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Strategies to Increase Port Competitiveness

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Abstract

Improving the competitiveness of local businesses and their products within worldwide markets is a vital element for the long-term economic growth of a region. This paper presents a summary of ongoing research needs and outcomes formulated from a partnership between the University of Queensland and the Port of Brisbane Pty Ltd (PBPL), in order to facilitate international trade growth in Queensland and improve PBPL's competitiveness. As part of this partnership with PBPL, we explore strategies to overcome inefficiencies in supply chain and infrastructure and discuss subsequent prospects for further investigation. The key goals of the partnership program for transport-related issues have been identified as: (i) providing a platform for freight actors trading through the port, in order to increase the performance of their logistics operations by adopting cooperative strategies; (ii) exploring modal shift opportunities to enhance the sustainability and the efficiency of the logistics operations of importers and exporters; (iii) facilitating improved inland supply chains for local export commodities through new trans-shipment points, back-loading opportunities, and logistics cost minimisation.

1. Introduction

Efficient logistics services are a precursor for competitive domestic industries in the international market, and, accordingly, contribute to driving economic growth in a region. The freight and logistics sector, as an essential component of the Australian economy, accounts for 10.2% of the country's GDP (BITRE, 2016).

In recent decades, global freight transportation has increased steadily. Among other modes of transportation, maritime transport remains the dominant form of transportation for worldwide trade. Approximately 90% of world trade volumes are transported by sea, which highlights the importance of seaports as a gateway to international supply chains (Li et al., 2015). Moreover, ports, by providing a lower cost of trade to the regions, generate employment opportunities and promote economic growth at the regional and national levels. Numerous empirical studies have been based on evaluating the economic impacts of ports and port activities (e.g. (Bottasso et al., 2013); (Ferrari et al., 2010) (Shan et al., 2014);(Acciaro, 2008). The outcomes of these studies provide quantified measures on the direct and indirect benefits of a port to inform adequate development and investment strategies for both the port and the region. Given some of the key features of ports and the scale of port activities, failing to deliver a competitive service would have a significant impact on end-users and thus a direct influence on the wider economy.

Port competitiveness as a focal policy issue for port authorities (and, in a broader sense, as a regional and national concern), is well recognized by the research community, as well as practitioners. Many studies have explored the main determinant factors influencing port competitiveness. In summary, identified factors can be categorized into three interdependent groups: hinterland-related, maritime-related and efficiency of port operations (Grossmann et al., 2007);(Notteboom, 2009).

Munidal (2001) describes five interacting forces accountable for competition amongst port service providers and port authorities: (i) rivalry among existing contestants; (ii) the emerging threat of new competitors; (iii) worldwide alternatives, substitute suppliers entering the field; (iv) the bargaining strength of port users; and (v) the bargaining capacity of port service providers. These forces affect ports of all sizes and drive the requirement for port expansion, service improvement, pricing decisions and other management actions.

Efficiency of port infrastructure as a measure of promptness and reliability of terminal operators has been a prime criterion for shipping lines. To measure the efficiency of terminal operation, the Australian Competition and Consumer Commission (ACCC) began monitoring the container stevedoring industry in 1998–99, annually reporting on the three key indicators of quayside productivity: net crane rate, elapsed labour rate, and shipping rates for major Australian ports. This report exhibits a continuing trend towards the automation of terminal operations.

Port authorities can increase their competitive advantage by providing value-added services to the market. In a broad sense, value-added services can be defined as strategically formulated activities that are beyond the primary objectives of port governance and complement the ports offerings, which can be beneficial to the port's business (Zondag et al., 2010).

With the exponential increase in worldwide transactions, using enhanced data and analytics to improve customer satisfaction and the service experience is an attractive prospect. As an example, the Port of Rotterdam provides supplementary services through the European Gateway Services network, e.g. paperless transport delivery orders, which enables customers to achieve increased efficiency. Such an integrated solution provides value-added information services for various participating parties.

Australian ports, likewise, initiated their own improvement process with the creation of value-added services. Where most of the major ports in Australia have either transferred responsibility from the government to the private sector or are somewhere in the process of privatization, a global outlook, more than ever, is important. While the worldwide experience of similar restructures has demonstrated an improvement in the technical efficiency of the port and an increase in inter-port and intra-port competition (Chang and Tovar, 2014; Hoffmann, 2001), landlord ports are yet to find an effective consultation mechanism for the provision of professional and industrial value-added services. The objective of such services is to facilitate information sharing among different parties to implement any of the cooperative strategies mentioned above.

The special discrepancy of Australian landlord ports is contribution to an invisible inner-port competition. However, they do vie for funding for investment into additional infrastructure. The inherent cost of land transport in Australia means that there is effectively no competition between container ports for goods that originate from or are destined for one of the main capital cities. The supplier of the goods has simply no choice but to use the closest local port. However, some factors affect rivalry among adjacent ports for attracting regional commodities, such as road congestion, lack of connectivity to the rail network, and the regulation of heavy vehicles on some regional routes.

The need for research on innovative solutions to maintain the competitiveness of trading and business advantage has been recognized, and it motivated the establishment of a formal research partnership between the University of Queensland and PBPL in April 2015. The primary purpose of this $2M partnership is to provide PBPL with innovative solutions that will future-proof its position as one of Australia's and Queensland's major facilitators of trade and commerce. Under this partnership, a set of research themes is being pursued that address the significant challenges facing PBPL, as well as many other ports regionally and worldwide. One of the main themes considers economic analyses that will improve the optimization of supply and logistic chains, as well as new initiatives around how PBPL manages its economic, social and environmental reporting.

This paper presents the preliminary results of the ongoing projects active under this partnership, while the need for further research is also predicted. The remainder of this paper is organized as follows. Following a brief review of the case study in section 2, the balance of the paper focuses on opportunities to enhance the competitive position of the Port of Brisbane (POB) through increased integration with the supply chain. A preliminary analysis, followed by a summary of research opportunities, is presented in section 3. The paper concludes by summarizing the future research in section 4.

