MULTIMODAL FREIGHT DATA EXCHANGE

PILOT PROJECTS SUMMARY REPORT

AUGUST 2020

Australian Government
Department of Infrastructure, Transport, Regional Development and Communications

iMOVE

GS1 Australia

FOREWORD

In late 2019, the Australian Government, in cooperation with iMOVE and selected industry partners, commenced work on a set of joint Freight Industry Data Exchange Pilot Projects, aimed at improving the visibility of and access to freight consignment event message information across all parties involved in the handling and transport of several different product supply chains.

The initial Freight Data Exchange Pilot Projects were designed as three separate related projects to investigate, develop and demonstrate the capability for supply chain partners to share freight consignment information in real time and also assess the feasibility of aggregating freight consignment event/message data to produce aggregate outputs that help inform infrastructure planning and policy priorities.

This report briefly outlines some of the key outcomes of the three projects and suggests directions for further work.

This report was produced in collaboration between iMOVE and BITRE[1]. iMOVE Australia and BITRE would like to thank and acknowledge the assistance of participating industry operators, including Woolworths, Nestlé, Toll Holdings, Infrabuild and GS1 Australia, in providing initial direction to the project. All results and findings are those of BITRE and iMOVE Australia and should not be attributed to the project industry partners.

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August 2020

1 This research was funded by the Australian Government and iMOVE CRC and supported by the Cooperative Research Centres program, an Australian Government initiative.

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INTRODUCTION

NATIONAL FREIGHT DATA HUB

The Australian Government is working to settle the design of a National Freight Data Hub (NFDH), in accordance with the National Freight and Supply Chain Strategy (Transport and Infrastructure Council 2019). The aim of the NFDH is to provide freight-related information in Australia, in order to assist freight industry operators, governments and the broader community better understand the freight system, improve day-to-day operations and better plan for the future.[2]

Consultation to design the National Freight Data Hub has identified three key challenges that limit the usability of Australia's freight data:

1. Lack of coordination and leadership across industry and government in the approach to freight data is undermining strategic planning
2. Operational freight data is not captured or visible, meaning supply chain risks cannot be proactively managed
3. Australia's freight sector is not fully capitalising on data and analytics, making it difficult to generate insight to improve performance.

Industry, governments and other stakeholders have also identified foundational questions for the NFDH:

- What and how much freight is moved?
- Where does freight move and what routes are used?
- When does freight move?
- How is the network performing, e.g. timeliness of delivery?
- What is the extent of freight consignment delays?

2 Development of the NFDH was informed by the 2019 iMOVE Cooperative Research Centre review of Australia's freight data needs (iMOVE Australia 2019).

> “ Increasing digitalisation of supply chain processes and freight consignment information offers further opportunities to increase the efficiency and productivity of Australian freight supply chains.

FREIGHT DATA EXCHANGE PILOT PROJECTS

Industry cooperation and participation is essential to the success of the NFDH—it is industry that transports freight and generates information about how the freight transport system is used (e.g. freight volumes, freight vehicle use, routes used and transport costs).

> “ Industry also stands to benefit most significantly from any potential productivity and efficiency improvements that might be achieved through more timely exchange of information across supply chains.

Some of the specific problems noted by industry include the lack of real-time freight data availability, which inhibit supply chain partners' ability to respond to supply chain disruptions.

The Freight Data Exchange Pilot Projects were designed to address these issues. The initial round involved three separate but interrelated pilot projects:

- Two supply chain pilot projects – intended to investigate methods and systems to share freight consignment information in real time across supply chain participants.
- A data aggregation project, aimed at developing methods and systems to aggregate raw freight consignment message data into outputs that could help inform infrastructure planning and policy—in other words, methods to convert raw operational data into strategic-level data.

Planned project outputs were to include identification of barriers to data sharing, development of prototype data transfer protocols and production of some example aggregate outputs that could help inform planning.

UTILISING INDUSTRY FREIGHT DATA TO IMPROVE DECISION MAKING

Information technology and data are increasingly essential to modern business operations.

For industry, increasing digitalisation can assist improved visibility of freight consignments and interoperability between supply chain partners. Improved visibility can help improve predictability, efficiency, and productivity of the freight industry, and improve industry responsiveness to supply chain delays, bottlenecks or errors.

