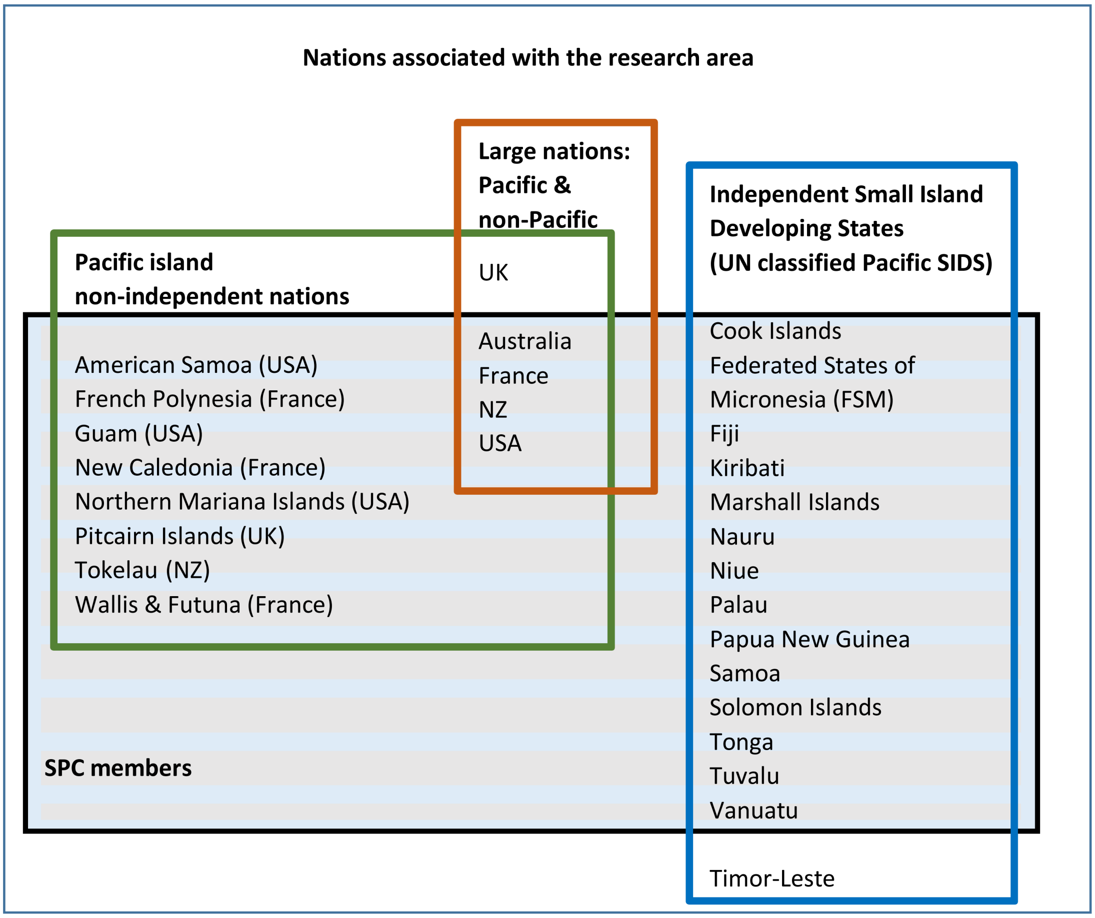


Figure 3.1: National regional political relationships in the research area. Timor-Leste is classified by the UN as a Pacific SIDS but is not an SPC member state, although it has applied for membership. Papua New Guinea has a greater land area and higher population than New Zealand but it is classed as a SIDS due to its location, associated small islands, and political and economic status.

research, investigates ship propulsion fuels for sustainable maritime transport in the region. (SPC, 2014c)

3.6.2 Massey University ethical considerations

Ethical considerations are required for several key groups involved in research – the individual participants, the researcher(s), the groups or communities involved, and Massey University. This section considers the Massey University requirements.

Where interviews are carried out, or persons are involved in document search, data capture or analysis, or such activity related to the research, respondents must be assured that ethical principles are being complied with. The Massey University Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants is followed by the research. (Massey University, 2013)

The principles of the code are summarised as:

- Respect for the person
- Respect for the organisation or group
- Minimisation of harm - physical or emotional (including embarrassment)
- Informed voluntary consent for participation required
- Respect of privacy and confidentiality for person and organisation
- Avoidance of deception by the researcher
- Social and cultural sensitivity
- Justice available in the event of a difficulty

Although the research topics and questions in this proposal are not considered controversial or at a significant risk of offending any person, there is always that possibility to be aware of. The Massey University Screening Questionnaire for ethical considerations is completed and attached as Appendix A.

3.7 Analysis of the research data

Data analysis has two distinct but interwoven foci – establishing an appropriate system model, and comparing the models when populated with data. Establishing an appropriate model includes selection, ranking and weighting of variables and other related methods in order to synthesise the data into coherent patterns. The use of the fundamentals of a dynamic system analysis is necessary in order to consider the wide range of data needed in the sustainability model analysis – i.e. data covering the conceptual model structure shown in Figure 2.4, although quantitative in nature, is not all discrete and linear.

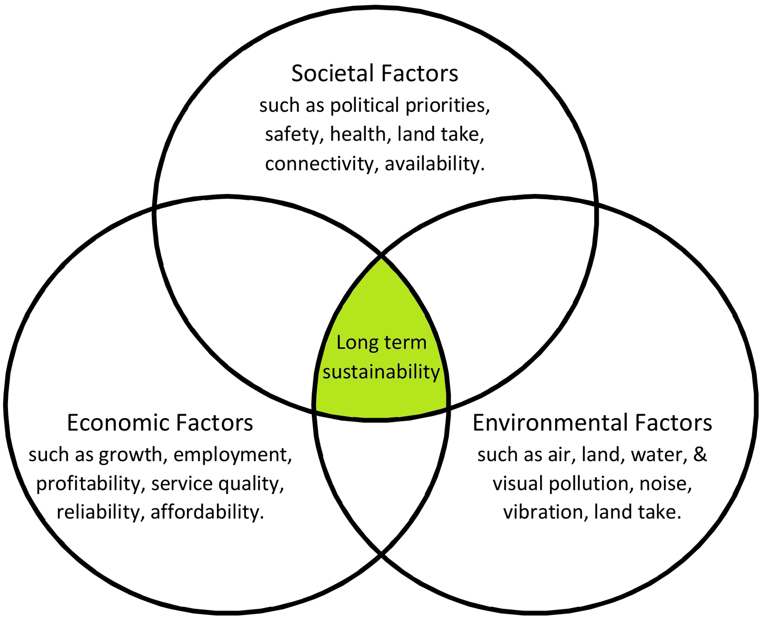


Figure 3.2: Sustainability factor categories. Any logistics activity that does not encompass consideration of all three data sets, and hence falls outside the 'long term sustainability' sector cannot be considered to be sustainable for the long term.

A set of measurement criteria suitable for feedback is required to be developed in order to assess the relative values of any model selected for comparison and research, or developed from the data obtained. For example, the system must be easy to operate and the source data must be readily and reliably available. As pointed out by Morana:

> In the context of sustainable supply chain management, it is important to have a dashboard which has common indicators. This tool should be explicit to people within the organisation and to the whole of the supply chain . . . The most difficult thing here is to find the key indicators, in reduced number . . . and which are apt to respond to the three desired economic, environmental and social/societal dimensions. (Morana, 2013, page 164)

An important requirement for the research is to maintain the sustainability factorial balance as shown in Figure 3.2, rather than focus on one particular aspect or factor. Some organisations such as APICS add ethics as a fourth element in the sustainability data set, covering ethical and moral considerations. For this research, ethics is considered to be ubiquitous throughout the three categories of economic, environmental, and societal elements, and is therefore not treated as a separate identifiable element.

The following chapter, 'The research case study findings and analysis', describes the research process, defines the boundaries, and elaborates and analyses the data and findings.

Chapter 4

The research case study findings and analysis

4.1 Introduction

In this chapter the research boundaries and method are described in practical detail, and findings are quantified and summarised. The population structure and the physical environment of the nations researched is described in appropriate detail, as this has a significant effect on the logistics processes that are practicable in the region. The organisations interviewed for the research are identified. Further, the semi-structured interview question results are collated and the relationship of the findings to the research question 'What factors may be used to reliably measure current levels of sustainability of logistics in the small island nations of the Pacific' are discussed. The available logistics data to support the research environment is obtained, analysed and discussed. Finally, data gaps are highlighted and explained.

4.2 The SIDS nations in the research group

The selection of Pacific nations to be included in the research was considered, as discussed in Chapter 2. Following discussions with the Massey research supervisor, it was agreed that to avoid becoming too wide in focus; the research would remain focused on the aggregated data looking at the nations as entities rather than individual business organisations in the region. It was decided to include all those nations that are classed as SIDS in SPC membership for consistency of reporting and also due to an initial finding that most of the nations do not have suitable databases of their own to enable individual analysis. Aggregated or calculated data, coordinated through the regional organisations, is therefore necessary for many data items. Some features describing the population and physical environment of the nations are discussed as it is important to relate the logistics capability and management to this.

The only nation that is classed as a SIDS, has SPC membership, and has a population over one million is Papua New Guinea, with nearly eight million residents. Care needs to be taken to ensure that this, together with its large land area, does not distort the data findings. Similarly at the other end of the size spectrum, Niue, with a resident population of only approximately 1,500 persons, could also distort data findings when statistical analysis is conducted.

4.2.1 SIS sub-group

Some of the Pacific SIDS are further defined by the Pacific Island Forum into a sub-grouping of nations named ‘Smaller Island States’ (SIS). These nations are given additional attention by the Pacific Island Forum via the Smaller Island States Unit based in Suva. To be designated as a SIS, the nation must have a population of less than roughly 100,000, and comply with several other criteria that are quantitatively not so well defined, but place the nation at the more severe end of the qualitative spectrum of SIDS geographic and economic features:

> The grouping criteria for membership were established by the Forum in 1985 in recognition of the unique problems that its smaller members faced with particularly severe problems for the SIS identified as (a) limited agricultural and manufacturing potential (b) dis-economies of scale and weak bargaining power (c) expensive and irregular transport links, and (d) inadequate communications.
>
> Together these problems create a situation such that smaller island country economies face great difficulties in generating self-sustaining economic activity and are therefore heavily dependent on a continuing flow of external

> assistance. The Secretariat recognises that these characteristics, problems and economic structure characterise the majority of Pacific island countries, but that they are significantly accentuated for SIS. (PIF, 2015)

In the following research analysis information, tables, and discussions, the SIDS are shown in two groupings, each of seven nations: the larger SIDS and the smaller SIS sub-group. Some features of the nations are summarised in Table 4.1 showing selected significant information regarding their size and principle features related to logistics. The table also highlights the significantly large ocean territory (EEZ) of the SIS subgroup when compared to their small land areas.

4.2.2 Political relationships

Political affiliations and associated relationships could be expected to have a significant role in influencing levels of income and other metrics for the nations. For example the Cook Islands and Niue have a close relationship with New Zealand, Nauru and PNG with Australia, and Palau, FSM, and the Marshall islands have close relationships with the USA. All of the research nations except the Cook Islands and Niue are individual members of the United Nations. Political relationships are likely to significantly influence the level of transport infrastructure development undertaken, but the investigation of the relationship is not part of this research. Some aspects of these political relationships are however inevitably directly or indirectly reflected in the logistics data, including for example air service connectivity. The level of Official Development Assistance (ODA) received also reflects this relationship and is included in the discussion. See for example Table 4.8 where ODA is shown as a percentage of GDP.

In addition to the SIDS status, four of the countries researched have chosen to be classed as Less Developed Countries (LDC) in the UN system: Solomon Islands and Vanuatu in the large SIDS group, and Kiribati and Tuvalu in the SIS sub-group (UNOHRLLS, 2015a). Samoa was also in this LDC group until graduating out in 2014 (UNOHRLLS, 2015b).

Even this LDC classification is a movable debate regarding the measurement of the data used for the basic ranking, as indicated in the following quotation from the Committee for Development Policy (CDP) of the United Nations:

Nations selected as the research group					
Pacific nation	**UN status**	**Pop'n '000**	**Land area** km^2	**EEZ area** km^2	**Land type**
Larger SIDS					
Fiji	Member, SIDS	867	18,270	1,290,000	atolls, mountainous, dormant volcanoes
FSM	Member, SIDS	102	702	298,000	atolls, dormant volcanoes
Papua New Guinea	Member, SIDS	7,744	452,860	3,120,000	mountainous, active volcanoes
Samoa	Member, SIDS	187	2,934	120,000	mountainous, dormant volcanoes
Solomon Islands	Member, SIDS and LDC	642	27,540	1,340,000	atolls, mountainous, active volcanoes on islands and undersea
Tonga	Member, SIDS	103	718	700,000	atolls, mountainous, active volcanoes undersea
Vanuatu	Member, SIDS and LDC	277	12,200	680,000	atolls, mountainous, active volcanoes on islands and undersea
SIS subgroup					
Cook Islands	SIDS	15	237	1,830,000	atolls, extinct volcanoes
Kiribati	Member, SIDS and LDC	113	811	3,550,000	atolls, spread over three island groups - Gilbert, Phoenix, and Line – 3,300 km apart
Marshall Islands	Member, SIDS	55	181	2,131,000	low sand islands, atolls
Nauru	Member, SIDS	11	21	320,000	plateau island, cliffs
Niue	SIDS	1	260	390,000	plateau island, cliffs
Palau	Member, SIDS	18	458	629,000	mountainous, low islands
Tuvalu	Member, SIDS and LDC	11	26	900,000	atolls

Table 4.1: Pacific SIDS included in the research. Population data is SPC EDD 2015 estimates. Land area is total for all the islands in the nation, excluding significant inland waterways and lagoons; the number of islands is shown in Table 4.2. For comparison, New Zealand land area is 268,000 km^2, roughly half that of PNG.

> The CDP uses three criteria to classify countries as LDCs: per capita gross national income (GNI), Human Asset Index (HAI) and the Economic Vulnerability Index (EVI). Both HAI and EVI are composed of several indicators . . . Vulnerability is a function of the magnitude and frequency of shocks, the exposure to such shocks and the resilience (i.e., the capacity to react to shocks). The EVI has two main components, an exposure index and a shock index. The exposure index contains indicators of population size, remoteness from world markets, merchandise export concentration and the share of agriculture, forestry and fisheries in the gross domestic product (GDP). The shock index utilizes indicators of the instability of exports of goods and services, homelessness from natural disaster and variability of agricultural production. (UN, 2015a, page 1)

The inputs required to calculate these indices are not always very clear and definable, and are not completely objective as discussed by Bruckner (2012). Within this grouping, four of the research nations feature in the top five ranking in global vulnerability on the EVI index; Kiribati is ranked as the most economically vulnerable nation in the world. The EVI values for the research nations are shown in Table 4.8 with the societal factor discussion in section 4.5.3.

A map showing the nations selected for the research is Figure 4.1. Comparing this map with that of Figure 2.2 highlights the significant east-west spread of the SIDS, particularly Kiribati, when the other nations are removed from the coverage area. The map also shows the main container-capable ports.

The political affiliations often change over time, and some of the nations have been dependencies or colonies of several larger nations such as Australia, New Zealand, Germany, Japan, and USA. The current time can be considered as a similar scenario, with other nations such as China involved in the power balancing relationships. The SIDS nations now are able to utilize organisations such as the UN, ADB and others to achieve political goals and receive assistance money:

> The Pacific states' main use of UN membership is to manoeuvre and beg for aid. (Hughes, 2003, page 4)

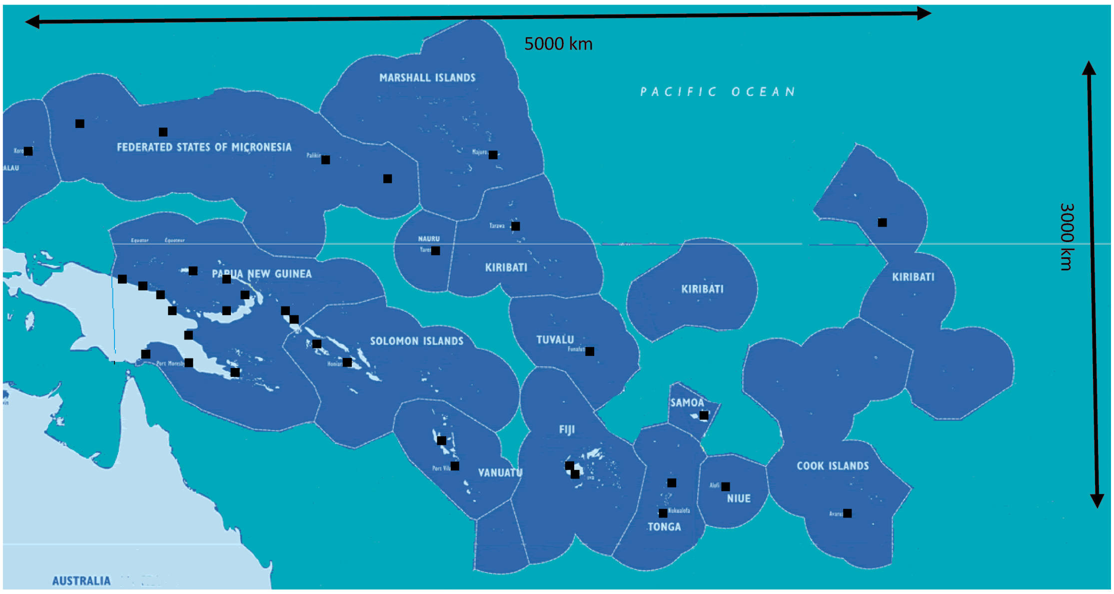


Figure 4.1: Selected SIDS for the research. The map also shows the main container-capable ports. An approximate scale of distance is shown.

Whether this statement by Hughes is still valid is not investigated in the research, but the influence of the UN membership and its associated travel and resource effects would definitely be a significant influence in the small island states. All of the nations except Cook Islands and Niue are individual members of the United Nations.

4.2.3 Population data

Population concentration or urbanisation is a significant item to consider when investigating the sustainability of logistics, even in the research nations where there are no large cities, because urbanisation results in heavy concentrations of air, land, and water pollutant production activity as reported by Fong et al. for the World Resources Institute:

> Cities are integral to tackling the global challenges of climate change, as both a major source of greenhouse gas emissions, and a major source of innovative climate solutions. An estimated 70 percent of the world's energy related greenhouse gas emissions come from cities, a number that is likely to continue to increase as two thirds of all people are expected to live in urban areas by mid-century. (Fong et al., 2014, page 7)

Population density data for the research nations

Pacific SIDS	**Pop'n '000**	**Number of islands, total**	**Number of islands, inhabited**	**Total pop'n density, persons per km^2**	**Urban ratio, % of pop'n living in urban areas**	**Urban pop'n density, persons per km^2**
Larger SIDS						
Fiji	867	332	110	48	51	-
FSM	102	607	65	145	22	514
Papua New Guinea	7,744	600	50	17	13	-
Samoa	187	9	2	64	20	-
Solomon Islands	642	992	330	22	20	-
Tonga	103	176	36	138	23	2,123
Vanuatu	278	84	6	23	24	-
SIS subgroup						
Cook Islands	15	15	13	63	74	195
Kiribati	113	33	21	139	54	3,184
Marshall Islands	57	1200	34	298	74	1,502
Nauru	11	1	1	524	100	-
Niue	1	1	1	5.8	36	-
Palau	18	386	9	39	77	248
Tuvalu	11	9	9	423	47	1,610

Table 4.2: Research nations' population density data 2015. Sources: (SPC, 2015a), (UNOCHA, 2014), and researcher calculations. Numbers may not be additive due to rounding. The total number of islands does not include very small islets and reefs, of which there are many. A '-' symbol shows that data is not available.

It is reasonable to expect that heavy concentrations of population in the research region, such as in Tarawa, would produce proportionately valid pollutant effects, and some of these are clearly observed in that area. Tarawa in Kiribati is the most densely populated urban area in the research nations, with about 3,184 persons per km^2; for comparison, Paris has a density of 3,800 persons per km^2 and New York is 1,800 persons per km^2. Also by way of comparison, New Zealand in 2013 had an overall population density of 15.8, with 80% living in urban areas, which have an average urban density of 522 persons per km^2 (Statistics NZ, 2015).

Urbanisation influences logistics demands significantly, including the infrastructure needs of the nations for sustainable domestic operation; the logistics of food supplies, water, and sanitation for example is a core function of any centre of population. A working paper of ADB discusses the difficulties caused by increasing urban population in the research nations:

> Increasing numbers of unemployed youth and poorly managed urbanization are other major social concerns. Population growth has tended to outstrip job creation in many Pacific DMCs [Developing Member Countries], leading to younger populations and increasing numbers of disenchanted, unemployed youth. Rapid population growth is a serious concern in some Pacific DMCs. Rapid urbanization in the Pacific has caused severe strains on urban infrastructure and services, leading to haphazard provision of urban infrastructure, environmental degradation, and bottlenecks to expansion of economic activity and growth. Increasing urbanization is at least in part a response to the lack of economic activity as well as weak fiscal management and a decline in the delivery of basic social services in rural areas and outer islands. Traditional land tenure regimes in urban centers have largely been unable to adapt to the needs of rural and outer island immigrants, and this has led to the development of insecure squatter settlements with very poor solid waste, water, sanitation, electricity, and other urban services. (ADB, 2009, page 7)

Population density data is summarised in Table 4.2 which was compiled by the researcher based on various data sources. The number of islands shown for each nation indicates the large spread of the land area and therefore the population. Not all the islands are inhabited, and the area and number of islands is, for most of the nations, a conservative value, as many small islets and atolls exist that are not included. The total land area data shown in Table 4.1, and used for density calculations in Table 4.2 includes all significant islands, whether inhabited or not, and excludes any significant inland or enclosed water bodies such as lagoons.

The populations' spatial spread clearly has significant domestic and international logistical consequences for the region. In order to measure the urban location's logistics related activity, there is a protocol developing for the accounting of the production and effects of emissions in cities, and Fong et al. (2014) discuss the practical issues of this process in detail. The relevant sections in this Chapter discuss the calculation method.

