Chapter 5

Sustainability cruising and its supply chain

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1 Introduction

The importance of the cruise market has been addressed in tourism literature. However, when it comes to resource distribution of the maritime sectors, total quantity in terms of twenty-foot-equivalent units (TEU) and volumes are used to show the important economic values created by the given industry. It is not the case for the cruise industry where quality of service is the key to maintain competitiveness and to fulfill the high expectation of cruise passengers who look for the ultimate relaxing and luxurious vacation experience at sea (Wang et al., 2019b). In this research, we offer a holistic viewpoint to capture the uniqueness and the complexity of the cruise industry—from the structure of the maritime cruise cluster and the environmental concerns raised by the stakeholders, to the sustainability of the cruise supply chain.

First, we discuss cooperation and vertical integration in cruise maritime clusters. The cruise industry contains maritime clusters, and the interaction of the businesses within the clusters is what drives the performance of cruises. To better understand cruise activity and business, we need to define cruise clusters, their objectives, and the extent of possible integration. The benefits of vertical integration in cruise ports and its supporting industries can be further quantified.

Second, from the public standpoint, cruise economic impact is an important part of regional economic growth. This section presents change to the Regional Economic Impact System (RECONS) established by the United States Army Corps of Engineers including both direct growth impacts and indirect environmental impacts. This section contributes to a responsible economic impact model supporting both economic growth and true environmental offsets.

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Third, switching to firm level, if public's interests can be aligned perfectly with the interest of the private sector, there may be a possibility to find a balance between efficient operations for profit-driven cruise companies and to address long-term sustainability concerns for stakeholders. Cruise companies' environmental efficiency is an important part of their corporate social responsibility. This is essential for long-term sustainability for cruise companies. The measurement of the relative efficiency of cruise companies is used to compare their efficiency in environmental practices and technological investment.

The fourth and the final section is about the efficiency and effectiveness of the supporting industry in the cruise maritime cluster. The oligopolistic nature of cruise lines creates a dominant position within the cruise supply chain. Using game theory and backward induction, optimal incentive mechanisms are identified in order to align the motivations of the supplier with the cruise line. The need for a reliable supply chain regardless of circumstances has created the need for the alignment of players' self-interests to reduce self-serving bias, moral hazard, and adverse selection (Wang and Pallis, 2014).

In the following sections, we provide an in-depth discussion for each topic mentioned above to address how sustainability issues are dealt with by players in the cruise maritime cluster.

2 Understand coordination and vertical integration in cruise ports

The cruise sector has interdependent players who provide services necessary for effective cruise operations. The maritime clusters' interactions stimulate the overall economic impact of cruise activities providing both direct and indirect impacts in jobs supported and income created. The interplay of cruise members is essential for the economic growth provided by this economic engine to support local business, tourism, and port-city development. The vertical integration and cooperation of cruise cluster players is essential for economic growth. The indirect and induced economic impact comes from markets other than cruise ports within core maritime industries. The cruise operation regional economic impact is a result of the interaction of the core cruise maritime industries stimulating growth in multiple areas simultaneously. The integration of services through cooperation can create flexibility within the cruise port value chain.

The high level of concentration of market and geographic areas can lead to delays and congestion of cruise areas. This section aims to provide an understanding of the composition of maritime clusters in cruise ports and the extent of coordination and cooperation in maritime industries. This serves as a foundation for the development of cruise integrated regulation regarding challenges and issues in cruise coordination, vertical integration, cooperation, and to align interests of cruise lines, cruise terminal operators, and port authorities. Business segments within the cruise industry fall into six categories: cruise operations, port operations, ground transportation (airport shuttles), tourism, healthcare, and finance. The interactions of these categories comprise the maritime clusters and