However, there are multiple freight data standards and information systems in use across industry, many unable to communicate with each other. Some industry operators report real-time information not being available about freight consignments when in the custody of a supply chain partner or transport agent. As a result, they may have no visibility of delayed or late shipments, until queried by the customer, impacting the ability to respond to unanticipated disruptions in a timely and efficient manner.

Moreover, despite increasing information technology use, paper-based documentation is still widespread, particularly among smaller operators. The inability to link information across supply chain partners can result in significant re-keying of the same information multiple times across the supply chain, increasing cost and reducing efficiency.

For governments and transport planning agencies, the increasing digitalisation of freight supply chain information offers the potential to generate the strategic-level data necessary to inform planning and investment, more cheaply and more effectively, than possible with traditionally-used large-scale sample survey approaches (see Box 1).

BOX 1 – CONTRASTING TRADITIONAL DATA COLLECTION METHODS AND USING DIGITAL OPERATIONAL DATA

Freight movements data has historically been collected using large scale sample surveys. Such surveys are expensive and infrequent, and availability of results often significantly lags collection (up to 6-12 months). Furthermore, while providing reliable information about trends in total road freight at national and state/territory level, sample surveys are not necessarily able to provide the detailed-level information required to inform 'last-mile' infrastructure planning and investment decisions.

Harnessing digital freight consignment and event message data offers a potential alternative source of strategic-level data that could augment or ultimately replace traditional survey-based collections.

For example, BITRE has been collecting GPS-based telematics data from a small number of participating freight operators for over 18 months. That data provides detailed information about freight vehicle use of the network, places where freight vehicles are significantly affected by road congestion and common places where freight vehicles stop. Freight vehicle telematics data, however, does not provide any information about the volume and type of freight carried by the vehicle.

Freight consignment data, collected as a by-product of electronic data exchanged between supply chain partners and at sufficient scale, could potentially provide an alternative means of producing strategic-level freight performance indicators, more frequently and more cheaply, and better help inform freight-related network planning, infrastructure investment and freight policy.

PROJECT ACTIVITIES

The Freight Data Exchange Pilot projects were designed as three separate but related projects:

Pilot Project 1:
Supply Chain Freight Data Trial

Pilot Project 2:
Multimodal Supply Chain Trial

Pilot Project 3:
Freight Consignment Data Aggregation Pilot Project

SUPPLY-CHAIN PILOT PROJECTS

The two Supply Chain Pilot Projects (**Pilot Project 1** and **2**) were intended to develop and demonstrate the capability for supply chain partners to share freight consignment information in real time, and thereby improve end-to-end supply chain visibility and productivity. The projects were undertaken in cooperation with industry operators: Nestle, Woolworths, Toll, Infrabuild & GS1.

Early project activities included efforts to identify matching unique consignment identifiers across partner supply chain management systems and investigating mechanisms to match and share information across those systems. Illustrating the issues associated with multiplicity of standards and systems in use across industry, project participants were unable to reconcile and match related consignment records across the different systems. Not long thereafter, the impact of the COVID-19 pandemic impacted industry priorities and limited further progress on **Pilot Projects 1** and **2**.

DATA AGGREGATION PILOT PROJECT

The Data Aggregation Pilot Project (Pilot Project 3) was designed to utilise a sample of real-time consignment data from the two supply chain projects to demonstrate how raw freight consignment (operational) data may be aggregated into strategic-level outputs that help inform infrastructure planning and policy.

Despite the limited progress on the two Supply Chain Pilot Projects, the project team was able to develop methods to extract, store and aggregate information from raw freight consignment messages to produce demonstration (strategic level) outputs. The work included: i) the development of a suite of functions to extract data from consignment (shipment) messages, and ii) the development of a project-specific (prototype) relational database to store extracted raw data and draw from these to produce aggregate outputs.

In lieu of an adequate sample of freight consignment messages from Pilot Projects 1 and 2, the project team generated a sample of synthetic messages using five (5) separate freight supply chain scenarios:

- a short-haul, single-leg urban freight supply chain
- a short-haul, multi-stage urban freight supply chain
- a multi-stage, multi-modal (road and rail) long-distance (North-South) supply chain
- a multi-stage, multi-modal (road and rail) long-distance (East-West) supply chain, and
- a multi-stage, multi-modal (road and sea, Bass Strait) supply chain.

