ASSESSING THE CAPACITY OF THE PACIFIC NORTHWEST AS AN INTERMODAL FREIGHT TRANSPORTATION HUB

FINAL PROJECT REPORT

by

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16. Abstract

This project synthesizes information from multiple sources about the capacity of the Pacific Northwest region to handle intermodal freight transportation demand. The findings from this research are intended to be used as a framework to start a research program focusing on the planning decision making needs of stakeholders in the region. The major sources of information about intermodal capacity were published reports from different stakeholders, online resources, and information obtained through conversations with a small set of stakeholders. Information about the current and future demand for intermodal freight transportation in the region was obtained from the FAF^3 database of the Federal Highway Administration (FHWA) and complemented by information available in published reports. The analysis of the current and future gap between capacity and demand for intermodal freight transportation was completed using the Strength, Weaknesses, Opportunities, and Threats (SWOT) approach to develop a more complete understanding of the factors affecting the development and expansion of intermodal freight transportation in the region. Although the accuracy of the quantitative data cannot be considered very high, general trends can be analyzed. Most of the intermodal freight flow in the region is containerized cargo that visits the main marine ports: Port of Seattle, Port of Tacoma, and at a smaller scale Port of Portland. Other port terminals that are able to handle intermodal freight flow exist in the region but represent a small portion of the total flow. Burlington Northern Santa Fe (BNSF) Railway and Union Pacific (UP) Railroad have dedicated intermodal terminals in the region providing service for truck-road intermodal transportation, and rail connectivity to marine ports is also available. An analysis of the difference between intermodal capacity and demand at an aggregate level indicates that the current infrastructure is able to handle the existing demand for containerized international freight flow in the region. However, different scenarios of demand growth show that if capacity expansion does not occur, the existing capacity will not be sufficient to satisfy the demand in the future. Main factors affecting the perception of stakeholders about the level of service and future expansion of intermodal freight transportation in the region include highway congestion in the major metropolitan areas, lack of other generators and receivers of intermodal freight flow, coordination between different stakeholders, and limited availability of ocean carriers providing service to the Port of Portland.

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Executive Summary

This project is a first attempt at synthesizing information from multiple sources about the capacity of the Pacific Northwest region to handle intermodal freight transportation demand. The findings from this research are intended to be used as a framework to start a research program focusing on the planning decision making needs of intermodal freight transportation stakeholders in the region.

The major sources of information about intermodal freight transportation capacity were published reports from different stakeholders, online resources, and information obtained through conversations with a small set of stakeholders. Information about the current and future demand for intermodal freight transportation in the region was obtained from the FAF^3 database of the Federal Highway Administration (FHWA) and complemented by information available in published reports. The analysis of the current and future gap between capacity and demand for intermodal freight transportation in the region was completed using the Strength, Weaknesses, Opportunities, and Threats (SWOT) approach. The purpose was to develop a more complete understanding of the factors affecting the development and expansion of intermodal freight transportation in the region.

Although the accuracy of the quantitative data cannot be considered very high, general trends can be analyzed and broad conclusions obtained. There has been an increase in the amount of intermodal freight transportation flow within the region in the last few years after the economic recession. Most of the intermodal freight transportation capacity and demand in the region is in the state of Washington with about 64 percent of the total intermodal freight transportation flow in the region. Oregon follows with about 25 percent of the flow of intermodal freight. Most of the intermodal freight flow in the region corresponds to containerized cargo that visits the main marine ports (e.g., Port of Seattle, Port of Tacoma, and at a smaller scale Port of Portland). Other terminals that are able to handle intermodal freight flow exist in the region but represent a small portion of the total flow. Burlington Northern Santa Fe (BNSF) Railway and Union Pacific (UP) Railroad have dedicated intermodal terminals in the region providing service for truck-road intermodal transportation, and rail connectivity to marine ports is also available.

An analysis of the difference between capacity and demand for intermodal freight transportation at an aggregate level indicates that the current infrastructure is able to handle the existing demand for international freight flow which is the largest source of intermodal transportation due to the use of containers and the long distances that the shipments travel. However, different scenarios of intermodal freight transportation demand growth indicate that if capacity expansion does not occur, the existing capacity will not be sufficient to satisfy the demand in the future.

Main factors affecting the perception of stakeholders about the level of service and future expansion of intermodal freight transportation in the region include highway congestion in the major metropolitan areas (e.g., Puget Sound and Portland) that produce delays and additional costs, lack of other major metropolitan areas that could serve as generators or receivers of freight flows for intermodal transportation, coordination between different stakeholders to improve efficiency and minimize delays, and limited availability of ocean carriers providing service to the Port of Portland which further reduces the amount of containerized cargo available for intermodal transportation. These factors should be considered by different stakeholders and policy makers if the objective is to increase the market share of intermodal freight transportation in the region.

Chapter 1 Introduction

The economic health of the Pacific Northwest greatly depends on domestic and international trade markets and the efficient performance of freight transportation systems and their interconnections across the region. Very important industries in the region such as manufacturing, agriculture, forest products, retail and construction are heavily dependent on freight transportation. In the state of Oregon only, $16 million worth of cargo was moved on roads each hour of every day during 2008 [1]. Intermodal transportation refers to the use of at least two transportation modes to move goods that are in the same transportation unit from origin to destination to take advantage of economies of scale (for example, containers that are moved from a ship to a truck or to a train). Besides the economic benefits of intermodal transportation, overall sustainability is also improved as the linkages between different transportation modes allow better utilization of transportation assets and a reduction of greenhouse gas emissions as goods are transported more efficiently [2].

The Pacific Northwest has a geographical advantage as it can easily connect Eastern markets in Asia with consumers in the Midwest region of the United States [1]. However, although some previous studies have analyzed the potential of the intermodal infrastructure and operations in some of the states in the region, it remains unclear how the Pacific Northwest as a whole is currently positioned to serve as a major hub for intermodal freight transportation and what are the major areas for improvement in order to increase the overall economic and environmental sustainability of freight transportation.

1.1 Research Objective

The objective of this research study was to investigate the current capacity for intermodal freight service in the Pacific Northwest with respect to the potential demand for intermodal freight transportation in the region. The goal is to identify the logistics infrastructure and planning activities that exist in the region and what are the factors affecting the expansion of intermodal freight transportation and its associated environmental sustainability and economic competitiveness benefits in the region. This will help policy makers and major stakeholders throughout the region as they develop plans for future projects needed to expand the infrastructure and operational capacity of the Pacific Northwest as a major intermodal freight transportation hub within the United States.

1.2 Research Approach

In order to reach this objective, this project was divided into two main tasks: data collection and gap analysis.

The data collection task concentrated in obtaining information to estimate intermodal freight transportation demand and assess infrastructure and planning capacity available in the region. A review of relevant research on intermodal freight transportation planning and capacity assessment was completed. For demand estimation, information from the Freight Analysis Framework (FAF^3) database [3] was mainly used to collect aggregate level information about the past and expected demand for intermodal freight transportation in the region. Available information from online sources about intermodal facilities located in Pacific Northwest as well as information provided by published reports and a reduced set of stakeholders were used in the survey of existing intermodal freight transportation infrastructure and planning capacity.

In the gap analysis task, the quantitative information collected in the first task was used to complete a numerical comparison between demand and capacity considering three scenarios of demand growth until 2040. The results of the comparison and descriptive information available in published reports and provided by stakeholders were used to perform a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis in order to develop a more complete understanding of the factors affecting the development and expansion of intermodal freight transportation in the region.

The rest of this report is organized as follows. In chapter 2, a review of existing literature related to this research study is presented. Chapter 3 presents the method, sources and data associated with intermodal freight demand estimation that were used in this research. Similarly, chapter 4 presents the method, sources and data used for capacity assessment. Chapter 5 shows the comparison between demand and capacity data, and the results of the SWOT analysis identifying strengths and weaknesses associated with intermodal freight transportation service in the Pacific Northwest. Finally, general findings of the research and recommendations are presented in chapter 6.

Chapter 2 Literature Review

2.1 Intermodal Freight Transportation

Intermodal freight transportation refers to the use of at least two transportation modes to move goods that are in the same transportation unit (i.e., a shipping container that is transferred from a ship to a truck or to a train) from origin to destination to take advantage of economies of scale and increase the efficiency of the transportation system. Besides the economic benefits of intermodal transportation, overall sustainability is also improved as the linkages between different transportation modes allow better utilization of transportation assets and a reduction of greenhouse gas emissions as goods are transported more efficiently [4].

According to the Intermodal Association of North America (IANA) [5], intermodal freight transportation combines the benefits of using roads, rail and waterways, and it is an appropriate alternative to single mode transportation for long-haul domestic and international transportation of goods. For example, cargo could be shipped from Asia across the Pacific Ocean and up the Columbia river to the Port of Portland, where it is loaded onto a truck and transported to a rail loading facility, sent across the country on a train to Chicago and then unloaded at another facility, put back on truck, and then taken to a manufacturing or distribution facility in the Midwest. IANA [5] estimates that every year 25 million containers and trailers are moved using intermodal transportation and that intermodal service is growing faster than any other transportation mode. The basic enabling feature of this system relates to the use of standard containers to ship cargo which can be transferred from ships or barges to trains to trucks without affecting the contents inside [4]. Figure 2.1 shows shipping containers being transported on a train providing intermodal freight transportation service. The advantages of using shipping containers for intermodal transportation are that they are stackable (which improves economies of scale in long-haul movements) and that they can be easily transferred between different transportation modes. Another alternative is the use of a trailer-on-flatcar (TOFC) configuration which has been used to easily transition between rail and road for domestic intermodal freight transportation (see fig. 2.2). Out of the two, intermodal containers are largely used in practice.

Figure 2.1 Shipping containers transported by train providing intermodal service [6]

Figure 2.2 Crane loading a trailer onto a flatcar at an intermodal facility [6]

In intermodal freight transportation, the transfer of cargo in shipping containers and trailers between different transportation modes occurs at intermodal facilities located in terminals, ramps, container yards and depots [4]. IANA [5] maintains a list of intermodal facilities located in the United States and Canada (see fig. 2.3), and provides an interactive map of the North American Intermodal Rail Network. Figure 2.4 shows the intermodal rail networks for the two Class I Railroads providing service to the Pacific Northwest: Burlington Northern Santa Fe (BNSF) and Union Pacific (UP).

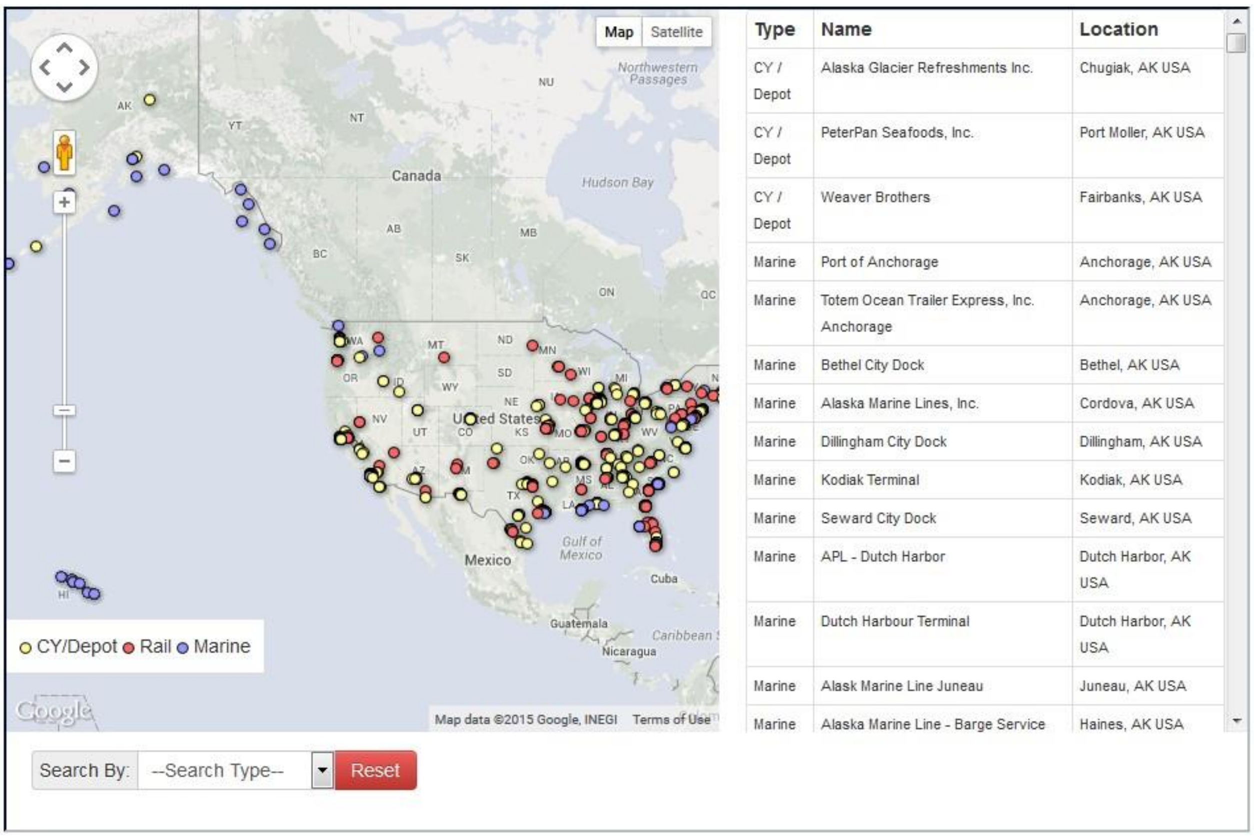

Figure 2.3 IANA's interactive "Intermodal Facilities Directory" [5]

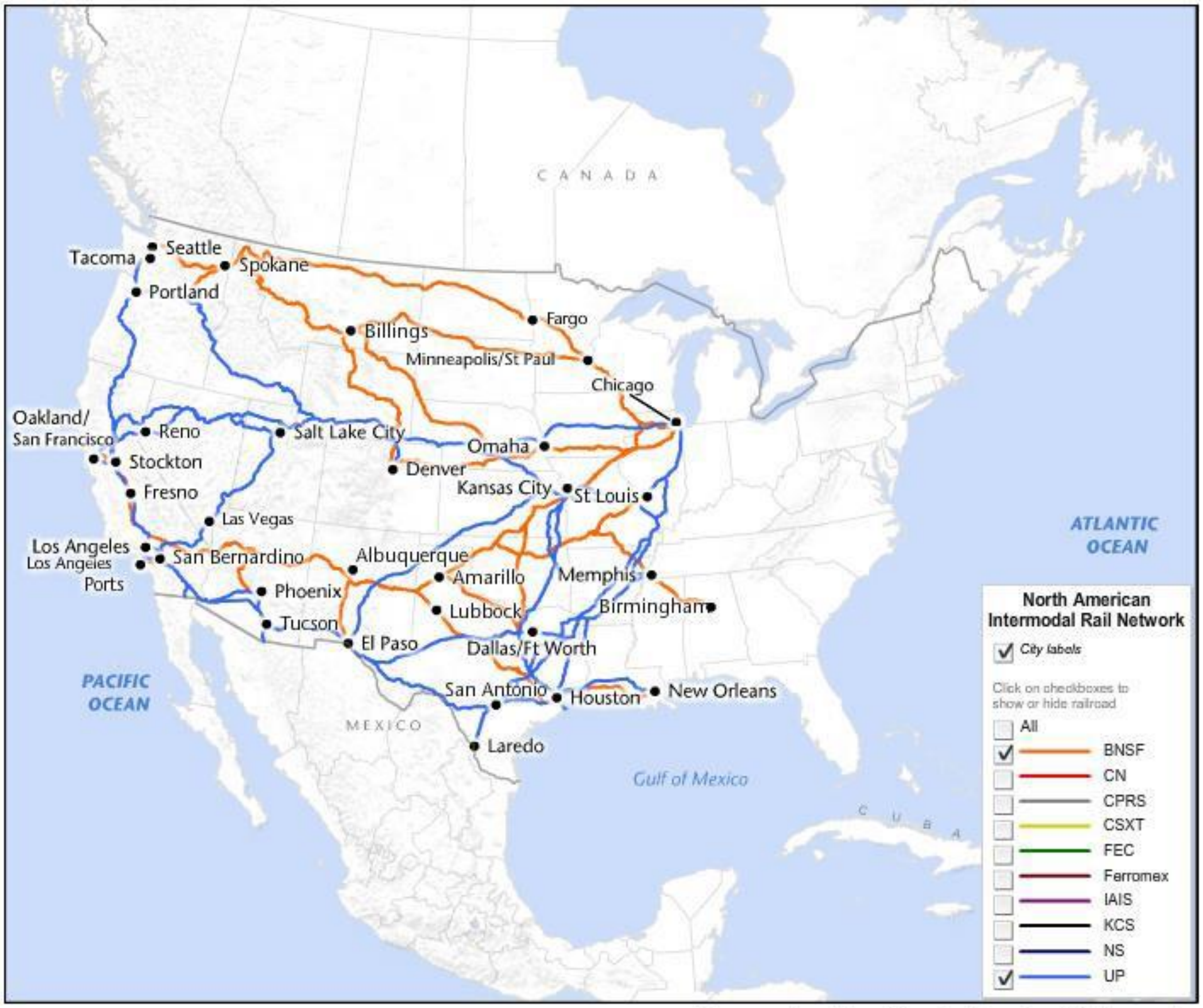

Figure 2.4 Intermodal rail networks for BNSF and UP [5]

According to [7], there are four different types of operators in intermodal freight transportation: *drayage operator*, *terminal operator*, *network operator*, *and intermodal logistics operator*. The roles of these different operators are described below:

1. Drayage Operator: this operator is responsible for all the decisions regarding the short-haul transportation of cargo (usually handled by truck) from shippers to terminal facilities and from terminal facilities to final destination. These decisions include the planning and scheduling of assets (e.g., trucks, trailers, containers, etc.).