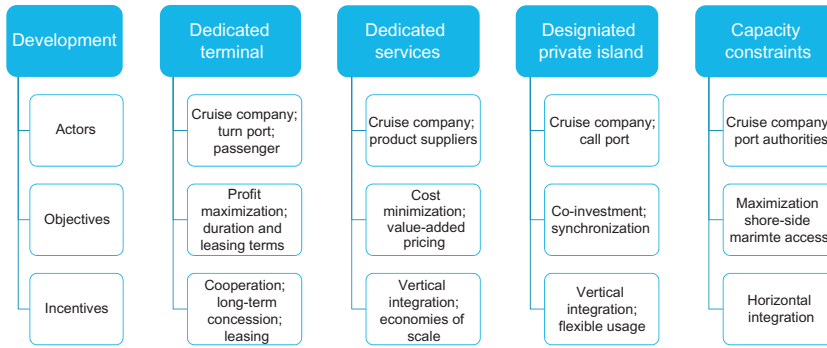

FIG. 1 Cruise cluster development and possible integration.

the extent of vertical integration (Fig. 1). Currently many cruises utilize dedicated cruise supply providers as a cost-effective segment of operations. The integration can be through integrated tourism and resort experiences. Combining travel packages is another form of integration for cruise lines to provide convenience and improve passenger experience (Wang et al., 2015; Wang and Zeng, 2017).

2.1 Cruise maritime cluster development—objectives and incentives

Maritime cluster development has a close relationship with supply chain management. Details of the interconnected maritime cluster and activities associated with it can be seen in the following examples (Fig. 2). Dedicated terminals are sometimes necessary to accommodate busy cruise traffic. Dedicated terminal also can be used to improve the efficient operations while in port. The differing interests of the terminal provider and cruise can be bridged because efficient

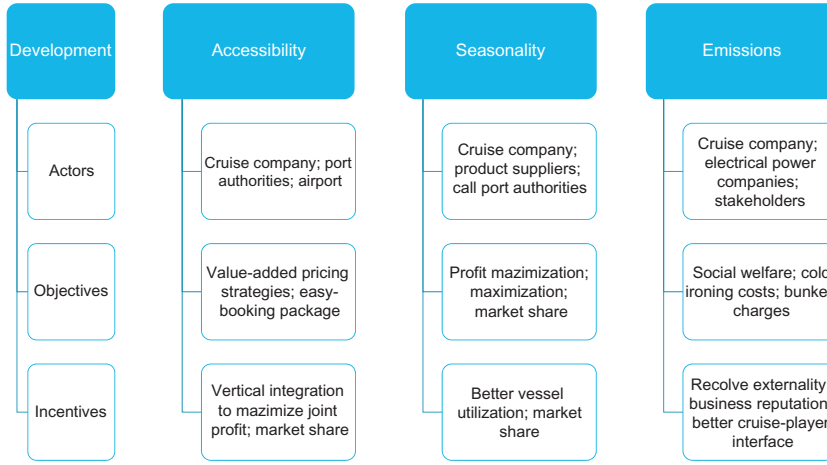

FIG. 2 Cruise cluster development and possible integration (continue).

cruise operation is in the best interests of both parties. Dedicated services are important for cruise lines because of the short time horizon in which activities in port need to be accomplished, such as services from berthing, stevedoring, and bunkering to passenger-related operations. Many cruise line companies will provide exclusive beach experiences, and some will utilize private islands to further differentiate their packages and stay competitive in the industry. Lease agreements can cause imperfect competition and price differentiation. Capacity constraints are important for the cruise sector. Shore excursions can be offered through cooperation between waterfront multipurpose terminals, cruise lines, and port authorities in order to promote tourism. Capacity constraints have to do with the volatility of cruise demand due to its nature as a luxury activity and its seasonal nature. Accessibility is another important consideration for cruise line companies because if cruise homeports are not easily accessible for cruise passengers it will increase costs to the consumer, and decrease the quantity demanded for the more elastic consumers who are very sensitive to price change. The possibility of transit packages being included for consumer convenience is an important consideration involving travel agencies, airlines, and land transportation. Air emissions and environmental issues are important for cruises; due to the different impacts on different stakeholders, cruises rely on environmental tourism, so the damage to that environment can decrease demand for cruises. The cruise terminals are focused on the social welfare of the hinterland and have their own concerns. The differing focuses between cost-efficiency and externality are essential for modeling effective cruise emission reduction.