2. Case study

As Australia seeks to increase its economic competitiveness in the world market, it is critical to have an efficient supply chain to support the growth in demand. PBPL, as Queensland's largest multi-cargo port and Australia's third largest container port, is driving economic growth throughout Queensland and northern New South Wales. PBPL handles about 1.1 million TEUs, (equivalent to almost $50 billion trade annually). Approximately 95% of international trade and almost 50% of Queensland's agricultural exports pass through PBPL. Top export commodities include grain, cotton, processed meat, coal, crude and refined oil, iron, and steel. Containerized exports accounted for 570,000 TEUs in the 2015-16 financial year, of which approximately 8% were transported by rail from regional areas in Queensland in Goondiwindi, Gladstone, Rockhampton, Mackay, Townsville, and Cairns. The lack of connectivity in the regional rail network to the production/processing locations of exporters is considered the main barrier for rail usage (PBPL, 2013).

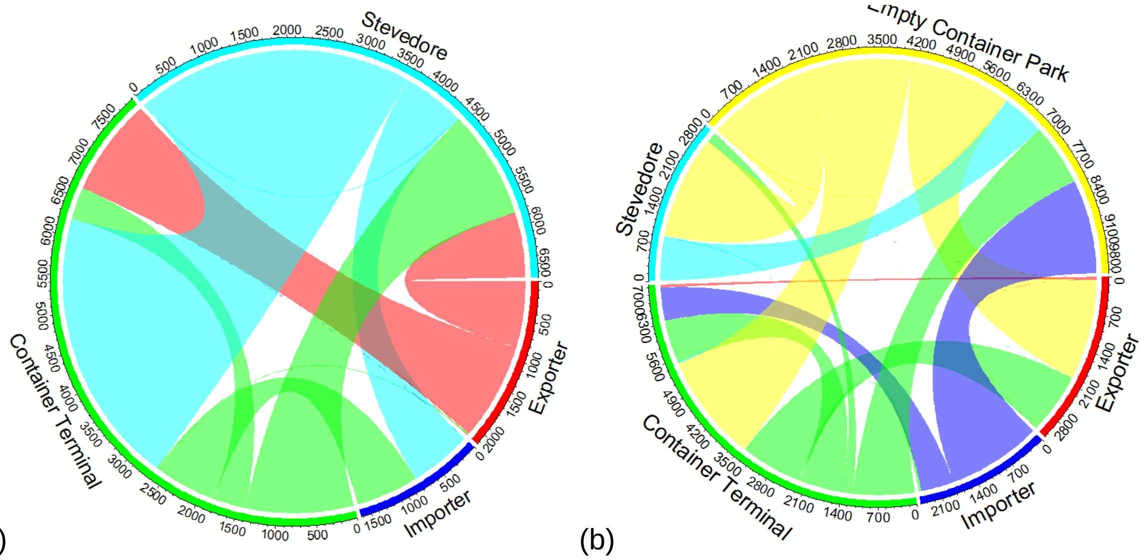
Containerized import trade accounted for 580,000 TEUs in the 2015-16 financial year, with a growth rate of 1.7%. Manufactured and household goods have the highest share (85%) of containerized imports which are destined directly for either retailers or distribution centres. A small proportion of import containers is crude material destined for processing and manufacturing industries. Non-containerised imports include project cargo, steel, and motor vehicles. Motor vehicles are an important import trade through the PBPL, which accounted for 240,000 units last financial year, with a growth rate of 8% (PBPL, 2016).

2.1. Nodal and modal activities

The main activity nodes in the import and export supply chain include intermodal terminal and transport yards located inside the PBPL, as well as other transshipment points across Brisbane and Queensland. One of the high demand terminals in Brisbane is a multi-user terminal at Acacia Ridge Rail Station on the south side of Brisbane, with a daily movement of about 500 – 1,000 trucks carrying full containers through major north-south corridors.

The transport modes involved in this chain are road carriers, with a 95% share, and rail operators which carry bulk commodities for mainly coal and mining. PBPL hosts several berths, terminals, transport companies, and other trade-related businesses such as customs. Three stevedores are operating 24/7 in container berths, namely, Hutchinson, DP World, and Patricks. Apart from a general purpose berth operated by Australian Amalgamated Terminal (AAT), which is used for general cargo and motor vehicles, there are also other berths for bulk commodities such as grain, coal, cotton, sugar, cement and wood chips. Two weeks of movement of containers between several actors trading through POB is shown in Figure 1 (2013). Based on the identification number of containers in this dataset, 277 shipping lines are involved in the import and export of 23,833 full and empty containers for these two weeks.

Figure 1: Container flow between various inland freight actors for (a) empty containers, (b) full containers



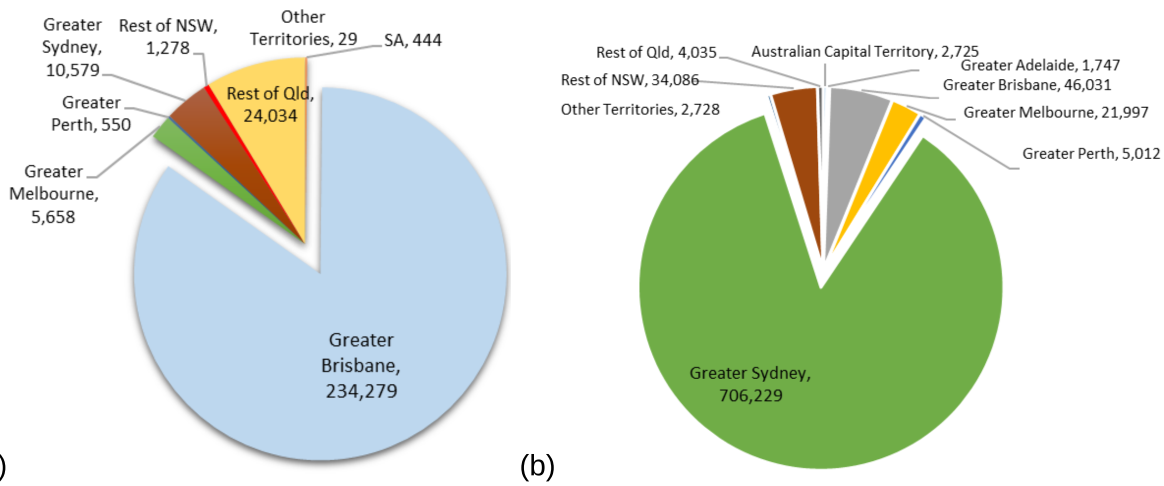
(a) (b)

Although wharf terminals, transport yards and stevedores operate 24 hours a day, importers, exporters, customs and transport companies have restricted working hours. The mismatch between the working hours of freight operators imposes negative effects, such as limited time slots available for the stevedores, a long queue for trucks at terminal gates, double-handling and the staging of containers.