4.3 Organisations interviewed for the research

This section details the characteristics of each organisation interviewed. As discussed in Chapter 2, the nature of the geopolitical area and the accessibility of individual SIDS required and enabled a regional approach to be taken for this research. Micro analysis for individual nations or businesses would certainly be of research value and many opportunities exist for that, but this research is focused on a national level and regional basis.

Focus was therefore established on the key regional governmental organisations, based in Suva, and contact was made with these. Non-governmental organisations visited were USP and Solander Pacific, both of which were not a critical part of the research, but are valuable in adding a level of triangulation to the conclusions reached. The organisations' information is shown in Table 4.3, and the individuals met within those organisations are detailed in Appendix C. The research on-site interviewing was carried out in Suva from 14th to 22nd April 2015.

A mix of government and private operations is relevant in the region, and an indication of this was highlighted at the regional meeting of Pacific ministers of energy and transport, held in Fiji in April 2014, where they produced the 'Denarau Communique' which among other points of operational agreements, noted the following specifically regarding transport and thereby specifically regarding logistics:

> . . . 9. Acknowledged the critical role of the private sector in achieving sustainable energy and transport solutions and encouraged more cooperation and collaboration with relevant private sector industries and enterprises to further enhance the contribution of energy and transport in sustainable development. (SPC, 2014a)

Four other items agreed by the governments involved in the Denarau Communique as being 'high priorities' , which are of real significance to the research topic and findings are:

1. Development of a regional energy data repository to aid decision making
2. Development of a regional maritime and aviation data repository to aid decision making

Organisations consulted for the research			
Organisation short name	**Organisation name**	**Location**	**Role**
SPC	Secretariat of the Pacific Community	Nabua, Suva	SPC Economic Development Division covers all transport modes and related activity, including economics and sustainability. Key organisational links with Pacific Island Forum and other organisations such as IMO. This organisation's Economic Development Division was the focal organisation for the research. SPC is a division of PIF.
PIF	Pacific Islands Forum Secretariat	Ratu Sukuna Road, Suva	Principle regional political organisation.
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific	Victoria Parade, Suva	A UN organisation, ESCAP maintains databases and coordinates research into sustainable development in the region. UN regional coordinator for the MDGs and SDGs.
ADB	Asian Development Bank	Gordon Street, Suva	Subregional office for the Pacific area. Research and investment in enhancing government organisations and infrastructure.
USP	University of the South Pacific	Laucala Campus, Suva	Regional state university, campuses in 12 of the Pacific nations including Fiji. Research base for many topics, including sustainable development.
Solander	Solander Pacific	Walu Bay, Suva	Fishing company and exporter with MSC certification. Corporate group head office is in New Zealand.

Table 4.3: Organisations consulted for the research.

3. Formation of a hydrographic unit at SPC to aid regional shipping development
4. Acknowledgement of the need to investigate energy efficiency and sustainable transport

   (SPC, 2014a)

Each of these four items fulfils an important function in the total logistics sustainability research, covering all aspects of economy, environment and society. Each also reflects the acceptance that a significant data gap exists and needs to be addressed to enable sound logistics decision making.

4.3.1 The Governmental organisations

The governmental organisations were the key groups for the research. In each case, the researcher was well received and a discussion on the issues was openly held. The major organisation consulted and interviewed was SPC, where significant staff time at the Economic Development Division was dedicated to assist the researcher. PIF, ESCAP and ADB were also interviewed. These organisations are investing considerable time and therefore money into the measurement of data for the benefit of sound long term decision making in a variety of aspects for the nations involved. However SPC is the key institute at a practical level where data is captured, collated, and used, and the Economic Development Division was the main focus of contact. ADB and ESCAP are involved in logistics projects, and as an example of the work conducted by ADB in the logistics function:

> Support for the transport sector in the Pacific has covered roads, maritime ports, and civil aviation subsectors. Since the start of ADB's support in the region, transport has dominated, accounting for 37.5 % of the overall support from 1969 to 2010. (ADB, 2011, page ii)

Contact was also made with the Pacific Islands Development Forum (PIDF) in Suva, but an interview was not able to be arranged with this organisation. The PIDF is a newly formed (2014) political organisation similar to PIF, but with membership of Pacific SIDS only, regardless of political ties, and with no large nation members.

Each of the individuals interviewed (for details see Appendix C) was committed to enabling the nations to obtain adequate data in a reliable and valid manner. Each had used the UN Millennium Development Goals (MDG) as core benchmarks. These were useful but have been found to be limited in some areas for practical decision making and monitoring purposes, and have now been replaced by the UN's Sustainable Development Goals (SDG) 2015 – 2030. The SDGs have 17 goals and about 169 draft indicators, compared to the MDG with less than half that number. As pointed out by PIF in the interview, 169 indicators are almost impossible to measure in a reliable and accurate fashion without significant advanced and ongoing resource allocation for this purpose. Thus although the PIF has ratified the SDGs on behalf of the Pacific nations, efforts will need to be made to limit the number of indicators, and to resource the data collection and monitoring. This is indeed an ongoing process with member nations of the UN, and efforts are being made to limit the number of indicators to about 100. However the SDGs do appear to supply some useful goals, and when the indicators are agreed, will have data sets of potential use in a logistics sustainability measurement system. ESCAP and ADB have long term goals for the region, but tend to be more project-focused than PIF and SPC, so have a slightly different frame of reference.

4.3.2 University of the South Pacific

The researcher visited the University of the South Pacific (USP) as a courtesy and discussion visit, and the input of that organisation has influence in the research as a general triangulation process. The University was visited as the researcher has had previous communications with USP Associate Professor Peter Nuttall regarding sustainable maritime transport in the region. Nuttall focuses usefully on the fuel and propulsion methods of the maritime transport units, such as in Mofor, Nuttall and Newell (2015) and in Nuttall (2013), whereas this research is based on the holistic view of logistics sustainability regardless of transport mode. Whilst fuel consumption and related CO_2 emission is important, and is included in this research, all aspects of the supply chain process need to be included for effective sustainability measurement.

As discussed by the researcher in the paper written discussing maritime transport sustainability in the region, SPC (2014c), only in this holistic frame of reference are meaningful political and economic solutions to be obtained.

4.3.3 Solander Pacific Ltd

An invitation on site was accepted to interview and observe the business of a significant fishing company in Fiji, Solander Pacific Ltd, that operates on an international sustainability system, detailed in Marine Stewardship Council (2015a). The company is head-quartered in Nelson, New Zealand and bases its Pacific operation in Suva, running twelve fishing vessels from there. The company, like other local fishing operations, is struggling to survive in the Pacific due to large numbers of operators from northern hemisphere nations, such as China, who do not follow sustainable practices and are often subsidised by their owning governments, as reported in January 2014 in fijivillage.com (2015).

There are two significant logistics elements of interest to the research that heavily influence the company's supply chain operations, and aspects of these could be common to businesses of all types in the region:

The outbound export logistics of the fish caught. For the outbound logistics and supply chain, the fish is coded, recorded and documented according to MSC criteria, and this enables sale in the EU (particularly The Netherlands) and Japan. Non-MSC operators such as China usually send their catch to canneries or less sustainably aware or compliant nations.

The inbound logistics of inventory. Charles Hufflett, Chairman of the Solander Group, advised the researcher that to keep the fleet of vessels operational, based in Fiji, the company needs to keep about F$2.8 million in ship and equipment spare parts inventory in Suva, due to long lead times and less than reliable logistics connectivity, whereas the inventory needed for the same ships in NZ would be about F$1.2 million.

The difference in inventory cost is a direct cost indicator for the logistics connectivity and reliability differences. The fishing industry is therefore discussed here as an example of the logistics sustainability difficulties in the region. Further research on such companies in the region is a significant opportunity for study.

Solander Pacific's fishing is conducted by long line, outside Fiji's designated pelagic zone. Voyages are usually about 20 days duration. Catches are now very poor (often around 5 tonnes per voyage, or 5,000 tonnes per year) due to the overfishing by purse seine vessels in the area; other Fijian companies have closed operations due to the poor catches. The purse seine vessels are sometimes, but not always, fishing legally under international agreements such as the PNA, but are not able to be considered in any way a sustainable system. Fish schools, predominantly tuna, are hunted by helicopter from the purse seine ship, the whole school is netted and hundreds of tonnes are caught, together with significant bycatch. The total PNA catch by this method was over 1.5

million tonnes in 2014. Many of the ships are Chinese, and subsidised. A token gesture of sustainability by China's fleet has just occurred, but this does not include purse seine operations:

> The Cook Islands Exclusive Economic Zone (EEZ) South Pacific albacore longline fishery has become the first Chinese tuna fleet to be certified by the Marine Stewardship Council (MSC). Certification of this Pacific tuna fishery is welcome news as it represents growing supply of MSC certified sustainable tuna. The fishery produces 2,300 tonnes of tuna per annum. (Marine Stewardship Council, 2015b)

Fish quality can be roughly grouped into three broad categories, each dependent on the catch method:

high quality pole & line with barbless hook, no by-catch (used by Japan and some Pacific fishermen)

middle quality longline with (circle) hooks, minimal by-catch (used by Solander and some Pacific fishermen)

lower and poor quality net catches, significant by-catch (used by purse seine vessels and others)

The longline and other fishing methods catch smaller sustainable quantities for the higher value market such as being sent by airfreight chilled to Europe. MSC measures and certifies fisheries based on sustainability, and the Fiji long line operation is qualified in this regard. To obtain and retain this certification, documentation is required from the Fiji government to verify the catch method and location. The process is expensive and time consuming, but should result in premium prices from the buyer. The PNA (Parties to the Nauru Agreement) is also MSC approved. However this agreement covers days fishing on the PNA Vessel Day Scheme (VDS), and local crewing, but does not ensure physical sustainability of the resource, as it allows for the expansion of purse seine fleets as long as they are proportionately crewed by PNA citizens and/or pay the daily fee.

Fishing licensing, such as through the PNA agreement, is a significant income source for PICT nations, but political care must be taken with the related logistics and the supply chain and sustainability. While it is not specifically a subject for this research, it is a suitable example of the mix of factors that are often overlooked when dealing with logistics effects and sustainability in the PICT area.

Several examples of wasted aid money exist, such as for example in Tuvalu, where fish distribution infrastructure was built by a Japanese aid project, but never used, due to inadequate planning of logistics and the fish supply chain.

The ocean resource is important to the research nations, and the deep-sea fisheries need careful monitoring. As stated by IUCN:

> Fishing is often undertaken without proper catch limits and enforcement of obligations. ...this deep-sea fishery, if not properly managed, has the potential to decimate unique species and ecosystems that the international community has only just started to discover. Ensuring the sustainability of deep sea fisheries is still feasible, and would only require a fraction of the efforts needed to fix other fisheries. It simply requires a strong political will.
>
> “It is urgent to deal with fisheries subsidies. States should urgently put in place regulations to remove all incentives that result in excess capacity of fishing fleets, ineffective distortions of socio-economic systems, and economic policies that exacerbate threats to the sustainability of deep water resources”, said Harlan Cohen of IUCN’s Global Marine Programme. “Where there is no management, there should be no fishing”.
>
> While deep sea fisheries face challenges related to the lack of knowledge about deep sea species and ecosystems, many of the management issues actually relate to a lack of implementation of general fishery governance and management principles. “Fishing should not be allowed in areas where data are not collected or shared”, said Imene Meliane, Director of International Marine Policy at the Nature Conservancy. (IUCN, 2015)

Further background and updates to the political nature of the fishing environment were covered in a recent Radio New Zealand Pacific news item, illustrating the sustainability difficulty:

> The WWF's Western and Central Pacific Tuna Programme Manager, Bubba Cook, says expansive fishing fleets from countries like China in the Pacific have created a crisis for local fishers and pose a big threat to the sustainability of stocks. He says some of these countries show complete disregard for the authority of the Commission. Mr Cook adds that fishing activities on the high seas remains a major black hole that Pacific nations need to tighten up on. "The Western and Central Pacific Fisheries Commission overall, the membership is at risk of becoming irrelevant very quickly if they don't figure out a way to be more forceful about the way they address the reluctance or the non-compliance of some of these nations to provide fundamental data that is necessary to manage the fisheries." (Radio New Zealand, 2015)

The sustainability of fishing in the Pacific is heavily dependent on open political involvement, and of the effectiveness of the logistics factors of the product. Further research is needed.

4.4 Summary of interview findings

In this section, the research semi-structured interview results relating to the logistics sustainability data, its capture, and its reporting are considered, and leading from these findings the question of a more appropriate model to be used is considered in more detail.

The organisations and individuals interviewed were all very positive in their desire to have a suitable sustainability measure or index; agreement on the definition and measurement of the data and its use is the ongoing significant question. The answers in the summary tables are those that the researcher understands from the discussions with the interviewees. Interviews were not recorded, and were approached in the manner of discussion rather than from a rigid interview process. The results are summarised and divided into two tables, with a brief overall summary covering the governmental organisations:

- Figure 4.2 is a brief overall summary of the four government organisations' measuring and reporting procedures as detailed in Tables 4.4 and 4.5.

- Table 4.4 is a summary of findings relating to the organisational and reporting aspects

- Table 4.5 is a summary of findings relating to the data quality aspects

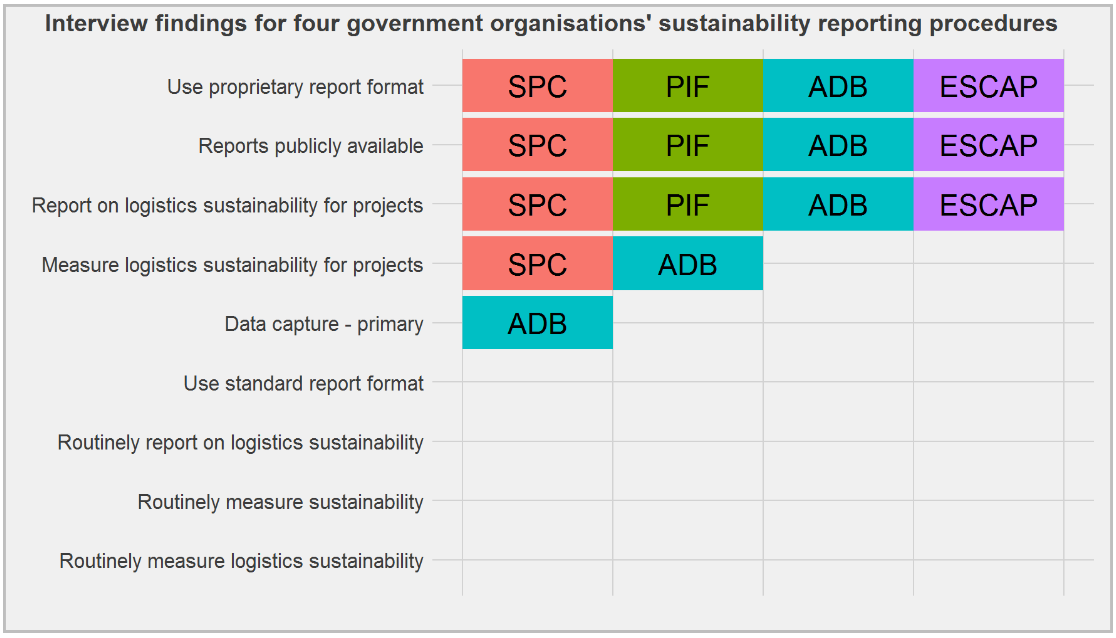


FIGURE 4.2: Brief summary of interview findings for the four government organisations' sustainability reporting procedures

The following sections gather data and coordinate the theme to attempt to reach an answer to the research question, based on a holistic sustainability view. Available indicator data for the economic, environment, and societal categories of logistics sustainability is considered and analysed.

Interview results relating to sustainability reporting

Q	**Reporting question**	**SPC**	**PIF**	**ADB**	**ESCAP**	**Solander Pacific**
3.	Type of organisation	regional government	regional government	regional development bank	UN body	private company
4.	Countries covered	all PICTS	all PICTS	all PICTS and Pacific nations	all PICTS and Pacific nations	Fiji based company, NZ owners
5.	Focus of the organisation's work	economic development and related actions	economic development and political actions	infrastructure	all development	fishing business
6a.	Does the organisation measure sustainability	no, uses data from other sources	no, uses data from other sources	no, uses data from other sources	no, uses data from other sources	no, but it is critical for company's survival
6b.	Does the organisation measure logistics sustainability	not directly, except for specific projects	no	no	no	yes
7a.	Does the organisation report on sustainability	yes, indirectly via various statsitics and reports				yes, on website and indirectly via MSC
7b.	Does the organisation report on logistics sustainability	not directly except for projects such as CPSC	not directly	not directly except for infrastructure projects	not directly	yes
8j.	What report format is used	the organisation's own standard report style is used				MSC report
8k.	Is the report publicly available	through the PIF governments or own publications or websites	through the PIF governments or own publications or websites	through ADB	mostly, through UN	yes, selected items via MSC
9.	Views & discussion	this aspect is discussed in the appropriate sections				

Table 4.4: Summary of interviews conducted in Suva, April 2015; organisations and their sustainability measuring and reporting. The question number from the semi-structured questionnaire is shown in column one.

Interview results relating to sustainability data

Q	**Data questions**	**SPC**	**PIF**	**ADB**	**ESCAP**	**Solander Pacific**
8a.	What data is captured	no primary data capture	no primary data capture	no primary data capture except for projects	no primary data capture	primary GPS related, fish data
8b.	How is the data captured	by SIDS government departments as requested	by SIDS governments	by SIDS governments or ADB consultants	by SIDS governments	some automatic for live transmission, some manual
8c.	How frequently is data captured	census, annual sometimes, project based also	as required	census, annual sometimes, project based also	census, annual sometimes, project based also	some live or to half hour logistics e.g.GPS
8d.	Who is the data captured for	PIF and PICT governments	PIF members, UN papers	ADB	UN	MSC and the company
8e.	How reliable do you consider the data to be	data often low reliability, with large gaps in time or data				very good
8f.	Is the data valid for the purpose	valid but date is often problem	varies, needs care	varies, needs care	yes	yes
8g.	Is there better or other data that could be captured	has to be improved	has to be improved	would be good to have	no concern	up to the PICTs, data is OK, action on the data is not
8h.	Where is the data kept or stored	Suva, or Noumea	Suva	ADB	UN	MSC and company
8i.	Who analyses the data	SPC	PIF	ADB	UN	MSC and the company

Table 4.5: Summary of interviews conducted in Suva, April 2015; data capture, storage, and reliability. The question number from the semi structured questionnaire is shown in column one.

4.5 Metrics related to the three sustainability categories

This section discusses the metrics based on the three category requirements for sustainability – economic, environmental, and societal – as shown in Figure 3.2. When gathering and analysing data for such small nations as the target group of SIDS, with the apparent unreliable and incomplete statistical processes, care is needed that the aggregated data available is not used inappropriately. For example, some data items gathered by the UN include the kilometres of road per km^2 of land area, and the percentage of that road that is sealed, which is used as an indicator of logistics infrastructure development. In all such criteria however there exists an optimum point, so that the road area may become an economic and societal cost rather than a benefit; in the small island nations of the research area, the tipping points from benefit to cost are reached earlier than in a nation such as New Zealand. The area of land used for road and logistics purposes such as warehousing, airports, terminals and so on is referred to as 'land take' and needs to be measured as a logistics cost also, not simply as a benefit. See for example Cullinane (2014, page 21), where the land take for logistics in the UK is discussed. The land take can be considered a negative indicator that balances against the positive connectivity indicators.

In these small island nations, the distinction between roles of the land can sometimes be flexible. For example, many airstrips have alternative uses as roads or recreational facilities rather than being locked into a single use. Figure 4.3 shows the airport in Tuvalu being used as a sports ground when no aircraft are due that day, as the air service generally only occurs on two days per week.

FIGURE 4.3: Mixed roles of airport land – logistics and recreational – a typical example at Funafuti, Tuvalu.

In Kiribati as the sealed road distance was increased to reduce dust, so did the vehicle speed, and with that the associated costs including accidents and road related deaths. This cost increase can occur only with societal acceptance, and in this case the society and community allow a system for passenger mini-buses that encouraged maximum trips, regardless of speed. Therefore, speed and driving standards were unsuitable for such a physically close environment, as observed by the researcher. The injury and death statistics will be allocated to the road infrastructure, but in reality the societal situation is the driving force.

In Tuvalu, speed limits are more realistic, and more effectively enforced and followed. However, the sealed road at Funafuti is under pressure from a group of importers that has requested an upgrade to enable the carriage of loaded TEU into the village, to avoid containers remaining at the port area for cargo distribution from there. This will undoubtedly incur significant additional costs for the society and the government. A logistics sustainability analysis must take these cost and benefit factors into consideration. The SDG indicator development attempts to include such costs.

The Melanesian Spearhead Group (MSG), based in Vanuatu, has worked for some time to develop a set of alternative indicators of societal wellness, relevant to the community and culture rather than imposed from Europe. The most recent of the associated work on this is a publication detailing alternative measures that reflect local societal values for Vanuatu:

> The three unique domains of well-being explored in the study – resource access, cultural practice, and community vitality – are intended to modify the existing progressive measures accepted internationally by governments and aid agencies in order to better track the factors that contribute to, specifically, ni-Vanuatu well-being. (Vanuatu National Statistics Office, 2012, page i).