3 Responsible cruising and its economic impacts

The United States budget for port construction and maintenance is usually used for cargo port maintenance, transport cost reduction, and total tonnage increase, while ignoring factors such as the number of passengers served. The growth and development of the cruise sector in the United States has not been correlated with an influx of federal funding. The growing industry's infrastructure may be disregarded for cargo terminal maintenance and expansion. It is important to develop a method of incorporating cruise ports into regional economic impact studies. The Regional ECONomic System (RECONS) is the system used by the US Army Corps of Engineers to estimate growth, jobs, and other economic activities (Wang et al., 2018). This section aims to reevaluate how cruise impact analysis incorporates corporate social responsibility (CSR) in regard to environmental and social welfare. Value-added activities by cruise port operations need to be included into the economic evaluation. Thus, economic growth will be balanced with environmental impacts in order to present the true long-term economic impact of cruise activity on a region.

3.1 Social, cultural, and environmental externality

Responsible cruising is essential for economic growth. The direct relationship between cruise revenue and cruise responsibility should lead to benefits for

local economies, but the local economies only retain around half of the economic benefit through tourism expenditures. In the long run, cruise operations' continued growth depends on the reliability and capacity of the maritime space. Risk of the "tragedy of the commons" within cruise call locations leads to an increasing awareness of the need for responsible cruise practices in order to have market success. Implementation of clear standards of environmental and social responsibility may be one of the needed steps. The measurement of cruise companies' corporate social responsibility and externality to the local stakeholders in the efficiency study is important to benchmark how companies truly impact the economy, local communities, and the environment.

To understand potential externalities, categorization of qualitative and quantitative aspects of corporate social responsibility and sustainability within the cruise industry is needed. This categorization is used to identify how information can be inputted into the dynamic RECONS input-output model. For example, quantitative information such as carbon footprint, cold ironing capacity, energy consumption, waste reduction, exhaust gas cleaning technology, and water efficiency can be tied directly to the operation expenses and cost savings. Qualitative information such as crew trainings, health, safety, and security issues must rely on subject experts to identify the implicit values in order to quantify the impacts associated with the activities and investments. Externalities usually refer to the negative impacts of cruises to the local economies. The positive impacts of cruise economic activity on a region must be balanced with environmental offsets from the externalities of cruising. These offsets include measuring the waste management of cruise lines and identifying this impact on local communities. The input of emission activity economic offset is another important externality that can negatively impact the quality of life of local communities. The impacts are not just environmental; cruise tourism can have a negative sociocultural impact on call port communities. This is a significant issue for these communities because the host communities are not receiving equivalent benefit from on-shore activities. The excursion deals offered by cruise lines sometimes cause the tour guide to receive less than 50% of the total profit. Cruise lines also have cultural impacts through peoples' pollution where the influx of passengers can overwhelm the populations of small cities and this can significantly change the way of life for these communities and be larger than a community can handle.

3.2 Challenges to quantify environmental externality

Standard measurements of job creation, economic growth, and impacts do not fully show the importance of cruise ports as a regional economic engine. Adjusted RECONS model (Fig. 3) including both environmental offsets and cruise specific inputs gives a clearer picture. The number of passengers and crew is used as an input for RECONS to estimate passenger and crew impact based on passenger and crew estimated expenditure. Cruise port economic impact is vastly different than standard cargo port economic impact because the cruise "cargo" has on-shore expenditure creating multiplier effects to