2. Terminal Operator: this operator is responsible for all the decisions regarding the planning and operation of terminals (i.e., intermodal facilities) including determining terminal resource levels and the planning and scheduling of all transshipment operations between different modes of transportation.
3. Network Operators: this operator is responsible for all of the decisions regarding the planning and organization of the intermodal infrastructure. This includes the design of the intermodal logistics network.
4. Intermodal Logistics Operator: this operator is responsible for all the decisions regarding the scheduling and routing of each cargo shipment. This operator is usually in charge of providing the service of intermodal transportation to shippers.

Note that a company might be able to take on more than one of these roles in practice. For example, major carriers might take on the roles of drayage, network and intermodal logistics operators at the same time. In addition, not only transportation and logistics companies, but also public actors such as policy makers and port authorities are key stakeholders of intermodal freight transportation systems.

Planning problems associated with intermodal freight transportation have been categorized based on the decision time horizon in which they are effective as: *strategic, tactical and operational* [7], [8]. A description of the different planning problems is presented below:

1. Strategic: decisions are made for a long term planning horizons (i.e., about 10 to 20 years). They relate to investment decisions on the present infrastructures. For example, terminal locations, network configuration and layout of terminals are

strategic decisions. Most of the time these decisions cannot be changed for a long time or any significant changes require a large capital investment.

2. Tactical: decisions that involve a time period of several months. They usually deal with the optimal utilization of the given infrastructure. For example, selecting services and associated transportation modes, allocating capacity to orders, and planning itineraries and frequency are tactical decisions. Systems costs, operation times, network structure, and customer requirements influence the decisions made at the tactical planning level.
3. Operational: decisions that affect day to day activities or even online decisions. For example, asset scheduling and routing are operational decisions. At this level, operators still look for the best options in terms of services and transportation modes, best itineraries and resource allocation. However, planning at the operational level considers the dynamic aspect of the operation and the uncertainty that are not explicitly addressed at the strategic and tactical planning levels. This includes managing disruptions in the system.

Due to its nature, intermodal freight transportation systems are complex given the integration of multiple transportation modes and the participation of multiple decision makers. This requires an increased level of coordination to manage the flow of cargo across the intermodal transportation network. For this reason, decision support tools have been developed and information technologies have been actively used to facilitate coordination across different stakeholders and users of intermodal freight transportation systems [9].

2.2 Freight Transportation Demand Estimation and Capacity Assessment

Previous research studies and published reports have dealt with one or both of the two aspects considered in this research: freight transportation demand estimation, and capacity assessment. Most of these research studies and published reports have been intended to inform policy or to provide information and tools for transportation planning. The following is not intended to be a comprehensive list of existing literature but just a representative sample of these studies and reports.

Goodchild, Jessup and Fugisawa [10] focused on developing and refining a freight modeling approach for the movement of containerized cargo from ocean ports to handling facilities and from handling facilities to the final market in the Puget Sound region with the purpose of informing regional policy and planning. To develop and validate the freight model capturing underlying economic forces that influences decisions made by shippers, the researchers identified and used data to estimate freight transportation demand from several existing sources: publicly available survey data sources such as Washington State Survey Data, the Commodity Flow Survey (CFS) of the Bureau of Transportation Statistics (BTS) [11] and the Freight Analysis Framework (FAF) version 2 database of the Federal Highway Administration (FHWA) [3], private enterprise operational data, and roadway sensor data. Data from these sources were evaluated and incorporated as part of the regional freight model intended to estimate current and future freight movements through the Puget Sound region.

In a different research study, Goodchild [12] recommended some criteria that can be used in defining the Washington State truck intermodal network after performing a four-step analysis. First, methods used by other states and metropolitan planning organizations to define their freight truck intermodal transportation systems were reviewed. Second, information about national intermodal facilities and connectors provided by the National Highway System (NHS) and the Bureau of Transportation Statistics (BTS) datasets was used to create a list of all facilities in the state of Washington. Third, the list generated in the previous step was sent to regional and metropolitan transportation planning organizations, ports, and tribes to have them nominate additional facilities and connectors and describe the criteria used to identify them. And finally, a prioritized list of measurable freight system benefits was developed working with three Washington State Freight Mobility Plan Technical Teams. An important observation of this research study was that the lack of measurable criteria affects the definition of critical facilities and connectors. Moreover, the relationship between truck movements and company characteristics had not been fully identified when developing freight transportation plans. As a result, policy makers were used to use freight transportation models that were similar to personal transportation models. The personal transportation models consider only household demographics and reasons that families travel. So, making decisions based on freight transportation models that are similar to personal transportation models can lead to wrong decisions.

Moving away from the use of personal transportation models to model freight transportation, Goodchild, Gagliano, and Rowell [13] used a supply chain-based model to characterize Oregon's supply chains and provide recommendations to improve existing freight transportation models in the state of Oregon. With this purpose, the researchers used data available in national freight transportation databases and a survey of licensed motor carriers. Data sources used by the researchers include the Commodity Flow Survey (CFS), the Freight Analysis Framework 3rd Generation (FAF^3) database, the Oregon Commodity Flow Forecast, the Annual Survey of Manufacturers (ASM), the Federal Motor Carrier Safety Administration's

Company Snapshot, and other minor sources. Moreover, a survey was developed to gather responses from different motor carriers about general demographic and freight-related questions aimed at capturing how freight moves in Oregon. A screening question was included in the survey to ensure a credible respondent. Some of the questions included in the survey focused on obtaining information about number of vehicles, private/for-hire classification, travel locations, travel distances, delivery/pick-up types, vehicle types, time windows, travel times, delivery/pick-up locations, related facilities, facility locations, facility size, and company revenue. The information was used to identify clusters of company types based on their characteristics, and an assessment of how to integrate the relationships found into existing freight transportation models in Oregon was discussed.

In another study, Goodchild, Albrecht, Lam, and Faust [14] analyzed the shipment of containers between the port of Prince Rupert in British Columbia, Canada and the hinterland. The objectives of this research were to assess strengths and weakness associated with the facility to support freight transportation operations in the region and present recommendations for planning activities. The authors evaluated the existing capacity of the transportation infrastructure, the demand for freight transportation as well as the dynamics of the market. They also analyzed the impact of Canadian and U.S. laws and regulations on the performance of the facility under study. They concluded that this port could potentially affect logistics practices in the freight transportation system because of its unique characteristics. Regarding the collection of the data for this study, the authors used information provided by stakeholders or available online.

Considering the potential to increase intermodal freight service in the state of Montana, Prime Focus LLC and the Western Transportation Institute [15] completed a study to investigate the potential demand for such service, understand limitations for its implementation, and explore incentives to promote it. The approach used consisted in reviewing existing intermodal operations, surveying potential users about their interest and needs, interviewing various stakeholders involved, assessing container demand across Montana at the network-level using available databases, identifying programs to incentivize the service, and providing an overall assessment of the feasibility of expanding intermodal service in the state.

A similar research study was previously completed by Berwick, Bitzan, Chi, and Lofgren [16] who analyzed the North Dakota transportation system and emphasized on the opportunities for intermodal freight transportation. The North Dakota transportation system and potential market for intermodal transportation was investigated based on information provided by surveys of value-added processors, manufacturers, and specialty agriculture producers. The results were intended to be used by policy makers to evaluate the viability of establishing an intermodal container facility in the state. Moreover, the researchers provided information related to the transportation needs of manufacturers and value-added agricultural producers to help transportation planners make decisions more accurately.

To assess capacity constraints and network limitations in the freight transportation system in Oregon and to inform freight transportation planning and policy, the Oregon Department of Transportation (ODOT) commissioned two reports: WOC #2: Task 5.1 Inventory of Oregon Freight Infrastructure [17] and WOC #6: Oregon's Freight Profile [18] as part of the Oregon Transportation Plan (OTP).

The objective of the WOC #2 Report [17] is to look at the issues of capacity constraints and network limitations in the freight transportation system of the state. It provides a systematic overview of each freight mode, based on current publicly available data that has been assembled as part of the Oregon Freight Plan. Each mode was analyzed in terms of physical network (facility ownership and control, conditions, and restrictions), freight volumes, congestions and checkpoints, facilities within Oregon's freight transportation network, and planned infrastructure. As part of the overview of freight generators, receivers and volumes transported through the network, the FAF version 2.2 [3] database was used to observe aggregate-level information of the volumes transported by mode in, out and across the state. Additionally, each mode was analyzed explicitly with its own characteristics. For the road/highway mode, a description of roads and bridges that play an important role in freight movement, pavement conditions in Oregon's highway network, impediments to freight movement, and a description of the intermodal connectors on the national highway system was provided. For assessing freight volume on this mode, ODOT traffic data was used as the main data resource. In addition, for each mode of rail, marine, and aviation, a list and classification of Oregon's railroads, important marine ports in freight movement with freight volumes, and Oregon's airports was provided along with the data sources used for assessing freight volumes of each mode.

The WOC #6 Report [18] focused mainly on the economic aspects of freight movement in Oregon, especially from the shippers' perspectives. It explains the issues that shippers may encounter when moving raw materials and components to manufacturing facilities and finished goods to markets across the state. The main purpose of the report is to enable Oregon policy makers to make investments in Oregon's multimodal freight infrastructure to benefit Oregon's economy. A brief description of Oregon's freight system was provided along with an assessment of the relationship between freight transportation and economic development and its implications for Oregon. Special attention is given to the Port of Portland which is deemed to largely serve a local and regional market with relatively small amount of discretionary cargo moving through the state to other locations in the U.S. Moreover, factors that influence shipper's decision criteria (e.g., service reliability, security and safety, product type, etc.) are discussed and an overview of shippers' surveys and interviews is provided divided into five categories: Goods Movement, Freight Mobility, Freight Policies, Costs, and Infrastructure.

In addition to the previous two reports, more specific studies to assess freight transportation capacity have been completed for particular regions within Oregon. For example, a profile of the regional freight transportation system in the Portland-Vancouver Metropolitan region commissioned by Metro in 2007 [19], and a study of marine cargo demand and capacity for West Hayden Island completed by BST Associates for the Port of Portland in 2010 [20].

At a larger regional scope, but focusing on marine cargo and rail interactions, BST Associates and MainLine Management also completed a study and developed a report for the Pacific Northwest Rail Coalition in 2011 [21]. The objectives were to update the Pacific Northwest marine cargo forecast and assess rail capacity in the region to handle the traffic of containerized cargo. The projected level of rail traffic was compared with the capacity of various mainline segments in the region to produce a prioritized list of projects to address anticipated capacity constraints. For the marine cargo forecasts, it was assumed that the necessary marine terminals and rail capacity will be in place to meet market demand and unconstrained forecasts were developed. The first step in the forecasting approach was to update cargo volumes observed in 2009 by commodity and region using the most recent data available. Then, the forecasts provided in a previous version of the Marine Cargo Forecast (in 2009) were updated based on adjusted trends and forecast growth rates (including potential market opportunities that were evaluated by individual ports). Finally, the inland mode of transportation was estimated for each scenario by commodity, sub-region, and growth scenario. The rail demand forecasts included a projection of the number of trains under moderate and high growth scenarios, and under both average and peak operating conditions. In addition to the marine cargo forecasts, domestic freight traffic and passenger train traffic were considered in the rail forecasts using Washington State DOT and ODOT studies.

2.3 Gap Analysis

In management literature, gap analysis is the comparison of actual performance with potential or desired performance [22]. Gap analysis identifies gaps between the optimized allocation and integration of the inputs (resources), and the current allocation level. This analysis reveals areas that can be improved. Moreover, it provides a foundation for measuring investment of time, money and human resources required to achieve a particular outcome [22].

Gap analysis can also be used to analyze gaps in processes and the gap between the existing outcome and the desired outcome. This step process can be summarized as follows:

- Identify the existing process
- Identify the existing outcome
- Identify the desired outcome
- Identify the process to achieve the desired outcome
- Identify gap
- Document the gap
- Develop the means to fill the gap
- Develop and prioritize requirements to bridge the gap

One popular method of gap analysis for long-term planning is the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. A SWOT analysis is a planning method used to evaluate the factors determining the strengths, weaknesses, opportunities, and threats of a project or business venture [23]. A SWOT analysis can be carried out for a product, place, industry or person. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are desirable and undesirable in achieving that objective [24].

After the SWOT analysis has been performed, specific strategies to achieve the objective can be defined.

- **Strengths:** internal factors or characteristics of the business or project that give it an advantage over others.
- **Weaknesses:** internal factors or characteristics that place the business or project at a disadvantage relative to others.
- **Opportunities:** external factors or characteristics of the environment that the project could exploit to its advantage.
- **Threats:** external factors or characteristics of the environment that could cause trouble for the business or project.

Identification of SWOTs is important because they can inform later steps in planning to achieve the objective.

First, the decision makers should consider whether the objective is attainable, given the SWOTs. If the objective is *not* attainable a different objective must be selected and the process repeated. The analyst needs to ask and answer questions that generate meaningful information for each category (strengths, weaknesses, opportunities, and threats) to make the analysis useful.

SWOT analysis can be utilized in any planning procedure. It has been applied in various fields: business, marketing, and organizational planning. There is almost no limit on the application of SWOT analysis since it can be applied on numerous subjects (e.g., person, product, industry, company, etc.).

The SWOT analysis usually results in a matrix called the SWOT matrix where all factors (strengths, weaknesses, opportunities, and threats) are considered and the analysis can be conducted based on the identified factors [24]. Figure 2.5 shows a template of a SWOT matrix.

Figure 2.5 Template SWOT matrix

Chapter 3 Intermodal Freight Transportation Demand Estimation

3.1 Demand Estimation Method

Transportation demand estimation is one of the fundamental requirements for any analysis and decision making process in the transportation industry. The gap analysis that is part of this research, considers the evaluation of the gap that exists between the current and potential demand and capacity of the intermodal infrastructure and service in the Pacific Northwest region at an aggregate level. In this study, we refer to the region comprised by the states of Washington, Oregon and Idaho plus the state of Alaska as the Pacific Northwest region, although they are not geographically co-located. Therefore, information about intermodal freight transportation demand for these four states should be gathered, synthesized and evaluated to inform the analysis. As part of this research, two different types of information about current and potential intermodal transportation demand were collected: numerical from databases and descriptive from questionnaires and published reports.

3.1.1 Demand Estimation Quantitative Information Sources

Quantitative information was mainly obtained from publicly available freight transportation flow databases which have been consistently used to inform policy and decision making as described in section 2.2.

The Census Bureau and the Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation conduct the Commodity Flow Survey (CFS) every 5 years on those years ending in “2” and “7” [11]. The information gathered during this survey and from other sources such as the Rail Waybill Sample and the Waterborne Commerce Statistics are used to construct the *Freight Analysis Framework* (FAF) database [3]. As a result, FAF is a comprehensive database that stores freight movements within the Unites States in addition to all imports and exports by all modes of transportation. The FAF is maintained by the Federal Highway Administration (FHWA) of the U.S. Department of Transportation and is made publicly available. The FAF 3rd Generation or FAF3 database is the latest released version of the Freight Analysis Framework and contains real data derived from the 2007 CFS in addition to forecasted yearly flow data from 2015 in intervals of five years until 2040. The FAF3 database contains information on the type of commodities that are shipped, the origin and destination of each shipment, the transportation mode and the weight, value, and tonnage-mile of each shipment. FAF3 is a reliable resource to estimate freight transportation at an aggregate level and it was used in this research to extract quantitative transportation demand data.

In the FAF3 database, each shipment is divided into eight different categories according to the mode of transportation used [3]. These categories are:

1. **Truck:** freight flows moved by truck either private or for-hire are considered in this category. Truck movements that are part of **Multiple Modes and Mail** or truck in combination with domestic air are not included in this category.
2. **Rail:** freight flows moved by common carrier and private railroads are considered in this category. It does not include rail that is part of **Multiple Modes and Mail**.
3. **Water:** freight flows moved by ship or barge including shallow draft, deep draft, Great Lakes and intra-port shipments. It does not include water flows that are part of **Multiple Modes and Mail**.
4. **Air:** freight flows typically exceeding 100 lbs. that are moved by air or a combination of air and truck in commercial or private aircraft. It also includes air freight and air express. It does not include air flows that are part of **Multiple Modes and Mail**.

5. **Multiple Modes and Mail**: shipments moved by multiple modes are considered in this category that also includes parcel delivery services, U.S. Postal Service, or couriers.
6. **Pipeline:** this category includes crude petroleum, natural gas, and product pipelines, along with flows from offshore wells to land. It does not include pipeline flows that are part of **Multiple Modes and Mail**.
7. **Other and unknown:** movements that cannot be classified in a special shipment category, and shipments for which the mode cannot be determined.
8. **No Domestic Mode:** shipments with an international mode but no domestic mode are classified in this category. It is limited to import shipments of crude petroleum transferred directly from inbound ships to a U.S. refinery at the zone of entry.