The dilemma facing the region in working how to measure the societal factors is not unique to this region. These factors are considered more significant globally than the simple economic factors but because of the difficulty in quantitative measuring, and the associated relative power discrepancy in the Pacific (political and economic), little progress has been made, as discussed by the Vanuatu National Statistics Office:

> In 2006, the UK based New Economics Foundation published The Happy Planet Index: An index of human well-being and environmental impact in which countries were ranked in relation to three indicators of well-being: life satisfaction, life expectancy, and ecological footprint. These three indicators were chosen by the Foundation to represent the ecological efficiency of delivering human well-being within the constraints of equitable and responsible resource consumption. The report declared Vanuatu to be the happiest country in the world. Vanuatu was and still is worthy of such a title. However, Vanuatu is currently classified by the United Nations as one of the world's most impoverished countries and is labelled by the organization as economically handicapped. The Happy Planet Index brought forth awareness in the region of the need for new indicators to be developed that take into account the income-neutral factors contributing to Melanesian well-being, rather than continuing to rely solely on GDP growth to measure success or progress. (Vanuatu National Statistics Office, 2012, page 2)

Another example of this wider investigative process for monitoring sustainability indicators is found in Bhutan, which has had a Gross National Happiness index (GNH) since before 1980, as reported by Cheong, Bark and Jeong (2015) in a working paper for the ADB on Bhutan's trade balance:

> GNH is a multi-dimensional development approach that seeks to achieve a harmonious balance between material well-being and the spiritual, emotional, and cultural needs of our society. (Cheong et al., 2015, page 8)

Measuring societal factors is not easy, and a greater awareness of the societal and wider environmental factors in addition to the standard economic metrics, is attempted to be built into the newly developing UN's SDG. Awareness of the need for community involvement in the sustainability measurement process, particularly in relation to – but not limited to – the societal factors, is indicated in the Citizen Scorecard process discussed by SPC's Economic Development Division:

> Citizen Scorecards are participatory surveys that provide quantitative feedback on user perceptions on the quality, adequacy and efficiency of public services . . . (SPC, 2014b, page 251)

Each of the three categories, and their relationship to the research, are examined in the following sub-sections.

4.5.1 Environmental category

The data captured for environmental measurement and monitoring has tended to be focused on GHG, particularly CO_2 or CO_2 equivalent. While this is a useful core base and readily calculated, it is important also to include in any measurement system the recognition of other environmental aspects, such as the effect of the product or service on air and water quality, noise, and visual effects that may influence living standards and quality of life for the local population. Consideration must also be able to be made on the effect on other businesses in the area, such as tourism. Suva harbour for example appears to be heavily polluted by Pacific standards and is therefore not attractive to visitors, especially with expensive new hotel constructions at the water's edge. Only recently are steps being taken to clean the water and foreshore, including capturing the run-off from ship repair yards, which currently flow directly into the harbour. Standard water metrics are available for use for sea and fresh water monitoring, and these can be adopted as part of the sustainability monitoring and enhancing process.

As found by the research and summarised in Figure 4.2, none of the organisations interviewed regularly capture or record this data, doing so only based on discrete project requirements, when great detail is involved. For example, ADB's environmental impact study in preparation for development of the port at Pohnpei in FSM involved significant capture of primary environmental data (Asian Development Bank, 2013). It appears however that following the initial project research, little or no routine data capture takes place by either the island government or the ADB.

In order to develop a longitudinal data set, a standard measurement and recording system is needed, and SIDS government resources for the measurement need to be committed. The methodology options for this are examined in this research, and clearly there are advantages in adopting existing systems as much as is possible and relevant.

Table 4.6 shows the elements that are required to be measured and reported on in the Green SCOR system. Although this table may look simple, for an organisation to comply with Green SCOR almost 100 elements are required to be recorded. This is similar to the ISO system, where ISO 14000 environmental standards have over thirty elements that require reporting, each with many sub-parts. This is therefore unlikely to be of practical value for SIDS due to the highly complex operation. As pointed out by Morana there must be a high value in compliance for a company, organisation, or government to undertake the ISO commitment, because "it is unwieldy and bureaucratic to implement" (Morana, 2013, page 91). However the metrics involved are useful for any system.

Green SCOR metrics		
Metric	**Units**	**Notes**
Carbon emissions	Tonnes CO_2 equivalent	Common GHG measure
Air pollutant emissions	Tonnes or kg	COx, NOx, SOx, volatile organic compounds, particulate matter
Liquid waste generated	Tonnes or kg	Regardless of disposal method or location in supply chain
Solid waste generated	Tonnes or kg	Regardless of disposal method or location in supply chain
% Recycled waste	%	% of the solid waste recycled

Table 4.6: Green SCOR data measurement units. Source: Supply Chain Council (2013, section 6.1.1).

The discussion on the balance of environmental issues and the economic demand issues is a continuous process in the region as highlighted for example in the working papers for the Strategy for Climate and Disaster Resilient Development in the Pacific (SRDP):

> ICAO has called on world governments to agree on measures to manage carbon dioxide from air travel, which would come into force from 2020. . . . Regardless, emissions by the aviation sector will eventually be regulated, with costs being passed on to passengers and other customers. A similar situation exists for maritime transport. As PICTs are heavily reliant on both international aviation and maritime services, including cruise ship tourism, any cost increases will have economic and social consequences. Arguably, impacts will be greatest for those PICTs with tourism dependent economies. In the case of the Caribbean, a study suggested that the introduction of international regulation of aviation emissions could cause tourist arrivals to the Caribbean to decline by between 1 and 4% by 2020, and by as much as 24% under a worst case scenario of a 'serious' climate policy. Recent research

> on climate change policy and tourism in PICTs has included examining the impact of different aviation policies on airfares and arrivals at small island destinations. However, analyses of the impact of international emissions reduction policies on tourist arrivals for PICTs has yet to be undertaken. This Strategy recommends that such fore sighting studies be undertaken. (SPREP, 2014, page 25)

Examining the CO_2 emissions of each nation is a worthwhile process, as the emissions are readily calculated from nationally available information once the data capture process is refined and is reliable. The emissions of CO_2 from all sources in the research nations is shown in the graphs Figure 4.4 and 4.5, indicating the strong relationship between emissions and each nation's GDP per capita. Thus the nations emit more CO_2, and consequently also other pollutants, as their GDP increases, reflecting the societal shift in the populations' behaviour and expectations that influence emissions of CO_2.

The CO_2 emissions that occur as a result of burning transport fuel in the research region are calculated, as much as is possible with available data, in the section on each individual transport mode. In general, it could be expected that these individual modal emissions would follow a similar relationship pattern to these graphs.

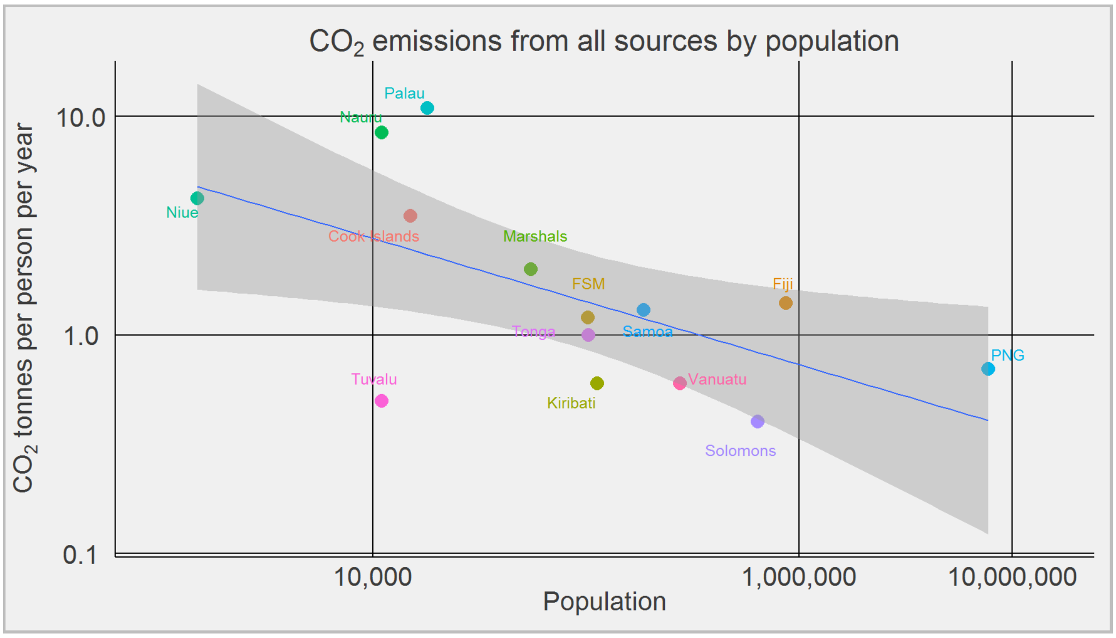


Figure 4.4: CO_2 emissions, all sources by population. Both scales are logarithmic. Emissions all sources value is sourced from World Bank and UN databases for these nations. Linear correlation is -0.20, and logarithmic correlation is -0.59.

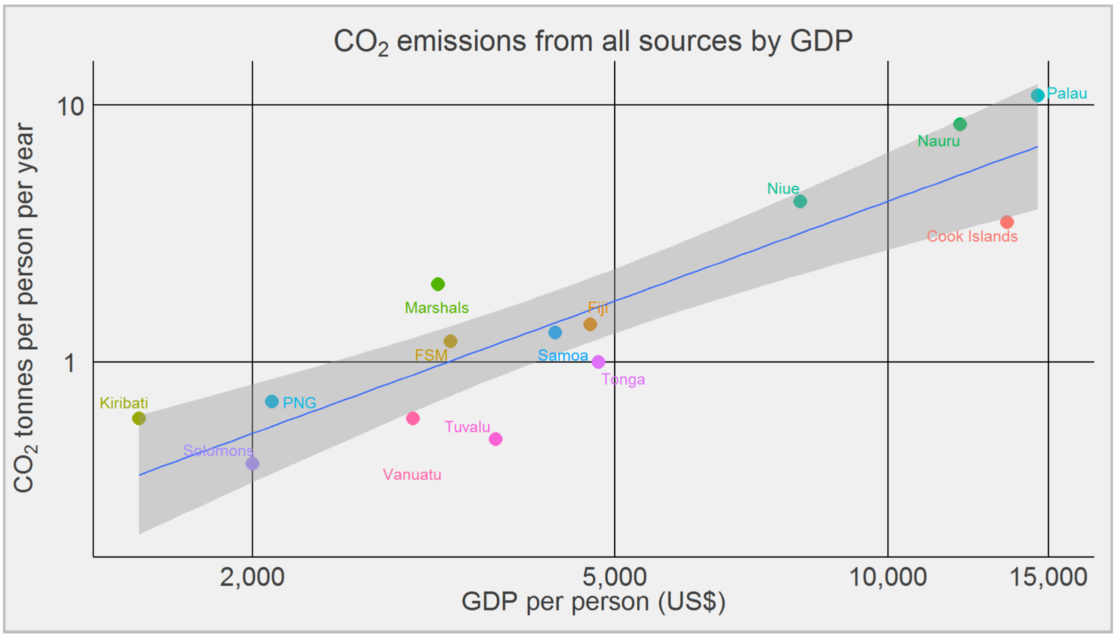


FIGURE 4.5: CO_2 emissions, all sources by GDP. Both scales are logarithmic. Emissions all sources value is sourced from World Bank and UN databases for these nations. Linear correlation is +0.82, and logarithmic correlation is +0.88.

4.5.2 Economic category

For the purposes of the research, the UN Economic Vulnerability Index is included in the societal category data, rather than in the economic section.

Economic data assessment can use the relative freight and passenger costs as an indicator; sufficient market forces can be considered to be in play for products to respond somewhat to price, showing any possible elasticity. The measurement of this has not been part of this research but indicative costs are shown where appropriate, or discussed as needed for the element being considered. Airfares and freight rates are necessarily higher in the region due to the small market size, imbalance of volumes, and infrastructure facility limitations. Air services and some land and sea services are subject to government licence systems and controls with a general overall goal of improving affordability for the customers and economic longevity for the operators.

One significant logistics project undertaken in order to enhance the stability of logistics sea services and freight rates is the formation of the Central Pacific Shipping Commission (CPSC). This was formed by the SIDS governments, through the coordinating organisations PIF and SPC. Its formation process is outlined in the review report SPC (2014d) examining the early stages of the CPSC. In the review, the difficulty in obtaining data is discussed. The researcher was advised by SPC that the official published statistics were so inaccurate that the investigation team needed to go to basics, getting primary data directly from ports and customs source paperwork rather than published statistics. The CPSC is reported to have resulted in a stabilisation of freight rates, and a greater awareness by the SIDS governments of the need for effective port and infrastructure facilities that are a key driver of rate and service stability. Structures such as the CPSC work in limited carefully defined areas, and do not directly influence rates and services from main service routes.

Sea cargo rates are necessarily higher for SIDS than for larger nations, due to the economic imbalance of movement and the smaller volumes of trade. UNCTAD freight data shows that sea freight costs as a proportion of imported product value for the past 10 years average about 10% for SIDS, compared to the 8% global average. Only Solomon Islands has a very high figure at 16% (UNCTAD, 2015, page 109). This 2% difference is not in general excessive, and freight costs are not the main driver of retail pricing, which is why for example Fiji bottled water can be purchased by a consumer at a lower price in New York than in Suva, depending on where and when the water is purchased.

Air cargo rates are almost always expensive compared to sea rates, due also to the imbalance of movement, smaller volumes, and also small individual package size. However only air often supplies the required reliable scheduled connectivity between the nations. Air passenger service affordability is a significant issue for the population, as is also the limited availability of seats and space. Sea transport is usually the only available option for domestic inter-island travel due to the lack of airfields, but sea service frequency and reliability do not usually compare well with the equivalent air services.

Connectivity, availability, and affordability issues are certain to affect economic development more than the direct unit freight cost. These issues are investigated in the research, as they influence the factors that may be useful to monitor for sustainability metrics. All these cost items then need to be related to average incomes in the SIDS to enable an affordability index to be calculated for passenger movements. There are several methods for this, relating transport costs to income. The research does not develop this further, but it is a topic for possible further research. Table 4.7 shows for example the airfare for a passenger between Fiji and each of the countries, as compared to the nation's GDP per person. GDP is used as the benchmark as it is reliable and consistently available data, whereas wage and income data is inconsistent. The table is based on the cheapest available flights, as sourced on the national airlines' websites or on general travel search sites when otherwise not available. The data shows a wide range of generally unaffordable air transport prices, ranging from 4% to 67% and averaging approximately 23% of GDP for one flight to Fiji; by comparison, the cost from Auckland, New Zealand to Fiji represents less than 1% of the GDP of an average New Zealand resident.

SIDS indicative air passenger transport affordability

Pacific SIDS	**GDP, USD per person**	**Air fare, one person, one way, cheapest USD**	**% the airfare is of GDP per person**	**Notes**
Larger SIDS				
Fiji	4,700	373	8	to Tuvalu
FSM	3,300	2209	67	to Fiji
Papua New Guinea	2,100	667	32	to Fiji
Samoa	4,300	288	7	to Fiji
Solomon Islands	2,000	420	21	to Fiji
Tonga	4,800	423	9	to Fiji
Vanuatu	3,000	314	10	to Fiji
SIS subgroup				
Cook Islands	13,500	675	5	to Fiji
Kiribati	1,500	689	46	to Fiji
Marshall Islands	3,200	1988	62	to Fiji
Nauru	12,000	480	4	to Fiji
Niue	8,000	1620	20	to Fiji
Palau	14,600	1860	13	to Auckland, fares are up to US$5,000 to fly to Fiji, due to connection difficulties.
Tuvalu	3,700	373	10	to Fiji

Table 4.7: Air fare affordability, fares based on Fiji Airways, Air Niugini, Air Nauru, and other PICT airlines, one way cheapest available advertised flights. The Fiji example uses the fare to Tuvalu. These are indicative, as fares change and the conversion to US$ will vary significantly.

Sea transport is not available as an alternative to air in all cases, and when it is, there are usually more affordable cost options. Sea transport from Tuvalu to Fiji for example, would cost approximately A$80 for sleeping on deck with no cabin, including meals, and approximately A$320 for a cabin and meals - almost the same as the airfare. These represent 2% and 9% of the average GDP per person. Additionally, the sea service takes about 4 days, and has no regular schedule.

Because of the lack of air services and facilities, sea transport is the most common inter-island domestic, as compared to international, transport mode in many areas.

4.5.3 Societal category

Overall, the PICT nations are in low income groupings, and Table 4.8 shows the GDP per capita together with other societal information. As can also be seen from the table the nation's size, as measured by population or land area, is not directly related to the level of economic wellness as indicated by GDP per capita. For example, the only SIDS with a GDP per capita above US$10,000 are the Cook Islands, Palau, and Nauru, each of which is classed as a SIS. Each of these nations' political affiliations and associated relationships would appear to have a great role in that income metric. For example the Cook Islands and Niue have close relationships with New Zealand, Nauru with Australia, and Palau, FSM, and the Marshall islands have a close relationship with the USA.

Political relationships are very likely to significantly influence the level of transport infrastructure development undertaken, but the further investigation of this correlation is not part of the research. Some aspects of these relationships are however reflected in the logistics data, including connectivity, particularly of air services. The ODA value is also of interest in that it shows the level of dependence of assistance rather than earnings. Natural resources and access to income through activities such as tourism also have an influence, but political relationships appear to be dominant.

The two UN global societal indicators shown in Table 4.8, the Human Development Index (HDI), and the Economic Vulnerability Index (EVI) reflect in conjunction with GDP, aspects of the societal soundness of the nations. The HDI is an index for the general standard of living including health related factors; the EVI is essentially a broad index of the exposure of the nation to a total shut-down of external logistics i.e. the case where all trade stops through political or natural disasters, and the country is reliant on its own resources. The EVI is therefore of core underlying value in this research. Kiribati is ranked as the world's most economically vulnerable nation, followed by The Gambia in Africa, then Palau, Nauru, and the Marshall Islands; thus making these SIDS four of the worlds five most vulnerable nations. All the Pacific SIDS are in the top 50 EVI ranking nations, with the exception of PNG, which is ranked 78.

SIDS societal status						
Pacific SIDS	**GDP, USD per person**	**ODA, as a % of GDP**	**Human Devel-opment Index, (HDI)**	**HDI world ranking (1= best)**	**Economic Vulnerab-ility Index, (EVI)**	**EVI world ranking (1= worst)**
Larger SIDS						
Fiji	4,700	2	0.724	88	38.8	50
FSM	3,300	42	0.630	124	55.2	11
Papua New Guinea	2,100	5	0.491	157	39.3	78
Samoa	4,300	16	0.694	106	44.0	30
Solomon Islands	2,000	30	0.491	157	50.8	17
Tonga	4,800	20	0.705	100	55.5	10
Vanuatu	3,000	12	0.616	131	60.4	23
SIS subgroup						
Cook Islands	13,500	34	0.829	-	-	-
Kiribati	1,500	27	0.607	133	71.5	1
Marshall Islands	3,200	41	0.708	-	62.3	5
Nauru	12,000	44	0.637	-	67.9	4
Niue	8,000	225	-	-	-	-
Palau	14,600	15	0.775	60	69.6	3
Tuvalu	3,700	77	0.691	-	54.0	13

Table 4.8: Research nations' societal status data; various sources: SPC, ESCAP. GDP data is estimates from IMF (2014) and UNdata (2014); Official Development Assistance (ODA) from UN DESA (2014). A '-' symbol indicates data is not available in the database.

Societal data for logistics sustainability is the area of data most difficult to quantify into monetary or other quantitative values. The societal aspects are however a key driver to the logistics industry, as this is where the demand for the logistics services is set. Increasingly, as more SIDS politicians for example travel internationally and wish to have the 'New York' lifestyle while remaining on their island, the demand for air services and consumer product importing increases significantly. Other non-political international work, such as seafaring and seasonal work, can be expected to have a similar effect. This transfer of desires in the population sectors involved incurs a high air travel element, high import demand, and other related features to inevitably modify the PICT lifestyle.

The measurement of some of the societal aspects is capable of being covered by some of the UN Sustainable Development Goals (SDGs) and the associated indicators, and there is a correlation that could make it possible to link specific goals to a logistics sustainability focus. Each of the goals has related targets and indicators. The reality would appear to be however that many of these indicators are not yet measurable in the PICTS or SIDS or many other countries with any degree of reliability, and are yet to be fully developed. The indicators are progressively being worked on and defined, and a central UN body working on these is the Data for Sustainable Development thematic group of the UN's Sustainable Development Solution Network (SDSN), which has the aim of finalising suitable indicators:

> It seeks to identify solution - orientated approaches to measuring progress on the SDGs, to strengthen the cross-sectoral and multi-scalar analysis of data for SDG monitoring, and encourage greater frequency and quality of data production and monitoring. (UN Sustainable Development Solutions Network, 2015)

The seventeen UN draft Sustainable Development Goals, developed from the Inter Agency Expert Group on Sustainable Development Goal Indicators ((IAEG secretariat, 2015)) for the years from 2015 to 2030, are listed below. Targets and indicators are used to measure the progress towards the goals. Logistics is an embedded ubiquitous component of most of the goals to varying levels, and brief notes are added by the researcher to the list for those that contain targets that are specifically logistics related and could be considered in a sustainability index:

GOAL 1 End poverty in all its forms everywhere

- Target 1.4 relates to access to economic resources

GOAL 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture

- Several of these targets require effective logistics services, such as 2.1 which relates to access to food

GOAL 3 Ensure healthy lives and promote well-being for all at all ages

- Target 3.6 relates to halving road deaths and injuries, Target 3.9 relates to air, water, and soil pollution causing deaths and illnesses

GOAL 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

GOAL 5 Achieve gender equality and empower all women and girls

GOAL 6 Ensure availability and sustainable management of water and sanitation for all

- Several targets relate to water access, pollution, and affordability

GOAL 7 Ensure access to affordable, reliable, sustainable and modern energy for all

- Target 7.b relates to improving energy efficiency and sustainability, specifically for SIDS

GOAL 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

- Target 8.9 relates to developing sustainable tourism

GOAL 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

- Target 9.1 relates to the infrastructure needed for affordable, sustainable accessibility, and a 'logistics performance index' is proposed

GOAL 10 Reduce inequality within and among countries

GOAL 11 Make cities and human settlements inclusive, safe, resilient and sustainable

- Target 11.2 relates to transport accessibility and affordability

GOAL 12 Ensure sustainable consumption and production patterns

- Several targets relate to supply chain efficiency and wastage, particularly for food and chemicals; Target 12.6 relates to the reporting of sustainability; Target 12.7 is 'Promote public procurement practices that are sustainable', in accordance with national policies and priorities

GOAL 13 Take urgent action to combat climate change and its impacts

GOAL 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development

- Several targets relating to fishing management and related reporting and logistics

GOAL 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

GOAL 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

GOAL 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

(IAEG secretariat, 2015)

Further discussion on the requirements for the principle of setting data collection processes for the SDGs are covered in Lu, Nakicenovic, Visbeck and Stevance (2015). These goals and indicators however are still in working draft form, and a UN Department of Economic and Social Affairs (DESA) meeting in Bangkok on 26-28 October 2015 is the next stage in discussing formulation of the indicators. The UN DESA's Statistics Division is organising this second meeting of the Inter-agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs), where it is hoped that some finality can be placed on some of the key indicators. (UN DESA Statistics, 2015).