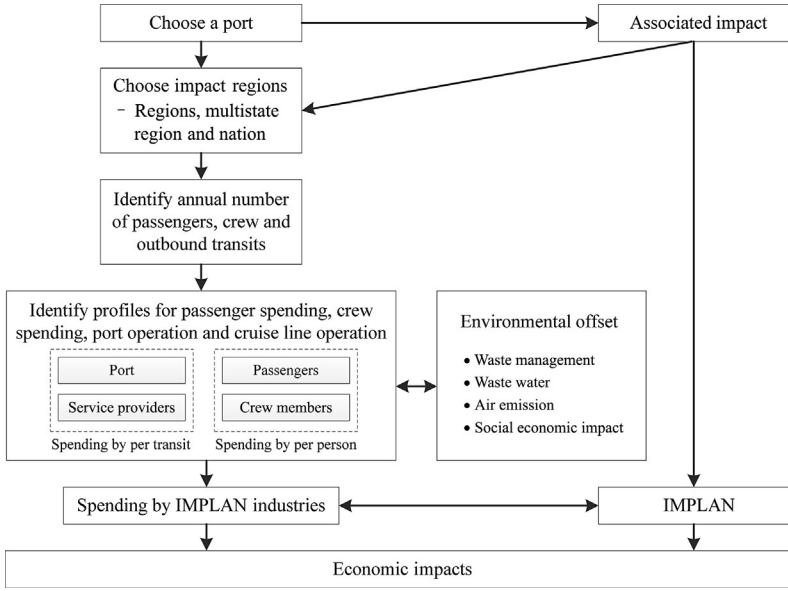

FIG. 3 RECONS configuration. *(From Wang, G., Chang, W.-H., Yue, C., 2018. Responsible cruising and its economic impact. In: International Association of Maritime Economists Conference, Kenya; Wang, G., Xiao, Y., Li, K., 2019a. Measuring environmental efficiency of cruise company considering corporate social responsibility. Mar. Policy. Accepted; Wang, G., Chang, W.-H., Yue, C., Qi, G., Li, K., 2019b. Sustainable Cruise Shipping With Environmental and Economic Considerations. Submitted.)*

local economies. The inclusion of passenger and crew member spending shows the cruise economic impact in a region due to the differences between a cruise port and a cargo port. The multiplier also captures the percentage of the economic impact retained by the regional economy. Other than passenger and crew spending, RECONS also captures the value-added activities associated with daily cruise operations by cruise port and cruise lines.

Quantifying these externalities is difficult. While taxation, "cost of damages," and "cost of control" are used to quantify the externalities, these can be positive economic generators because it creates spending and thus multiplier effects to the community. Discussion of externalities using taxation mechanism creates positive monetary flow such as revenue for the government that may not truly reflect the negative impact to the local stakeholders. The externalities and implicit costs are often neglected in impact studies. Conflicts of interest along the value chain also are an important consideration. The social costs involved must be considered in order to effectively measure the true impact. Effective taxation is another consideration due to the widespread adoption of flags of convenience by cruise lines. The lack of standardized taxation for cruise ships also needs to be considered for a more responsible economic impact model.

The balance of environmental offsets with economic growth is important to the new cruise economic impact model. While responsible cruising should minimize the negative externalities, the focus for cruise lines remains on profit maximization. Maximization of profit should lead to responsible cruise tourism if the interests of the cruise lines are aligned well with the public's interest. Responsible cruising is essential for long-term sustainability in the cruise sector due to dependence on both the environment and local communities to provide the cruise experience.

4 Marine environmental efficiency and CSR

This section aims to help cruise shipping companies identify issues that present risks to the maritime space's internal and external stakeholders. The use of environmentally friendly technology is an important part of corporate social responsibility for cruise lines in mitigating negative externalities to stakeholders and to the public. The growth of the installation of exhaust gas cleaning systems and advanced wastewater purification systems onboard cruise ships shows an increase in compliance with International Convention for the Prevention of Pollution from Ships (MARPOL) regulations. To quantify environmental efficiency, Carnival Corporation, with its subsidiaries, Costa Crociere and Holland, was selected because of its large market presence in the Caribbean (Wang et al., 2019a). This application is aimed to identify environmentally friendly strategies and the extent to which these can be effectively implemented in order to reflect corporate social responsibility in the cruise sector. Further, the goal is to provide policy advice aligning public interests with cruise stakeholders.