Note that the “Multiple Modes and Mail” category of the FAF^3 database does not necessarily capture the actual total flow that uniquely corresponds to intermodal transportation (i.e., containerized and trailer-on-flatcar cargo), however to assess future scenarios with a rather optimistic outlook on demand, the flows that correspond to this category are assumed to represent *intermodal freight transportation flow*.

Three different measures were recorded from the FAF^3 database: *weight, value, and ton-miles*. However since the purpose of the analysis is to compare demand data to capacity, *weight* information is critical for the analysis. Various queries were designed to extract useful quantitative freight demand data from the FAF^3 database. The information is synthesized in section 3.2.

Note that the FAF^3 forecasts are a reasonable projection of current trends, but they do not consider significant changes in the economy, capacity, transportation costs and technology. In our analysis we consider this aspect by evaluating different scenarios of projected growth as it is discussed in section 5.1.

3.1.2 Demand Estimation Descriptive Information Sources

Descriptive information was obtained from stakeholders of intermodal freight transportation to capture their perspectives with respect to the current level of service in the region and potential growth. A questionnaire was developed and a list of stakeholders was generated including third-party logistics providers and road carriers (i.e., drayage operators). Phone interviews with those willing to participate were completed in August 2014 and February 2015. Additional information comes from published reports that have carried out more extensive and in-depth surveys of stakeholders in the region. The obtained descriptive information is used in addition to the numerical data to inform the SWOT analysis presented in section 5.2.

Table 3.1 shows the questions developed for third-party logistics providers and transportation carriers to obtain information about their perception of the state and future growth of intermodal freight transportation in the region.

A group of 14 third-party logistics providers and 13 road carriers were identified from an original listing of 42 third-party logistics providers and 61 road carriers. From this sample, only 3 third-party logistics providers and 3 road carriers responded to the questionnaire over the phone. The respondents maintain operations mainly in Washington and Oregon. The actual names of the companies that participated have not been disclosed due to confidentiality of the information provided.

Table 3.1 Intermodal freight transportation demand estimation questionnaire

Questions
For third-party logistics providers: • What is the predominant method of freight shipping that your company uses to serve customers? • Please estimate, what portion of the shipments arranged by your company uses intermodal transportation? • Please estimate, what is your annual volume of intermodal transportation shipments that generate, terminate or transit through the Pacific Northwest region? • What are the top five inbound freight origins for your intermodal shipments to the Pacific Northwest? • What are the top five outbound freight destinations for your intermodal shipments from the Pacific Northwest?
For road carriers: • Does your company provide service for intermodal transportation shipments?
Common questions: • Please estimate, what is the percentage of your intermodal shipments in the Pacific Northwest that are domestic? • Is your perception that the market for intermodal transportation is growing in the Pacific Northwest region? • Is your perception that any changes in the market share of intermodal transportation in the last five years have been marginal or marked? • Do you agree that intermodal transportation produces benefits from an environmental perspective due to reduction of greenhouse gas emissions?

3.2 Intermodal Freight Transportation Data

For the purpose of our analysis, we consider freight transportation data for the *Pacific Northwest* as the aggregated freight flow data for the states of Washington, Oregon, Idaho, and Alaska.

In 2007, according to the FAF[3] database, trucks moved most of the commodities flow in and out of the Pacific Northwest region. In particular, 71% of total weight of freight flow in the Pacific Northwest region was moved using trucks (see fig. 3.1). As discussed in section 3.1.1, the flows that are moved by trucks as part of intermodal transportation are not included in the truck category but are included as multiple modes. After trucks, rail and pipeline are the next transportation modes that moved a big portion of all commodities in the Pacific Northwest region. Each of these two modes transported 8% of the weight of all commodities in the region. Intermodal transportation could be a combination of truck, rail, air and water and accounts for 6% of the annual weight of all commodities moving through the region. Water moves 4% of the weight of commodities, while the air has a very small portion. This is reasonable mainly because air is mostly used to move small and expensive commodities so the total weight that is moved by air is relatively small when compared to other modes of transportation.

Table 3.2 shows the annual value, weight and ton-miles transported by different transportation modes through the Pacific Northwest region in 2007.

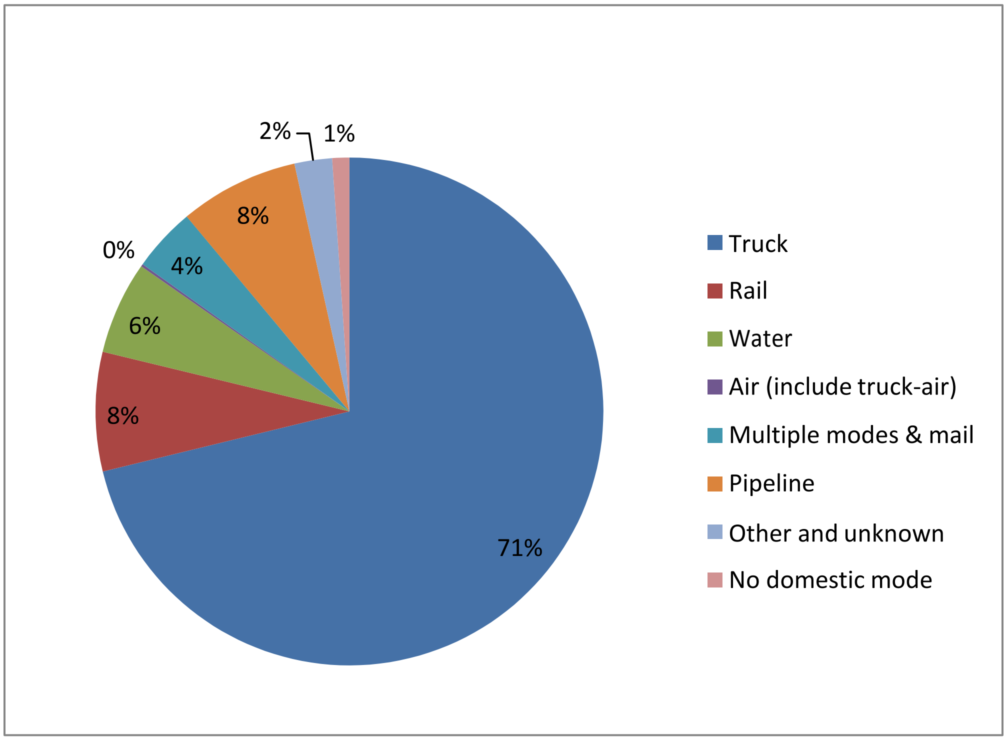

Figure 3.1 Total freight flow in the Pacific Northwest by mode in 2007 (weight percentage)

Table 3.2 Total freight flow in the Pacific Northwest by mode in 2007

Mode	Value (in $ million)	Weight (in thousand tons)	Ton-Miles (in millions)
Truck	871,428	1,284,187	288,051
Rail	44,357	136,892	142,948
Water	45,435	106,621	189,185
Air (includes truck-air)	192,302	2,786	5,816
Multiple modes & mail	191,779	73,627	86,892
Pipeline	58,255	136,947	94,143
Other and unknown	291,302	43,103	15,442
No domestic mode	8,270	19,639	-

To characterize the proportion of intermodal transportation flow (in weight percentage) in each state in 2007, the total flow of the Pacific Northwest region was disaggregated to the state level and it is presented in figures 3.2, 3.3., 3.4, and 3.5.

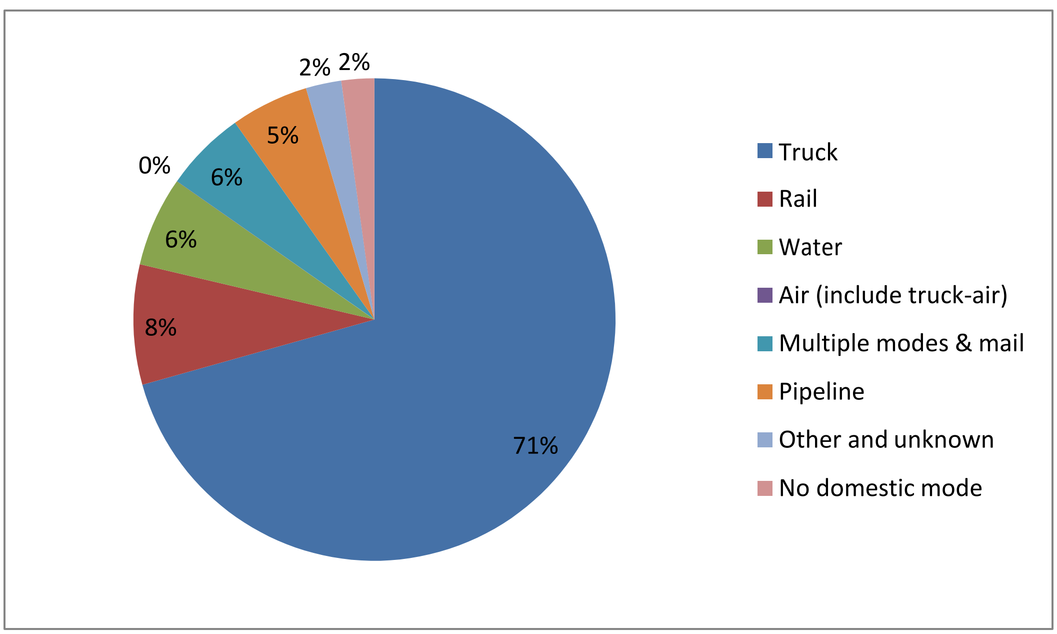

Figure 3.2 Total freight flow in Washington by mode in 2007 (weight percentage)

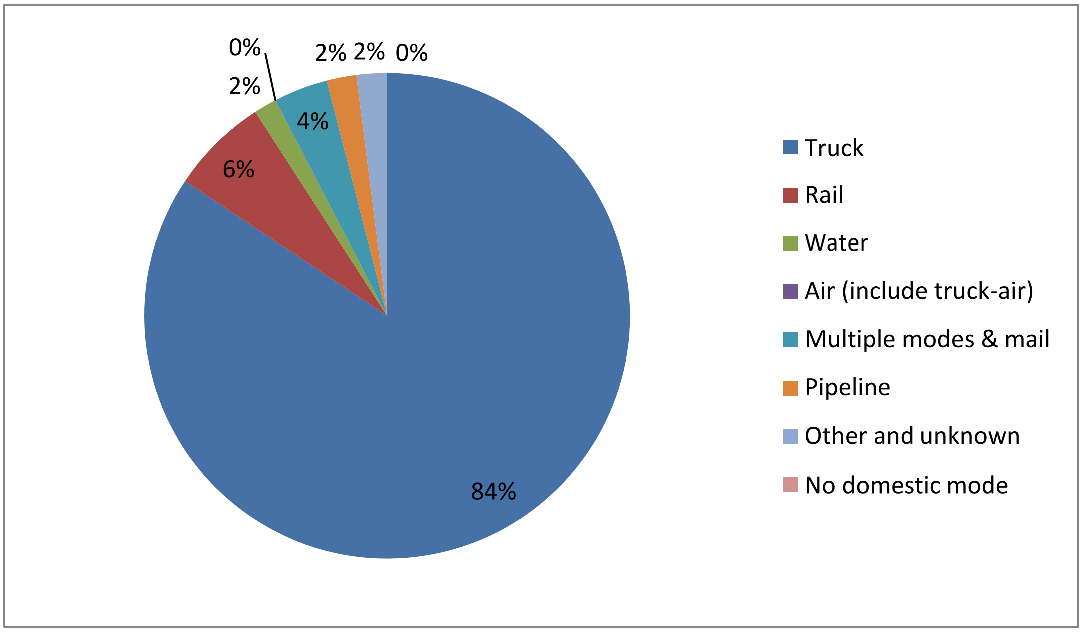

Figure 3.3 Total freight flow in Oregon by Mode in 2007 (weight percentage)

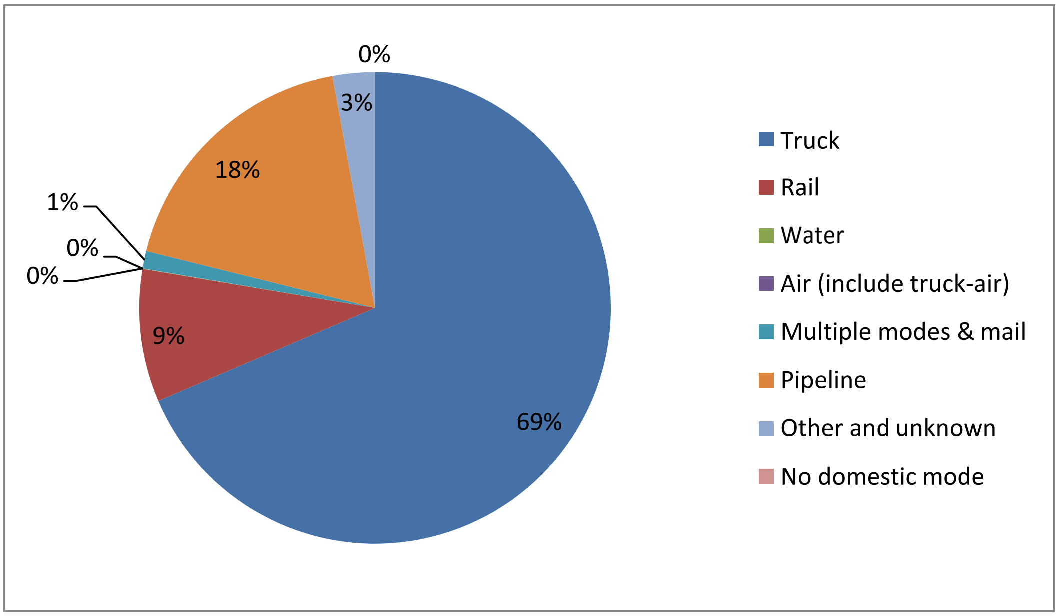

Figure 3.4 Total freight flow in Idaho by mode in 2007 (weight percentage)

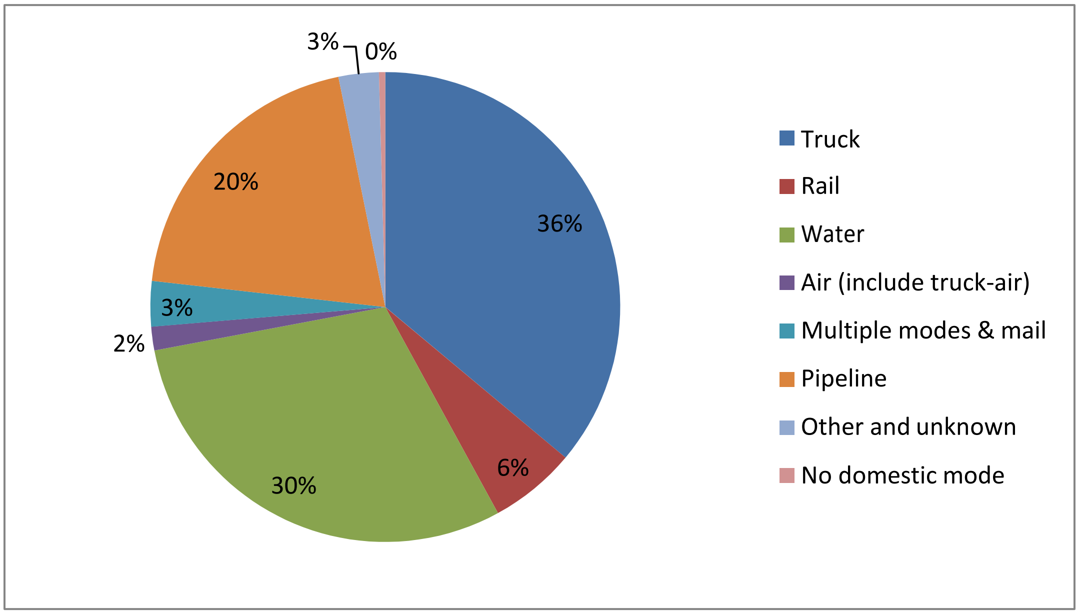

Figure 3.5 Total freight flow in Alaska by Mode in 2007 (weight percentage)

The share of intermodal transportation flow (in weight percentage) in the state of Washington of 6% is the largest across the region, followed by Oregon at 4%, Alaska at 3% and Idaho at 1%. This is definitely influenced by the infrastructure that is available in each state to handle intermodal transportation and the markets that are served.

Even in the case where only domestic inbound and outbound flows are considered, the proportions observed in figure 3.5 are maintained for the most part. Tables 3.3, 3.4, 3.5, and 3.6 show the inbound and outbound flows (in tons) for each of the transportation modes in each state, respectively.

Note that for the most part, the flows for domestic intermodal transportation are balanced for inbound and outbound movements in all states.