4.6 Metrics and data related to transport modes

In this section a further comparative analysis is made of the transport modes and how their characteristics influence their use for logistics in the region and how the modes link into the three sustainability categories. It is necessary to examine the role of each mode, as sustainability metrics will relate to the mode and its function.

Each transport mode naturally has a varied role appropriate to its features, and different priorities exist between modes according to the region's geography and population distribution. In the research region, dominant modes are air and sea, with the road being an important local connection mode in some of the larger locations. None of the SIDS have rail transport except the small seasonal rail operations for sugar cane movement from fields to the initial processing refineries in Fiji. All have significant sea boundaries, and only PNG has a land border with another country, but the topography significantly limits land transport across the border.

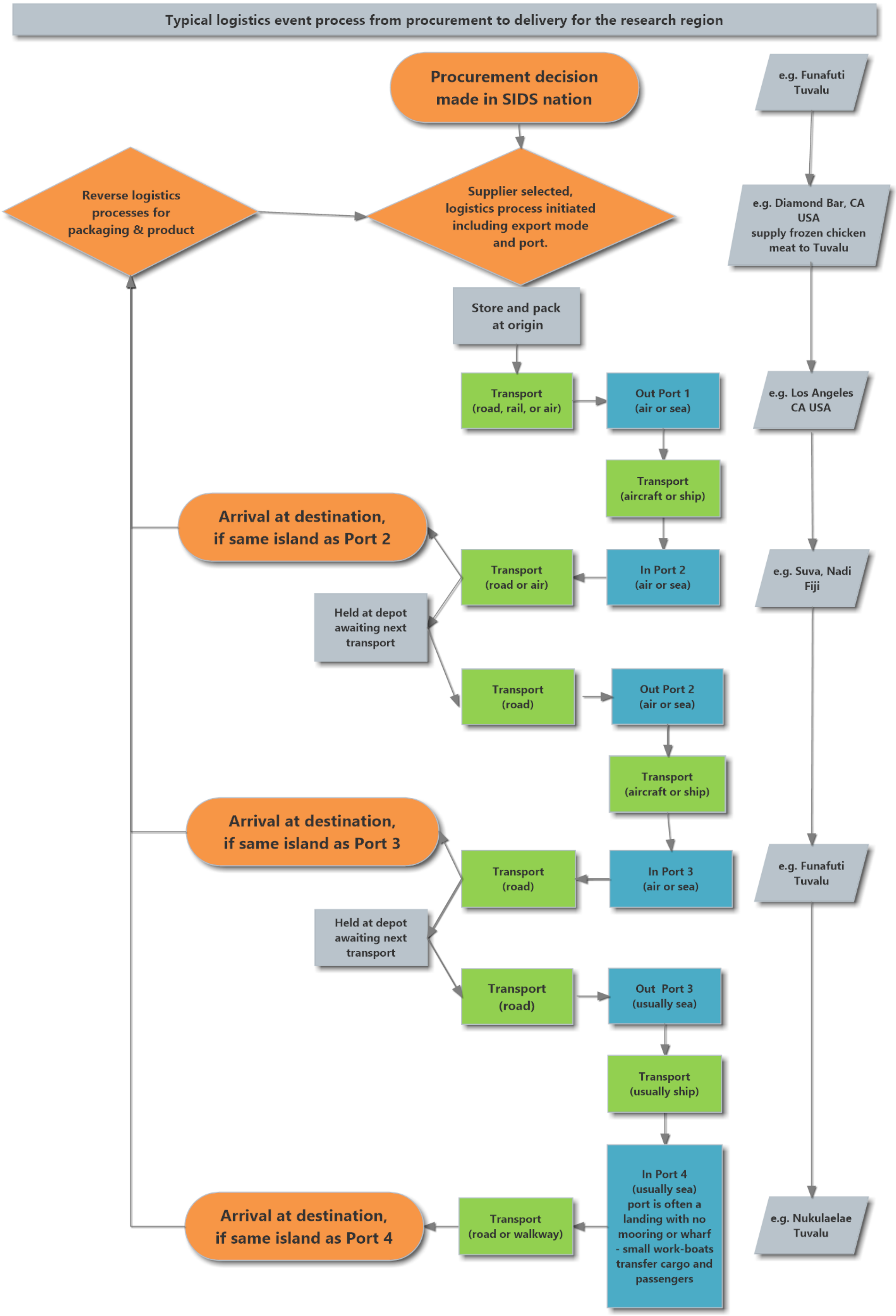


FIGURE 4.6: Logistics events for typical processes; an example from west coast USA to an outer island of Tuvalu. Possible destinations are also shown at stages of the import process.

The logistics elements are expanded to establish a logistics flow chart and locations of potential sustainability measurements in Figure 4.6. This shows the possible transport modes used, and the locations of storage involved in a typical hubbing process for imported goods. As discussed earlier, the goods include any product or passenger travelling by air or sea. A photograph of a typical final port is shown in Figure 4.7; the product in this case is drums of petrol, but it could equally be passengers, and the discharge method would be modified accordingly. For domestic micro scale logistics, the same principle applies in a simplified manner, and with quantities and distances being smaller, transport units are those such as trucks, buses, hand carts, personal walking or similar mechanisms.

FIGURE 4.7: Common logistics operation, landing ashore at the final destination island. This is Port 4 in the logistics process flow chart in Figure 4.6. Photo by researcher.

The procurement decision, whereby the supply chain events are activated and transport modes selected, is required to be made ahead of the planned delivery date, (often six months ahead for large imported items to SIDS) but is not considered as part of this research. However the procurement decision moment is the fundamental time at which the influences on a sustainable logistics and supply chain choice are initiated.

For the environmental elements, there are international standards for most factors that could be monitored, therefore no primary research is required. What is required is the research to enable the adoption and utilisation of the processes. There is no doubt that water pollution exists in the research area, but to what level and under what regime to report is unknown without regular monitoring.

Connectivity metrics are used to compare logistics services which relate to the societal environment as they reflect the ease of access to the logistics service. Connectivity is largely a social aspect, as airline services for example are operated under bilateral agreements, and many of the local or regional sea services are either government operated or have a licensing system, including that of the regional multilateral CPSC. Connectivity and affordability are not necessarily related.

Modal data in the research indicates that international air connectivity is essentially related to GDP, and that the small nations have superior logistics connectivity; sea connectivity is related to population, and the larger nations have better connectivity. These relationships reflect the societal and economic factors involved in generating demands for the service. These factors are investigated further and shown graphically in the subsections discussing each transport mode.

Transport connectivity and availability are critical for the success of the Sustainable Development Goals set by UN and agreed to by the PICTs, and must therefore be considered in a sustainability analysis. All the SDGs, as listed in the subsection discussing Societal data, contain embedded logistical components and within each of the goals are targets and indicators; there is further detailed information as to how to measure the items. The list does not show what are the actual metrics used to measure the achievement towards reaching those goals, but that is the needed next step which the appropriate organisations are working on. Some specific draft transport examples are listed below:

- 3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents.
- 9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

- 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
- 14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.

Each of these is measurable and fits within sustainability reporting methodology.

4.6.1 Transport emissions

Transport emissions include CO_2, other gases, solid particulates and so on, with the major volume of these emissions being the CO_2. The CO_2 component is also simpler to measure and is a common benchmark because of this, so is used in the research. CO_2 is not necessarily the worst pollutant for the nation, but it is the easiest to quantify.

Two main methods of calculating CO_2 emissions for transport exist which are discussed in Fong et al. (2014, page 73) in the transport environment context for a city. The methods are referred to as the ‘top down’ and ‘bottom up’ methods. The ‘top down’ method uses the quantity of fuel used, multiplied by a standard emission factor for that fuel. The quantity of fuel used is obtained from sales data, and assumes for example that all the petrol sold in Fiji is used in Fiji. The ‘bottom up’ method uses carrying capacity and related items in the analysis, such as tonne-km or passenger-km. Sample emission rates for this bottom up calculation are shown in Table 4.9. Many large international companies use the bottom up method in the GRI report system, but it is much more data-demanding, and for a wider regional approach in the research area it has significant practical difficulties. In the research area therefore, it is considered that the appropriate relevant and practicable statistical system is to use the top down method. Thus emissions can be calculated based on the actual tonnage of fuel consumed and the average CO_2 output per tonne of fuel. The relevant CO_2 emission rates are shown in Table 4.10. These do not include the solid particulate or other GHG elements, which also vary with fuel type and quality.

CO_2 emissions by transport mode category		
Transport mode	**Grams of CO_2 per tonne-km**	**Notes**
Sea	3 to 8	Range is due to differing ship types, speed and size.
Land - rail	1-13	Ranges from 1 for low speed freight train to 13 for high speed passenger rail.
Land - truck	12-110	Range is due to differing size of trucks.
Air	100-1000	Size of aircraft and length of route influence CO_2 output.

Table 4.9: Indicative levels of CO_2 produced by each transport mode. Tonne-km is a measure of the work done, used for logistics supply & demand. Source: extracted from IPCC (2014)

CO_2 emissions by fuel type			
Fuel type and approximate Specific Gravity (SG)	**Tonnes of CO_2 per tonne of fuel burnt**	**Tonnes of CO_2 per litre of fuel burnt**	**Notes on logistics use in the region**
Petrol (SG 0.75)	3.0	0.0023	Cars, small commercial vehicles, motor bikes.
Diesel (SG 0.85)	3.2	0.0027	Larger commercial vehicles, transport equipment, small island ships.
Aviation Fuel (SG 0.82)	2.7 to 5.5; average 3.16	0.0022 to 0.0045	Aircraft: SIDS aircraft are at the higher end of the emissions scale; ICAO rate the Fiji Air Tuvalu aircraft at 4.2 tonnes CO_2 emitted per tonne of fuel burnt.
LPG (SG 0.5)	6.0	0.003	Vehicles, transport equipment. Not a common transport fuel in SIDS
Marine fuel oil (SG 0.9)	3.2	0.0029	Heavier marine fuel, not common in SIDS ships but used by international vessels. Greatest emitter of Sulphur and solid particulates.

Table 4.10: Indicative levels of CO_2 produced by each main type of fuel. Data source: per litre values extracted from NZ Ministry of Environment (2014) with the remainder calculated by researcher.

Using the emissions data in Table 4.10 and the information for the Tonnage transport fuel consumed by the research nations, shown in Table 4.11, it is possible to calculate an effective and useful figure for the CO_2 emissions. Table 4.12 shows the transport related CO_2 emissions as calculated for the nations that have the data available. This information is then included in the environmental category of sustainability.

Some of the aviation and marine fuel may be burned outside the SIDS territory once the aircraft or ship has embarked on its journey and has left the EEZ. However this effect

SIDS transport fuel data				
	Litres burned for transport per year			
Pacific SIDS	**Diesel**	**Standard petrol**	**Aviation fuel**	**Notes**
Larger SIDS				
Fiji	34,000,000	50,000,000	113,000,000	2008 data
FSM	-	-	-	-
Papua New Guinea	-	-	-	-
Samoa	-	30,819,265	13,962,700	2013 data, no diesel data
Solomon Islands	-	-	-	-
Tonga	2,216,998	-	743,518	2008 data, no petrol data
Vanuatu	-	-	-	-
SIS subgroup				
Cook Islands	-	-	-	-
Kiribati	5,451,584	6,387,513	2,018,582	2013 data
Marshall Islands	2,743,762	5,123,618	11,588,103	2014 data
Nauru	-	-	-	-
Niue	-	-	-	-
Palau	-	-	-	-
Tuvalu	-	-	-	-

Table 4.11: Research nations' transport fuel consumption. Sources: core data from the EDD PRDR. Additional calculations by researcher. A '-' symbol indicates data is not available. LPG and kerosene are not included as transport fuels.

is not considered in the research as it is not practicable to measure the allocation and is not considered to be significant in the range of accuracies in the data available. It would also require that fuel burned that was not purchased in the region, but was consumed in there by the aircraft or ship, must be added. This level of calculation and data is not readily available without additional detailed research, and is of limited marginal benefit to the quality of the data. A similar approach is taken when analysing city emissions, where fuel sold in the city is assumed to be predominantly used in the city, as discussed in Fong et al. (2014, page 71-73).

It is important to remember that the reliability of the current data is low and data is incomplete; however the indicators obtained in this way are useful. The lack of data prevents a reliable calculation on total fuel and CO_2 emissions from being obtained for each nation. The core data source would require allocation of use to factors such as energy and electricity production, which is expected to be a significant proportion in the smaller nations such as Tuvalu and Niue. This allocation process is in international standard statistical use.

SIDS transport fuel CO_2 emissions						
	Tonnes CO_2 emissions by transport fuel per year					
Pacific SIDS	**from Diesel**	**from standard petrol**	**from aviation fuel**	**Total transport CO_2**	**Total tonnes CO_2 per person, transport**	**Total tonnes CO_2 per person, all sources**
Larger SIDS						
Fiji	91,800	115,000	339,000	545,800	0.62	1.4
FSM	-	-	-	-	0.60	1.2
Papua New Guinea	-	-	-	-	0.35	0.7
Samoa	-	70,884	37,699	-	0.57	1.3
Solomon Islands	-	-	-	-	0.20	0.4
Tonga	59,986	-	2,007	-	0.58	1.0
Vanuatu	96,695	1,525	7,092	105,312	0.41	0.6
SIS subgroup						
Cook Islands	-	-	-	-	1.75	3.5
Kiribati	14,719	14,691	5,450	34,861	0.34	0.6
Marshall Islands	7,408	11,784	31,288	50,480	0.95	2.0
Nauru	-	-	-	-	4.20	8.4
Niue	-	-	-	-	2.10	4.2
Palau	-	-	-	-	5.50	10.9
Tuvalu	-	-	-	-	0.23	0.5

TABLE 4.12: Research nations' transport fuel CO_2 emissions. Source: calculations by researcher based on consumption data in Table 4.11. The per person all sources value is sourced from World Bank and UN data bases for these nations, and the transport emission per person is calculated at 50% of the 'all sources' value. A '-' symbol indicates data is not available.

The following subsections examine the relevant aspects of each transport mode to the logistics question.

4.6.2 Air transport

Air transport, for cargo and personnel, is an important part of logistics services for the SIDS. A logistic service provided by air is using the most expensive, most GHG polluting, and generally less 'green' form of transport, but has the service reliability and short delivery lead times that are frequently desired for logistics. The cost per tonne-km by air is globally higher than any other mode but the significant use of air in the region reflects the benefits of its characteristics that the user is prepared to pay for: frequency, reliability, comfort, and short lead times. The sustainability calculation needs to allow for this, and also for the difference in capital infrastructure required on the land. On the smaller islands, significant land area is taken for landing fields; initially air services used water (lagoon) landings where possible, then grass whereby the runway was, and still is in many areas of SIDS, a multi-purpose surface. The larger aircraft in use today however require good quality surfaced runways, and regular maintenance of them. The land area used for airports is included in the logistics 'land take' calculations and is a useful component for logistics indicators. The aircraft also require guaranteed fuel quality, which can be a difficulty in some of the SIDS. Maintaining this fuel standard can be an expensive process.

Operating air services to the SIS nations has additional factors that require the higher fares that exist. For example Tuvalu's twice weekly service from Fiji is that country's only international air service, and the operating costs include the normal route factors and additional considerations such as carrying additional fuel for safety. The only route available to a safe haven if Tuvalu's Funafuti airport is not able to be landed on (due to a dog on the runway or other serious runway issues), is to return to Fiji. Also, if an incident occurs to an aircraft on the island, it is extremely expensive to freight parts and expert personnel or undertake whatever action is required, and sea transport may be needed but not available.

International air service connectivity is shown in Table 4.13, and the number of available airports, indicating accessibility, is shown in Table 4.14. Air service affordability is shown in Table 4.7, and this clearly shows the lack of affordability of this transport mode to the general population of the region.

Calculations of GHG issued by air can be conducted using ICAO data. ICAO uses a standard average figure of 3.16 tonnes of CO_2 produced by every tonne of aviation fuel burned, or more accurate figures can be calculated using specific aircraft data. The ICAO calculator shows that the aircraft used on the Fiji - Tuvalu flights produces 4.3 tonnes of CO_2 per tonne of fuel burnt; this is due to the nature and size of the aircraft. Thus air transport emission calculations are readily feasible using either the 'top down' or 'bottom up' models as described in the previous section, and warrant further research for incorporation into a sustainability model.

Air service implementation is dependent on achieving a bi-lateral government agreement to use the airports and airspaces on a regular service. Reflecting the high importance of air services, some of the SIDS nations have commenced operating their own government-owned airlines, with mixed results. For example the Nauru state-owned airline has had several attempts at providing a service, including calls at Australia, Kiribati, and Fiji amongst other destinations.

SIDS international air service connectivity

Pacific SIDS	**Inter'l airports**	**Inter'l service airline coy's**	**Inter'l scheduled services, total per week**	**Inter'l services per week within PICT area**	**Inter'l services, total per week, per 1,000 persons**	**Inter'l services, total per week, per person, index base Fiji 100**
Larger SIDS						
Fiji	2	10	130	31	0.15	100
FSM	4	2	25	2	0.24	164
Papua New Guinea	2	3	61	3	0.01	5
Samoa	1	3	23	7	0.12	82
Solomon Islands	1	4	16	9	0.03	19
Tonga	1	3	15	10	0.14	97
Vanuatu	2	6	31	15	0.12	82
SIS subgroup						
Cook Islands	1	3	15	0	0.75	512
Kiribati	2	2	6	5	0.06	39
Marshall Islands	1	2	8	5	0.15	103
Nauru	1	1	5	2	0.50	341
Niue	1	1	2	0	2.00	1365
Palau	1	4	17	7	0.81	552
Tuvalu	1	1	2	2	0.20	136

Table 4.13: Research nations' international air service connectivity; note that the services within PICT area are included in the total per week services. Source: Service data provided by SPC, calculations by researcher. For comparison, NZ has 1200 international flights per week, or 0.26 per 1,000 persons.

Domestic air services are important is some SIDS, but non-existent in others, depending on topography and population. Information on the availability of airports, reflecting the use of air transport in the nation, is shown in Table 4.14. Because the International Air Transport Association (IATA) is an airline industry trade association, and the International Civil Aviation Organisation (ICAO) is a specialised United Nations agency, they have slightly differing focuses in their airport identifier code allocations. The USA Federal Aviation Administration (FAA) has a code for the airports that have a heavy USA presence, such as Majuro and Yap. Airports in the table are not defined by any quality standard, and some are simply grass or road strips suitable for very small aircraft; in Fiji two of the airports are for seaplanes only, being lagoon sheltered waters for resorts or other related activities. However, all are recognised as legal airports for pilots by the adoption of an IATA, ICAO or FAA code identification. Unlisted airports have not been allocated a code, but also exist in practice in some nations, such as at mission stations in PNG.

SIDS airport accessibility

Pacific SIDS	**IATA coded airports**	**ICAO coded airports**	**Uncoded or FAA airports**	**Total 'official' airports in the nation**	**Total airports per 1,000 persons**	**Total airports per person, index base Fiji 100**
Larger SIDS						
Fiji	32	26	0	32	0.04	100
FSM	5	4	1	6	0.06	146
Papua New Guinea	392	235	31	570	0.08	193
Samoa	5	4	0	5	0.03	66
Solomon Islands	43	32	0	43	0.08	190
Tonga	6	6	6	6	0.06	143
Vanuatu	32	32	0	34	0.13	334
SIS subgroup						
Cook Islands	9	9	0	10	0.50	1267
Kiribati	21	21	0	21	0.20	512
Marshall Islands	35	6	3	37	0.70	1769
Nauru	1	1	0	1	0.10	253
Niue	1	1	0	1	1.00	2534
Palau	2	2	2	4	0.19	483
Tuvalu	1	1	0	1	0.10	253

Table 4.14: Research nations' air services, availability of airports. Note: The number of airports includes both international or local domestic use without distinction. Rows may not be additive as duplication in coding exists. Source: Fubra Ltd (2014). For comparison, New Zealand has 206 airports which gives 0.05 airports per 1,000 persons.

The graph Figure 4.8, which is a log-log scale, shows a low negative linear correlation between the population of the SIDS and the international air connectivity. In essence, the smaller the nation the better the connectivity, which reflects the demands of the nations due to their geography and political involvement rather than their population.

Figure 4.9 shows that there is a strong positive correlation between air service connectivity and GDP. This is also an example of the features of the small nations and the role

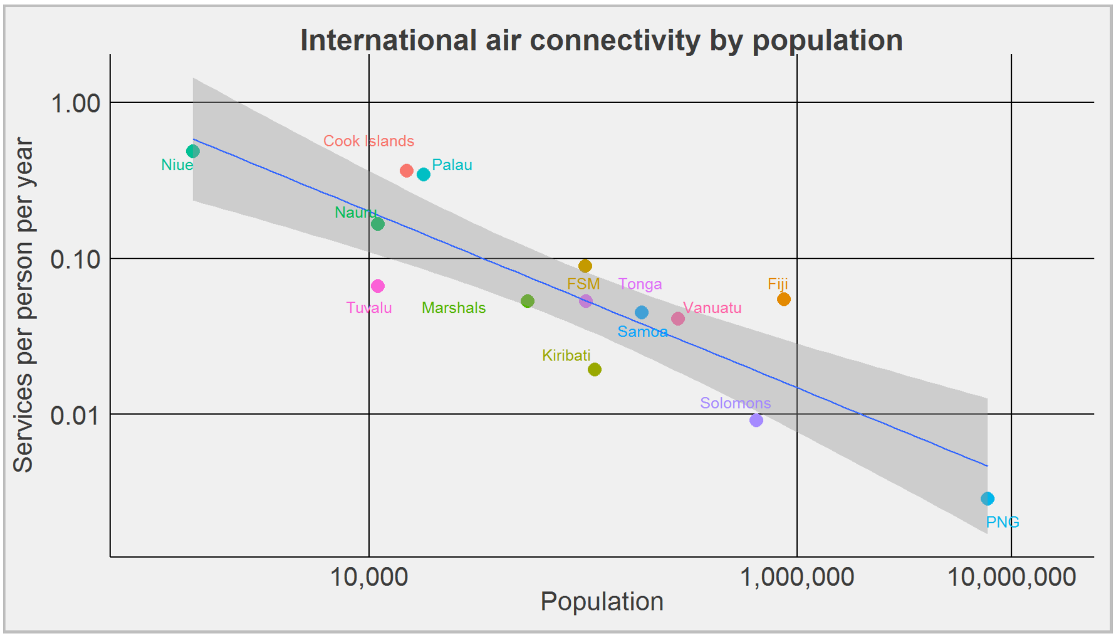


FIGURE 4.8: Research nations' international air service connectivity by population. Data from Table 4.13. Both scales are logarithmic. Linear correlation is -0.25, and logarithmic correlation is -0.88.