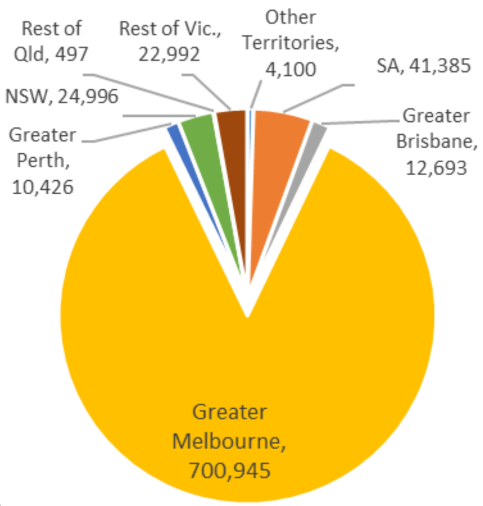
2.2. Port competitiveness

Although the distribution of Australian ports is not considered as a threat to their competitiveness with each other, the increasing efficiency of supply chains helps local businesses to compete in international markets. Therefore, looking at the port choices of importers and exporters can explain the logistics deficits, which can then be tackled in future plans. A lack of information about the origin or final destination of containers is a barrier to the study of port choice. The only available dataset provides the containers' final destination, imported from four important ports. Figure 2 shows about 50,000 TEUs destined for Queensland, imported from Port of Sydney, and a lesser rate (13,190 TEUs) imported from the Port of Melbourne.

Figure 2: Final destination of imported containers from (a) Port of Brisbane, (b) Port of Sydney, (c) Port of Melbourne, (d) Port of Adelaide (ABS, 2011a)



(a) (b)



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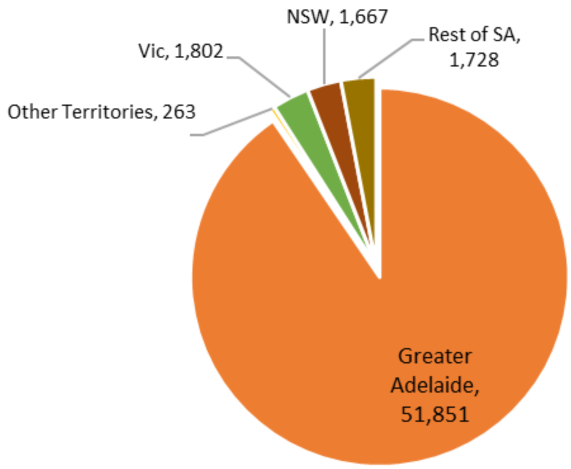
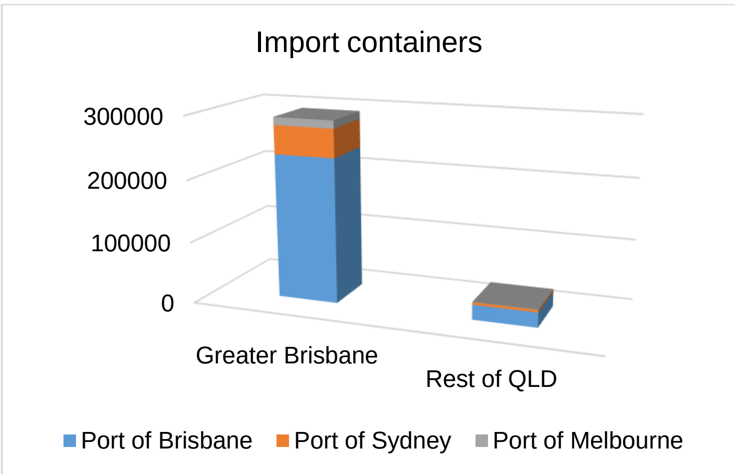


(d)

Figure 3 indicates that some of the shipments are traded through a different port, as opposed to the port that is closer within the region. Accordingly, influential factors of nodal inefficiency can be named as: port infrastructure, port-related regulations and charges, port calls by some kinds of vessels, shipping lines, and transhipment points. The review of the technical reports highlights some modal factors that negatively affect the choice of POB, including road congestion, regulations, constraints on heavy vehicles on the road network, a lack of rail connection to the vicinity of export businesses, and interruptions to the road and rail network due to flooding and/or severe weather conditions. Visits to the Ports of Botany and Melbourne by larger vessels, the flexibility of container staging in wharf terminals, lower charges, and back-loading opportunities are other factors that can be further investigated.

It should be noted that rivalry is not constrained to these four main ports. Other ports in the vicinity of POB: the Port of Newcastle and the Port of Gladstone, are competing in bulk commodities, namely, grain, coal, dry bulk and liquids. The Port of Townsville is also the main competitor for the importation of motor vehicles, and the Port of Mackay for project cargo imports.