While there are a range of potential electronic data interchange systems and standards in use across industry, this study only considered GS1's Transport Instruction (TI), Transport Status (TS) and EPCIS (Electronic Product Code Information Services)[3] message standards, which are all part of GS1's suite of Data Exchange Standards. GS1's global data standards also include unique identification keys covering business entities and locations, as well as unique identifiers for consignments, shipments, logistic units and transport assets. (GS1 (2019) provides an introduction to GS1's Logistics Interoperability Model and lists the various message standards.)

TI messages are used to convey relevant information about cargo that needs to be moved and include information about the consignor/shipper, consignee/receiver, origin and destination locations, cargo type, cargo volume and weight, request transport service (transport mode), and planned pick-up and delivery dates/times, among other elements. TS messages are used to query and report relevant information about the current status of a freight consignment. A single freight consignment may have multiple TS notification messages, providing a complete record of the process involved in transporting a consignment between consignor (or shipper) and consignee (or receiver). Information contained in TS messages include actual pick-up and delivery locations and times, and information about each transport leg, including mode of transport and vehicle type. Figure 1 illustrates typical TI and TS message exchanges involved for a single freight consignment—this example contains one TI message and six TS messages for each consignment.

Key message elements (data items) relevant to production of strategic-level outputs included:

- Consignment (shipment) identifier – uniquely identifying each consignment - **What**
- Consignor/consignee (sender/receiver) – **Who**
- Origin & destination location – **Where**
- Cargo characteristics (commodity, volume/weight, quantity) - **What**
- Transport instructions (mode, vehicle type) – **How**
- Planned/actual departure and arrival times – **When**

3 EPCIS is the GS1 [ISO/IEC 19987] standard designed for electronic exchange of physical event based visibility & traceability data.

Figure 1: Scenario 1 TI and TS messages

PROJECT OUTPUTS – PRODUCING STRATEGIC-LEVEL OUTPUTS

Strategic-level outputs that can be derived from raw freight consignment messages include:

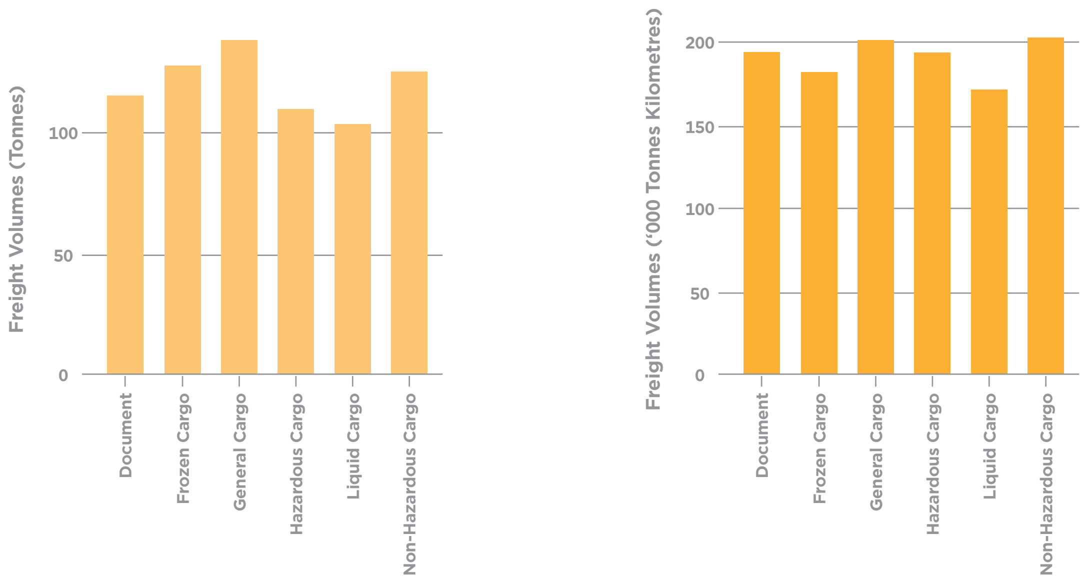
- Freight volumes by mode and commodity for specified time periods
- Supply chain-specific freight volume metrics
- Supply-chain and network performance metrics, e.g. travel times, estimated arrival times, etc.)