Table 3.3 Domestic inbound and outbound flows for Washington in 2007 (weight)

Mode	Outbound (thousand tons)	Inbound (thousand tons)
Truck	298,414	309,554
Rail	20,357	48,832
Water	19,722	32,145
Air (include truck-air)	49	112
Multiple modes & mail	25,468	21,534
Pipeline	25,459	19,555
Other and unknown	9,771	10,686

Table 3.4 Domestic inbound and outbound flows for Oregon in 2007 (weight)

Mode	Outbound (thousand tons)	Inbound (thousand tons)
Truck	219,337	210,381
Rail	8,106	25,004
Water	3,026	4,710
Air (include truck-air)	9	57
Multiple modes & mail	9,234	9,157
Pipeline	56	10,004
Other and unknown	4,932	5,367

Table 3.5 Domestic inbound and outbound flows for Idaho in 2007 (weight)

Mode	Outbound (thousand tons)	Inbound (thousand tons)
Truck	90,272	99,747
Rail	12,217	13,045
Water	36	16
Air (include truck-air)	5	7
Multiple modes & mail	1,721	1,625
Pipeline	32,955	17,578
Other and unknown	3,606	4,402

Table 3.6 Domestic inbound and outbound flows for Alaska in 2007 (weight)

Mode	Outbound (thousand tons)	Inbound (thousand tons)
Truck	28,122	28,360
Rail	4,693	4,637
Water	41,049	5,918
Air (include truck-air)	1,648	899
Multiple modes & mail	2,917	1,972
Pipeline	15,669	15,669
Other and unknown	2,168	2,171

To assess the importance of each state in the whole region with respect to freight transportation and intermodal transportation in particular, the following plots were generated. Figure 3.6 shows the proportion of the freight flow from each state with respect to the total flow in the Pacific Northwest region, while figure 3.7 shows the proportion of intermodal transportation flow from each state with respect to the total intermodal flow in the region.

Note that Washington has the largest portion of the total and intermodal transportation flow in the region. However, the proportion of the flow that corresponds to intermodal transportation is much more significant at 64%. Contrary to Idaho, the other two states (Oregon and Alaska) seem to maintain a relatively similar proportion of the intermodal flow when compared to the total flow in the region.

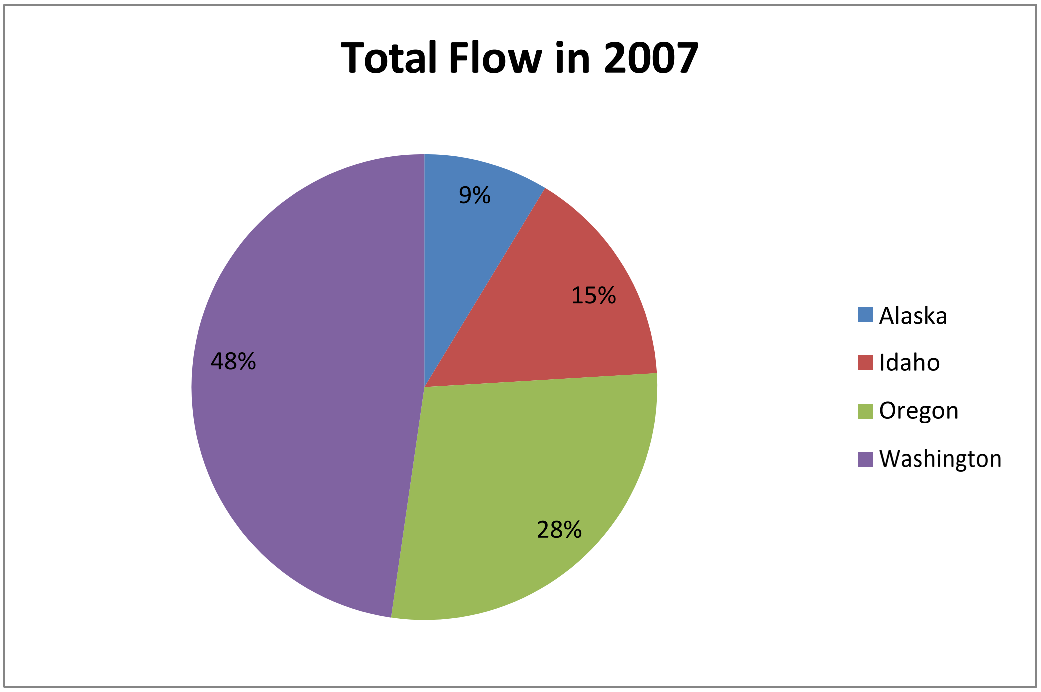

Figure 3.6 Weight fraction of the total freight flow in the Pacific Northwest for each state (2007)

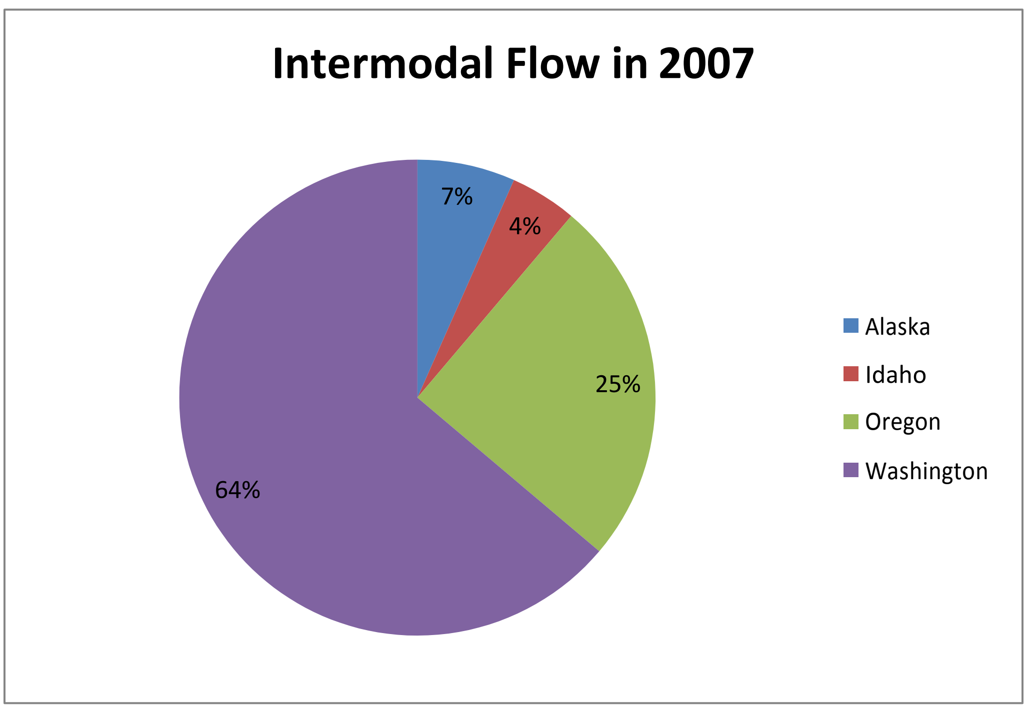

Figure 3.7 Weight fraction of intermodal freight flow in the Pacific Northwest for each state (2007)

An interesting observation from the information available in the FAF[3] database is that the forecasted increase in intermodal transportation flow in the region is not expected to be uniform across all states in the Pacific Northwest. Figure 3.8 shows the weight proportion of freight flow from each state that is forecasted for 2040 with respect to the total flow in the region. Note that with the exception of Alaska that sees a reduction from 9% to 4% in the total flow for the region, all other states are forecasted to experiment a slight increase in participation (compare fig. 3.5 with fig. 3.8). However, as observed in figure 3.9 that shows the weight proportion of intermodal freight flow from each state that is forecasted for 2040 with respect to the total intermodal flow for the region, Washington sees an increase of 4% of the intermodal flow as compared to 2007, while Alaska sees a reduction of 5%. Idaho sees an increase of 1%, while Oregon remains at the same level.

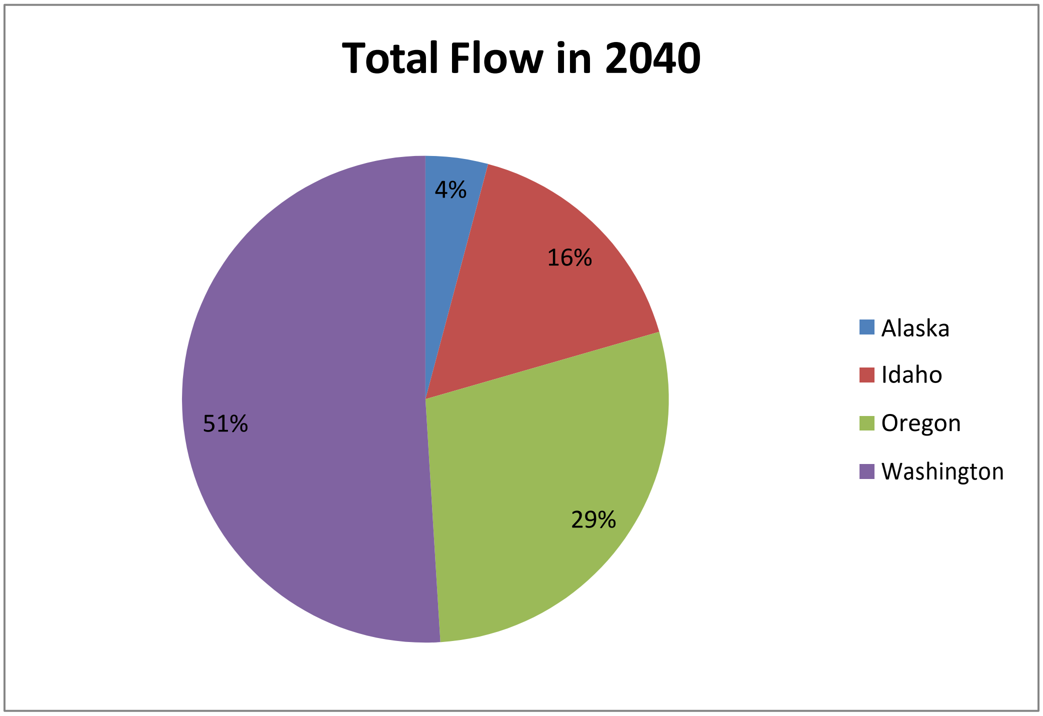

Figure 3.8 Weight fraction of the total freight flow in the Pacific Northwest for each state (2040)

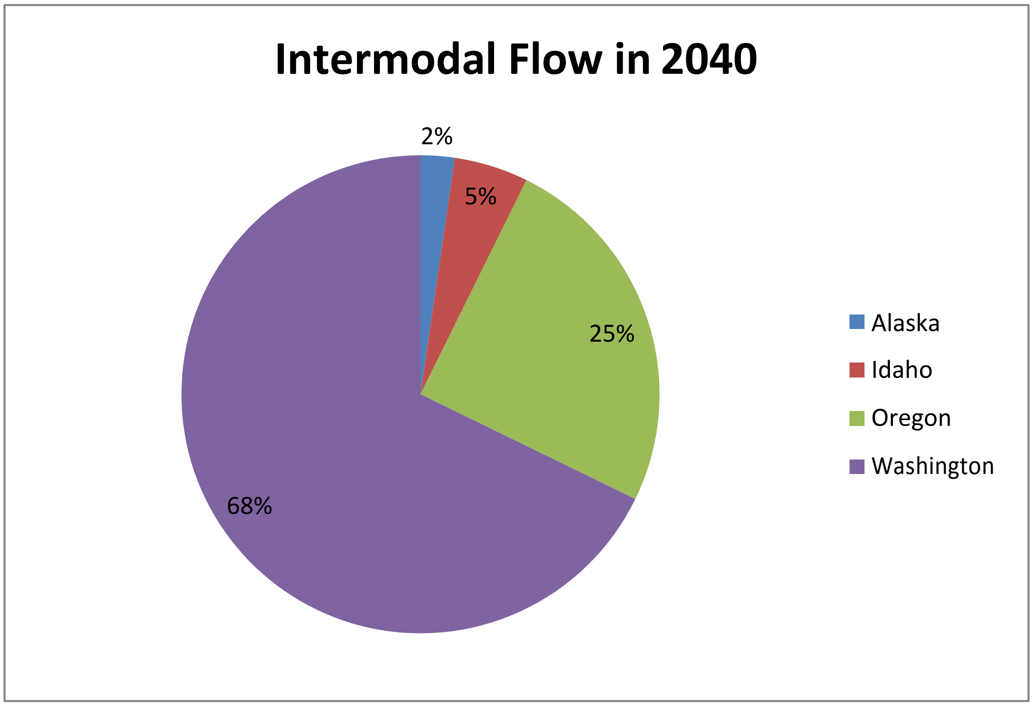

Figure 3.9 Weight fraction of intermodal freight flow in the Pacific Northwest for each state (2040)

The projected trends in domestic intermodal transportation flow from 2015 until 2040 based on the information collected from the FAF[3] database are presented for each state in table 3.7 and figure 3.10. The total projected intermodal flow for the Pacific Northwest is presented in table 3.8, and illustrated in figure 3.11.

Table 3.7 Projected domestic intermodal flow in each state from 2015 until 2040 (weight)

State	2015 (thousand tons)	2020 (thousand tons)	2025 (thousand tons)	2030 (thousand tons)	2035 (thousand tons)	2040 (thousand tons)
Washington	60,195	70,441	80,678	88,830	96,098	106,328
Oregon	21,845	24,785	28,536	31,879	35,198	39,064
Idaho	3,918	4,751	5,554	6,285	7,050	7,855
Alaska	4,377	4,162	3,834	3,550	3,510	3,611

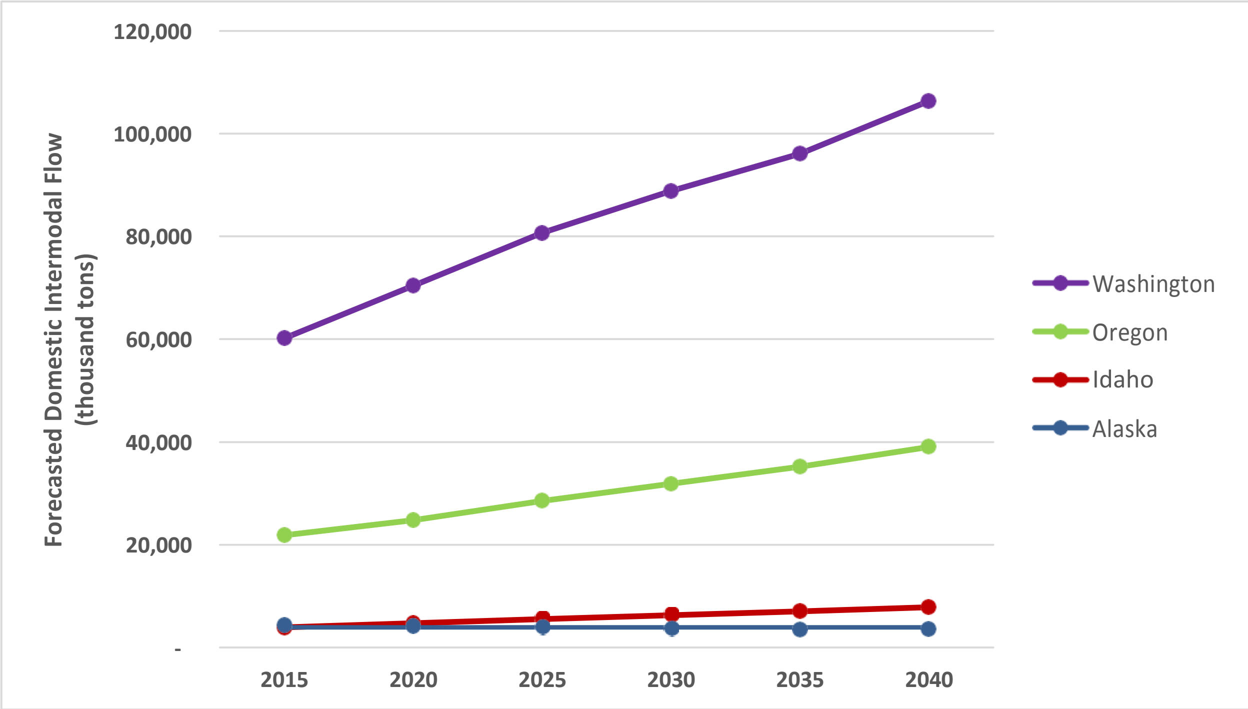

Figure 3.10 Projected domestic intermodal flow for each state from 2015 until 2040 (weight)

Table 3.8 Projected intermodal flow in the Pacific Northwest from 2015 until 2040 (weight)

	2015 (thousand tons)	**2020 (thousand tons)**	**2025 (thousand tons)**	**2030 (thousand tons)**	**2035 (thousand tons)**	**2040 (thousand tons)**
Pacific Northwest	90,335	104,139	118,603	130,544	141,857	156,858