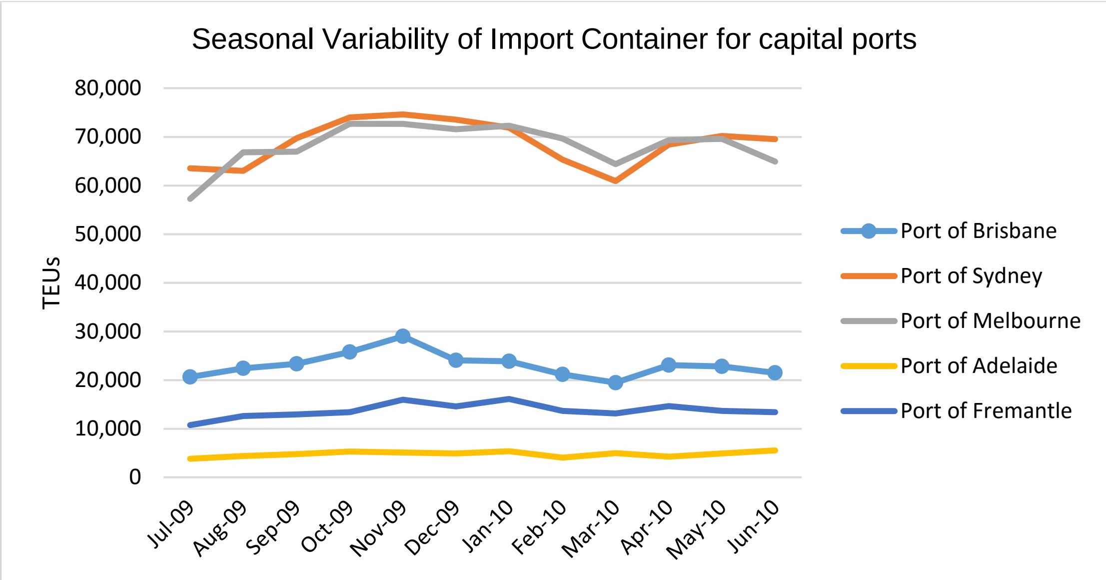
Figure 3: Import containers destined to Queensland from Australian ports (ABS, 2011a)



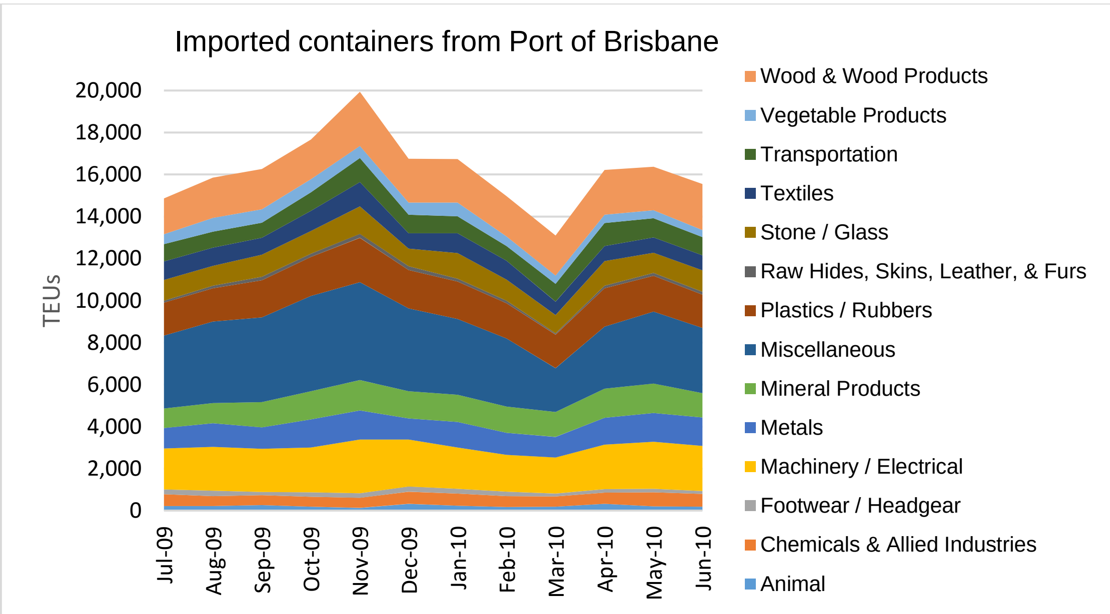
2.3. Seasonal variation

At POB, the seasonal variation in freight activity is identified as one the factors having significant negative impacts on the port's market in terms of the level of demand for import and export movement, in addition to operational efficiency (PBPL, 2013). The causes of seasonal variability are known as: (1) weather and rain events which affect the volume of agricultural export products (grains, cotton, meat) and the related importation of farm machinery and fertilisers, (2) trends in the construction and mining industries which influence the import of containerized construction materials and cargo through the port, and (3) seasonal fluctuations in the production of grain, cotton, and other agricultural commodities. The dispersed nature of agricultural production, mining, and project cargo across the state, aside from the seasonal variability, makes it difficult for long-term freight solutions and infrastructure investment. Figure 4 represents the seasonal variability of imported containers during financial year 2009-10 for each commodity type and in comparison with capital ports.

Figure 4: Seasonal variability of import container chain (a) capital ports, (b) various commodity types traded through port of Brisbane (ABS, 2011b)



(a)



(b)

3. Preliminary results

3.1. Role of information sharing

While billions of dollars have been invested in infrastructure, the complexity of the freight market, the misalignment and the lack of collaboration between the various actors in this market often lead to an inefficient use of infrastructure. Freight actors mostly aim for profitable and safe operations, as they share or interact with the same infrastructure. Yet, due to data confidentiality and competition, there is poor information sharing, which contributes to the suboptimal use of extant infrastructure. While port authorities are limited in their roles as landlords, individual freight actors optimize their own logistics process, regardless of opportunities that may exist from collaboration with each other, which could address such issues as more truck movements than necessary, thus incurring higher transport costs. Furthermore, emerging major alliances and partnerships in maritime shipping necessitate the need for infrastructure to maintain the competitiveness of the smaller freight actors within the market. While introducing IT-based and real-time control systems during the past decades, which have facilitated collaboration between individual freight companies, port authorities can play a key role in improving the efficiency of freight actors' services and maximising their competitiveness by facilitating these initiatives.