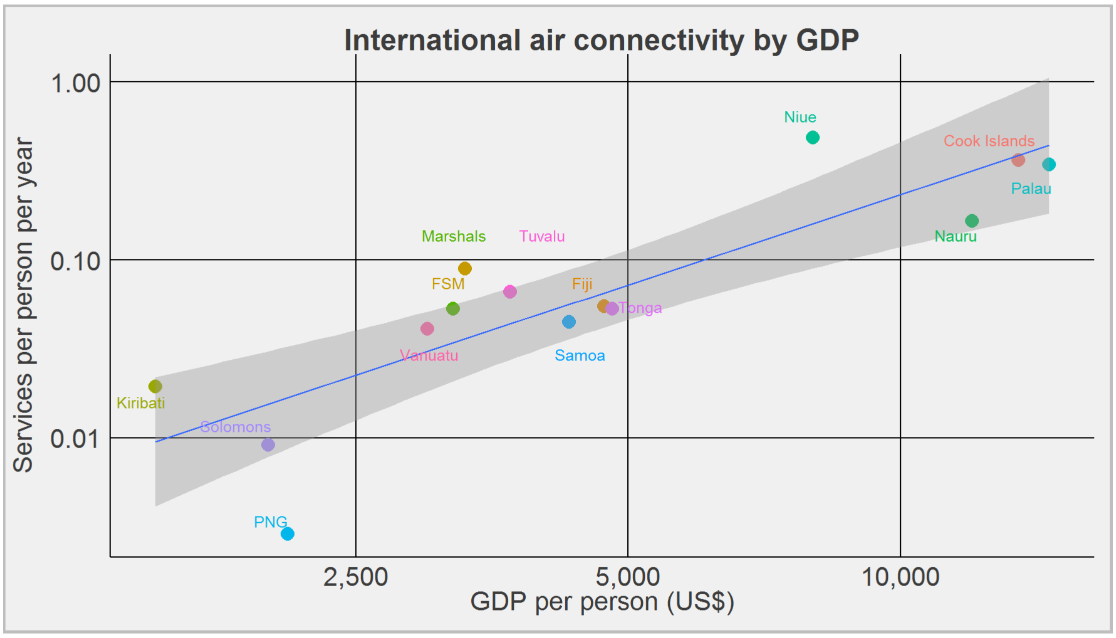


FIGURE 4.9: Research nations' international air service connectivity by GDP. Data from Table 4.13. Both scales are logarithmic. Linear correlation is +0.65, and logarithmic correlation is +0.84.

of their political relationships having a significant effect. This reflects the affordability data.

By comparison, the number of airports related to the number of populated islands or the population shows no clear relationship.

4.6.3 Sea transport

Table 4.15 indicates the connectivity in international container shipping services in the region. The Liner Shipping Connectivity Index (LSCI) is a broad measure used by UNCTAD as a logistics quality indicator, based solely on container shipping services. A benchmark country that scores around 100 is Singapore. The index clearly has limitations for logistics measurements for nations without container services, but it has some value for the research as it indicates the Pacific hub ports that handle the container trade; unsurprisingly, the nations with the highest LSCI are those with the highest populations, suitable ports and geographic location for hubbing to other smaller nations: Fiji, Papua New Guinea, Solomon Islands, and Vanuatu. The index structure is described as follows:

> The Liner Shipping Connectivity Index captures how well countries are connected to global shipping networks. It is computed by the United Nations Conference on Trade and Development (UNCTAD) based on five components of the maritime transport sector: number of ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's ports. (World Bank, 2015a)

It is important to note that a low LSCI index score does not mean a poor logistics service; it is a measure of containerised service connectivity, not a measure of efficiency. What a low index does show is that there are less container ships, smaller container ships, less frequent container services, and fewer shipping companies involved. Each of these features is related to trade volumes and population, as well as port suitability. Some of the ports in the region, principally in PNG, are ports for mining operations, which are often private, and these are not considered in the research.

Domestic-only ports are very important and are included in the table, but many of these are not physical ports with harbours and wharves, as many of the islands do not have

SIDS sea port connectivity and accessibility						
Pacific SIDS	**Container capable ports**	**LSCI 2014**	**Domestic ports, non container capable**	**Total ports per 1,000 persons**	**LSCI 2014, index base Fiji 100**	**Total ports per 1,000 persons, index base Fiji 100**
Larger SIDS						
Fiji	2	9.4	108	0.12	100	100
FSM	4	1.3	61	0.63	14	504
Papua New Guinea	16	9.0	34	0.01	96	5
Samoa	1	4.4	1	0.01	47	8
Solomon Islands	2	6.9	328	0.58	73	464
Tonga	3	3.6	33	0.34	38	274
Vanuatu	2	6.4	4	0.02	68	19
SIS subgroup						
Cook Islands	1	-	12	0.65	-	524
Kiribati	2	2.9	19	0.20	31	163
Marshall Islands	1	2.9	33	0.64	31	517
Nauru	1	-	0	0.10	-	81
Niue	1	-	0	1.00	-	806
Palau	1	1.3	8	0.43	14	346
Tuvalu	1	-	8	0.90	-	726

TABLE 4.15: UN Liner connectivity data for the region; a '-' symbol indicates data is not available. Source: after (World Bank, 2015a) Note that 'container capable ports' includes those that may require that containers are handled via barge, or that fine weather operation only is possible, such as Niue and Nauru. By comparison, New Zealand has a LSCI of 21 in 2014.

such facilities. Cargo and passenger operations are conducted via workboats from a ship anchored or drifting offshore, on to beach landings, or similar operational methods such as landing craft. The 'domestic port' definition therefore is a more legal one, however it is an important logistics node and reflective of the true nature of logistics operations in the research area. Therefore the research uses the domestic port numbers in Table 4.15, which are calculated by equalling the number of inhabited islands without container capable ports. This is expected to be a conservative number, as many islands will have more than one landing area.

The data shows a strong positive correlation for international sea connectivity and population, but a weak negative correlation with GDP. Figures 4.10 and 4.11 illustrate these relationships. This compares with the air service correlation that is the inverse, the air

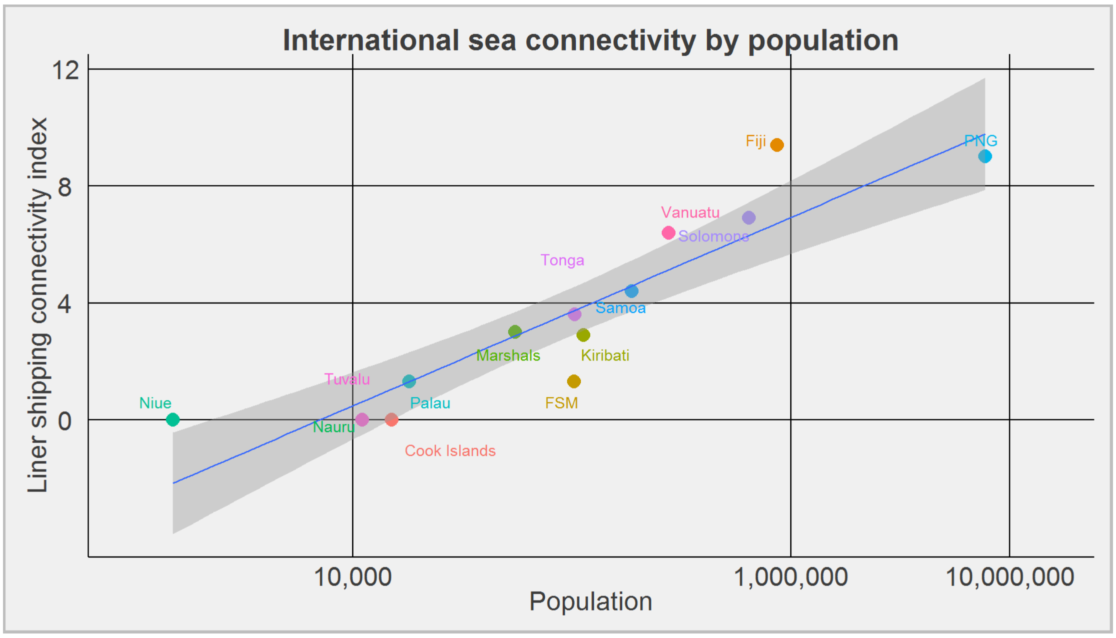


FIGURE 4.10: Research nations' international sea service connectivity. Data from Table 4.15. The population scale is logarithmic. Linear correlation is moderate +0.50, and the correlation of the index with the log of the population is a high +0.89 (log-log correlation is about +0.85, depending on estimates for the non-rated nations).

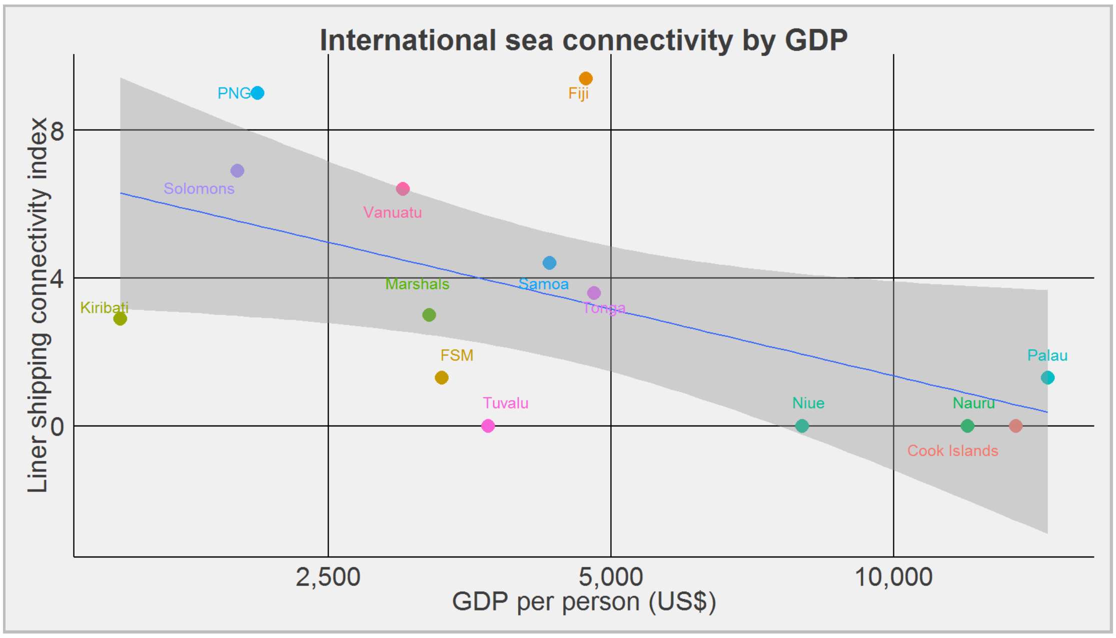


FIGURE 4.11: Research nations' international sea service connectivity. Data from Table 4.15. The GDP scale is logarithmic. Linear and log GDP correlations are both -0.57 (log-log correlation is -0.63, depending on estimates for the non-rated nations).

connectivity being strongly correlated with GDP rather than with population. This reflects the differing products and services delivered by the two modes to differing sectors of the nations' populations. These aspects are not examined further in the research, and no comparison is made with other nations of other regions, but it is expected that such relationships influence the value and selection of possible metrics for sustainability monitoring.

4.6.4 Land transport

Every item of product that is involved in the logistics process travels by road at some point in its supply chain. It is well established that the land transport sector of logistics, in any nation, has the greater cost in terms of total outputs of GHG emissions, noise, dust, vibration, land pollution and other environmental metrics. Casual observations of the SIDS, particularly in areas such as Fiji, show that the road situation and the associated pollution, together with the other social costs such as noise and accidents, would enable real and immediate environmental solutions to be available in that mode.

Storage and distribution centres including airports and seaports are included in the definition of road or land transport when considering land utilisation in the 'logistics land take' data.

Table 4.16 shows the level of road infrastructure currently in place, and Table 4.17 shows the estimated land take for logistics functions of road, airport, and seaport. No addition is made for separate logistics hubs such as consolidation areas in the larger nations. The road data is considered unreliable, and for consistency the raw data in the NMDI tables in Figure 5.3 is used.

It can be argued that the smaller nations in general have a greater road connectivity, but the effect of this on logistics sustainability needs more detailed research relating to the road type, transport capability and other factors. The weaker correlation compared to international transport modes is of interest in reflecting the demands on each mode. The road is closely related to the port and airport infrastructure on islands that have those facilities, and in the term 'land take' for logistics, these facilities are included. A major SIDS airport such as Nadi in Fiji could have a land area of about 4 km^2, and a smaller airport such as at at Funafuti or Tarawa an area of about 1.5 km^2. In the

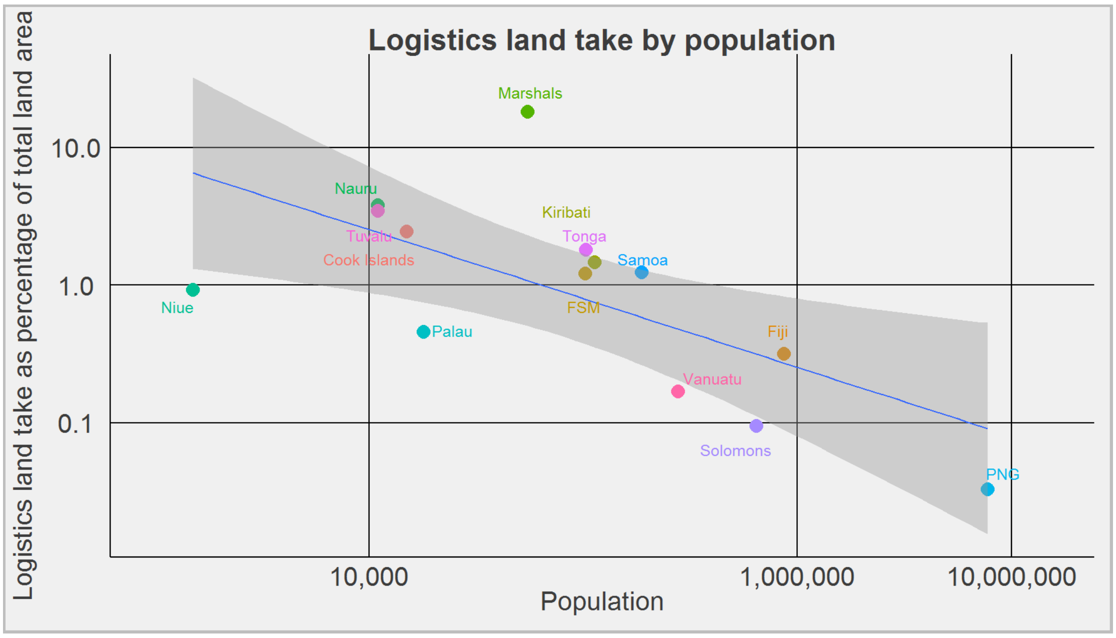


FIGURE 4.12: Research nations' road and logistics infrastructure area, data from Table 4.16. Both graph scales are logarithmic. Linear correlation is low, -0.19, and logarithmic correlation is a moderate -0.65

FIGURE 4.13: Research nations' road infrastructure, data from Table 4.16. Both graph scales are logarithmic. Linear correlation is very low, -0.07, and logarithmic correlation is moderate +0.31.

SIDS road connectivity and accessibility

Pacific SIDS	**Road length, total km**	**Road area** km^2	**Road area as % land area**	**Road km per ’000 person**	**Road area as % land area, Fiji base 100**	**Road km per ’000 person, Fiji base 100**
Larger SIDS						
Fiji	3,440	51.6	0.3	4.0	100	100
FSM	200	3.6	0.5	2.4	182	59
Papua New Guinea	9,349	140.2	0.1	1.2	11	30
Samoa	2,337	35.1	1.2	12.5	424	315
Solomon Islands	1,360	20.4	0.1	2.1	25	53
Tonga	680	10.2	1.4	6.6	485	97
Vanuatu	1,070	16.1	0.1	3.9	47	97
SIS subgroup						
Cook Islands	320	4.8	2.0	21.3	720	538
Kiribati	670	10.1	1.2	5.9	440	149
Marshall Islands	2,028	30.4	16.8	36.9	5,971	929
Nauru	24	0.4	1.7	2.2	609	55
Niue	120	1.8	0.7	80.0	245	2016
Palau	61	0.9	0.2	3.4	71	85
Tuvalu	8	0.1	0.5	0.7	164	18

TABLE 4.16: Research nations’ road connectivity data; road length data from SPC NMDI. Road length data is not considered very reliable due to differing definitions. Road area is calculated by the researcher at the kilometre length at an average width of 15 m, and surface quality is not considered. For comparison, New Zealand has 0.7% of its land as roadway, which represents 21 km per ’000 persons.

logistics sustainability analysis, these areas including ports and freight forwarding areas are significant and need to be included.

The logistics land take is offset as a balancing factor against the connectivity data in the nation’s societal decision process. Allocating a sustainability value to this feature and balance is subjective and qualitative, but the need for inclusion as quantitative data in the model is apparent. Without the quantitative input, the decisions and values could be politically rather than more balanced by economic or societal considerations.

4.7 Measuring the sustainability of logistics in the SIDS

The interview findings and the results of existing data search in the previous sections of this chapter, indicate that a significant gap exists between the official political image and

SIDS land take for logistics functions

Pacific SIDS	**Road area** km^2	**Airport area** km^2	**Seaport area** km^2	**Total logistics area**	**Total logistics area as % land area**	**Logistics area as % land area, Fiji base 100**
Larger SIDS						
Fiji	51.6	5.3	1.2	58.1	0.3	100
FSM	3.6	3.7	1.3	8.5	1.2	381
Papua New Guinea	140.2	8.1	1.0	149.4	0.1	10
Samoa	35.1	1.3	0.1	36.4	1.2	390
Solomon Islands	20.4	2.3	3.3	26.0	0.1	30
Tonga	10.2	2.0	0.7	12.9	1.7	563
Vanuatu	16.1	3.2	1.3	20.6	0.2	53
SIS subgroup						
Cook Islands	4.8	0.7	0.3	5.8	2.4	763
Kiribati	10.1	1.3	0.4	11.8	1.5	456
Marshall Islands	30.4	1.6	0.7	32.7	18.0	5671
Nauru	0.4	0.4	0.1	0.8	3.7	1167
Niue	1.8	0.6	0.1	2.4	0.9	293
Palau	0.9	1.0	0.2	2.1	0.5	146
Tuvalu	0.1	0.6	0.2	0.9	3.5	1088

Table 4.17: Research nations' logistics land take data. Road surface quality is not considered. Measurements of air and sea ports are indicative, calculated by the researcher using Google Earth, and including an allowance for every inhabited island as requiring some logistics space in the sea port area.

the actual measurement and reporting on sustainability in the research region. Emissions are certainly low in the SIDS nations, and population-based indicators show results significantly more sustainable than in larger Asian or European nations. There are also negative societal factors for sustainability, such as the low level of international air transport affordability, and increasing domestic pollution generation. There is however no clear longitudinal data available on sustainability.

The research question therefore appears to need to be answered by a fresh set of factors and reporting, rather than modification of any existing method. In doing so, the overall process as outlined in Chapter 2 section 2.3 is followed to produce Table 4.18.

In the following chapter, the findings from the discussions and interviews, and the related data assessments for logistics features in the region are discussed further and developed into a potential logistics sustainability monitoring model. The data is used to answer

Overall process for sustainability model development	
Development step	**Discussion**
Set objectives and build a process map	Key objective is to measure sustainability, focused on logistics. Consider using the existing proven processes of the GRI system, and implement associated with the SDG process
Select the calculation approach and define metrics and boundaries	Develop these in conjunction with the SDG metrics
Collect data	Develop mechanisms to gather and store the data reliably and timely from the SIDS, such as with the PRDR and other functions within SPC
Conduct calculations and analysis	Use the core national data to calculate and develop data for reports in SPC
Verify and disclose	Publish reports

Table 4.18: Main steps of the model development process in answering the research question.

the research question, and effective conclusions that may be able to be reached and directions for further research are developed.

Chapter 5

Further discussion on the research findings

5.1 Introduction

This chapter discusses the research findings detailed in Chapter 4, and considers the validity and effectiveness of the models, metrics and data involved. Research sub-question 2, ‘Is there a model for analysing sustainability levels that is more appropriate for the region?’ is developed more fully in the context of the research question. Recommendations are developed for possible future directions in formulating a model suitable for the factors that could be measured to establish sustainability levels.

5.2 Review of findings

The research question the research set out to answer was: ‘What factors may be used to reliably measure current levels of sustainability of logistics in the small island nations of the Pacific?’ This question was divided into three practical sub-questions:

1. What models and metrics are currently being used for analysis of logistics sustainability levels in the region?
2. Is there a model for analysing sustainability levels that is more appropriate for the region?

3. How sustainable is current logistics in the region considered to be, using the current and proposed models?

As summarised in Table 4.4 and Figure 4.2, the research finds that the answer to the first sub-question is that no models are currently being used that give a logistics sustainability report, and therefore the answer to the second sub-question is that the model and factors to be reported on needs to be developed. The third sub-question can be answered in general but not in comprehensive detail on the current data sets.

