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Article

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Original Article

A social network analysis of interconnections among cruise ports

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ABSTRACT

Despite the dominance of the Caribbean as the leading cruise destination in the world, research that focuses on the network of cruise ports in the region is limited. To fill this research gap, the current study carried out social network analysis (SNA) to inquire into cruise port interconnections and their influence on the operation of the entire Caribbean port network. The results are summarized as follows: First, in terms of connections among ports linked to the Caribbean region, a European port and a Southampton harbor exhibit the most significant in-degree and out-degree centrality. Nevertheless, ports within the Caribbean region are still significantly represented as regards both indexes. Second, in the matter of port influence, Caribbean ports are considerably the most important with respect to hub and authority centrality (HAC), especially those located in Florida and the eastern Caribbean. This research contributes to industry through its presentation of an extended panorama of the cruise network in the region, subjecting several ports to respective analyses that describe their principal characteristics and attractiveness in the industry.

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1. Introduction

The tourism industry has served as a major economic sector for all countries localized in the great Caribbean region (Zampino, 2005). It is the foremost export enterprise that also wields the ability to diversify the Caribbean economy (Charlier & McCalla, 2006). As corroboration of its influence, the region received 46.7 million international visitors in 2016, thereby contributing 15.2% to the Caribbean's GDP. These visitors come from the United States, which accounts for approximately 50% of tourist influx, making it the most important market of origin, followed by Europe, the Caribbean itself, and Canada (World Travel Tourism Council, 2018).

Within diverse tourism segments, the cruise industry has gained exponential global popularity as a leisure choice for travelers, thus representing the fastest-growing core sector the world over (Dickinson & Vladimir, 1997). This industry has registered double digits in overall growth rates since 1980 and has generated an estimated 126 billion dollars in total economic impact (Florida-Caribbean Cruise Association, 2018). Its success is attributed to capitalization on the reputation of the Caribbean region as the world's premier cruise destination. As the cruise industry expanded

to global operation (Charlier & McCalla, 2006), the Caribbean region has continued to register the most remarkable achievements in terms of passenger embarkation and disembarkation, the number of ports of call, diversity in cruise itineraries, and the number of vessels committed to the region (Cruise Lines International Association, 2018).

Accordingly, the Caribbean is heavily targeted by cruise operators given that its privileged geographical location and year-round tropical temperatures, its closeness to the United States, and its paradisiacal landscapes combined with diverse cultural heritages translate to an exceptional opportunity to maximize tourism in the region (Brida & Zapata-Aguirre, 2009). The exploitation of this opportunity has meant that 68% of all cruises in the last 10 years have traveled to the greater Caribbean region (Cruise Lines International Association, 2018). Additionally, the proximity of the Caribbean islands facilitates accessibility to numerous ports, providing cruise ships the option to offer their passengers a port-a-day itinerary without having to travel at high speeds to reach the next port of call (Sheller, 2009). The development of tourism in the region has altered the structures of several Caribbean island cities, which have evolved from quiet towns to densely developed urban areas intended to support a large volume of visitor arrivals (Braun, Dander, & White, 2002). In recent years, a number of countries have heavily invested in cruise tourism infrastructure in an effort to satisfy the demands of cruise operators (Weeden, Lester, & Thyne, 2011). Every year, Caribbean countries seek to attract more of the cruise market by developing appealing tour opportunities

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and shopping experiences aimed at stimulating tourist spending in the area. Unsurprisingly, certain islands continuously establish sophisticated port facilities for potential profit and reduce the loss of profits that occurs in these destinations (Douglas & Douglas, 2004). Meanwhile, the cruise industry emphasizes its strategy to increase supply by expanding capacity and encouraging demand; this scheme is tantamount to the incorporation of new destinations to cruise itineraries (Piesley, 1986).