3.1.1. Port community system

In this setting, freight transportation actors may be aided by the exchange of information concerning road traffic conditions, real-time availability of drivers and carriers, and opportunities for the bundling of shipments into fewer vehicles. This information sharing can be provided via an online system supported by a port authority, where information becomes available in a multi-level access system to the involved actors, which would then be referred to as a "Port Community System (PCS)." A PCS is formally defined as "a holistic, geographically bounded information hub in a global supply chain that primarily serves the interests of a heterogeneous collection of port-related companies" (IBISWorld, 2015). Some successful PCSs around the world can be named as Virtuele Haven in the Port of Rotterdam, DIVA in the Port of Hamburg, CCS Dakosy in the Port of Antwerp, and Portnet Trade Exchange in the Port of Singapore.

A PCS helps port authorities take the lead by providing a logistics solution to private actors, encouraging them to share information that may lead to lower logistics costs, faster delivery/pickup in the import/export chain, and increased customer satisfaction. Bringing all users together enhances the efficiency of the physical flow of freight, drives economic growth, and, as a secondary benefit, assists in the reduction of externalities such as pollution, congestion, and land use impacts. For example, a PCS helps transport yards and container parks to predict and plan future shipments, and helps carriers to better plan for their fleets.

3.1.2. Empty container repositioing

As one example of information sharing, it can help shipping lines with empty container repositioning to decrease their maritime and inland transportation costs. This repositioning, known as "street-turn strategy," can be carried out as container swapping, substitution or in the form of leasing, where information about the empty containers of all shipping lines is provided through a decision support system, referred to as a "virtual container yard," or "matchback." Examples of such decision support systems are at Ports of Oakland (SynchroMet), Los Angeles, Long Beach, and Montreal (Maguire et al., 2010)). In maritime empty container repositioning, when a shipping line encounters a shortage of empty containers, it can cooperate to transport a full import container from another shipping line instead of returning an empty container or leasing it from a container company. In the inland example, an exporter's demand for empty containers can be linked directly to the nearby empty containers from an importer. Therefore, the proposed solutions provided by decision support systems focus on balancing the supply and demand of empty containers across all the involved parties.

3.1.3. Truck appointment system and truck sharing

The truck appointment system which is now used at PBPL can also be considered as one form of an information sharing system between stevedores and trucking companies, where the objective is to provide the scheduling of truck arrivals at the port to reduce long queues and truck congestion at the yards.

Truck sharing between various shippers or shipping lines is another application that can significantly reduce empty vehicle running. Unladen and return trips do not generate any revenue and are considered as an incurred expense for the carrier and consequently for the shippers. With heavy commercial vehicles, empty running is not just an apparent wastage, but also contributes significantly to the truck nuisance impact on the quality of life in both cities and the countryside in terms of noise and damage to roads (Dejax and Crainic, 1987).

3.1.4. Case study of information sharing

Due to the significance of decision support systems, there is an enormous body of research on the development of strategies for the reduction of empty vehicle runs and empty container movements. Researchers have tried to address this problem at different levels and scales. For example, it was studied at a high level with regard to multiple shipping lines and multiple ports by formulating a network design to reduce the number of trips with empty containers (e.g. (Theofanis and Boile, 2007; Crainic et al., 1993). However, these studies considered neither the container nor the vehicle allocation problem. To the best of the authors' knowledge, regarding studies that quantified the benefits of container swapping and truck sharing simultaneously, only one can be named (Theofanis and Boile, 2007; Sterzik et al., 2015).

This gap in the literature necessitated research under the partnership program in order to explore the benefits of information sharing among shipping lines trading through POB. Accordingly, Irannezhad et al. (2017a) developed a multi-agent-based simulation model to examine an application of the PCS in PBPL, allowing shipping lines to coordinate the delivery of import containers for shipment bundling and routing decisions. The agent-based model developed in this study is based on the idea that freight markets are not usually in a state of equilibrium, as has been simplistically assumed in traditional modelling approaches, because agents are highly heterogeneous and should have the freedom to choose non-optimum actions. By providing a prototype of a PCS, the simulation undertaken in this study allowed for some agents to experience their output through the system, to learn and to then decide and act, based on logistics costs yielded from cooperation or individual action, while occasionally deciding to change their strategy.

A case study of two weeks' import and export container movements trading through PBPL revealed that the cooperation between shipping lines in sharing vehicles through a PCS could decrease the total travel distance and total logistics costs, as well as improve the vehicle utilization with a vehicle shift from semi-trailers to B-double trailers. Interestingly, the savings in logistics costs from cooperation are generally higher for shipping lines which have fewer shipments to deliver, while cooperation sometimes imposes a higher logistics cost upon the major shipping lines. This is why, after going through the learning process, some shipping lines (mainly big actors) would prefer individual operation to cooperation in the proposed reinforcement learning algorithm, and it has led to a less complete improvement compared to the full cooperation approach.

In another study by Irannezhad et al. (2017b), the effects of truck sharing and inland empty container repositioning were examined by using the same dataset. Accordingly, a simulation-based model was presented to identify the quantitative benefits of cooperation, where inland empty container reuse is optimized in integration with a dynamic vehicle allocation and routing problem with time-window constraints. Furthermore, this study considered a two-dimensional capacity for vehicle types and demands, while maintaining the objective to minimize total transport cost in a time-varying network and considering the constraints of some road segments on the use of B-double trucks. Given mass limitations on some road segments, the two-dimensional capacity of vehicles is an important issue. For example, based on

Queensland's road network regulations, an A-double trailer is only allowed to carry two full 20-foot containers, however, it may carry two empty 40-foot containers. The findings of this study revealed that there are a significant number of unnecessary truck movements and storage days for empty containers which could be avoided via cooperation amongst shipping companies. Furthermore, B-doubles, utilised because of truck sharing, are more environmentally benign and cost-efficient choices when compared to smaller trucks.

It should be noted that the imbalance of import and export containers in Australia is exacerbated by the preference of 20-foot containers for exports and 40-foot containers for imports. As a result of constraints and limitations in some countries, exporters are not always flexible in the choice of type of container, therefore, 40-foot containers are used when exporters encounter a shortage of 20-foot containers. Generally, 20-foot containers are preferred because they are easier to transport, both on the network and in the yard, without the need for a heavy-duty forklift and the flexibility on control of space. However, the availability of high productivity vehicles and road infrastructure in Australia does not impose any restriction on importing 40-foot containers. Given that the majority of importation container trade through POB relates to household, electrical and clothing, a light 40-foot container can be transported and handled for a lower price, due to the economies of scale. Accordingly, this imbalance causes a significant amount of 40-foot empty container staging and a shortage of 20-foot containers, which sometimes leads to the import of empty 20-foot containers. To address this issue, more comprehensive research considering the whole international supply chain is projected under the partnership program.