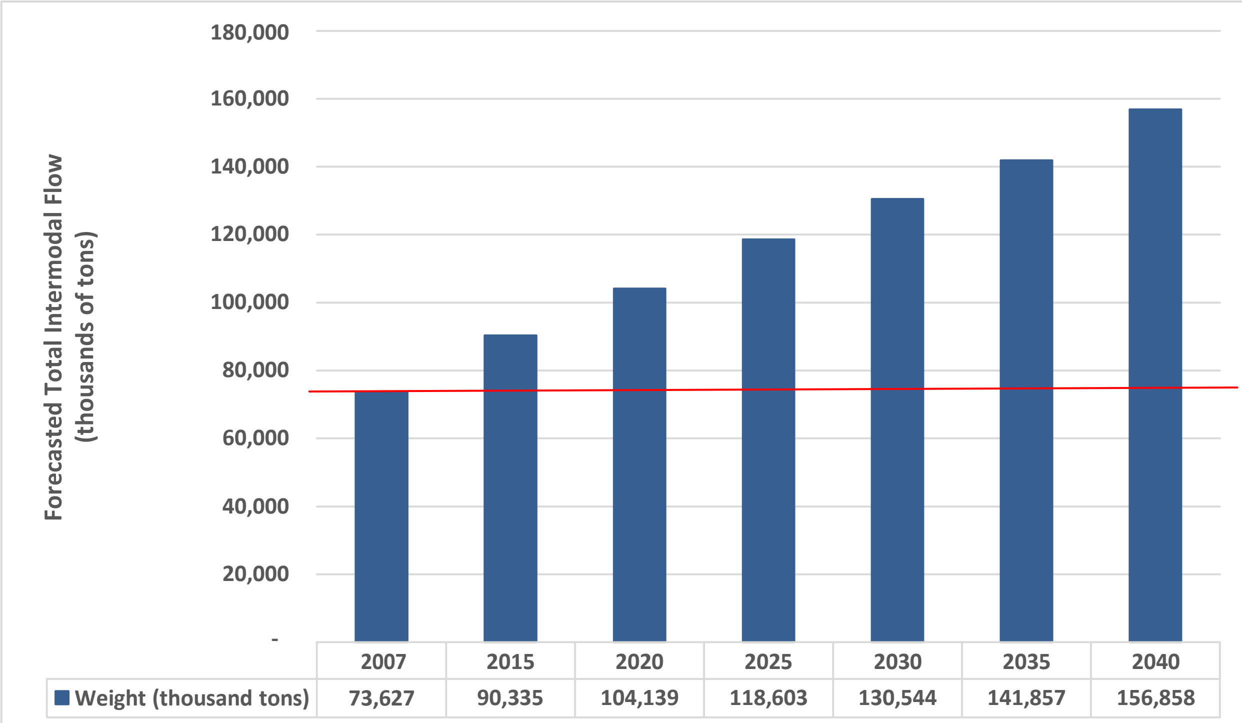

Figure 3.11 Projected intermodal flow in the Pacific Northwest region from 2015 until 2040 (weight)

Chapter 4 Intermodal Freight Transportation Capacity Assessment

4.1 Capacity Assessment Method

An assessment of the existing capacity of the transportation systems in the Pacific Northwest to handle intermodal freight transportation is needed to perform a gap analysis and understand limitations and opportunities. A few questions arise here as one tries to assess the current capacity of intermodal freight transportation in the Pacific Northwest region: how much freight is currently being handled by intermodal facilities yearly? Is there enough infrastructure (e.g., roads, rail, airports, and marine ports) to make these transfers as efficient as possible? Are the facilities working at their full capacity? If so, should there be any planning on expanding the current facilities in order to increase the amount of intermodal freight transportation in the region? These questions should be addressed in the assessment of the current state of intermodal freight transportation capacity in the Pacific Northwest region. The approach taken in this research is explained below.

Information about intermodal facilities in the region was obtained from the directory maintained by IANA [5] to define facilities to be studied in more detail.

The data collection process for capacity included the search for information in the websites of the major intermodal facilities (e.g.., intermodal rail yards, marine ports, and airports) in the Pacific Northwest region. Assuming that intermodal facilities are working at their full capacity, the reports that are available on their respective websites about the freight volume that was transported every year can provide information to estimate a lower bound on their capacity for intermodal freight transportation. For railroads, two major Class I rail lines that carry out most of the freight movement in the region were identified as well as their accessibility to intermodal freight transportation centers in the Pacific Northwest region.

Information about highways was collected from the web as well. For highways, major freight corridors and their intermodal connectors were identified in the Pacific Northwest region along with their proximity to marine ports, air ports, and rail yards. The available information for each mode of intermodal transportation is presented in section 4.2. More detailed information on the data collection process for each mode is provided in the respective sub-section. Additional information about intermodal freight transportation capacity in the region was collected from the published reports that are described in section 4.2.5.

Finally, as described in section 4.3, a questionnaire for intermodal freight transportation stakeholders was developed to collect descriptive information about the current and future state of intermodal transportation in the region from a capacity perspective and validate some of the information obtained from other sources.

4.2 Intermodal Freight Transportation Capacity Data

The first step in the analysis of intermodal freight transportation capacity was the identification of intermodal facilities in the region as classified by IANA in its "Intermodal Facilities Directory" [5]. A total of 100 facilities are listed in IANA's directory in Washington (60), Oregon (12), Idaho (5) and Alaska (23). These facilities and their locations for each state are presented in tables 4.1, 4.2, 4.3, and 4.4, respectively. This listing includes rail and marine port terminals where interchanges between transportation modes occur, but it also includes supporting facilities such as drayage operator facilities, container storage facilities, among others. Note that the listing only includes those facilities that are affiliated to IANA and might not be a complete listing of currently existing intermodal facilities in the region.

Table 4.1 Intermodal facilities located in Washington [5]

Facility Name	City
APMT - TACOMA	TACOMA
HANJIN - PORT OF TACOMA	TACOMA
UP - TACSIM WA	TACSIM
FLEXI VAN LEASING	TUKWILA
BELLINGHAM PORT DOCK	BELLINGHAM
WEST COAST CONTAINER REPAIR	KENT
NORTHWEST CENTER VIRTUAL INVENTORY	PASCO
PACIFIC COAST CONTAINER S SEATTLE	S.SEATTLE
WESTERN PORTS TRANSPORTATION, INC.	SEATTLE
TERMINAL 18 - SEATTLE SSA	SEATTLE
SEATTLE TRANSLOAD, INC.	SEATTLE
PACER CARTAGE SEATTLE	SEATTLE
NORTHLAND SERVICES DOCK	SEATTLE
UNITED MOTOR FREIGHT, INC.	SEATTLE
TRANS-HOLD INC.	SEATTLE
TRANS PACIFIC CONTAINER SERVICE SEATTLE	SEATTLE
TOTAL TERMINALS INTERNATIONAL, TERMINAL 46	SEATTLE
APL/EMS GLOBAL GATEWAY NORTH	SEATTLE
NORTHWEST CONTAINER SERVICE, INC. SEATTLE	SEATTLE
SEA FREEZE	SEATTLE
NORTHLAND MARINE SERVICES SAMSON TUG & BARGE	SEATTLE
PACIFIC COAST INTERMODAL	SEATTLE
SAMSON TUG AND BARGE CO	SEATTLE
SAMSON TUG AND BARGE CO	SEATTLE
CITY ICE	SEATTLE
ALASKA MARITIME LINES/BARGE OP	SEATTLE
BNSF - Seattle Intl Gateway (SIG)	SEATTLE
BOYER LOGISTICS	SEATTLE
CONGLOBAL INDUSTRIES - SEATTLE	SEATTLE
MATSON TERMINALS, INC. SEATTLE	SEATTLE
NORTHWEST CONTAINER SVC (ALTERNATE DEPOT)	SEATTLE
PACIFIC COAST CONTAINER SEATTLE	SEATTLE
SEATTLE INT'L TERMINAL 18	SEATTLE
SHIPPERS TRANSPORT EXPRESS SEATTLE	SEATTLE
SSA TERMINALS SW SEATTLE	SEATTLE
T37, NYK Line	SEATTLE
MACMILLAN-PIPER INC.	SEATTLE
BNSF - South Seattle (SSE)	SEATTLE
UP - SEATTLE (DAS)	SOUTH SEATTLE

BNSF - Inland Empire (SPO)	SPOKANE
WASHINGTON UNITED TERMINALS (WUT TERMINAL)	TACOMA
NORTHWEST CONTAINER SERVICE, INC.TACOMA	TACOMA
MACMILLAN-PIPER INC.	TACOMA
TACOMA TOTEM OCEAN TRAILER EXPRESS	TACOMA
CARLILE TRANSPORTATION SYSTEMS, INC	TACOMA
AFFORDABLE STORAGE	TACOMA
AFFORDABLE STORAGE CONTAINER	TACOMA
BNSF - North Yard (TNO)	TACOMA
CSXI - Lincoln Avenue (LIN)	TACOMA
HUSKY TERMINAL & STEVEDORING, INC.	TACOMA
KONOIKE PACIFIC (K-PAC)	TACOMA
MACMILLAN-PIPER INC.	TACOMA
OLYMPIC CONTAINER TERMINALS LLC (OCT)	TACOMA
PIERCE COUNTY TERMINAL (MARINE TERMINAL CORP.)	TACOMA
PORT OF TACOMA	TACOMA
TACOMA & SEATTLE TRAILER REP.	TACOMA
TRI PAK, INC.	TACOMA
UP - NORTH YARD (TNO)	TACOMA
ELLIOTT BAY SERVICE TRANSFER (H.E.K)	TUKWILA
ROADLINK INTERMODAL	VANCOUVER

Table 4.2 Intermodal facilities located in Oregon [5]

Facility Name	City
TIDEWATER TERMINAL	BOARDMAN
UP - BROOKLYN (BRK)	PORTLAND
NORTHWEST CONTAINER SERVICE, INC. PORTLAND	PORTLAND
PORTLAND CONTAINER REPAIR	PORTLAND
TERMINAL 6 PORTLAND	PORTLAND
BNSF - Lake Yard (YEO)	PORTLAND
CONGLOBAL INDUSTRIES- PORTLAND OR	PORTLAND
MORGAN CFS1	PORTLAND
NORLIFT OF OREGON	PORTLAND
CONTAINER STORAGE DEPOT PORTLAND	PORTLAND
BTS CONTAINER SERVICE, INC.(U.S. CUSTOMS STATION)	PORTLAND
PORT OF UMATILLA	UMATILLA

Table 4.3 Intermodal facilities located in Idaho [5]

Facility Name	City
PORT OF LEWISTON CONTAINER YARD	LEWISTON
APEX CONTAINER, INC.	NAMPA
CONTAINER WEST INC.	NAMPA
CONTAINER WEST INC. VIRTUAL	NAMPA
T.R. COMPTON	NAMPA

Table 4.4 Intermodal facilities located in Alaska [5]

Facility Name	City
PORT OF ANCHORAGE TM 1/CP SHIPS	ANCHORAGE
SEALAND ANCHORAGE TERMINAL	ANCHORAGE
TOTEM OCEAN TRAILER EXPRESS, INC. ANCHORAGE	ANCHORAGE
BETHEL CITY DOCK	BETHEL
ALASKA GLACIER REFRESHMENTS INC.	CHUGIAK
ALASKA MARINE LINES, INC.	CORDOVA
DILLINGHAM CITY DOCK	DILLINGHAM
APL DUTCH HARBOR	DUTCH HARBOR
DUTCH HARBOUR TERMINAL	DUTCH HARBOR
WEAVER BROTHERS	FAIRBANKS
ALASKA MARINE LINE - BARGE SERVICE	HAINES
ALASKA MARINE LINE JUNEAU- C/O JAMESTOWN BAY WHSE	JUNEAU
NORTHLAND MARINE SERVICES JUNEAU	JUNEAU
ALASKA MARINE LINES-KETCHICAN- C/O JAMESTOWN BAY WHSE	KETCHIKAN
KODIAK TERMINAL	KODIAK
NAKNEK CITY DOCK	NAKNEK
PETERSBURG TERMINAL	PETERSBURG
PETER PAN SEAFOODS	PORT MOLLER
SEWARD CITY DOCK	SEWARD
ALASKA MARINE LINE SITKA- C/O JAMESTOWN BAY WHSE	SITKA
NORTHLAND SERVICES, INC.	SITKA
ST PAUL TERMINAL	ST PAUL (PRIBILOF ISLANDS
TOTEM OCEAN TRAILER	VALDEZ

After identifying intermodal facilities in the region, additional information was obtained for rail and marine port facilities by reviewing their respective websites. Similarly, aviation facilities with intermodal capabilities were investigated along with major road connectors in the region. The following subsections summarize the information that was obtained. Additionally, data available in published reports was evaluated and included to provide a more detailed view of the currently existing infrastructure.

4.2.1 Rail

The Pacific Northwest railroad network mainly consists of two Class I railroads: Burlington Northern Santa Fe (BNSF) Railway, and Union Pacific (UP) Railroad (see fig. 2.4). Table 4.5 is a list of rail yards with intermodal capabilities in the Pacific Northwest region categorized by state. The main data sources were the BNSF [6] and UP [25] websites. The facilities that are exclusively designated as intermodal facilities are indicated with an asterisk. Rail freight volumes are measured by railroad companies using gross tons (in millions), and in average trains per day, however these are proprietary information to the rail companies.

Figure 4.1 shows the intermodal service map for BNSF [6], where the intermodal facilities in the region are identified. The layout of the existing intermodal facilities of BNSF: Seattle International Gateway (SIG), South Seattle, Spokane and Portland are shown in figures 4.2, 4.3, 4.4, and 4.5, respectively [6].

Similarly, Figure 4.6 shows the intermodal service map for UP [25], where the intermodal facilities in the region are identified. The location of the existing intermodal facilities of UP: Seattle, Tacoma (TacSim), and Portland are shown in figures 4.7, 4.8, and 4.9, respectively [25].

Table 4.5 Rail yards with intermodal capabilities in the Pacific Northwest

Oregon:
UP
Albina Yard (Portland)
Brooklyn Yard (Portland)*
Klamath Falls Yard
BNSF
Lake Yard (Portland)*
Port of Portland

Idaho:
Hauser Yard (Hauser)
Boyer Yard (Sandpoint)

Alaska:
Whittier
Seward

Washington:
UP
Erie Street Yard (Spokane)
Seattle*
TacSim (Tacoma)*
BNSF
Seattle:
- Seattle SIG*
- South Seattle*
- Balmer Yard
- Stacey Street
Spokane:
- Spokane*
- Yardley Yard
- Hillyard Yard
- Erie Street Yard
Vancouver Yard
Delta Yard (Everett)
Pasco Yard (Pasco)

Figure 4.1 BNSF national intermodal map [6]

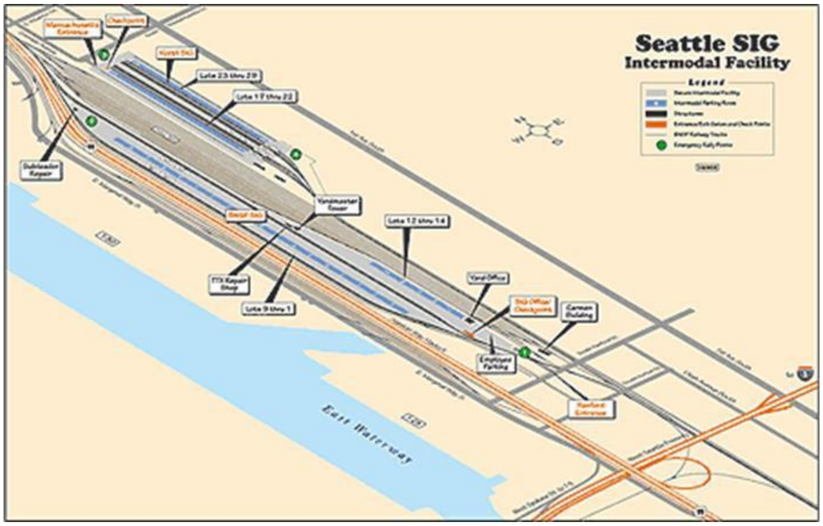

Figure 4.2 BNSF intermodal facility in Seattle SIG [6]

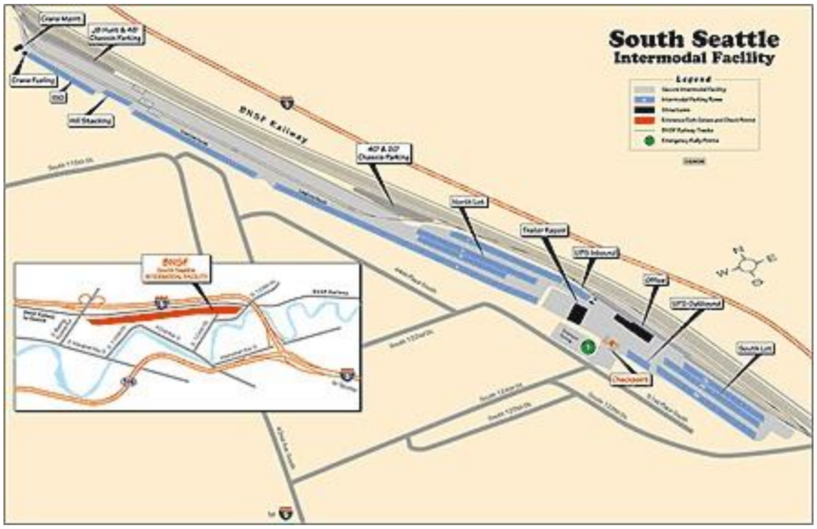

Figure 4.3 BNSF intermodal facility in South Seattle [6]

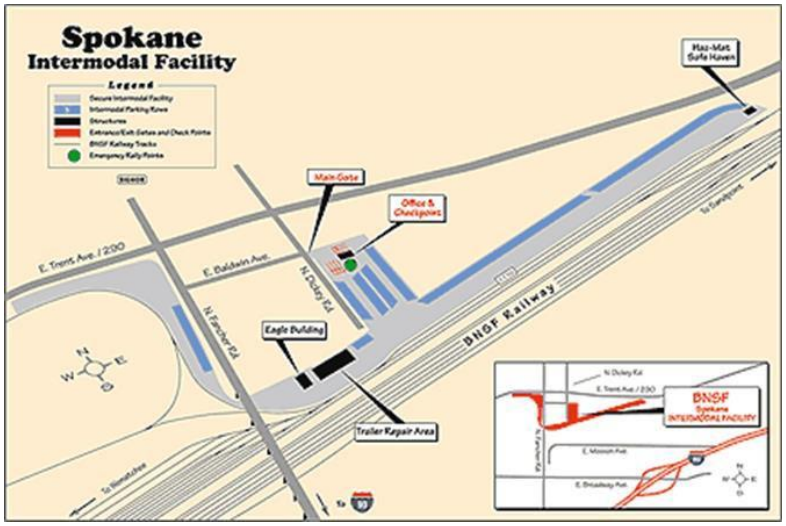

Figure 4.4 BNSF intermodal facility in Spokane [6]