4.1 Quantify environmental efficiency with undesirable output

By utilizing statistical tools such as the superslack-based measure (SBM) model and the Malmquist productivity index, undesirable environmental externalities, such as air emissions, wastewater, and other pollution, as well as other undesirable outputs are taken into consideration when we measure environmental efficiency. Wang et al. (2019a) utilized empirical data from Carnival cruise lines and its subsidiaries to compare CSR based on air emissions, gray water discharge, bilge water discharge, and solid waste across the companies. A Data envelopment analysis (DEA) method was used to measure the efficiency of decision-making units through a linier combination of inputs and outputs. In order to allow for the changes of efficiency over time, the DEA method was combined with super-SBM and the Malmquist index. These methods are used to find the relative efficiency in different areas and the Malmquist productivity index was used to expand upon the findings of the super-SBM based on inputs of employers, energy consumption, and water consumption with revenues as the desirable outputs.

This methodology captures not only the desirable outputs but also the undesirable outputs such as air emissions, wastewater, solid waste, and energy consumption as discussed in the previous section as externalities in cruise operations. Analysis at the firm level shows that certain companies are well equipped with the needed technology to tackle environmental concerns and others may have facility and infrastructure advantages. Similarly, the model can identify areas of inefficiency. Some firms have disadvantages in wastewater, while others may have weaknesses in air emissions. For example, Costa Crociere was the best in air emissions environmental efficiency when compared to the other Carnival companies. Its efficiency has also been shown overtime to increase between 2010 and 2015. Carnival was the most efficient in wastewater treatment due to significant investment into technology and effective ways of managing wastewater. In both air emissions and wastewater areas, companies studied showed significant investment in technology to enhance overall efficiency. While Carnival was not as environmentally efficient as its subsidiaries it has made significant progress in emissions reduction technology and energy conservation. While the cruise industry is generally more environmentally aware due to its nature of capitalizing on the environment, it still has a long way to go. It provides a method to measure environmental and social responsibility efficiency for sustainable cruising.

5 Incentive mechanism in cruise supply chain

The reliability and sustainability of cruise operations depend on the interactions among players within the value-added supply chain. The negotiation of cruise port-cruise line contracts is important for establishing long-term interactions between the players. Cruise ports' motivations are the long-term port-city development and economic growth, whereas the cruise line's motivation is profit maximization. This causes many ports to offer incentives to receive long-term contracts, which ensures long-term economic growth (Wang et al., 2014a,b). The vertical integration and cooperation within the supply chain is important to maintain a successful and reliable cruise supply chain. The utilization of incentives to align the motivations of members of the maritime cluster which form a cohesive and stable unit.

5.1 Contract theory to overcome moral hazard and vulnerability

The cruise supply chain is made up of multiple players, the cruise line, the cruise ports (home and call), the cruise suppliers, the travel agency, and excursion providers. The interdependence of the cruise supply chain with different self-interests can create conflicts of interest leading to a less efficient and sustainable supply chain. The asymmetric information between cruise players in the cruise supply chain can lead to adverse selection (before the contract is signed) or moral hazard (after the contract is signed). These supply chain