3.2. Modal shift opportunities

Over the last ten years, Queensland's freight has increased by 2.1% per annum compared to a 3.7% per annum growth in GDP. In terms of freight movement, it increased by 4.95% to 115.4 billion tonne kilometres, where road accounted for 44% and rail accounted for the remaining 56% (BITRE, 2014).

3.2.1. Rail Transport

The Queensland rail network is predominantly used to transport bulk non-time-sensitive export commodities (such as coal and iron ore). By comparison, the road network carries both bulk and non-bulk time-sensitive commodities. However, trains can also cater for refrigerated containers such as Sea-Freighter, which are dedicated meat refrigerated container trains that have the capacity to carry more than 20,000 TEUs a year to the POB for export. Overall, as distances increase, so does rail competitiveness. There are three major intermodal rail services running several times each week to and from the Brisbane multimodal terminal located at POB, Goondiwindi, Rockhampton and Townsville. The interstate standard-gauge freight line starts from Melbourne and ends at the POB, where it connects to the dedicated narrow gauge freight rail at Fishermans Island. The interstate rail is used to bring freight into Queensland from southern locations such as northern New South Wales. The dedicated narrow gauge freight network of 81km extends from Bromelton to Yeerongpilly Junction, where it then connects to the passenger network, and from there to Swanbank, the Ipswich Workshops and Ebenezer to Fishermans Island.

However, containers transported by rail in south east Queensland represent only about 5% (56,000 TEUs) of the total of containers transported to and from the port, which is low by comparison with other Australian container ports for a couple of reasons. Firstly, the interstate rail network operates alongside passenger trains and is heavily utilized during week days. Secondly, rail is not accessible to the agricultural growing areas producing cotton and grain. Looking at export grain as an example, the grain growing areas are mainly located in the south of Queensland and northern areas of NSW, where they can then be transported via the NSW rail network to the Port of Newcastle in a more cost-effective way in comparison to road transport.

3.2.2. Road transport

The existing road network used for container movement also experiences significant congestion at different times of the day, in particular, the morning peak period. Key container truck routes that are likely to experience periods of congestion are the Toowoomba Range Crossing, Ipswich Motorway, Gateway Motorway, Port Drive, Pacific Motorway, and Warrego Highway (PBPL, 2013).

Restrictions on the use of large vehicles such as road trains and B-doubles can also cause diversions and additional costs, due to the need to break down road trains into smaller vehicles to get to importer and exporter locations. The impact of an inefficient road transport network on overall logistical costs is significant, and, as a result of international trade pressure, necessitates upgrading of the road and rail network.

Considering the lower transport cost of rail and its greater environmental sustainability, it is important to investigate in what circumstances importers and exporters are willing to shift from road to rail transport. However, modal shift studies should be done considering the heterogeneity found among all freight actors of various sizes and resources. For example, considering that about 43.7% (21,421) of Queensland's road carriers are ancillary operators (NTC, 2016), the modal shift uptake will not be easy in the short term.

3.2.3. Coastal Shipping

The coastal shipping market share in Australia accounts for around 17% of the total domestic freight movements and comprises 10% of total freight volumes (PBPL, 2013). There is currently no significant volume of coastal shipping between the capital cities located along the Australian east coast (i.e. Melbourne, Sydney, and Brisbane). Long transit times for coastal shipping compared with road and rail transport are considered to be a barrier, as shown in Table 1.

Table 1: Typical freight transit times

MODE	SYDNEY-MELBOURNE	SYDNEY-BRISBANE	MELBOURNE-BRISBANE
COASTAL SHIPPING (DAYS)	2-3	2-3	4-6
RAIL (HOURS)	17	21.5-26	36.5-45
ROAD (HOURS)	11	15	23

Source: Australian Rail Track Corporation (ARTC)

Coastal shipping in Queensland is mostly containerized freight, and it is mainly a service offered by ships under foreign flags. However, the transport of bauxite between Weipa and Gladstone alone accounted for about 30% of the total Australian domestic sea freight in 2011 (PBPL, 2013). As such, coastal shipping can be considered to be an alternative option for moving of bulk commodities over the long distances of Queensland. Due to the dispersed location of Queensland's regional townships, the overall cost of road and rail transportation lessens profitability of any export businesses. Queensland's export supply chain currently is highly relying on the road transport for the non-bulk fright. For example, it is estimated that approximately 95% of the non-bulk freight volume on the Brisbane-Townsville freight corridor (1,300km distance) is transported via road and the remaining 5% via rail. The significant social costs coupled with road and rail transport, such as operational cost, cost of congestion in metropolitan areas, as well as the overall reduction in the safety of road users makes coastal shipping a viable alternative transport mode. While it is not expected that the entire freight volume on the Brisbane-Townsville corridor would shift from the existing modes to the sea mode, the new mode can potentially attract certain groups of transport agents alleviating some pressure from road transportation in the future.

Costal shipping offers competitive freight rates in comparison with other modes. It is mainly due to the inherent economies of scale, and lower maintenance cost of infrastructure.

Generally the investment required for port operation and maintenance are insignificant when compared to those required by road and rail infrastructure (Paixão and Marlow, 2002). Moreover, sea freight would be a green choice in terms of energy consumption (Paixão and Marlow, 2002).

There are some weaknesses associated with coastal shipping services. Because provision of door-to-door service is unaffordable for service providers, intermodal arrangements are required so that coastal shipping retains its competitive position when compared with other modes (Paixão and Marlow, 2002). Ports and/or terminal operators should consider indirect costs associated with the friction costs (e.g. waste, road congestion) which may incur with increased freight volume when planning for coastal shipping (Paixão and Marlow, 2002).