Some example aggregates and supply-chain specific outputs generated in Project 3 are presented below.

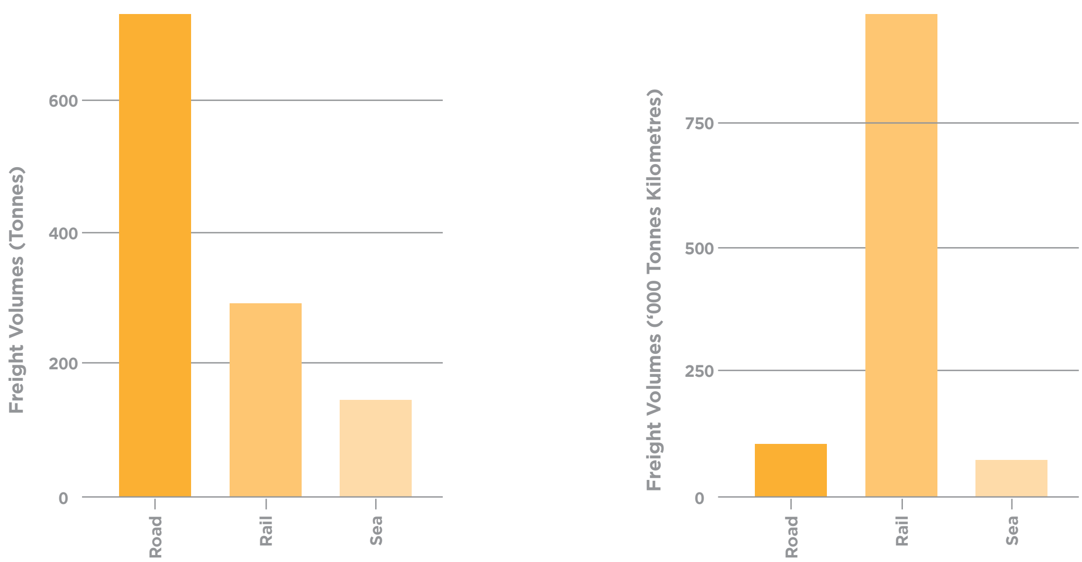
AGGREGATE FREIGHT MOVEMENT METRICS

Figure 2 illustrates some examples of aggregate freight volume metrics produced from raw consignment messages. **Panel (a)** shows total freight volumes (tonnes & tonne kilometres) by freight type. **Panel (b)** shows aggregate freight volumes by transport mode – note inclusion of two long-distance rail scenarios is the source of high rail tonne kilometre estimates. **Panel (c)** shows aggregate volumes by mode and month.

Figure 2: Aggregate freight volume metric examples



Panel (a) - Aggregate freight volume by commodity type



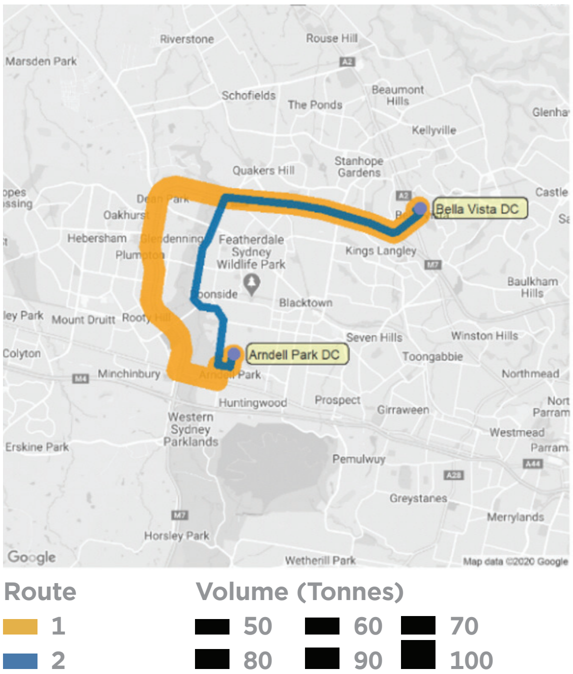
Panel (b) - Aggregate freight volume by transport mode