Indications show that both sustainable and non-sustainable factors are present in the data and observations. An example is discussed that a logistics system which allows the end of life of transport units to be as shown in Figure 5.1 is clearly not a fully sustainable system for a SIDS. The research additionally finds that it also cannot be considered valid to hold external nations, even the nation from which the item or product was purchased, responsible for the local sustainability situation. Waste disposal is a significant difficulty in the small nations, and solutions to this must begin early in the supply chain decision process.

Key findings are discussed further in the following sections.

5.2.1 Defining sustainability

One of the major issues in defining the research criteria was, as discussed in Chapter 2, to define the term ‘sustainable’ in the context of the research area’s development and logistics. As Nuttall said after the meeting at USP, “we’ve used the word ‘sustainable’ many times in our discussion but we haven’t agreed what it means,” and this was a factor in all the discussions. It is succinctly summarised by Fischer (2013):

> But what is ‘sustainable development’? The term is merely a statement of principle, one lacking the theoretical and methodological specificity to be measured and the clarity of policy to be implemented . . . National governments and regional organisations will always have to play a vital role in the process of sustainable development, however this may be defined.
>
> (Fischer, 2013, page 285)

Figure 5.1: Transport unit end of life, an example in Tuvalu. The total width of the island at this point is approximately 60 metres.

Holistic 'sustainability' is the long term requirement and a key component of this research. It appears clear that the societal aspect of sustainability as a whole in the PICT region is showing signs of strain, as thoroughly discussed by UNDP in 'The state of Human development in the Pacific' and summarised in that publication:

> Today these traditional social protection systems are under significant stress from a wide range of social, economic, internal, and external factors . . . Many of these factors are driven by globalisation, changing demographics, and the current transition of most PICs from a traditional subsistence based economy to a market based economy.
>
> (UNDP, 2014, page 2,3)

It may be tempting for some organisations, as a result of this sustainability definition variability and the associated data measurement difficulty, to take the path of least complexity and replace the word 'sustainable' with the word 'green', and focus on that for logistics. ‘Green’ is a more limited and understandable description, is easier to describe and is readily quantifiable:

> Eco-efficiency indicators measure how the environment is used for economic activity, and how it is affected by economic activity. Organisations, including the OECD, ESCAP and the national statistical agencies, have been developing frameworks for effective measures of green-growth. (UNDP, 2014, page 118)

However green-growth represents only a portion of the whole situation, and enables political and other leaders to establish a diversion from the core sustainability issues and the effective actions needed. It is therefore important that the factors measured produce a comprehensive holistic result. This need for a balanced system is reflected in the conclusions from the UN MDGs final report:

> One theme emerging from the debate on the successor agenda to the MDGs [the SDGs] is the importance of true integration of environment into development ambitions. Environmental sustainability is a core pillar of the post-2015 agenda and a prerequisite for lasting socioeconomic development and poverty eradication. . . . Therefore, it is crucial to ensure that the development agenda for the future reflects the links between socioeconomic and environmental sustainability and protects and reinforces the environmental pillar.
>
> (UN, 2015b, page 61)

5.2.2 Sustainability categories

Within the societal context the logistics component has a very significant role, whether it is from implementing a simple sourcing of supplies from cheaper costs of production nations overseas in the globalised trading environment, a modal shift due to improved services in less environmentally disruptive transport such as sea transport, or a loss of access to traditional territory due to logistical and connectivity modifications.

As an example of the latter it is possible to observe, in several nations including Fiji, that on several coastal regions, local villagers have increasingly restricted access to traditional fishing and coastal food gathering locations due to large secure walled resort properties or gated community developments along the coast. This is a social loss caused by a disruption of logistics connectivity. Whether this is sustainable or not is dependant on the frame of reference of the organisation asking the question. For the Fiji government it is possibly considered a sustainable development; for the local people, it clearly does not allow continuation or improvement of their mixed modern/traditional lifestyle, has a negative effect on life in general, and is therefore considered unsustainable. This could be a reflection of the movement of some aspects of PICTs societal features due to monetisation of the society referred to by UNDP (2014). These issues of logistics accessibility and sustainability are thoroughly discussed in relation to tourism for Fiji by Scheyvens and Russell (2010) and for Vanuatu (Scheyvens & Russell, 2013).

The research findings give an overview of the importance of the logistics infrastructure on the nation's land use and connectivity; the graphs in Chapter 4 show the relationships between sample societal and logistics factors. The comparative graphical presentation in Figure 5.2 shows the logistics infrastructure data relative to Fiji on a 'per capita' unit except land take, which is based on the percentage of total land area. It can be seen that the smaller nations are better supplied with air logistics services and infrastructure. For sea based logistics, service connectivity is less variable, and the infrastructure data reflects the high need for seaport operations in the smaller research nations. Land-based logistics connectivity, as reflected by total land take, increases with the size of the nation, whereas road length per capita is higher for smaller nations.

The absolute values of these logistic factors are not defined; what constitutes a good value for land take, or air service connectivity, or other indicators, is a subjective value that is a matter for further research when applying such models. For example, Eurostat (2015) reports that land take for transport in European nations averages 2.4% of the total land area, which is almost the same value as the research's calculated average of 2.5% logistics land take for the research nations. Further research is appropriate to decide which value, perhaps from Europe or other areas, can reliably be used as a relevant benchmark for the SIDS.

The uses made of the data such as shown in Figure 5.2 for sustainability measuring is a matter for further discussion and research, and the benchmark absolute values are not considered in this research. Comparing environmental data, such as CO_2 emissions per

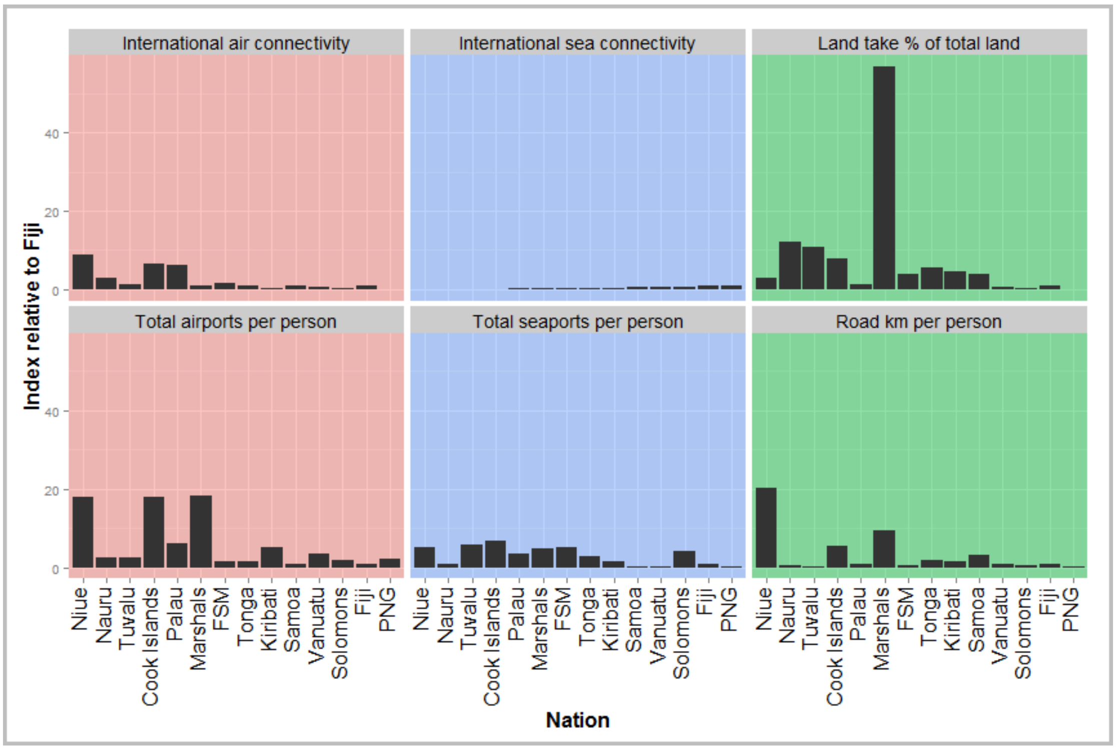


Figure 5.2: Logistics features compared to Fiji. Fiji is an index value 1 on the scale, while other nations are plotted as index of the Fiji value. Nations are listed in order of increasing population size.

capita, with other nations compared to the research nations has some validity; however, what is important is the data is relevant to the local environment and any ongoing processes in the region. Effective longitudinal data is not currently available. Using a previous example, in large external nations a few vehicles being left to rust on the roadside may not even be noticeable, but the same number of vehicles in a SIDS is a major difficulty due to land area considerations, as shown in Figure 5.1. In both cases, an important consideration is the action being taken to improve the situation for that indicator. The international political meetings regarding climate change focus on the changes that are to be made to current levels, rather than the absolute value. Environmental data for all sectors of the research nations' environment - air, water (sea and fresh), and land - needs more appropriate monitoring in order to give a full picture of environmental changes for any individual island and nation.

Economic factors are considered for sustainability and examined from two main frames of reference, excluding the political framework, and these frameworks need to be clearly defined:

1. the business operating the logistics service must be profitable to continue supplying the service.
2. the population of the nation must be able to have access or benefit from the service.

In each case, there needs to be acknowledgement of costs and benefits of the logistics service and its infrastructure.

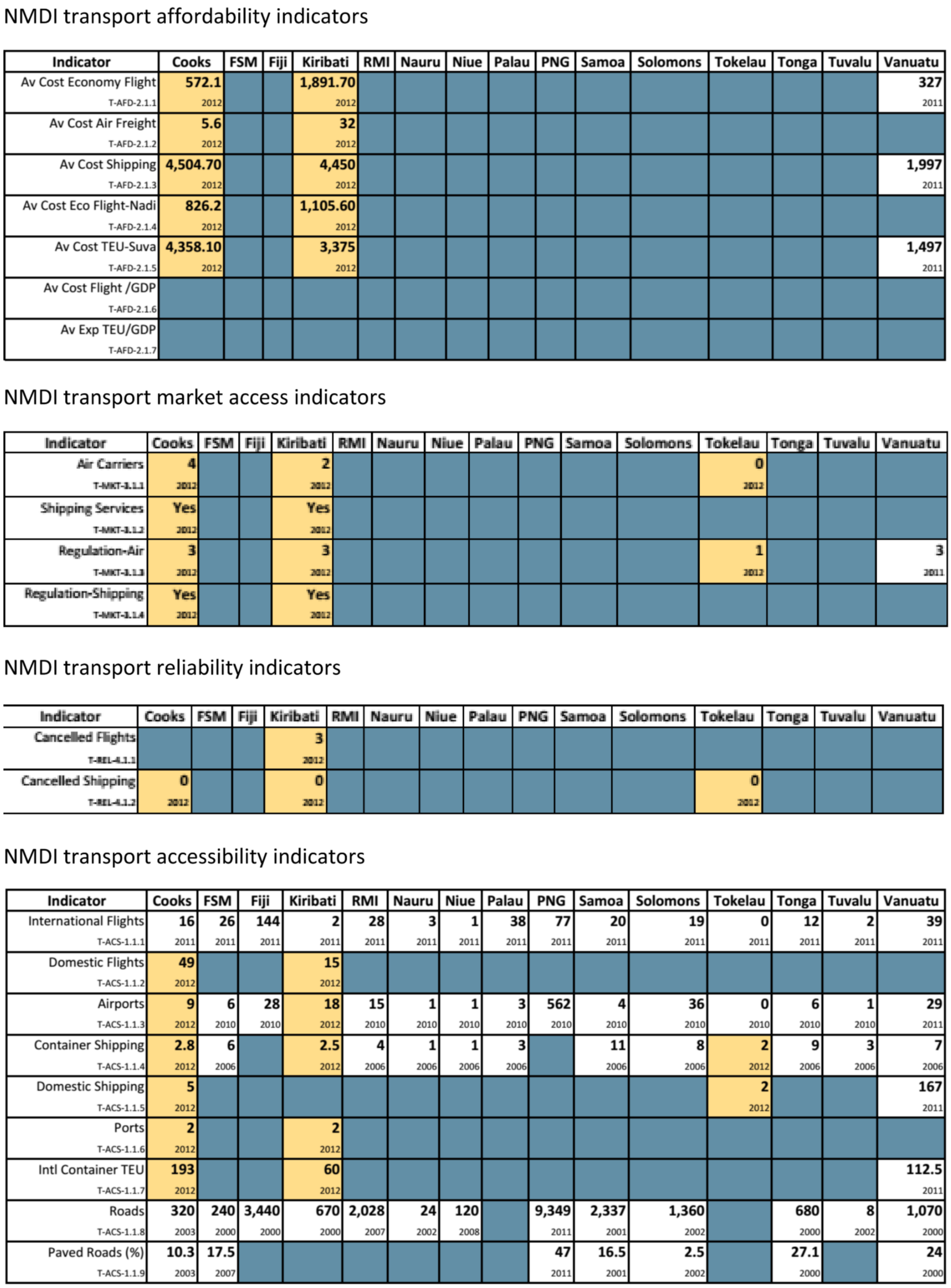
The research finds that it is important that the sustainability indicators developed be comprehensive, and be able to be managed by small nations that would not have the administrative resources to enable the required data manipulation; therefore a regional approach seems important.

5.3 Review of metrics and data effectiveness

The data in the research analysis has been developed from core secondary information as much as is possible. A significant portion of data in the area is not very recent, and this is indicated on the regional SPC databases so that researchers and users have a better idea of the data reliability. The SPC database shows where gaps in data exist, and the year of capture of the data in use, which is useful statistical information.

Efforts are being made via the regional organisations to improve the frequency and reliability of the data capture. This is significant as this data in turn is then incorporated into international databases such as those issued by UN organisations, IMF and World Bank. Figure 5.3 shows the current status of the National Minimum Development Index (NMDI) data available relating to transport sustainability. Clearly a wider data capture is needed for sustainability reporting, and data is needed to be updated more frequently. For this to occur, the data needs to be appropriate and realistic, and the government or appropriate organisations need to be disciplined.

The metrics and data used in the various reports are of a range of primary and secondary nature; in the research area all the parties used only secondary data. When a greater certainty level is required for the data user, such as for project work, it is necessary to go to primary sources for ‘as now’ data scenarios, and then usually the data is secondary for projections and decisions for future actions.



NMDI transport affordability indicators

Indicator	Cooks	FSM	Fiji	Kiribati	RMI	Nauru	Niue	Palau	PNG	Samoa	Solomons	Tokelau	Tonga	Tuvalu	Vanuatu
Av Cost Economy Flight T-AFD-2.1.1	572.1 2012			1,891.70 2012											327 2011
Av Cost Air Freight T-AFD-2.1.2	5.6 2012			32 2012											
Av Cost Shipping T-AFD-2.1.3	4,504.70 2012			4,450 2012											1,997 2011
Av Cost Eco Flight-Nadi T-AFD-2.1.4	826.2 2012			1,105.60 2012											
Av Cost TEU-Suva T-AFD-2.1.5	4,358.10 2012			3,375 2012											1,497 2011
Av Cost Flight /GDP T-AFD-2.1.6															
Av Exp TEU/GDP T-AFD-2.1.7															

NMDI transport market access indicators

Indicator	Cooks	FSM	Fiji	Kiribati	RMI	Nauru	Niue	Palau	PNG	Samoa	Solomons	Tokelau	Tonga	Tuvalu	Vanuatu
Air Carriers T-MKT-3.1.1	4 2012			2 2012								0 2012			
Shipping Services T-MKT-3.1.2	Yes 2012			Yes 2012											
Regulation-Air T-MKT-3.1.3	3 2012			3 2012								1 2012			3 2011
Regulation-Shipping T-MKT-3.1.4	Yes 2012			Yes 2012											

NMDI transport reliability indicators

Indicator	Cooks	FSM	Fiji	Kiribati	RMI	Nauru	Niue	Palau	PNG	Samoa	Solomons	Tokelau	Tonga	Tuvalu	Vanuatu
Cancelled Flights T-REL-4.1.1				3 2012											
Cancelled Shipping T-REL-4.1.2	0 2012			0 2012								0 2012			

NMDI transport accessibility indicators

Indicator	Cooks	FSM	Fiji	Kiribati	RMI	Nauru	Niue	Palau	PNG	Samoa	Solomons	Tokelau	Tonga	Tuvalu	Vanuatu
International Flights T-ACS-1.1.1	16 2011	26 2011	144 2011	2 2011	28 2011	3 2011	1 2011	38 2011	77 2011	20 2011	19 2011	0 2011	12 2011	2 2011	39 2011
Domestic Flights T-ACS-1.1.2	49 2012			15 2012											
Airports T-ACS-1.1.3	9 2012	6 2010	28 2010	18 2012	15 2010	1 2010	1 2010	3 2010	562 2010	4 2010	36 2010	0 2010	6 2010	1 2010	29 2011
Container Shipping T-ACS-1.1.4	2.8 2012	6 2006		2.5 2012	4 2006	1 2006	1 2006	3 2006		11 2006	8 2006	2 2012	9 2006	3 2006	7 2006
Domestic Shipping T-ACS-1.1.5	5 2012											2 2012			167 2011
Ports T-ACS-1.1.6	2 2012			2 2012											
Intl Container TEU T-ACS-1.1.7	193 2012			60 2012											112.5 2011
Roads T-ACS-1.1.8	320 2003	240 2000	3,440 2000	670 2000	2,028 2007	24 2002	120 2008		9,349 2011	2,337 2001	1,360 2002		680 2000	8 2002	1,070 2000
Paved Roads (%) T-ACS-1.1.9	10.3 2003	17.5 2007							47 2011	16.5 2001	2.5 2002		27.1 2000		24 2000

Figure 5.3: NMDI publicly available logistics databases. These supply a good indication of the age of the data and also gaps in the data. Source: accessed in August 2015 from http://www.spc.int/nmdi/transport

An example of the data capture difficulties for a indicator that would be expected to be simple, accurate and reliable, is that regarding measuring the length of roads. For example the NMDI database shown in Figure 5.3, and also the CIA World Factbook (CIA, 2015), show that Niue has declared 120 km of road, whereas Tuvalu has declared 8 km. The researcher's personal observations and an inspection on Google Earth indicates that to reach this figure, Niue has included all small roads and access ways, some only between 3 and 5 metres wide, whereas Tuvalu has only included the sealed road on Funafuti, and has not included any unsealed roads or roads on the other islands. Tuvalu's road length, using the same parameters as for Niue, would be closer to about 40 km as a minimum.

Similarly, the Marshall Islands have clearly included roads and access ways that make its road distance look very large, an impression that is not supported by an inspection of Google Earth. One effect of these differences in definition is to make the land-take calculations of limited accuracy and reliability when using standard road widths. Compare the data for example in Figure 5.2, where this is reflected. The research uses the NMDI data.

The research adopts a road width of an average 15 metres for the calculations of road area. Larger nations such as Fiji would have significant road lengths of 20 metres width, so the value used is an indicative average, which would perhaps slightly overstate the road area on the small nations.

For reliable data measurement, clear parameters need to be set by the appropriate divisions of the regional organisations involved. A definition for road length for example needs to be clear on how much of a suburban or urban road network is included, and what type of roads are included. The research finds that regional organisations involved, such as SPC, clearly have an important role in establishing the parameters for any sustainability measurement. This is in line with the findings and recommendations of SPC:

> To achieve these goals, countries need to take an active role in identifying and addressing their data collection and information management requirements in port and shipping services, as well as in the areas of trade, customs, and border control. The tools to accomplish this would include developing a

> centralised database, incorporating relevant software and adequate backup systems, and trained qualified personnel. (SPC, 2014b, page 239)

Clear parameters also need to be set for calculation involving GHG and other pollutants. The research recommends that standard calculations for CO_2 based on the tonnage of each fuel type consumed for logistics are achievable and realistic. This is the 'top down' method discussed in the section 'Metrics and data related to transport modes'. Even this basic level of required data is not currently reliably available, as shown by Tables 4.11 and 4.12.

When attempting to quantify the societal or economic variables, there are several methods which could be subject for further research initiatives; however the aim of simplicity must be remembered. Mathematics can be used for quantifying some indices but the reality of its use and the benefit from doing so would need evaluation in each case, as the danger of losing effectiveness due to excessive analysis is real in this environment:

> ... Therefore, mathematically, sustainability is a composition of functions of several variables which, in turn, are also composite functions of more primitive variables. There are two reasons why it is not possible to determine these functions explicitly:
>
> 1) Sustainability is an inherently vague and complex concept and cannot be described, let alone measured, by traditional mathematics. ... For example, degrees of law enforcement, the state of civil liberties, and the state of human rights in a country, which are important components of human sustainability, are often obtained by subjective assessments.
>
> 2) Statistics and system identification are used to build models for systems whose structure is not known. ... Although many of the inputs are measurable, it is impossible to estimate the output, e.g., the sustainability of a country in a given year.
>
> Fuzzy logic, on the other hand, is suitable for assessing sustainability because it can model complex systems about which we have only partial knowledge as to their dynamics, the parameters or inputs that affect them, and the values of these inputs.
>
> (Phillis & Kouikoglou, 2009, page 12)

One of the important issues for the SIDS however is to keep the indicators as metrics that can be readily obtained and recorded with a minimum of equipment but with regional disciplines. For this, no sophisticated mathematics but political and management commitment is required.

5.4 Requirements for a sustainability model

There is no evidence of any single method of agreed data and monitoring standards for the topic of sustainability. Significant international academic, government, and business research is beginning to be conducted on the metrics, and as one example the organisation Global Initiative for Sustainability Ratings (GISR) was constituted in 2014 with the goal of attempting to simplify and validate styles of sustainability metrics and reporting:

> GISR's mission is to drive transparency and excellence in environmental, social, and governance (ESG) research, ratings and indices to improve business performance and investment decision-making. (GISR, 2015)

A useful indicative table is supplied by Scarpellini, Valero, Llera and Aranda (2013, page 161) as part of the discussion on metrics for European passenger transport. This is shown as Table 5.1 with additions by the researcher.

Within the PICT context, it is relevant to consider the practices used by global companies that trade and work in the region. For example, during the researcher's visit to Suva, Tate & Lyle managers from the UK were in Fiji discussing with the Fiji Sugar Corporation the principles of aligning with the Tate & Lyle reporting process for Corporate Responsibility (CR). The CR report within the Tate & Lyle annual report is a simplified version of the GRI system and has benefits for the research area. Similarly, over 100 logistics and transport companies such as DHL, UPS, China Navigation Company (CNCo), Maersk, and COSCO, many of whom trade in or through the region, report on the GRI format. The shipping companies may also be involved with the Sustainable Shipping Initiative (SSI). Further research could therefore be developed for the implementation of this GRI system for the Pacific SIDS.