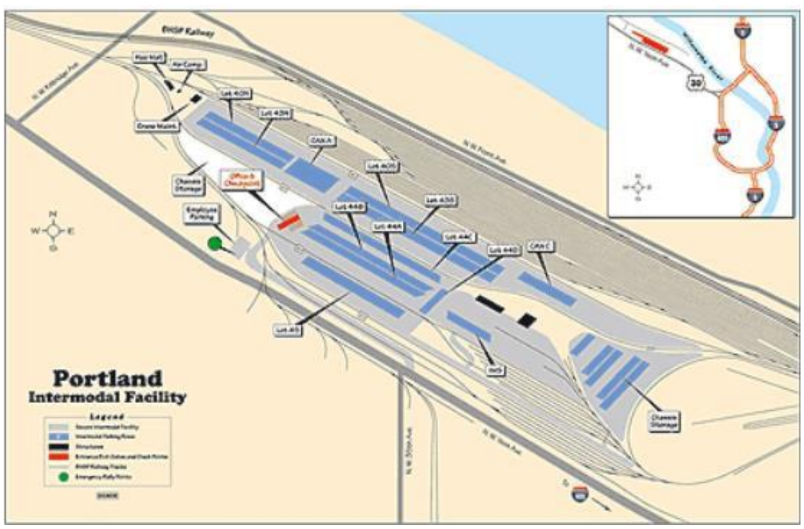

Figure 4.5 BNSF intermodal facility in Portland [6]

Figure 4.6 UP national intermodal map [25]

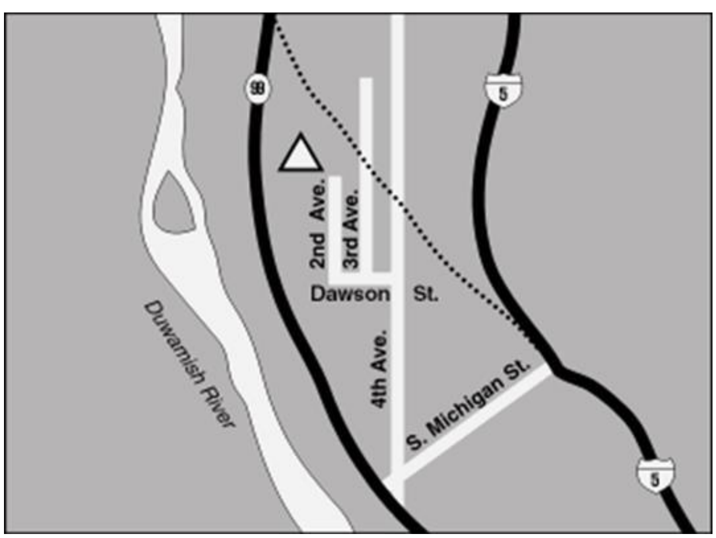

Figure 4.7 Location of UP intermodal facility in Seattle [25]

Figure 4.8 Location of UP intermodal facility in Tacoma (TacSim) [25]

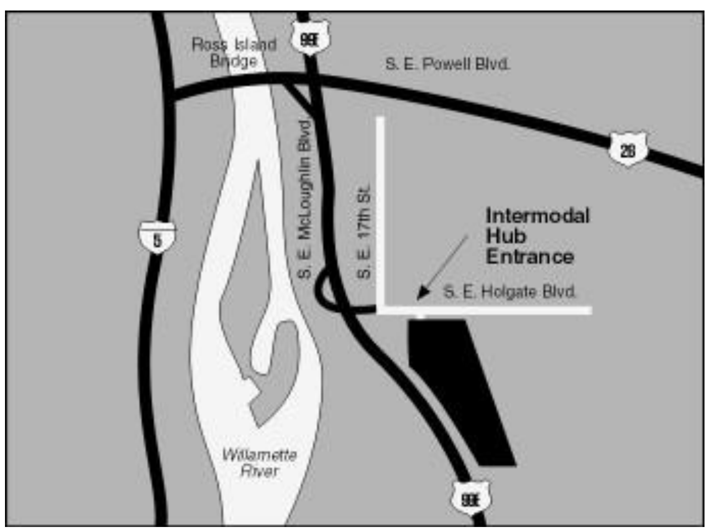

Figure 4.9 Location of UP intermodal facility in Portland [25]

Additional information about rail service in the Pacific Northwest was extracted from the 2011 report of BST Associates and MainLine Management for the Pacific Northwest Rail Coalition [21]. The report shows a projection of the number of trains under moderate and high growth scenarios of demand resulting from increased marine cargo volume in the region and an analysis of the capacity of various mainline segments to handle the additional traffic (including domestic and passenger traffic). Figure 4.10 shows the results of this study in terms of the assessment of the capacity constraints on the mainline segments in Washington and Oregon for BNSF and UP under two different growth scenarios.

	Moderate Growth Scenario		High Growth Scenario	
Line Segment	**Avg. Day**	**Peak Day**	**Avg. Day**	**Peak Day**
Pasco, WA to Vancouver, WA (BNSF)				
Pasco, WA to Wishram, WA	2030	2025	2025	2020
Wishram, WA to Vancouver, WA	---	2030	2025	2024
Hinkle, OR to Portland, OR (UP)	---	---	---	---
Pasco, WA to Spokane, WA (BNSF)	---	---	2030	2025
Spokane, WA to Sand Point, ID (BNSF)	---	---	---	---
Hinkle, OR to Eastgate, ID (UP)	---	---	---	---
Vancouver, WA to Tacoma, WA (Joint Line)				
Vancouver, WA to Kalama/Longview, WA	---	---	---	2030
Kalama/Longview, WA to Tacoma, WA	---	---	---	---
Tacoma, WA to Seattle, WA (Joint line)				
Tacoma, WA to Auburn, WA	---	---	---	---
Auburn, WA to Seattle, WA	---	---	---	---
Seattle, WA to Everett, WA (BNSF)	---	---	2023	2020
Everett, WA to Vancouver, BC (BNSF)	---	2030	2025	2020
Everett, WA to Spokane, WA via Stevens Pass (BNSF)	---	---	---	---
Auburn, WA to Pasco, WA via Stampede Pass (BNSF)	---	---	---	---

Source: MainLine Management

Figure 4.10 Anticipated year of capacity constraints, by line segment [21]

4.2.2 Waterway (Marine)

Marine ports play a significant role in freight movement in the Pacific Northwest region. Most of the international freight flow in the region is moved from/to the marine ports of Portland, Seattle, and Tacoma (the latter two form the “Northwest Seaport Alliance”). The Port of Portland is also connected to the Port of Lewiston, Idaho, which is the only marine port of Idaho, through the Columbia-Snake river system. Alaska has the marine Port of Anchorage as the key marine port for its marine freight transportation. Table 4.6 shows information obtained from the websites of representative marine ports in the region [26] – [36].

Available freight flow information for marine ports has been summarized in tables 4.7, 4.8, 4.9, and 4.10 for each state, respectively. This information will inform the comparison of intermodal freight transportation demand and capacity in section 5.

4.2.3 Aviation

Air freight movement in the Pacific Northwest region is mainly handled at the Portland International Airport (PDX) and Sea-Tac International Airport. Despite most of the freight flow is handled at these two airports, other airports provide capacity for freight movement in the region. Table 4.11 shows a list of airports in the Pacific Northwest that perform freight movement operations. Some information about characteristics of the airports such as proximity to marine ports, air cargo carriers, rail access, area, and cargo handling facilities are provided in table 4.11. These characteristics are helpful in the assessment of the current capacity of the airports for intermodal transportation. The data sources were each airport’s website [37] - [41].

Available freight flow information for airports has been summarized in table 4.12. This information will inform the comparison of intermodal freight transportation demand and capacity in section 5.

Table 4.6 Marine ports with intermodal facilities in the Pacific Northwest

Ports	Terminals	Number of Berths	Number of Cranes	Area (acres)	Warehouses at Site (sq. ft.)	Rail Access (on site)	Other
Port of Tacoma (WA) [26]	6+6	12	25	594	50 local warehouses	Yes	-
Port of Seattle (WA) [27]	4+3	12	27	523	local warehouses	Yes	-
Port of Everett (WA) [28]	5	8	4	-	-	Yes	-
Port of Longview (WA) [29]	3	8	-	-	500,000 (warehouse complex)	Yes	-
Port of Bellingham (WA) [30]	1	4	-	10 + 85,000 sq. ft.	-	Yes	-
Port of Port Angeles (WA) [31]	3	3	-	-	-	No	9 fork lifts, 6 log stackers
Port of Portland (OR) [32]	4	13	9	644	300,450	Yes	27.5 acres open storage are
Port of Umatilla (OR) [33]	3	-	1 (52 ton gantry crane)	-	-	Yes	2 top pick container handlers
Port of Coos Bay (OR) [34]	6	7	-	-	-	Yes	-
Port of Lewiston (ID) [35]	-	-	1 (240 ton mobile crane with 120-foot boom)	85	150,000	Yes (at warehouse section)	3 35-ton diesel container top lift trucks, 3 4-ton and 1 15-ton forklift trucks
Port of Anchorage (AK) [36]	3	4	2 (30 ton) + 1 (40 ton)	2,100 ft. of dock face	27,000 (heated storage)	Yes	-

Table 4.7 Freight data in Washington's main marine ports

Port of Tacoma [26]

Year	2012	2013
Containerized Cargo (tons)	12,007,646	14,075,373
Intermodal Lifts	439,760	486,365
Total Vessel Calls	1,106	1,278
Total Tonnage	17,917,598	17,938,799

Port of Longview [29]

Year	2012	2013
Total Tonnage	6,266,024	7,372,705
Vessel Calls	225	247

Port of Seattle [27]

Year	2012	2013
Total Containerized Tons	16,122,108	13,759,006
Non-Containerized Break Bulk	67,784	64,040
Grand Total Tonnage (Bulk)	20,046,323	16,011,122
Vessel Calls	1,487	1,420

Port of Everett [28]

Year	2009	2010
Total Tonnage	126,008	113,54
Vessel Calls	151	144

Table 4.8 Freight data in Oregon's main marine port

Port of Portland [32]

Calendar Year	Vessel Calls	Total Tonnage	Breakbulk Tonnage	Container TEUs			Automobile Units	Grain Tonnage	Mineral Bulk Tonnage
				Export	Import	Total			
2012	544	12,351,569	985,259	101,108	82,095	183,203	284,138	4,020,663	4,800,315
2013	514	11,937,580	903,067	96,115	82,336	178,451	262,512	3,511,490	5,072,060

Table 4.9 Freight data in Idaho's main marine port

Port of Lewiston [35]

Year	2011	2012	2013
Container Shipments (TEUs)	3,653	4,676	4,439

Table 4.10 Freight data in Alaska's main marine port

Port of Anchorage [36]

Year	2010	2011	2012
Total Freight Tons	3,962,962	4,135,214	3,754,231

Table 4.11 Airports with intermodal facilities in the Pacific Northwest

Airports	Carriers	Proximity to Seaports	Rail Access	Area (acres)	Parking Area (planes)	Federal Inspection Services (on site)
Sea-Tac International (WA) [37]	Alaska, Cargolux, China Airlines Eva Air, FedEx, Korean Air Cargo, Martinair Cargo	Yes	Yes	200 (logistics)	17	Yes
Bellingham International (WA) [38]	Alaska/Horizon, FedEx	Yes	Yes	1,663	-	No
Portland International Airport - PDX (OR) [39]	Aero Flight, Air Canada, Alaska, American Airlines, Ameriflight, Schenker, DHL, Empire Airlines, FedEx, Flight Frontier, Hawaiian, Southwest, United, UPS	Yes	Yes	-	-	Yes
Boise (ID) [40]	FedEx, Air Mail Facility, UPS, Westerm Air Express	No	Yes	-	-	Yes
Ted Stevens - Anchorage (AK) [41]	Air China, Cargolux, China Airlines, Shanghai Airlines cargo, Singapore Airlines	Yes	No	4,612+	500 (landings per week)	Yes

Table 0.1 Freight data in Pacific Northwest's main airports

Sea-Tac Airport (WA) [37]

Year	2011	2012	% Change
Domestic Freight (tons)	152,211	155,170	1.94%
International Freight (tons)	81,918	82,041	0.15%
Total Air Mail (tons)	45,496	46,289	1.74%
Total Cargo (tons)	279,625	283,500	1.40%

PDX (OR) [39]

Year	2012	2013	% Change
Domestic Freight (tons)	198,409	202,889	2.30%
International Freight (tons)	13,464	9,525	-29.30%
Total Enplaned & Deplaned Freight (tons)	211,873	212,414	0.30%

Boise Airport (ID) [40]

Year	2012	2013	% Change
Enplaned (lbs. in thousands)	39,181	39,368	0.48%
Deplaned (lbs. in thousands)	46,080	48,507	5.27%

Anchorage Airport (AK) [41]

Year	2012	2013	% Change
Enplaned (lbs. in thousands)	955,965	905,996	-5.23%
Deplaned (lbs. in thousands)	875,209	817,690	-6.57%
In-Transit (lbs. in thousands)	4,060,139	3,652,361	-10.04%

4.2.4 Road

There are four major highways in the Pacific Northwest region that play an important role in intermodal freight transportation: I-5, I-84, I-82, and I-90.

I-5 forms part of an international freight corridor connecting Oregon with California and Mexico to the south, and Washington with Canada to the north, while I-84 provides connection to the east including Utah and other eastern states [42]. I-90 connects Washington to eastern states and it is the longest interstate highway in the United States with its western terminus in Seattle, Washington, and its eastern terminus located in Boston, Massachusetts. I-82 extends from I-90 in Washington, connecting Washington to Oregon [43]. There are other state and national highways that are considered important for intermodal transportation in the region, but most of the freight that is moved through them derives from one of the major interstate highways mentioned above.

Table 4.13 shows data related to freight transportation for each highway. The first field "Daily Traffic Volume" shows the annual average traffic obtained from the Traffic Data section of the Oregon Department of Transportation (ODOT) [42] and the Washington State Department of Transportation (WSDOT) [43] websites. Intermodal connectors are regarded as an important element in intermodal freight transportation since they provide a means to exchange between different modes of intermodal freight transportation. The Federal Highway Administration of the U.S. Department of Transportation [44] provides a list of intermodal connectors in each state as part of the information available for the National Highway System (NHS); the intermodal connectors that are located on these four interstate highways are also listed in table 4.13. Data for the remaining fields (i.e., truck stops, weight of shipment, and port of entry) are derived from the ODOT [42] and WSDOT [43] websites. This information can be beneficial in terms of providing a picture of current capacities and infrastructure near roads.

Table 0.2 Highways with access to intermodal facilities in the Pacific Northwest

HW	Daily Truck Volume	Connectors to Intermodal Facilities	Truck Stops	Weight of Shipment (tonnage)	POE (Port of Entry)
I-5	12,000 (Portland area)	Yes	WA: Toledo, Longview, Ridgefield Oregon: Portland, Aurora, Brooks, Eugene, Rice Hill, Roseburg, Canyonville, Wolfcreek, Central Point, Medford, Phoenix	125,000,000	Ashland, Woodburn, Portland Bridge
I-84	-	Yes	Oregon: Troutdale, Biggs Junction, Pendleton, Hermiston, Stanfield, La Grande, Baker City, Ontario, Idaho: Caldwell, Boise, Mountain Home	62,500,000	Cascade Locks, Farewell Bend
I-82	-	Yes	Union Gap (Washington)	62,500,000	Umatilla
I-90	-	Yes	WA: North Bend, Cle Elum, Thorp, Ellensburg, Kittitas, Vantage, George, Royal City, Moses Lake, Lind, Ritzville, Tokio, Sprague, Chamberlain, Spokane, Greenacres, Otis Orchards Idaho: Post Falls, Huetter, Coeur D'Alene, Cataldo, Mullan	<62,500,000	Spokane

4.2.5 Additional Information

The reader is referred to other published reports for more detailed information about existing intermodal facilities in the Pacific Northwest region such as the BST Associates and MainLine management report for the Pacific Northwest Rail Coalition in 2011 [21] that completes a rail capacity assessment for regional mainlines considering updated marine cargo forecasts, the BST Associates report for the Port of Portland in 2010 [20] that includes information about port facilities in Portland and the Lower Columbia River, the WOC #2 [17] and WOC #6 [18] reports for the Oregon Department of Transportation (ODOT) with information about the transportation infrastructure in the state of Oregon, and the Washington State 2010-2013 Freight Rail Plan [45].

4.3 Intermodal Freight Transportation Capacity Questionnaire

A questionnaire was developed and a list of stakeholders was generated including terminal/equipment depot operators, third-party logistics providers, and road carriers (i.e. drayage operators) to obtain descriptive information about the current and future state of infrastructure and planning capacity to handle intermodal transportation in the Pacific Northwest. Additional descriptive information comes from published reports that have carried out more extensive and in-depth surveys of stakeholders in the region. The information obtained is used in addition to the numerical data to inform the SWOT analysis presented in section 5.2.