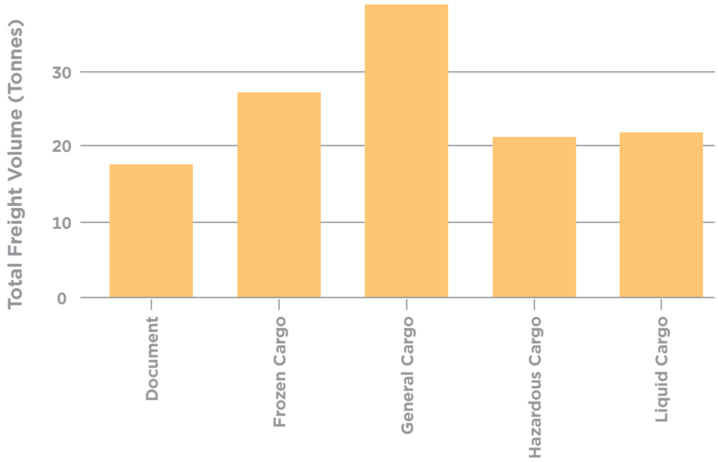
Panel (c) - Aggregate freight volume by month and transport mode

SUPPLY CHAIN-SPECIFIC FREIGHT VOLUME METRICS

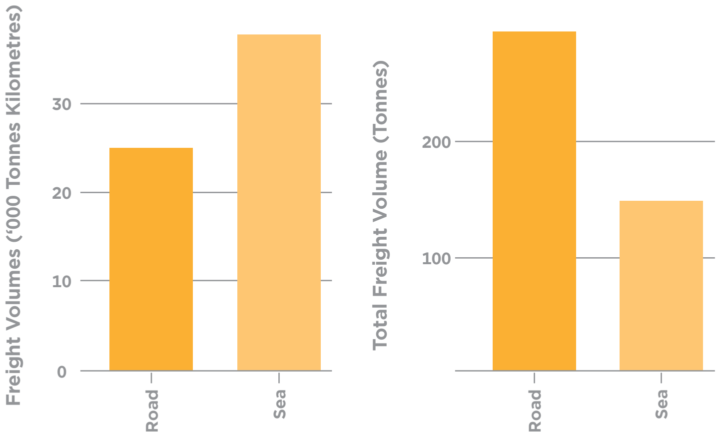
Figure 3 provides some examples of supply chain-specific freight volume outputs produced from raw consignment messages. **Panel (a)** shows freight volumes for the urban short-haul freight scenario, where multiple route options are available. **Panel (b)** shows the intermodal sea (Bass Strait) freight scenario outputs. **Panel (c)** shows intermodal rail (East-West) scenario freight volumes, by each transport leg.