The research finds that the logistics sustainability questions need to be directed at regional government level, due to several factors including the significantly larger direct

Samples of existing sustainability reporting systems		
System of indicators	**Organisation(s) responsible**	**Applicability and scope**
Sustainable Development Indicators	EU, Eurostat	environmental R&D indicators at macro level
SASB reporting standards	SASB (USA)	financial accounting indicators at larger corporate financial reporting level
Innobarometer	European Commission	innovation state, surveys at company level
set of indicators	European Environment Agency	environmental indicators at macro level
set of indicators (extended SDI)	IEA	environmental, societal, and economic indicators at macro level
set of indicators	Agenda 21	environmental indicators at macro level
set of indicators	OECD	environmental indicators at sector macro level
Millenium Development Goals	UNDP	environmental, human development indicators at macro level
SEEA	UN	accounting for resource flows, inventory, and environmental costs, at macro level
Living plant index and ecological footprint	WWF	environmental, biological and ecosystem rates
Ecological footprint	Global Footprint Network	resources, residues, and comparative rates
Life Cycle Analysis	businesses	several business related rates and indicators
Ecological rucksack	Wuppertal Institute	environmental, resources, and energy rates
Eco-compass	World Business Council for Sustainable Development	resources, energy, societal, and economic indicators
Human Development Index	UNDP	societal and economic rates
Corporate Social Responsibility	GRI	companies; economic, societal, and environmental indicators
ISO 2600	ISO	companies, public bodies economic, societal, and environmental indicators
SAFE	academia	companies; economic, environmental, focusing on the calculation method of the indicators, using 'fuzzy' maths
ISO 2600	ISO	companies, public bodies economic, societal, and environmental indicators

Table 5.1: Reporting systems and indicators available for sustainability measurement; after Scarpellini, Valero, Llera and Aranda (2013) with additions by the researcher.

role that governments in the PICT region have because of the small scale of the private sector. On the broad scale, Phillis and Kouikoglou point out:

> Politics play a central role in the discussion of sustainable development. After all, it is economic activity coupled with political decisions that affect the environmental or the social system. (Phillis & Kouikoglou, 2009, page 2)

In addition, the draft SDG targets and indicators relating to the model used and the logistics components are all directed at government level. For example, target 12.6 is ‘to encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle’, and target 12.7 is ‘to promote public procurement practices that are sustainable in accordance with national policies and priorities.’ The procurement decision is the point at which the logistics process begins, meaning that this target is of significant fundamental importance to logistics sustainability.

It is therefore a finding of this research that a nation-based sustainability reporting system on a format such as GRI is valid and suitable for the SIDS, can be linked to SDGs, and would supply longitudinal information over time. The UN reporting on Millenium Development Goals follows a format close to the GRI presentation, and is being targeted for public as well as academic and political information. The GRI principles of reporting comply with the holistic sustainability structure used in the research, and are suitable for any organisation’s report on sustainability. The principles for content and quality are usefully summarised in the Global Reporting Initiative implementation manual:

> **3.1 PRINCIPLES FOR DEFINING REPORT CONTENT**. These Principles are designed to be used in combination to define the report content. The implementation of all these Principles together is described under the Guidance of G4-18 on pp. 31-40 of the Implementation Manual.
>
> - STAKEHOLDER INCLUSIVENESS Principle: The organization should identify its stakeholders, and explain how it has responded to their reasonable expectations and interests.

- SUSTAINABILITY CONTEXT Principle: The report should present the organization's performance in the wider context of sustainability.
- MATERIALITY Principle: The report should cover aspects that reflect the organization's significant economic, environmental and social impacts or substantively influence the assessments and decisions of stakeholders
- COMPLETENESS Principle: The report should include coverage of material aspects and their boundaries, sufficient to reflect significant economic, environmental and social impacts, and to enable stakeholders to assess the organization's performance in the reporting period.

3.2 PRINCIPLES FOR DEFINING REPORT QUALITY. This group of Principles guides choices on ensuring the quality of information in the sustainability report, including its proper presentation. Decisions related to the process of preparing information in a report should be consistent with these Principles. All of these Principles are fundamental to achieving transparency. The quality of the information is important to enable stakeholders to make sound and reasonable assessments of performance, and take appropriate actions.

- BALANCE Principle: The report should reflect positive and negative aspects of the organization's performance to enable a reasoned assessment of overall performance.
- COMPARABILITY Principle: The organization should select, compile and report information consistently. The reported information should be presented in a manner that enables stakeholders to analyse changes in the organization's performance over time, and that could support analysis relative to other organizations.
- ACCURACY Principle: The reported information should be sufficiently accurate and detailed for stakeholders to assess the organization's performance.
- TIMELINESS Principle: The organization should report on a regular schedule so that information is available in time for stakeholders to make informed decisions.

- CLARITY Principle: The organization should make information available in a manner that is understandable and accessible to stakeholders using the report.
- RELIABILITY Principle: The organization should gather, record, compile, analyse and disclose information and processes used in the preparation of a report in a way that they can be subject to examination and that establishes the quality and materiality of the information.

(Global Reporting Initiative, 2015, pages 8-16)

The implementation manual provides the range of indicator reporting options in detail. These options are flexible enough to enable the SIDS organisations to adopt adequate indicators that also comply with the SDG indicator reporting requirements. The connections are shown schematically in Figure 5.4.

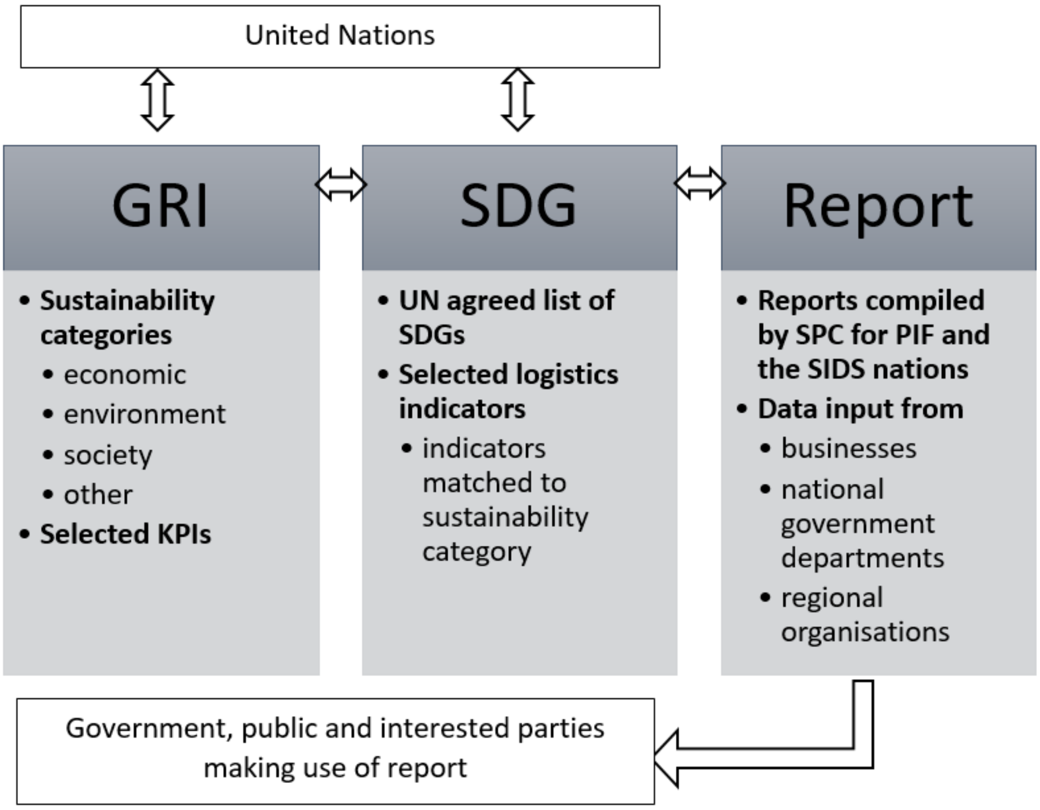


Figure 5.4: Connections between GRI and SDG for the purposes of a model for reporting on logistics sustainability.

The full analysis of the factors to be monitored and reported on are beyond the scope of this paper, particularly as the SDG indicators are still in draft form. However the following section lists some potential key indicators as it is clear from the examples in this research that the benefits of reporting in this manner are significant.

5.5 Possible suitable sustainability model and indicators

Using the SDG draft indicators as a base, and considering the findings of this research and the limitations of the data collecting systems, it is a possible solution to investigate a set of indicators that is of limited quantity but comprehensive scope. Some of these indicators are as suggested in Table 5.2, which supplies a core of possible data. Each indicator is a possible factor to reliably measure levels of sustainability of logistics in the small nations of the Pacific. Each indicator is measured currently in other countries such as New Zealand; what is desirable is for the calculation and data to be adapted for the SIDS.

Having compatibility with the GRI reporting principles and the SDGs would enable the reporting to be effective for the accumulation of data for longitudinal research. It would be useful to maintain communication with the SDSN Data for Sustainable Development Thematic Group 12, as this group works with academics and governments with the purpose of attaining indicators of value:

> The data revolution is poised to transform the way governments, citizens, and companies do business. The revolution is being defined by the explosion in availability of data resources and rapidly evolving technologies which are changing the way we collect, process, and disseminate data. The creation and implementation of the Sustainable Development Goals (SDGs) offers a unique opportunity to ensure that the benefits of the data revolution are extended to those most in need: that it becomes a data revolution for sustainable development. This thematic group will serve as an information and education hub on data collection, processing, and dissemination for sustainable development. It seeks to identify solution-orientated approaches to measuring progress on the SDGs, to strengthen the cross-sectoral and multi-scalar analysis of data for SDG monitoring, and encourage greater frequency and quality of data production and monitoring. (UN Sustainable Development Solutions Network, 2015)

Possible examples of sustainability indicators for a new model			
Sustainability category	**Sample indicator for a GRI report**	**Possible indicator metric**	**Related SDG target**
Societal			
	road deaths & injuries	public deaths & injuries per capita	3.6, 3.9
	logistics business employee deaths	employee deaths & injuries	3.6, 3.9
	logistics land take	% land area used; roads, ports, DC areas	-
	employment	% population employed by logistics operations	7
	connectivity, air	services and airports per capita	12
	connectivity, land	services and road length per capita	12
	connectivity, sea	services and ports per capita	12
Environmental			
	GHG from air transport	CO_2 per capita, consumption based	3.9
	GHG from sea transport	CO_2 per capita, consumption based	3.9
	GHG from land transport	CO_2 per capita, consumption based	3.9
	fresh water pollution	water standards and visual effects; includes road & land run-off	6
	sea water pollution	water standards and visual effects; includes road & land run-off	6
	air pollution	dust and standard particulate measurements	6
Economic			
	affordability, domestic	transport CPI or % average income spent on transport	7
	affordability, international	transport CPI or % average income spent on transport	7
	operator profitability	longevity of logistics service business operators	12
	connectivity	infrastructure access, network coverage	7, 9, 11, 12
	reliability	schedule adherence	12
	economic sustainability	service longevity	12

TABLE 5.2: Sample of representative factors that may be used as GRI sustainability report indicators. A mix of positive and negative indicators is required to obtain a balanced report.

The report produced by the UN Sustainable Development Solutions Network, Leadership Council (2015) has a wide discussion of the likely directions for indicators, and reinforces the principle of the longitudinal reporting requirement for any solution to be of value. Similar but more limited discussions are in the UN Environment Programme (2015) report.

Whatever indicators are selected, the ultimate purpose of the sustainability analysis needs to be remembered and the required actions taken need to be effective. Schaltegger and Burritt (2014, page 237) discuss practical actions that are possible for moving towards more sustainable supply chains (and hence logistics), and these are briefly summarised as:

- Eliminate the supply chain completely
- Substitute with a new supply chain
- Shorten the supply chain so steps are geographically nearer to each other
- Slim down the supply chains by using more sustainable suppliers
- Organise more efficiently: if the supply chain cannot be eliminated, substituted, shortened, or made slimmer, then reverse logistic systems, such as recycling, may help reduce the overall sustainability burden.

All of these actions are possible for supply chains and their logistics components in the research area's nations, and the data collected for the monitoring model needs to be appropriate to assist in the long term decision making process towards enabling a greater sustainability.

The following chapter further discusses the conclusions reached from the research, and elaborates the directions for additional action and research.

Chapter 6

Conclusions

6.1 Introduction

In this chapter, the answer to the research question is considered, and the contribution of the research is discussed. The methodology and the strengths and weaknesses of the research are evaluated. Finally, areas identified as available for or needing further research relating to sustainability in the research area are highlighted.

6.2 Research question conclusions

The research question was:

> What factors may be used to reliably measure current levels of sustainability of logistics in the small island nations of the Pacific?

For clarity of investigation it was divided into three subsidiary questions; this section considers the overarching research question. The research finds that factors needed to measure logistics sustainability are not currently being adequately defined, measured, or recorded in the Pacific SIDS. As a consequence of this it is not possible to obtain a reliable cross sectional analysis of the current level of sustainability of logistics activities. Researchers may find similar gaps in data in other subject focal areas in the research nations.

Publicly available data is of limited reliability, and much of the data supplied by the islands nations to the regional and international organisations, such as SPC, IMF, world Bank and others, seems to be of limited accuracy. One reason for this is that the parameters for the data appear to be needing more precise definition. The research uses the NMDI official data, and highlights the need for improvement in the defining of parameters. For example, the road data is used for connectivity and land-take calculations, but the published data is considered unreliable.

Whilst road area and land-take may not be considered one of the major criticality indicators for logistics, the discussion here can be applied to all indicator metrics' source data, and care must be utilised when using the data from these sources at this stage. The research finds that for effective data capture, consistent reporting is required, and each of the nations must be aware of the criteria and parameters set for each data item. This is a regional statistical function for the Pacific SIDS. For reliable data measurement, clear parameters need to be set by the appropriate divisions of the regional organisations involved, such as SPC.

At a political level, statements are commonly made that the SIDS, particularly the low lying island nations such as Kiribati and Tuvalu, are victims of the effects of climate change and associated processes. The assumed anthropogenic nature of the climate change, caused by the unsustainable energy use and fossil fuel burning practices of the larger nations, enables the SIDS politicians to allocate responsibility to those larger nations, and claim compensation accordingly via the United Nations and other regional mechanisms. The study of the effects of this on the national populations is an opportunity for societal research. There is evidence referred to in the research that does point out in several ways that the Pacific SIDS are themselves producers of some of the issues, often due to recent changing societal demands and increasing populations. The geomorphic processes cannot be held responsible for all ills:

> But even if climate change was not occurring, the vulnerability of PICTs is increasing, due to economic and social changes such as population growth and migration (internal and external), poorly planned coastal development, unplanned urban growth and land use, and environmental and ecosystem degradation including contamination of sub-surface and coastal waters.
>
> (SPREP, 2014, page 3)

The research finds that the indicators and metrics need to be relevant to the scale of the SIDS. Increasing population and the related land use difficulty is not unique to the SIDS – other nations such as New Zealand have demographic issues and effects that are proving difficult for governments to manage. However, the size of the population and land area of the SIDS makes action requirements more important, and action should be easier to manage. An example is given that a few abandoned rusting vehicles on a roadside in NZ or the USA may not even be noticed, but are a very significant problem of pollution in most of the SIDS due to the small quantity of land and road systems available. It is therefore a core of the research findings that reliable, valid, and objective indicators of sustainability need to be implemented in conjunction with the UN SDGs, thereby obtaining more efficient and reliable data collection to better enable decision processes.

The research finds that there is significant positive correlation between sea services and population, and a negative correlation with GDP, reflecting the user of these services being the general population and the products transported being basic foods and commodities. By comparison, international air services are strongly positively correlated with GDP, and negatively with population. Air services are also unaffordable for the general population. The data reflects the high demand for air services by politicians, international organisations, overseas aid project staff, and businesses, rather than by the general public. Affordability, together with connectivity and availability, is an important item for inclusion in a logistics sustainability analysis.

The research findings also show that because of the strong correlation between CO_2 emissions and the GDP per capita, as a nation increases its GDP, so it will increase its CO_2 emissions. The measurement of the sustainability effect of this in the region, together with any associated actions, is a matter for further research. For the research nations to avoid increasing emissions, or at least to minimise the amount involved in any increase, a longitudinal data monitoring availability is required. This in turn requires a sound consistent ability to obtain cross sectional data.

The need for effective indicator measurement and recording is recognised by the regional organisations interviewed. The research finds, within the constraints and limitations of this paper, that a generic monitoring system using readily available indicators could be considered and would enable the important longitudinal data capture ability to be developed. The UN's GRI system potentially complies with the needs of the answer to the research question, and this reporting method is used by large logistics and transport companies that operate in the Pacific. Further research could therefore be developed for the implementation of this system for the Pacific SIDS. The GRI also enables a consistent recording methodology that is not dependent on the political changes in reporting required, such as is the case with the MDGs and SDGs, but can be incorporated within such requirements. A positive aspect of this is that with the commencement of a recording and reporting system, changes in sustainability performance are measurable over time.

The factors that may be used for analysis of logistics sustainability levels in the region are contained as targets and indicators, or are embedded in the targets and indicators, within the reporting requirements for the Sustainable Development Goals that the SIDS have all adopted via the Pacific Island Forum. It is therefore a recommendation of this research that the SDG and GRI link be developed.

6.3 The research contribution

Ethical Corporation in April of 2015 undertook a survey regarding sustainability. Whilst this is a general business and academic survey, the returns are significant in pointing out that the highest scoring sector of a business that is important for sustainability is the supply chain:

> There is no doubt that, for multinationals especially, it is in the supply chain that the greatest sustainability risks lay – and where there is a huge task to raise standards and minimise environmental footprints. It is therefore perhaps not surprising that this is the area of greatest emphasis for sustainability teams . . . Our finding regarding the importance of supply chain management is backed up by the responses to a question on which areas of corporate strategy-setting should sustainability concerns be integrated into. This found that the top priority of corporate respondents is supply chain . . . (93 % said they agree or strongly agree), followed by marketing and communications (83 %), R & D (also 83 %) and human resources (trailing at 73 %). (Ethical Corporation, 2015, Chapter 5)

The research conducted for this paper has highlighted the need for practicable reliable indicators and factors to be measured for SIDS, and has aligned the benefits of two separate systems of reporting – GRI and SDG – linking into a coordinated monitoring methodology. This has contributed to future research directions in several areas.

6.4 Review of the research organisational focus level

The large geographical nature of the area covered by the research meant that some generalisations were needed, and this may limit the effectiveness of the research. However the importance of government involvement in the supply chain and logistics, which is central to this research, is validated by Amann, Roehrich, Essig and Harland (2014) in the research they conducted regarding government involvement in European nations. The significant value of socially responsible public procurement (SRPP) is a finding of their research. It could be expected that, due to the very small populations in the research group, the importance of SRPP practices by governments, including the regional organisations, is enhanced further. Thus the focus of the research at regional government level is a valid and effective direction.

6.5 Further research

The research finds that insufficient data is being gathered consistently to enable sound decision making regarding sustainability in the region, and a consequence of this is that a wide range of possible research directions are available.

Opportunities exist for development of research towards reporting for significant logistics and other industries in the region, private or public, in addition to the broad national basis covered in this research.

The overall question regarding sustainability indicators continues to be a challenge; it has exercised academics for a long time:

> The search for appropriate indicators of sustainable development has been going on for many years at many different levels of societal organization: small community, city, region, country and the world as a whole. There

> seems to be general agreement that a single indicator of sustainable development cannot be defined, and that a substantial number of indicators is necessary to capture all important aspects of sustainable development in a particular application. However, defining an appropriate set of indicators for sustainable development turns out to be a difficult task. If too few indicators are monitored, crucially important developments may escape attention. If a large number of indicators has to be watched, data acquisition and data analysis may become prohibitively expensive and time consuming. Obviously, practical schemes cannot include indicators for everything. It is essential to define a set of representative indicators that provide a comprehensive description – as many as essential, but no more. But what are the essential indicators? (Bossel, 1999)

The research finds that the indicators for this environment could be those of the Sustainable Development Goals, linked with other indicators through the Global Reporting Initiative system. Linking the supply chain aspects, logistics, and the UN Sustainable Development Goals would indicate a need for research to suitably combine existing indices with a common reporting system. What the SIDS do not need is another layer of statistical requirements that commits work and therefore costs, but does not enhance government decision making ability for the benefit of the SIDS populations. Tailoring the GRI system for this in conjunction with the SDGs seems to be a suitable direction to follow.

Historically the SIDS have had a very varied cultural and economic development, and the current period of time is a continuation of that, as discussed by Hepburn:

> Small island populations are among the most resourceful, innovative and adaptive in the world. These are the attributes that have allowed islanders to settle and thrive, often in geographically isolated and inhospitable locations.
>
> To small islanders, however, islands are not insular in the sense of being isolated. For millennia, islands have been centres for encounters between different cultures. Rather than separating them, the ocean as the medium for voyaging has served to connect islands with each other as well as with the continents. From the earliest open ocean voyages to the slave trade, islands have been places of encounter and exchange, as well as conflict.