Table 4.14 shows the questions developed for intermodal transportation stakeholders to obtain information about the current state of intermodal transportation infrastructure and planning in the region.

A group of 5 terminal/equipment depot operators, 14 third-party logistics providers and 13 road carriers were identified from an original listing of 12 terminal/equipment depot operators, 42 third-party logistics providers, and 61 road carriers. From this sample, only 3 third-party logistics providers and 3 road carriers responded to the questionnaire over the phone. The respondents maintain operations mainly in Washington and Oregon. The actual names of the companies that participated have not been disclosed due to confidentiality of the information provided.

Table 0.3 Intermodal freight transportation capacity assessment questionnaire

<table>
<tr><th>Questions</th></tr>
<tr><td>For terminal/equipment depot operators:

Do you consider that the current available space and equipment to handle intermodal containers in your facility are sufficient to satisfy the existing demand?
Does your company plan to expand the available space that is dedicated for intermodal freight transportation within the next 5 years? 10 years?
Does your company currently schedule resources (i.e., equipment, space, and workers) using a commercial decision support tool.
</td></tr>
<tr><td>For third-party logistics providers:

Please estimate, what is the proportion of shipments from customers for which you select the mode of transportation?
What are the main challenges with the selection of intermodal as the preferred mode of transportation for a particular shipment?
Please estimate, what is the proportion of intermodal shipments that you arrange that are dispatched on time?
Does the Pacific Northwest require more and/or improved railroad access?
</td></tr>
<tr><td>For road carriers:

What are the main reasons when you accept a shipment request corresponding to intermodal transportation?
What are the main reasons when you decline a shipment request corresponding to intermodal transportation?
Please estimate, what is the proportion of shipments corresponding to intermodal transportation that you decline?
</td></tr>
<tr><td>Common questions:

What is the biggest challenge associated with satisfying the demand associated with intermodal freight transportation?
What is the most important limitation for the expansion of intermodal transportation service in the Pacific Northwest?
What are the perceived benefits of using intermodal freight transportation from your perspective?
</td></tr>
</table>

Chapter 5 Gap Analysis

5.1 Comparison of Intermodal Transportation Demand and Capacity

The gap analysis between intermodal freight transportation demand and capacity performed in this research is informed by both quantitative and qualitative information. A comparison between values of projected intermodal transportation demand in the region and existing capacity is required to provide quantitative information that can be used in the analysis. This comparison is completed considering aggregate-level demand and capacity information that was collected as described in chapters 3 and 4, respectively. Note that the accuracy of the data might not be very high, but it will help us to identify the major trends at the regional level.

According to the accumulated freight handling capacity observed for major ports in the Pacific Northwest in year 2012 (see section 4.2), we can establish a lower bound on the capacity of the transportation facilities in the region that can handle intermodal freight transportation. The lower bound is set at a total of **56,953,660 tons** of freight in a year according to the data for year 2012.

To compare the identified infrastructure capacity with the estimated intermodal freight transportation demand data, several scenarios of demand growth were considered: baseline, 25% decrease from baseline, and 25% increase from baseline.

A *baseline* demand growth scenario was set based on the projected information for 2012 of the freight transportation flow (i.e., demand) that can be obtained from the FAF^3 database [3]. As described in section 3.1.1, the FAF^3 database divides shipments according to their mode into eight different categories. Among all of these categories, “Multiple Modes & Mail” was considered to represent the flows associated with *intermodal transportation*. As a result, the total flow including domestic, import and export flows that were moved using this category were considered when calculating the intermodal freight transportation demand for the Pacific Northwest region.

Figure 5.1 presents the estimated total intermodal transportation flow (i.e., demand) that is projected to exist between 2015 and 2040 in intervals of five years based on the method employed in the FAF[3] [3] to forecast future system demand.

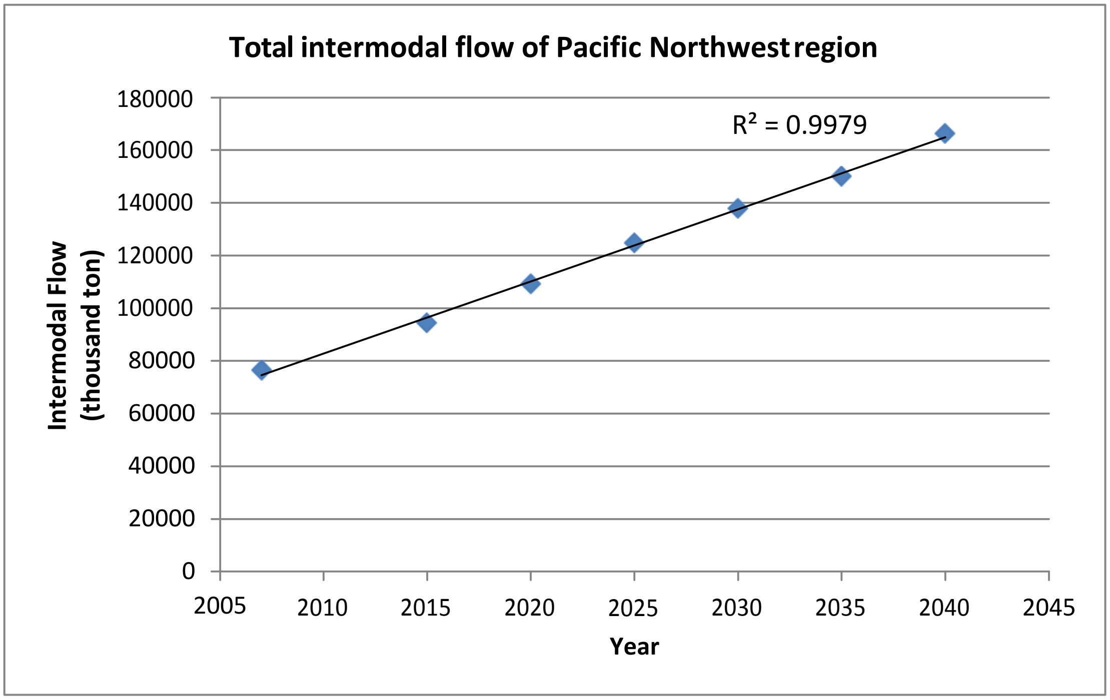

Figure 5.1 Projected intermodal flow in the Pacific Northwest between 2015 and 2040 (weight)

A linear regression (R-squared = 0.9979) of the data in figure 5.1 allowed us to interpolate the value of estimated intermodal freight transportation demand for 2012. According to figure 5.1 the total intermodal demand including the domestic flow as well as import and export flow in 2012 was **88,236,440 tons**. Since the infrastructure capacity of major ports and airports was **56,953,660 tons**, there was a significant gap between the total intermodal freight transportation demand and the infrastructure of major ports and airports in 2012. However this significant gap cannot be considered as a gap between intermodal freight transportation demand and infrastructure capacity because there are several smaller terminals that handle freight loads that are transferred between rail and trucks that were not included in the estimation of capacity of major ports and airports in the Pacific Northwest region. While these smaller terminals mostly handle domestic flows, international flows are handled in major ports and airports. Therefore, for a better estimate of the gap that exists between intermodal freight transportation demand and infrastructure capacity, the domestic demand should be excluded from total flow. Figure 5.2 presents the international freight flow that goes through or out of the Pacific Northwest region using intermodal transportation according to the information derived from the FAF^3 database.

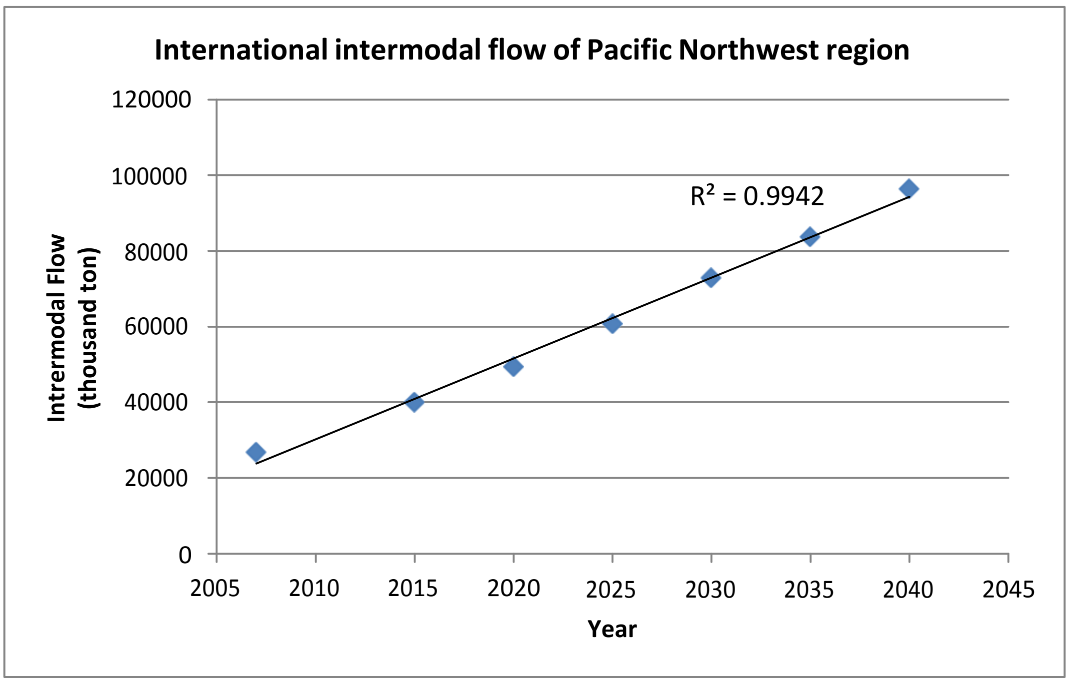

Figure 5.2 Projected international intermodal freight flow in the Pacific Northwest between 2015 and 2040 (weight)

Based on a linear regression (R-squared = 0.9942) of the information in figure 5.2, the total international intermodal flow in 2012 was **34,488,720 tons**. When compared to the capacity estimated for major ports and airports in 2012 (56,953,660 tons), a gap of 22,464,940 tons between the international freight transportation demand and the capacity of major intermodal ports in 2012. This is an aggregate-level analysis for the region, and does not explicitly consider specific limitations that may exist in some parts of the intermodal transportation system.

Knowing that major ports and airports in Pacific Northwest have more capacity than the existing international freight transportation demand, stakeholders can plan to attract more international flow.

Assuming that the intermodal demand grows according to what the FAF^3 database predicts and the intermodal infrastructure capacity remains the same as it was in 2012, the gap between intermodal demand and capacity can be calculated for future years in order to identify at an aggregate-level when the current capacity could be exceeded by potential intermodal transportation demand in the region.

First, note that according to figure 5.2, the total international flow including exports and imports in 2040 is predicted to be **96,281,354 tons**. As a result, it is projected that if no new intermodal infrastructure is installed until 2040; there will be a negative gap of **39,327,685 tons** between the international demand and capacity of major intermodal ports by 2040. This indicates that, there should be several enhancement projects that determine the location and capacity of new intermodal facilities in the Pacific Northwest region. Moreover, with no capacity improvements, the demand would exceed the installed capacity in major ports that handle intermodal transportation by 2022 (see point A in fig. 5.3).

Figure 5.3 shows the projections considering two additional scenarios of demand growth: a scenario with a 25% increase on the projected growth of the baseline case (representing a significant acceleration), and another scenario with a 25% decrease on the projected growth of the baseline case (representing a significant slowdown).

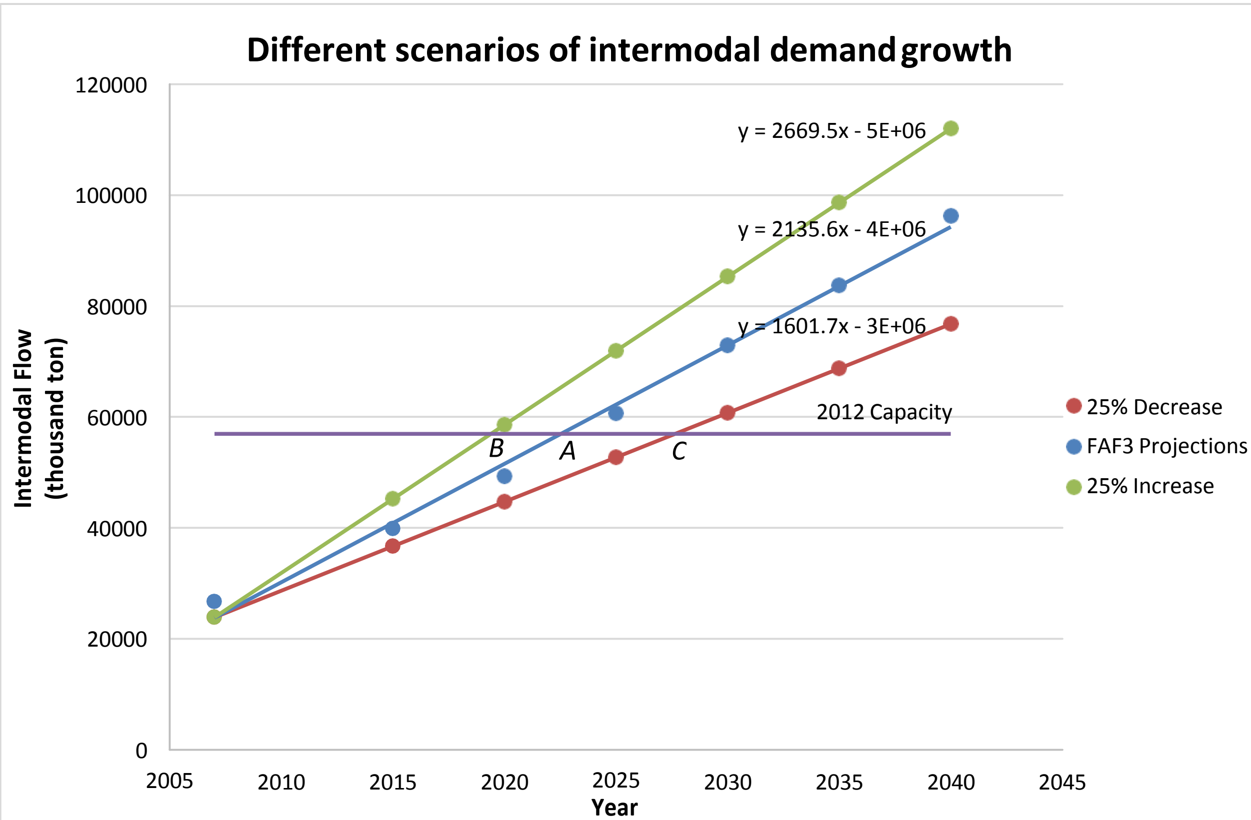

Figure 5.3 Intermodal demand growth under three different scenarios until 2040 (weight)

In figure 5.3, the 25% increase scenario considers an increase in the slope of the demand growth regression line based on the FAF^3 database projections (see fig. 5.2). The slope of the regression line in figure 5.2 is 2,135.6. With an increase of 25%, the slope for the regression line is now 2,669.5 as shown in figure 5.3. This new rate for demand growth shows that the international freight demand in 2040 is projected to be **111,984,700 tons**, which indicates that if the estimated capacity of 2012 (56,953,660 ton) remains constant; there will be a negative gap of 55,031,040 tons between demand and capacity by 2040. In order to handle this increased rate of demand growth of 2,669.5 tons per year, the estimated capacity 2012 capacity must be almost doubled by 2040. Under this scenario, the international freight demand is estimated to reach or surpass the capacity of major ports in the region by 2019 (see point B on fig. 5.3).

The third scenario assumes a 25% decrease in the slope of the regression line representing demand growth in figure 5.2. The new slope for the demand growth regression line is 1,601.7 (see fig. 5.3). Based on this growth rate, the international freight demand in 2040 is projected to be **76,747,300 tons**, which indicates a negative gap of 19,793,640 tons between intermodal demand and capacity by 2040, under the assumption that the 2012 estimated capacity is kept constant. Under this scenario, the international freight demand is estimated to reach or surpass the capacity of major ports in the region by 2028 (see point C on fig. 5.3).

In conclusion, all three scenarios indicate a future gap in 2040 between international intermodal demand and capacity with the demand surpassing the capacity. Also, according to FAF^3 projections, the international freight transportation demand is estimated to reach or surpass capacity at an aggregate level as soon as in 2019 and as late as 2028 if enhancement projects in the infrastructure of intermodal transportation of the Pacific Northwest region are not made. Note that the estimation of capacity considered only a lower bound on the actual installed capacity, which means that these projections are product of a rather pessimistic outlook of the current situation and might indicate that actual constraints in the system at an aggregate level could be observed later than anticipated in this analysis.

5.2 SWOT Analysis

Based on the quantitative and descriptive information collected in this study, the gap analysis between current and future capacity and demand for intermodal freight transportation in the Pacific Northwest region was made using a Strength, Weaknesses, Opportunities and Threats (SWOT) approach. Although a SWOT analysis is originally intended as a structured planning method for specific business ventures or projects, it can also be used to evaluate an entire industry [23]. A particular characteristic of the SWOT analysis is that it considers a long-range planning horizon. The SWOT analysis includes specifying an objective for the subject of the study and identifying internal and external factors that help or prevent to achieve that objective [24].