Figure 3: Supply-chain specific aggregate outputs





Panel (a) - Supply chain freight volumes – urban short-haul scenario



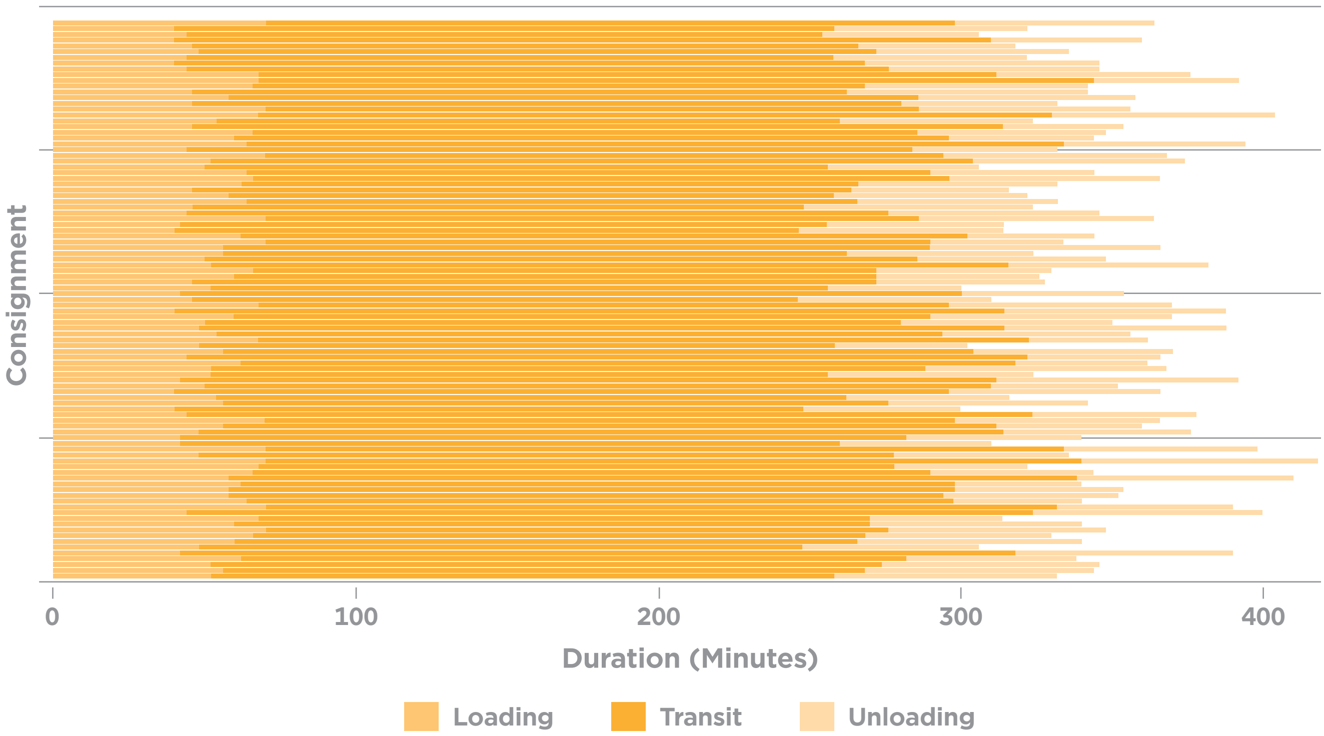
Panel (b) - Supply chain freight volumes – intermodal (sea) medium-haul scenario

Panel (c) - Supply chain freight volumes – intermodal (rail) long-haul scenario

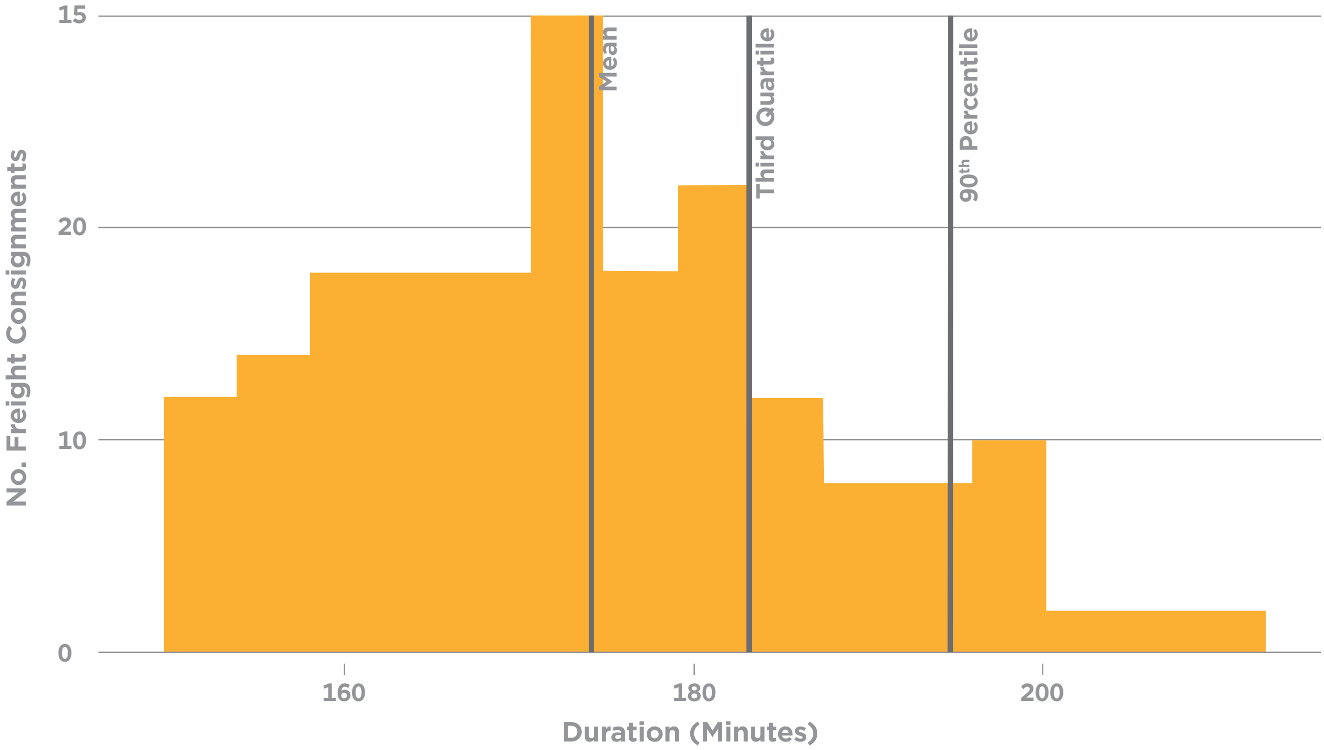
SUPPLY CHAIN TRANSIT TIME DISTRIBUTION METRICS