The limited uptake of coastal freight shipping in Queensland (and Australia-wide) is attributed to the existing coastal trade regulations. Australia's coastal trade regulations (*Navigation Act 1912*) limit access to national ship operators or national flag vessels with national crews (Webb, 2004), known as cabotage. The existing regulations provide that ships licensed to operate in coastal trade, among other things, must pay applicable Australian wages. Cabotage is a form of protection for Australian-registered ships. From an economic perspective, cabotage increases the freight transport cost when operated by a national crew. However, given the high level of competition in the freight and logistics industry, cabotage places national ship operators in a disadvantaged position compared to foreign-flag and foreign-crewed competitors (Webb, 2004).

Despite the existing challenges that potential coastal freight shipping services may face in Queensland, the freight and logistics industry is interested in assessing the potential demand for this mode as an alternative to road and rail transport. Provided that freight shipping can secure sufficient demand for costal shipping, the industry will be able to use this finding and challenge coastal trade regulations ruled by Australian federal government. Should coastal shipping not be seen as an economically sustainable mode by the Queensland freight and logistics industry, recommendations for roads and rail need to be considered to accommodate the expected increase in freight volume on the Brisbane-Townsville freight corridor over the coming decade, such as strategies to decrease public infrastructure costs for roads, and upgrade of rail network.

Accordingly, an online discrete choice experiment (DCE) was conducted to survey Queensland's consignors and freight forwarders. A DCE is a quantitative technique for eliciting preferences that can be used in the absence of revealed preference data. The method involves asking individuals to state their preference with regard to hypothetical alternative scenarios. Participants were asked to make their choice (between the modes of road, rail, and sea), given a number of mode-specific characteristics, such as freight costs, transit time, and services per week. The survey design was tested twice with selected industry members and finally distributed in May 2017. The analysis of the collected data is currently under way, and the final report on the findings of this study is expected to be available in March 2018.

3.3. Hinterland infrastructure development

An improved hinterland infrastructure of the Port of Brisbane could have a significant impact on transport efficiency in comparison with neighbouring ports, and on the overall supply chain of imports and exports.

3.3.1. Transshipment points

Transshipment points which are used for consolidation, deconsolidation or cross docking between different modes or vehicles are considered as a key element to achieve an effective logistics operation across the supply chain. Despite imposing an extra cost of double handling and storage, they facilitate the international trade through increasing reliability and solving the problem of misalignment of business hours. Furthermore, some smaller importers and exporters use these facilities as an extended component of their distribution system for storage, bundling, or packing/unpacking to reduce their operating cost (Rodrigues and Notteboom, 2007).

Transshipment points are categorized as intermodal terminals (used for cross docking between two different modes), container terminals (used for packing/unpacking and storage of containers), empty container parks (specific to empty container staging), domestic terminals (used for domestic freight tasks), and specialized depots for commodities (such as grain or meat depots).

In Queensland, there are three main domestic intermodal terminals located in the Brisbane metropolitan area, including the Aurizon Intermodal terminal located at Acacia Ridge; the Moolabin Intermodal terminal located at Tennyson, owned and operated by Toll Intermodal; and the Brisbane freight terminal located at Acacia Ridge, operated by Qube Logistics. An average of 37 rail services operate between these terminals and regional areas in Queensland and provide transshipment facilities for domestic freight tasks. Other intermodal terminals are located in regional towns, including Cairns, Townsville, Mackay, Rockhampton, Cloncurry and Mount Isa, serving local mineral and agricultural products.

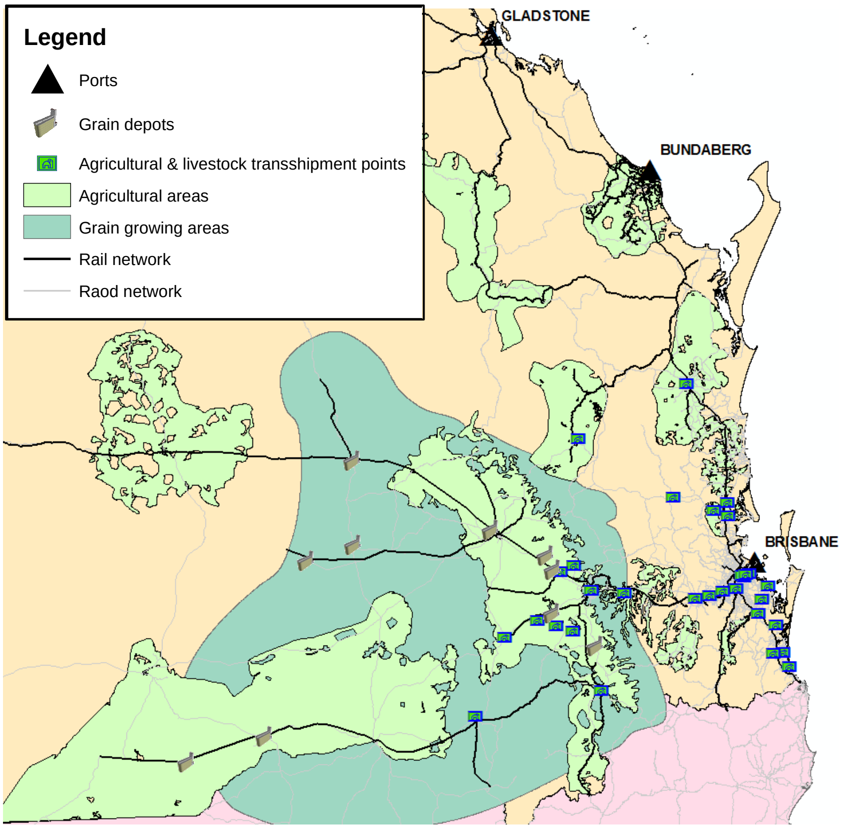
Bromelton is a proposed location for the future intermodal terminal in south east Queensland, which has access to the national standard gauge rail network. The existing dedicated freight network by a dual gauge line extends from Bromelton to Yeerongpilly Junction, where, after joining the passenger network, connects Swanbank, Ipswich Workshops and Ebenezer to POB. There are also a few planned freight precincts in south east Queensland, including Ebenzer Regional Industrial Area (5,400 Ha), Purga Industrial Area (400 Ha), Swanbank Enterprise Park (2,760 Ha), and North Maclean Industrial Area (260 Ha) (Urban Land Development Authority, 2010).