> . . . Nevertheless, small islands, their people and heritage are at risk. The last fifteen years have seen the continued expansion of global threats to which these islands are particularly vulnerable. These include climate change, inequalities in trade and finance, and the erosion of biological and cultural diversity.
>
> . . . Culture is the foundation upon which small island societies must develop responses to address these unprecedented threats to their sustainability. (Hepburn, 2011, page 4)

In order to ensure holistic sustainable development, within which logistics is a ubiquitous component, the societal, cultural, and environmental basis of supply chain decisions cannot be ignored, and the research comments on areas of potential research in social and other societal areas. The research finds that an effective way to incorporate that required base into a logistics sustainability reporting system, which allows the development of reliable effective cross sectional data sets enabling longitudinal analysis, is the GRI method linked with the SDG. Close coordination with the SDSN would be beneficial in the development of this system, as one of the goals of the process is to achieve a recording and reporting process that assists governments with management rather than being an additional data gathering burden. These factors are discussed by UN Sustainable Development Solutions Network, Leadership Council (2015, pages 93-96) in Annex 2: Moving Towards Annual Monitoring:

> To generate high-quality annual data, many countries will need to strengthen their systems for processing administrative data. Since administrative data is collected on a continuous basis there are no barriers to annual monitoring of administrative data. Annual monitoring is thus primarily a question of shortening processing and publication times, improving the quality and reliability of administrative data, and harmonizing for global monitoring. The quality of administrative data can be poor because the underlying data can be easily manipulated. For example, line ministries and local authorities may have an incentive to overstate progress and understate challenges in order to meet performance targets established by the central government. The only ways to improve the quality and reliability of administrative data is to strengthen the independence and impartiality of NSOs, [National statistical

> offices] their capacity to collect and cross-check data (often against household surveys), and to ensure public access to data along the full production chain. In this way, discrepancies can be spotted early and addressed.
>
> (UN Sustainable Development Solutions Network, Leadership Council, 2015, page 95)

Awareness of the need for community involvement in the sustainability process, particularly in relation to but limited to the societal factors, is indicated in the Citizen Scorecard process discussed and recommended by SPC's Economic Development Division (SPC, 2014b, page 251). The scorecard process is based on users of services (customers, using freight or passenger services) giving a subjective ranking to various aspects, such as is used for the World bank Logistics Performance Index. This index is based on subjective scores given by the respondents, and the statistical analysis transforms the aggregate into comparative global and domestic indices:

> The data used in the ranking comes from a survey of logistics professionals who are asked questions about the foreign countries in which they operate . . . The logistics performance (LPI) is the weighted average of the country scores on the six key dimensions:
>
> 1. Efficiency of the clearance process (i.e., speed, simplicity and predictability of formalities) by border control agencies, including customs;
> 2. Quality of trade and transport related infrastructure (e.g., ports, railroads, roads, information technology);
> 3. Ease of arranging competitively priced shipments;
> 4. Competence and quality of logistics services (e.g., transport operators, customs brokers);
> 5. Ability to track and trace consignments;
> 6. Timeliness of shipments in reaching destination within the scheduled or expected delivery time.
>
> The scorecards demonstrate comparative performance the dimensions show on a scale (lowest score to highest score) from 1 to 5 relevant to the possible comparison groups of all countries (world), region and income groups. (World Bank, 2015b)

The 2014 global LPI gives Fiji a score of 2.55 out of a possible 5, with a ranking of 111th out of 150 nations in the world. Germany ranks first, Australia 16th, New Zealand 23rd, Solomon Islands 106th, and PNG 126th.

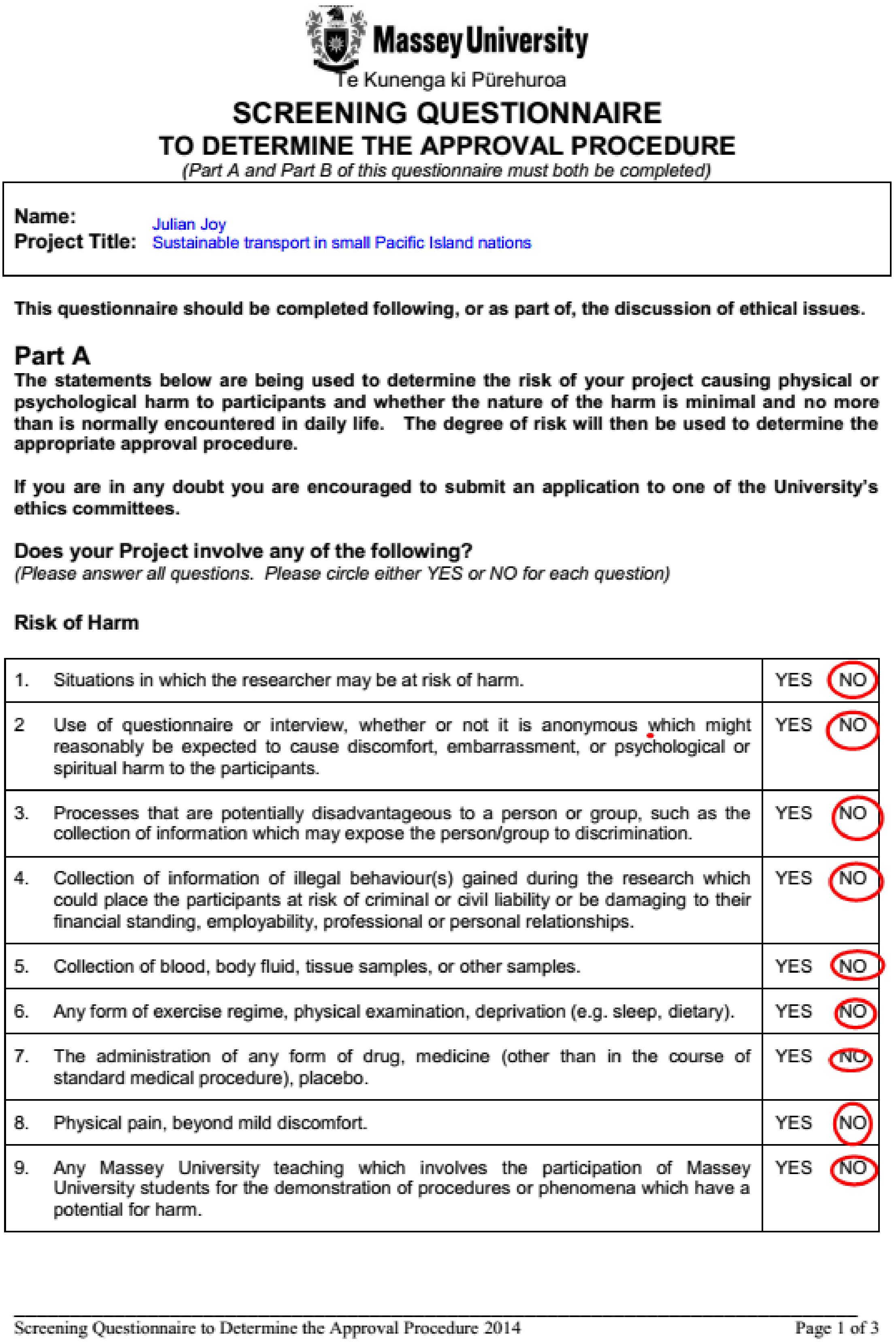
The development of directions for sustainable actions in Pacific SIDS is a significant government responsibility, and a lead can be given by the effective management of government procurement decisions, using socially responsible purchasing principles. There is evidence of a growth of awareness in this direction, as for example the appointment of a new position of 'SPC Director, Environmental Sustainability and Climate Change', to be based in New Caledonia (SPC, 2015b).

The factors that may be used to reliably measure current levels of sustainability of logistics in the small island nations of the Pacific have been examined by the research. Further research is warranted in drafting the detailed indicators, to enable reporting on the sustainability of logistics and other related activity in a reliable, relevant, trustworthy and effective manner.

Appendices

Appendix A

Massey University ethics screening questionnaire



Massey University

Te Kunenga ki Pūrehuroa

SCREENING QUESTIONNAIRE

TO DETERMINE THE APPROVAL PROCEDURE

(Part A and Part B of this questionnaire must both be completed)

Name: Julian Joy

Project Title: Sustainable transport in small Pacific Island nations

This questionnaire should be completed following, or as part of, the discussion of ethical issues.

Part A

The statements below are being used to determine the risk of your project causing physical or psychological harm to participants and whether the nature of the harm is minimal and no more than is normally encountered in daily life. The degree of risk will then be used to determine the appropriate approval procedure.

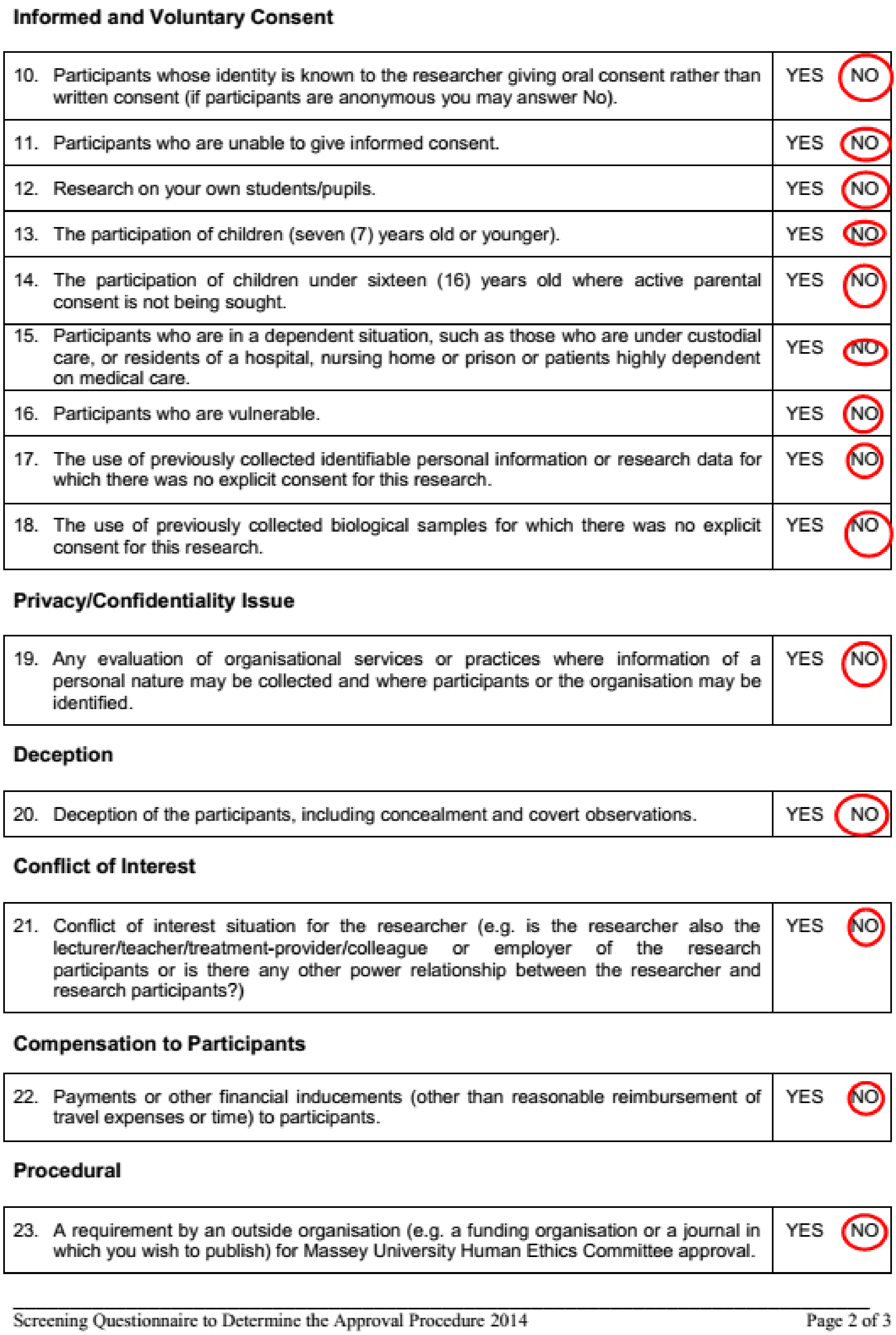
If you are in any doubt you are encouraged to submit an application to one of the University's ethics committees.

Does your Project involve any of the following?

(Please answer all questions. Please circle either YES or NO for each question)

Risk of Harm

1.	Situations in which the researcher may be at risk of harm.	YES [✓ NO]
2	Use of questionnaire or interview, whether or not it is anonymous which might reasonably be expected to cause discomfort, embarrassment, or psychological or spiritual harm to the participants.	YES [✓ NO]
3.	Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose the person/group to discrimination.	YES [✓ NO]
4.	Collection of information of illegal behaviour(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.	YES [✓ NO]
5.	Collection of blood, body fluid, tissue samples, or other samples.	YES [✓ NO]
6.	Any form of exercise regime, physical examination, deprivation (e.g. sleep, dietary).	YES [✓ NO]
7.	The administration of any form of drug, medicine (other than in the course of standard medical procedure), placebo.	YES [✓ NO]
8.	Physical pain, beyond mild discomfort.	YES [✓ NO]
9.	Any Massey University teaching which involves the participation of Massey University students for the demonstration of procedures or phenomena which have a potential for harm.	YES [✓ NO]



Informed and Voluntary Consent

10. Participants whose identity is known to the researcher giving oral consent rather than written consent (if participants are anonymous you may answer No).	YES [✓ NO]
11. Participants who are unable to give informed consent.	YES [✓ NO]
12. Research on your own students/pupils.	YES [✓ NO]
13. The participation of children (seven (7) years old or younger).	YES [✓ NO]
14. The participation of children under sixteen (16) years old where active parental consent is not being sought.	YES [✓ NO]
15. Participants who are in a dependent situation, such as those who are under custodial care, or residents of a hospital, nursing home or prison or patients highly dependent on medical care.	YES [✓ NO]
16. Participants who are vulnerable.	YES [✓ NO]
17. The use of previously collected identifiable personal information or research data for which there was no explicit consent for this research.	YES [✓ NO]
18. The use of previously collected biological samples for which there was no explicit consent for this research.	YES [✓ NO]

Privacy/Confidentiality Issue

19. Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.	YES [✓ NO]

Deception

20. Deception of the participants, including concealment and covert observations.	YES [✓ NO]

Conflict of Interest

21. Conflict of interest situation for the researcher (e.g. is the researcher also the lecturer/teacher/treatment-provider/colleague or employer of the research participants or is there any other power relationship between the researcher and research participants?)	YES [✓ NO]

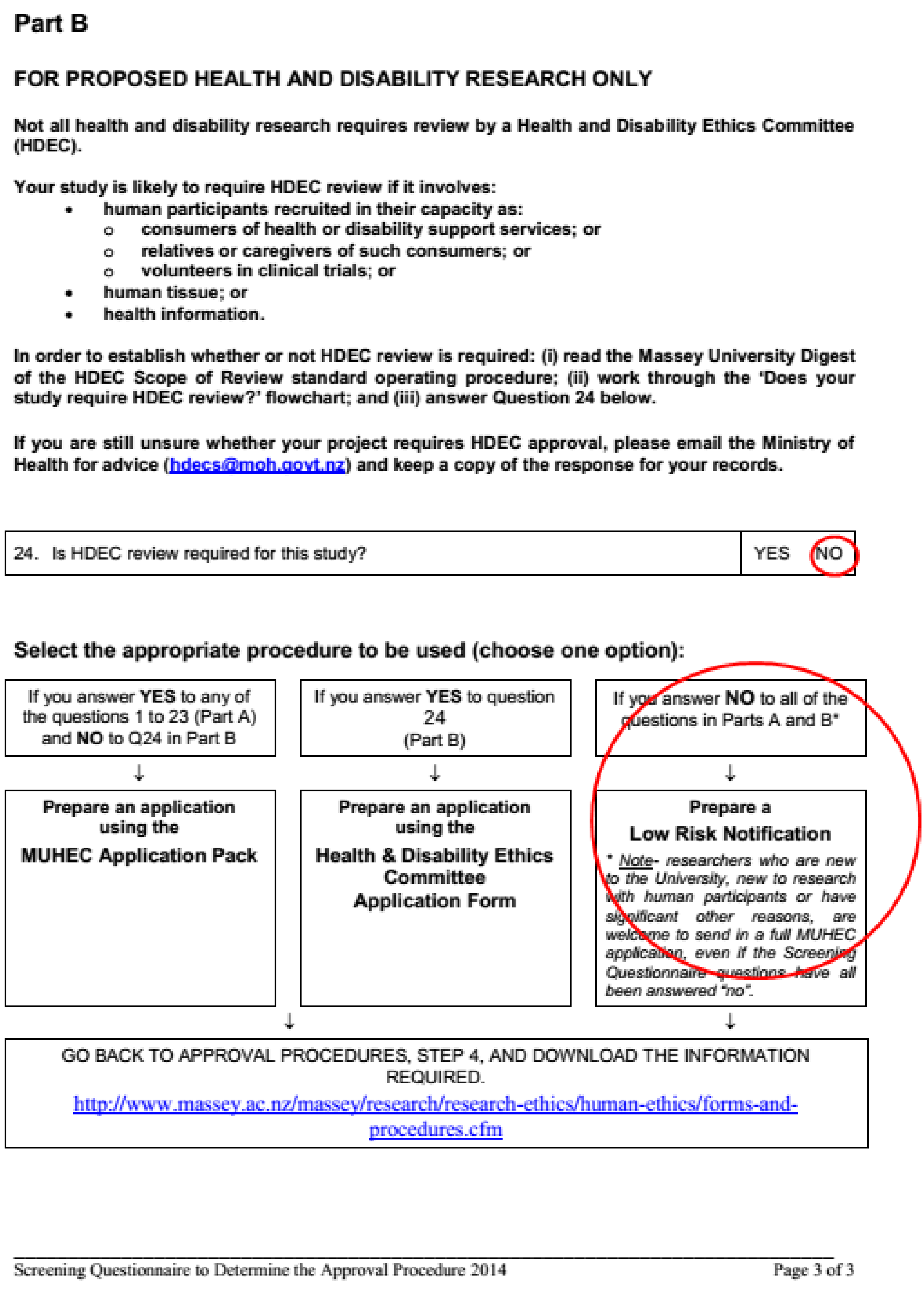
Compensation to Participants

22. Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.	YES [✓ NO]

Procedural

23. A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.	YES [✓ NO]

Screening Questionnaire to Determine the Approval Procedure 2014 Page 2 of 3



Part B

FOR PROPOSED HEALTH AND DISABILITY RESEARCH ONLY

Not all health and disability research requires review by a Health and Disability Ethics Committee (HDEC).

Your study is likely to require HDEC review if it involves:

- **human participants recruited in their capacity as:**
    - **consumers of health or disability support services; or**
    - **relatives or caregivers of such consumers; or**
    - **volunteers in clinical trials; or**
- **human tissue; or**
- **health information.**

In order to establish whether or not HDEC review is required: (i) read the Massey University Digest of the HDEC Scope of Review standard operating procedure; (ii) work through the 'Does your study require HDEC review?' flowchart; and (iii) answer Question 24 below.

If you are still unsure whether your project requires HDEC approval, please email the Ministry of Health for advice (hdecs@moh.govt.nz) and keep a copy of the response for your records.

24. Is HDEC review required for this study?	YES [✓ NO]

Select the appropriate procedure to be used (choose one option):

If you answer **YES** to any of the questions 1 to 23 (Part A) and **NO** to Q24 in Part B	If you answer **YES** to question 24 (Part B)	[✓ If you answer **NO** to all of the questions in Parts A and B*]
↓	↓	↓
Prepare an application using the MUHEC Application Pack	**Prepare an application using the Health & Disability Ethics Committee Application Form**	**Prepare a Low Risk Notification** ** Note- researchers who are new to the University, new to research with human participants or have significant other reasons, are welcome to send in a full MUHEC application, even if the Screening Questionnaire questions have all been answered "no".*

↓ ↓

GO BACK TO APPROVAL PROCEDURES, STEP 4, AND DOWNLOAD THE INFORMATION REQUIRED.
http://www.massey.ac.nz/massey/research/research-ethics/human-ethics/forms-and-procedures.cfm

Appendix B

Semi-structured interview questions

These questions were not supplied to the interviewees in any written form; the researcher discussed the topics and interviewed the contact persons, following which the researcher complied answers to the questions based on the discussions and interviews. Interviews were not recorded.

1. Name & contact details
2. Organisation represented
3. Type of organization
    (a) intergovernmental global (e.g. UN agency)
    (b) intergovernmental regional (e.g. SPC)
    (c) national government (e.g. Fiji)
    (d) other regional organisation e.g. ADB
    (e) NGO
    (f) private business
4. What countries does the organisation cover
    (a) PICTs and/or other (list or details)
5. What is the focus of the organisation's work

6. Does the organisation measure sustainability
   - (a) for any aspect (list or details)
   - (b) for supply chain or logistics aspect
7. Does the organisation report on sustainability
   - (a) for any aspect (list or details)
   - (b) for supply chain or logistics aspects
8. If sustainability for logistics aspects is measured or reported:
   - (a) What data is captured
   - (b) How is the data captured
   - (c) How frequently is the data captured
   - (d) Who is the data captured for
   - (e) How reliable do you consider the data to be
   - (f) Do you consider that the data is valid or useful for the purpose
   - (g) Is there better or other or additional data that could be used
   - (h) Where is the data kept or stored
   - (i) Who analyses the data
   - (j) What report format is used
   - (k) Is the report or data publicly available
   - (l) Any other comments
9. If sustainability for logistics aspects is not measured or reported:
   - (a) What are your views on this
   - (b) Discuss in relation to each item above

Appendix C

Contact and interviewee details

Interviewee contact information

Organisation	**Name**	**Role**
Secretariat of the Pacific Community, Economic Development Division, Nabua Suva	John Hogan	Director
	John Rounds	Shipping Adviser, Transport Programme
	Patricia Ho	Shipping Operations Officer
	Brenton Clark	Aviation Research Officer
	Uchenna Unozo	Energy/Transport Economist
	Delton Jones	Economic Adviser
	Caroline Tupoulahi-Fusimalohi	Research and Information Adviser, Research Information Unit
	Bernedine Monogreve	Administrative Assistant
Pacific Islands Forum Secretariat, Ratu Sukuna Road, Suva	Scott Hook	Economic Infrastructure Adviser
United Nations Economic and Social Commission for Asia and the Pacific, Victoria Parade Suva	Sanjesh Naidu	Economic Affairs Officer, Pacific Office
Asian Development Bank, Gordon Street Suva	David Ling	Transport Specialist, Transport, Energy and Natural Resources Division, Pacific Department
University of the South Pacific, Laucala Campus, Suva	Peter Nuttall	Associate Professor
Solander Pacific, Walu Bay, Suva	Charles Hufflett	Chairman, Solander Group
	Radhika Kumar	General Manager
	Tom Mayo	Fishing Operations Manager

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