Figure 4 provides some supply chain freight transit time related outputs produced from raw consignment messages. Panel (a) shows total supply chain transit times for a sample of consignments from the urban short-haul scenario, split into loading, transit and unloading time. Panel (b) illustrates the total transit time distribution for the urban short-haul scenario, as well as the mean, 75th percentile and 90th percentile transit times, and Panel (c) illustrates the travel time distribution for by transport leg for the intermodal rail (East-West) scenario.

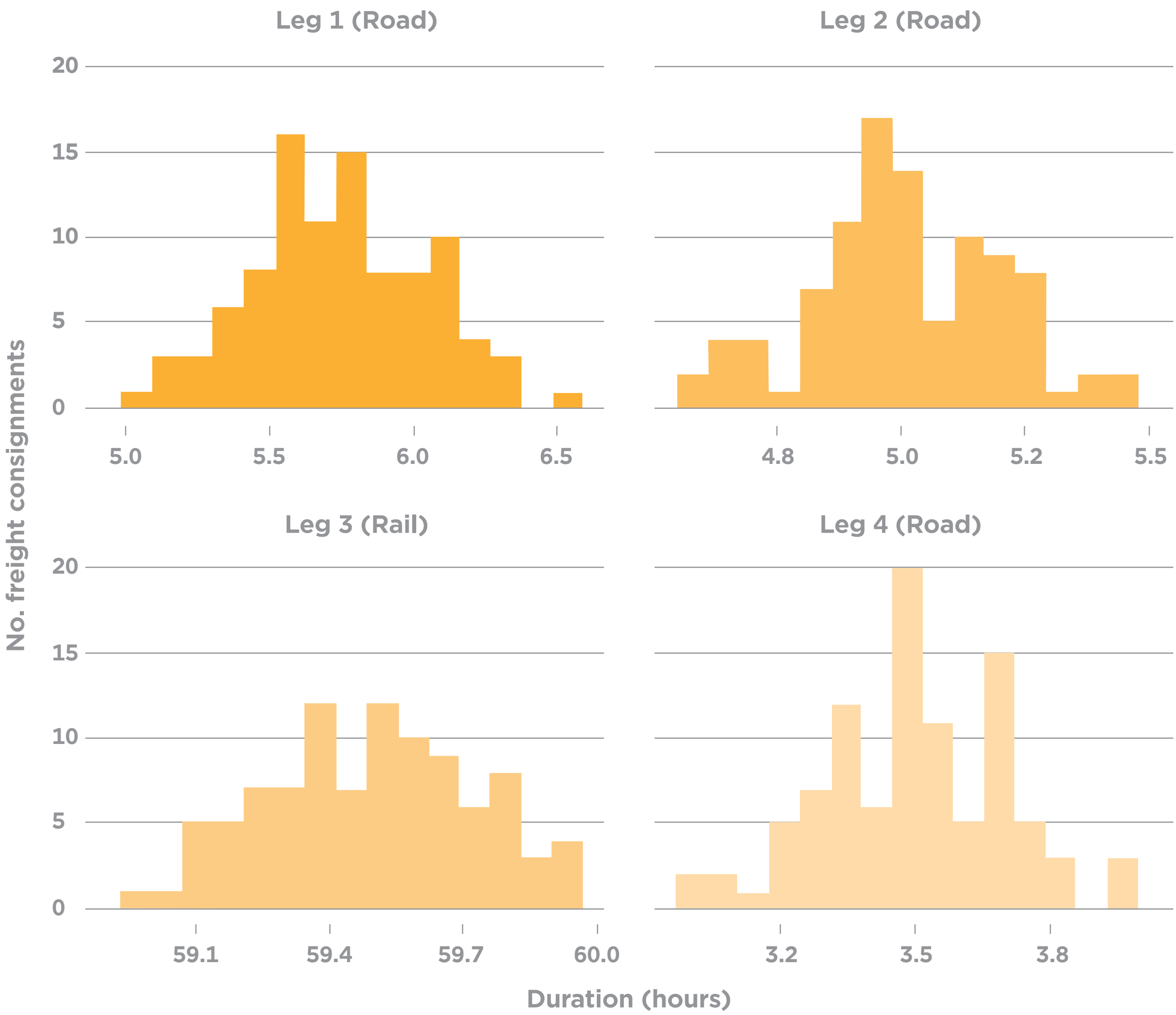
Figure 4: Supply-chain specific time-based outputs