In order to increase the reliability and flexibility of services, import and export containers mainly use container terminals located close to or at a port. As per the IMEX survey in 2013, about 34% of export shipments from POB are stored either at transport yards located in port (19%) or in Queensland regional areas (15%), or use both (5%), and 38% are packed at terminals located at the port. The share is different for the import container chain, as 28% of import containers are stored prior to handing to importers at container terminals at the port, 44% are unpacked, and 28% are delivered directly to importers (Irannezhad et al., 2017c).

Figure 5 represents the location of specialized depots for agricultural commodities in southern Queensland. Looking at the intensive agricultural land use in south east Queensland, the rail network is not accessible for exported agricultural commodities. Given that the planned intermodal terminal at Bromelton should offer locational advantages for logistics operations involved on a regional scale, the accessibility of this terminal to agricultural production areas should be investigated in more detail. Other research questions could be whether a new intermodal terminal will affect the modal shift or port choice or what commodity types are the target market for this new terminal.

Although the facility location problem is a well-established research area, either for a specific commodity (e.g. (Maurer, 2008; Friedrich, 2009), or a container chain (e.g. (Davydenko and Tavasszy, 2013; Limbourg and Jourquin, 2009; Zhang, 2013; Gu and Lam, 2013; Halim et al., 2016), the best location of a new intermodal terminal should be studied according to the network specifications and demand pattern in each case study. Accordingly, this field is foreseen as a research project under the partnership program.

Figure5: Existing agricultural-related transshipment points



3.3.2. Case study of transshipment points

However, while the optimisation of the location of transshipment points has been widely investigated in the research, only two studies can be named concerning the choice of transshipment points. Significant factors identified in the German Federal Transport Investment Plan (2003) are the location of the facility, transportation costs, travel time, and the surrounding area. Relevant parameters in a study by Kim et al. (2010) were the market characteristics (i.e. population and firm density), commodity type, average order frequency, company size, and annual sales.

Accordingly, as one of the research projects of the partnership, the choice of importers trading through the POB to use container terminals was investigated in a study by Irannezhad et al. (2017d). They investigated what attributes affect the choice of direct delivery (without using DCs) versus DCs as either an intermediate stop or a terminal stop for storage or packing/unpacking. Irannezhad et al. (2017c) extended this study by looking at the preferences of both importers and exporters, as well as adding the decision on the dwell time of the containers.

Relevant findings from this study were: (i) shorter distances increase the probability of direct delivery for both import and export shipments; (ii) larger industrial areas in both origin and destination suburbs increase the likelihood of storage at CTs; (iii) weekend or late arrival of import shipments increases the probability of direct delivery; (iv) import shipments are more likely to be stored at CTs if destined for suburbs with a higher number of retailers and industrial parks, and to be delivered directly if destined for suburbs with a larger wholesale sector; (v) heavier export shipments are more likely to be delivered directly or stored at CTs inside the port; (iv) late night or early morning arrival of export shipments increases the likelihood of storage at inland or port CTs; (vi) export containers originating from suburbs with a higher number of mining, agricultural, and manufacturing employees are more likely to be stored at CTs; and (vii) export containers originating from suburbs with a higher number of livestock-related businesses, distribution centres, and industrial parks are less likely to be stored at inland CTs (Irannezhad et al., 2017c).

4. Conclusion and future research direction

This paper presents the significant port-related issues concerning POB and proposed strategic plans under a partnership program with the University of Queensland. The goal of this partnership was set to stimulate trade growth for Queensland, and consequently benefit the broader community by:

- facilitating the more efficient handling of goods and supply chains
- providing an evidence-based analysis to inform strategic decision makers about modal shift opportunities, particularly exploring the coastal freight shipping demand between Townsville and Brisbane
- enhancing port infrastructure and operations by examining the role of IT systems
- proposing the best locations for transshipment facilities, considering the accessibility of exporter and importers to the road and rail network to facilitate inland logistics operations.

Based on the preliminary analysis, several directions for future research are foreseen. First, the street-turn strategy should be modelled, integrated with the maritime supply chain, while real-world considerations such as the various types of containers (e.g. refrigerated, open-top, among others), and the time needed for cleaning and repairing should be considered. Second, choosing a longer duration for the planning horizon is another necessary improvement so that if an empty container can be used by the same shipping line in the next couple of days, it is not swapped to another shipping line. Third, in order to reduce the number of empty vehicle runs, back-loading for non-containerized transport can be further investigated. Back-loading (also known as backhauling), as a street-turn strategy between importer and exporter, is defined as sending a truck back immediately after it is emptied, to be loaded at the exporter's location. Given POB is the only port of call in Queensland for most shipping lines, and the last one in a vessel's route, back-loading is recognized as an opportunity for importers to minimize the transit time to overseas destinations and a great potential for POB to increase its competitiveness.

Preliminary analysis of the choice of container terminal revealed that despite the high usage cost, terminals inside the port are the preferred option when compared to inland terminals. This is possibly because of higher reliability for shorter distances or larger availability of carriers, as well as terminal capacity at the port. Further research could look into additional factors such as the availability of resources for cargo owners, the relevance of owning land, the labour and machinery necessary for storage/packing/unpacking, the time-window constraints, the type of contract between buyer and seller (i.e. long-term vs. short-term), and the relevance of paying the costs associated with inland transport. Accordingly, a more detailed study can benefit by exploring new facility locations and estimating the demand for a new intermodal terminal.

Lastly, it is important to investigate in what circumstances importers and exporters are willing to shift from road to rail transport or coastal shipping. More specifically, investigation of the presence of demand for coastal non-bulk freight shipping on the Brisbane-Townsville corridor as an alternative freight mode for road and rail could be studied.

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