The objective set for the SWOT analysis was defined as: "*intermodal freight transportation capacity in the Pacific Northwest will be able to handle an increase in 2% in the share of total freight demand that corresponds to intermodal transportation by the year 2040.*" This objective was set considering the projections derived from the FAF^3 database with respect to the participation of intermodal transportation among all other transportation modes in the region. Figure 3.1 in section 3 shows that the participation of intermodal transportation was only 4% in 2007. The objective considers increasing this share to 6% by 2040. The projection made in the FAF^3 database show an increase of just 1% in the same time period, but it does not consider significant changes in the economy, capacity, transportation costs and technology. The objective set above could be considered ambitious, but recent efforts to increase the efficiency and sustainability of long-haul freight transportation systems suggest that it still may be attainable.

Table 5.1 shows the SWOT matrix that was developed based on the information collected and analyzed in this study.

Table 5.1 SWOT matrix for intermodal freight transportation in the Pacific Northwest

	Strengths	**Weaknesses**
Opportunities	• Port of Seattle, Port of Tacoma, and Port of Portland have intermodal facilities for containerized cargo • Current capacity of major ports in the Pacific Northwest exceeds the current amount of international freight that generates, terminates or goes through the Pacific Northwest • Two Class I Railroads have intermodal service and facilities in the region • Available port connectivity (rail and road access to marine terminals) • Prevalent perception among stakeholders that using intermodal transportation reduces gas emissions when compared to trucks • Prevalent perception among stakeholders that using intermodal transportation reduces road congestion	• Port of Portland does not serve a very significant flow of inbound containerized cargo for not being "first port of call" • California environmental regulations may shift containerized traffic to Pacific Northwest, but regional legislation in WA and OR can change to follow similar regulations • Prevalent perception among stakeholders that intermodal transportation is circuitous and might be affected by rail congestion • Prevalent perception among stakeholders that more coordination is needed to minimize delays • Projected international freight flow in the Pacific Northwest in 2040 exceeds the current capacity of major ports in the region
Threats	• Reductions in containerized cargo vessel calls at the Port of Portland may limit intermodal transportation demand leaving capacity unused • Panama Canal expansion might reduce traffic to Pacific Northwest ports leaving capacity unused	• Lack of economies of scale in operations outside of Puget Sound and Portland metropolitan regions due to absence of large metropolitan population • With the exception of Sea-Tac, limited international air cargo flights to and from the region • Prevalent perception among stakeholders that highway congestion near Portland and Puget Sound region is detrimental to intermodal service with increased delays and cost of operations • Labor disputes affect marine port operations

5.2.1 Opportunities-Strengths

The most significant strength of the Pacific Northwest as an intermodal freight transportation hub is the existence of the marine ports in the Puget Sound (e.g., Port of Seattle and Port of Tacoma) which are able to handle a large volume of containerized freight and have intermodal facilities and equipment available to integrate to rail and road efficiently connecting with other markets in the United States. At an aggregate level, the current capacity of the main marine ports in the Pacific Northwest exceeds the demand of international freight that originates, terminates or goes through the region.

Although the Port of Portland has a much lower volume of containerized freight than the ports in the Puget Sound, it does provide an important service to a good portion of outbound flow for freight that generates in the immediate region and there is a general perception from stakeholders that the service is good. Service reliability is one of the primary considerations for shippers [18].

In addition, two Class I railroads (e.g., BNSF and UP) have intermodal service and dedicated intermodal facilities in the region facilitating train-road intermodal transportation. There is a perception from stakeholders that the available port connectivity with the railroads is adequate, but it can always be improved.

Also, there is a general sense among stakeholders that intermodal freight transportation brings significant benefits from both sustainability and service points of view as they consider that intermodal transportation reduces gas emissions as compared to using truck when moving freight over long distances and reduces road congestion.

Regarding greenhouse gas (GHG) emissions, based on information on the U.S. Department of Transportation website [46], the transportation sector is the second largest source of GHG emissions in the country after electricity generation. Freight and passenger transportation directly accounted for about 28 percent of total GHG emissions in 2006 (see fig. 5.4). Within the freight transportation industry, road transportation (i.e. medium and heavy-duty trucks) is the most polluting, while other freight transportation modes accounted for much less GHG emissions in 2006 (see fig. 5.5). For example, freight trains are almost four times more fuel-efficient than trucks and have less environmental effects when compared to trucks. Since intermodal transportation mostly uses truck shipments only in the first and last part of shipments (in pickup and delivery) and uses other transportation modes in long-haul shipments, intermodal transportation has the potential to significantly reduce greenhouse gas emissions when compared to using only trucks for this service.

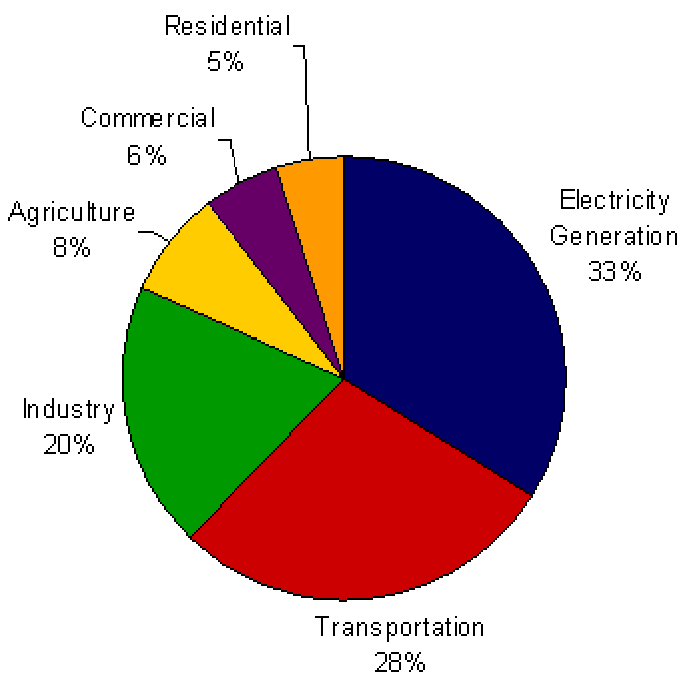

Figure 5.4 Percentage of U.S. greenhouse gas emissions in 2006 [46]

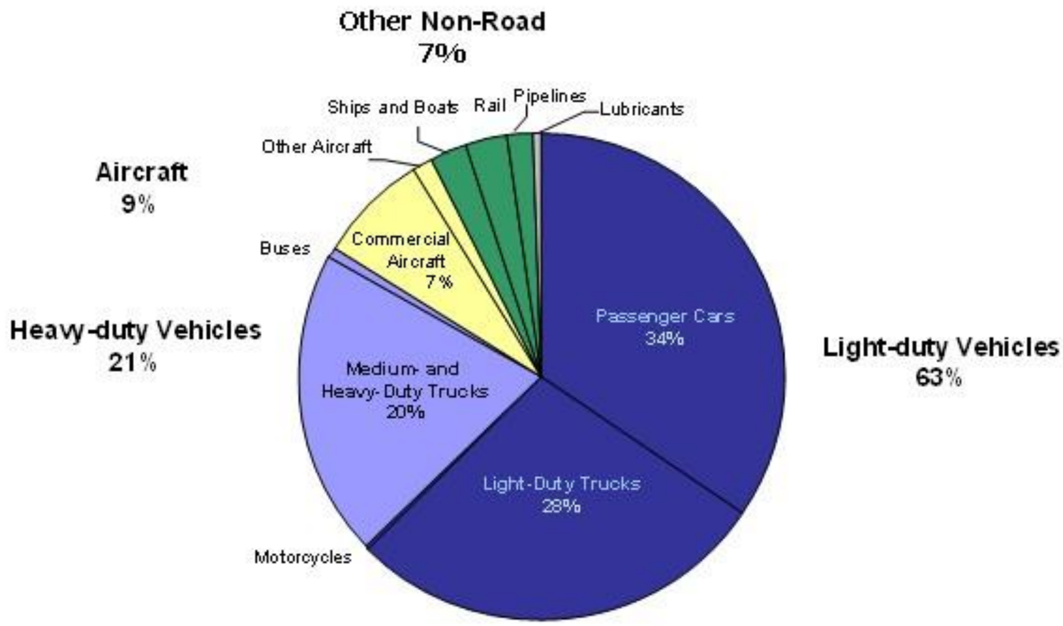

Figure 5.5 U.S. transportation greenhouse emissions by source in 2006 [46]

A similar strength of the intermodal transportation industry as perceived by stakeholders relates to road congestion. Long-haul shipments are done using a non-road mode of transportation like rail, water or air. As a result, using intermodal transportation can reduce road congestion by shifting traffic away from congested roads to rail, water or air.

5.2.2 Opportunities-Weaknesses

One of the factors that can be considered a weaknesses, but if addressed it could represent an opportunity for the region is the fact that the Port of Portland provides service mostly for exports rather than imports and has a reduced intermodal flow since it is not considered as a “first port of call” for ocean carriers and the actual availability of ocean carriers serving the Port of Portland is limited [18]. Port of Seattle and Port of Tacoma have larger ocean carrier availability and more favorable rail intermodal service according to the information provided by stakeholders.

An external factor that can be considered an opportunity for the region in terms of becoming an important intermodal freight transportation hub is the implementation of environmental regulations in California that might motivate shippers to shift containerized traffic to the Pacific Northwest ports (especially Port of Seattle and Port of Tacoma). However, the legislation in the states in the Pacific Northwest can change in the future to follow similar regulations to those imposed in California which will affect the competitiveness of the region.

Another potential weakness observed by stakeholders about the current state of intermodal freight transportation in the region is their perception that intermodal flows that are domestic and do not travel very long distances are very circuitous and might be affected by rail congestion [18]. Capacity improvements in the rail mainlines (especially east-west) of the Class I Railroads might shift that perception in the future.

There is also a general perception among intermodal transportation stakeholders that more coordination is needed to minimize delays and congestion in the system. This represents an opportunity in terms of planning models and technology solutions that can be developed and implemented to facilitate coordination between different stakeholders.

From the numerical analysis comparing intermodal freight transportation demand and capacity in the Pacific Northwest at an aggregate level, the projected international flow that is inbound, outbound or goes through the region by 2040 will exceed the current capacity of major ports in the region which can at this time be considered a weakness but at the same time represents an opportunity by having the required volume to justify expansion of the current capacity to be able to serve the demand.

5.2.3 Threats-Strengths

Having available intermodal capacity at the Port of Portland is considered a strength at the regional level, however a reduction in the availability of ocean carriers serving the port or a reduction of the number of vessel calls for those currently available will impact not only this port but also other ports in the Columbia-Snake river system. This will affect the availability of intermodal freight transportation service in places like Umatilla, OR and Lewiston, ID.

Also, a current strength of the Pacific Northwest refers to the preference of shippers that use the Pacific Northwest ports because of its geographical location connecting Eastern markets in Asia with the most populated markets in the Midwest region of the Unites States. However, an external factor that becomes a threat to this competitive advantage and affect the expansion in the share of intermodal freight transportation service in the region is the expansion of the Panama Canal which might result in shippers deciding to replace using the marine ports in the Pacific Northwest and the rail intermodal system east-west across the country in favor of routing their freight through the Panama Canal to East and Gulf Coast ports due to cost reasons [18].

5.2.4 Threats-Weaknesses

A factor that affects the expansion of intermodal freight service in the Pacific Northwest especially for domestic long-haul transportation is that with the exception of the Puget Sound and Portland metropolitan regions, no other large metropolitan centers exist in the region. This results in a reduction of inbound and outbound freight and affects the economies of scale needed to consolidate shipments and use intermodal freight service. Balance in inbound and outbound flows is important to facilitate equipment management and justify intermodal freight transportation service.

Also, with the exception of the Sea-Tac International Airport, there are very limited international air cargo flights that serve the region. PDX mostly serves regional air cargo flights which limits options for shippers from the area [18].

A very significant factor that affects the perception of stakeholders is that highway congestion near Portland and in the Puget Sound region significantly impacts intermodal freight service in the region by producing increased delays and affecting the cost of operations. According to stakeholders' comments, this is the single biggest factor that affects decision making when deciding transportation modes for shippers and the decisions to accept/decline shipments for road carriers serving intermodal facilities in these areas.

Another factor affecting the perception of stakeholders with respect to current level of service and future growth of intermodal freight transportation is the risk of experimenting delays and less reliable service from marine ports due to labor disputes that could significantly affect port operations.

Chapter 6 Conclusions and Recommendations

An aggregate level assessment of the capacity of the Pacific Northwest as an intermodal transportation hub was completed in this research. The findings presented in this study are based on quantitative information at the aggregate level for the region obtained from publicly available sources, and descriptive information based on a small sampling of stakeholders of the intermodal transportation system. However, information in published reports with more in-depth and larger samples of intermodal freight transportation stakeholders have been used to complement and validate information about the capacity available for intermodal freight service, and also to determine perceptions about future expected growth for the industry. For this reason, only broad conclusions are presented highlighting the general trends observed when completing a gap analysis between demand and capacity considering a long time horizon (i.e., until 2040).

The most significant source of intermodal freight transportation demand in the region corresponds to international containerized cargo that originates, terminates or goes through the region. The capacity available and other factors make Washington the most dominant player in the region for intermodal freight transportation with the Port of Seattle, the Port of Tacoma and intermodal facilities for two Class I railroads (BNSF and UP) in Seattle, Tacoma and Spokane. After Washington, Oregon has the largest amount of freight flow and capacity available to handle intermodal freight transportation service in the region. Idaho and Alaska have fewer participation in the intermodal freight transportation market mostly due to low population density, and in the case of Alaska, geographical location being mostly a receiver or a generator of low volumes of freight flow.

According to the gap analysis performed, the capacity of the main ports in the region is able to handle the current international containerized freight flow that is the main source of intermodal transportation demand in the region. Intermodal service benefits from port connectivity to rail and road transportation modes, but is affected with road congestion in highways near the largest metropolitan areas in the region (i.e., where the intermodal facilities are located). Rail capacity is considered to be adequate at the present time and for the foreseeable future, but the perception of some stakeholders is that there might be some rail congestion issues in the east-west mainlines of the Class I railroads that can be improved.

Assuming that the current capacity available at marine ports in the region remains the same for the future, three different scenarios of intermodal freight transportation demand growth were evaluated. The baseline scenario considered the projections made analyzing information available in a national freight transportation database (FAF^3). The other two scenarios considered a 25 percent increase and a 25 percent decrease in the projected baseline trend, respectively. The analysis determined that at an aggregate level the current available capacity will be exceeded at some point in the next decade. However, this analysis was made considering a lower bound on available capacity and it is more likely that significant capacity expansion will only be needed at a later time (if at all, based on the actual demand growth in the long term).

Information obtained from stakeholders and published reports was synthesized to present several strengths and weaknesses affecting the positioning of the Pacific Northwest as an intermodal freight transportation hub.

Strengths are associated with infrastructure available to handle the current demand and perceived benefits of intermodal freight transportation over other modes from an environmental and road congestion perspective.

Several of the weaknesses are related to the perception of the stakeholders about internal and external factors affecting intermodal service in the region and represent potential opportunities if they are successfully addressed in the future. Main factors include highway congestion in the major metropolitan areas (e.g., Puget Sound and Portland) that produce delays and additional costs, lack of other major metropolitan areas that could serve as generators or receivers of freight flows for intermodal transportation, coordination between different stakeholders to improve efficiency and minimize delays, and limited availability of ocean carriers providing service to the Port of Portland which further reduces the amount of containerized cargo available for intermodal transportation. These factors should be considered by different stakeholders and policy makers if the objective is to increase the market share of intermodal freight transportation in the region.

From the review completed in this study, it is apparent that the Washington State Department of Transportation (WSDOT) and the Oregon Department of Transportation (ODOT) have explored in detail the freight infrastructure available and are improving their efforts to model freight transportation flows considering different sources of information (including obtaining input from different stakeholders). These efforts should continue and be integrated with their long-term planning tools and periodic updates to their state freight plans in order to inform policy making and identify critical infrastructure projects to expand intermodal freight transportation in the Pacific Northwest. We also found some evidence that regional and local transportation agencies and port administrators have been engaging in similar efforts at a smaller scale.

An interesting observation is that most studies and published reports have concentrated in the economic aspects of intermodal freight transportation. More work seems to be needed to evaluate potential benefits of increased intermodal freight transportation traffic in the region from environmental and social perspectives. These efforts might help to better inform shippers and the general public about the industry and influence acceptance.

From a research perspective, it seems like more work is needed towards developing better models to estimate freight transportation demand, moving away from traditional methods used for public transportation demand estimation. Such efforts will definitely benefit similar studies by providing more accurate data. Surveys are very useful sources of information and they will continue to be in the future, but the prevalent use of information technologies in freight transportation, the constant transfer of data, and developments in data analytics could potentially represent a very important source of unbiased information to input into these demand estimation models.

Also, more research is needed to address the need for planning decision making for different intermodal freight transportation stakeholders when coordination between different (even competing) players is needed. The general perception of stakeholders is that more coordination will help improve the efficiency of the intermodal transportation system by reducing unnecessary delays and congestion. More opportunities to exploit economies of scale can be identified based on the same planning methods and tools, representing additional benefits to the expansion of the industry.

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