Panel (a) - Supply chain transit times – urban short-haul scenario



Panel (b) - Freight travel time distribution – urban short-haul scenario



> Further outputs are demonstrated in the Freight Consignment Data Aggregation Pilot Project technical report (BITRE & iMOVE 2020).

OTHER POTENTIAL OUTPUTS AND USES

Other potential outputs that were not possible to explore using the synthetic data set, but that may be feasible with a sufficiently large sample of actual consignment message data include:

- Benchmarking travel times and measuring freight delay.
- Using freight consignment data to produce predictive supply chain travel and arrival time estimates.
- Linking freight consignment messages to real-time vehicle location information – linking asset information contained in freight consignment messages to freight vehicles could, in theory, facilitate real-time tracking of freight consignments in transit.

FINDINGS AND RECOMMENDED FURTHER WORK

KEY FINDINGS

The Freight Data Exchange Data Aggregation pilot project results demonstrate how operational data can be transformed into strategic data that can help inform infrastructure planning, network operations, corridor planning and freight policy.

> In particular, aggregated raw consignment message data can provide strategic-level information on the volume and pattern of urban freight movements, which is a major gap in freight transport data due to the cost of collection.

Raw freight consignment message data can also provide insights about freight travel times between different freight locations and across key freight corridors, particularly in urban areas. Example metrics featured in the study include:

- average travel times and travel time distribution between high-volume freight locations
- variations in average travel time by time of day
- average travel times for common freight routes and/or freight corridors
- estimated time of arrival (ETA) by time of day, based on historical message information.

FURTHER WORK

While the Data Aggregation pilot project has demonstrated how freight consignment message data can be transformed into strategic-level data, the real-time data visibility element of the pilot projects remains untested. Further work is recommended to build on the outcomes of this project. In particular:

1 Generating strategic-level outputs from actual freight consignment messages

Due to difficulties in matching consignment message data across supply chain partner systems synthetic data samples were used. Testing the feasibility of the framework and utility of the outputs using a large sample of actual consignment data is an obvious next step.

2 Developing real-time supply chain data visibility

The real-time freight data exchange and visibility aspect of the pilot projects remains untested. It is recommended that additional supply chain stakeholders be identified and recruited to test and evaluate the benefits of real-time freight data exchange.

3 Understanding current use of freight industry data standards, protocols and systems

There is little industry-wide information available about the variety and use of freight industry data standards and systems in use across Australian industry. An industry survey, designed to gauge current Australian freight supply chain information technology and communication frameworks/standards in use would help inform research and development priorities.

4 Implement standards and methods to improve freight industry data exchange

Agreed standards and protocols for sharing data can reduce the cost and complexity of data exchange and are essential to improving the visibility of information across supply chain partners. It is recommended that government and industry cooperate to identify, prioritise and foster standards to improve freight industry data exchange.

5 Implementing a minimal freight data exchange dataset

In concert with Recommendation 4, government and industry could also cooperate to identify a minimal supply chain data set sufficient to facilitate effective real-time exchange of supply chain information necessary to improve efficiency and productivity.

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INDEMNITY STATEMENT

PUBLISHED BY

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