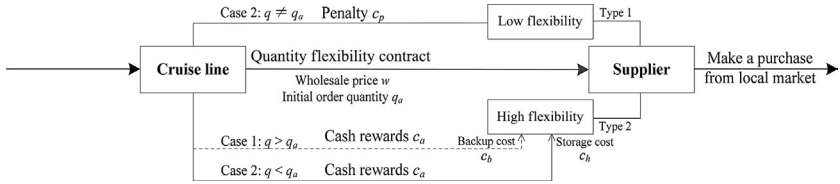

FIG. 4 Incentive mechanism design for supplier's flexibility. *(From Qu, Wang, and Zeng, 2019. Modelling the procurement process and production disruption of a multilayer cruise supply chain. Maritime Pol. Manag. submitted; Wang G., Qu, C., 2019. Modelling Incentive Strategy of a Multi-Layer Cruise Supply Chain. Transportation Research Board, United States.)*

players all have varying self-interests and motives. The need for reliability and flexibility for the cruise supply chain is essential for all parties to profit from the consumer's experience. In order to align the motivations of the supply chain stakeholders, a game theory approach with the cruise line, the cruise port, and the cruise supplier was developed to apply incentive mechanisms to enhance customer experience (Wang and Qu, 2019). This forms a more cohesive and reliable network. The Stackelberg leader-follower game was applied to model sequential decisions in the supply chain and to determine incentives that can promote optimal outcomes. Backward induction was used in order to find the right incentive method in the leader-follower framework.

Fig. 4 shows the incentive approach for the cruise line relationship with the cruise supplier. The cruise line must deal with asymmetric information because only the supplier knows if the supplier is flexible. The flexibility in the supply chain is essential for dealing with market disruptions and maintaining reliability. The cruise line wants a highly flexible supplier in order to accommodate changing onboard consumption and/or an unforeseen emergency resupply. The flexibility of service providers is incentivized through cash rebates in exchange for high flexibility. Using punitive measures will discourage flexibility causing inefficiency in the supply chain. Through a theoretical framework for the cruise supply chain including suppliers, cruise lines, and cruise port/terminals, the behavior and decision-making process of all players can be explicitly quantified. It finds that in order to maintain reliability of the supplier, the cruise line needs to incentivize the supplier. The optimal method of ensuring a highly flexible supplier is through nonpunitive measures reinforcing flexibility in the supply chain. The high market power of cruise lines due to their oligopolistic nature within the cruise supply chain places them in the dominant position in the supply chain. The differing motivations of players are essential for identifying the correct incentive methods of aligning the player's self-interest.

6 Conclusions

Supply chains for cruise ships enable passenger to enjoy the diverse experience of cruising. As a cruise ship travels to each port of call, its supply chain changes accordingly. This complexity adds vulnerability that can test the sustainability

and reliability of the chain. Given the fixed itinerary and short turnaround window, supply chain operations for the cruise industry are unique. Reliability in the supply chain is essential in order to adjust after an event (hurricane, port strike, etc.) that the cruise supply chain has reliable alternatives for and alternate routes where the supply can be adjusted. Alternatives need to be found to make the supply chains more resilient for future events. In order to improve on the reliability of the chains due to the economic significance of cruise lines to the nation and in particular the ports they visit, we investigate incentive strategies for cruise supply chains affected by natural disasters and forecasting error of consumptions. Assessment of the vulnerability of cruise emergency supply chains and resilience to disruption is essential for supply chain analysis. The utilization of incentives is used to improve potential outcomes of an event and provide resilience to event vulnerability. The development of plans of action for ship resupply, rescheduling, and rerouting is essential for overall reliability.

This game theoretical approach can be applied to different cruise regions around the world and the game has different results due to differing market setups. For example, the cruise sector in China has experienced significant growth, but the market dynamic is vastly different from that of the Mediterranean and Caribbean counterparts. The Chinese cruise market operates differently because the dominant position shifts to the cruise port due to the lack of multipurpose terminals willing to host cruise activities. This gives the cruise ports the negotiating power over the cruise lines; this is contrary to the Caribbean and Meditation markets where the oligopolistic nature of the cruise lines grants them significant negotiation power and market share. The reversal of the dominant position places the port in the dominant position of negation. This changes the overall dynamics of the value chain. Cultural and regional dynamics significantly influence the cruise supply chain's dynamics, and players. The use of incentive mechanisms needs to change toward the cruise market being served.

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Further reading

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