Despite the progress depicted above, however, the Caribbean faces various issues that affect its boundaries. The region is politically diverse as a direct consequence of its colonial history, being founded as a result of an international rivalry that was reared and nurtured in an environment of power politics (Williams, 1970). The region comprises 13 independent nations and several dependencies, territories, and possessions of France, the United Kingdom, the United States, the Netherlands, and Venezuela (World Bank, 2019). This structure tends to complicate the manifold decisions carried out in the region, what with heavy interest from several countries (Hanratty & Meditz, 1989).

The importance of the Caribbean region as a cruise industry has motivated researchers to put forward suggestions, such as implementing community-based development, to maximize the regional tourism generated in this sector (Zampino, 2005). Brida, Paulina, Riaño, and Zapata (2012), for example, analyzed passenger experience at embarkation ports and highlighted the importance of an appropriate infrastructure for passengers stopping over for long periods. Notwithstanding the value of these explorations, however, research focusing entirely on the network of cruise ports in the Caribbean is limited. With consideration for this challenge, the present study bridges this gap by identifying the leading ports and their principal characteristics and influences in the Caribbean network to stimulate the region competitiveness and further improve of ports connectivity by adopting social network analysis (SNA).

The rest of the paper is organized as follows. The second section presents previous studies on the Caribbean cruise network, and the third introduces the SNA methodology. The fourth section discusses the empirical analysis of network structure, and the fifth section concludes the paper with limitations and future research directions.

2. Literature review

The literature review indicated that cruise port research can be roughly classified into factor analyses of tourism at destination ports, economic benefits to stakeholders, environmentalism, and port policy. A number of studies have been directed toward cruise ship operations (notably, Klein, 2009) and other globalizing tourism businesses (Theobald, 2004), but scarce efforts have been extended to clarify port network-related issues in the Caribbean context.

Existing research regarding the cruise industry in the Caribbean has centered mainly on a wide range of issues related to tourism. Cases in point are the works of Larsen and Wolff (2015), Teye (2010), and Brida et al. (2012), who explored tourist motivations and how these figure in the satisfaction with cruise experience and loyalty to a cruise operator. Larsen and Wolff (2015) examined the various factors involved in whether tourists are likely to return if more opportunities arise. The authors determined that cruise tourists exhibit a lower inclination to revisit a port destination than do land-based travelers. Similarly, Silvestre, Santos, and Ramalho (2008) showed that city attractions and the overall experience in a port are critical determinants of the intention to recommend and return to a destination. Hilaire (2007), Wilkinson (1999), and Gui and Russo (2011) looked into predominant issues pertaining to the impact of cruise tourism on the ports of call in the Caribbean. They discovered that even though cruise tourism extensively affects the economy,

it potentially contributes a small proportion to the total incomes of destination ports.

Other studies revolved around the economic importance of the cruise industry. Brida and Zapata-Aguirre (2009) identified the costs incurred and the benefits earned by actors in the local economies of Caribbean ports of call. The study verified that ports more strongly perceive the cruise industry as necessary than do cruise lines, even under the reality that these actors mutually need one another. Braun et al. (2002) deduced that port regions receive minimal benefits from the cruise industry because of its dependence on passenger spending. Clancy (2008) demonstrated the importance of political economy, along with power negotiation strategies, in bypassing regulations that are imposed on other tourism providers. Sprague-Silgado (2017) focused on the expansion of capitalism in the Caribbean via leisure travel, supporting the idea that capital accumulation is substantively a contradictory and unsustainable global process. Moreover, scholars investigated the domination of different state elites in cruise ship destinations, looking into these entities' establishment of convenient routes and implementation of private business rules in the Caribbean (Klein, 2009). Other studies applied diverse methods in analyzing specific ports for the expansion of the cruise industry and the economic effects exerted on a particular port (Braun et al., 2002; Brida et al., 2012; Chase & McKee, 2003; Teye, 2010).

In elucidating the complexity of the industry in the Caribbean, Sheller (2009) argued that new transregional approaches are needed to describe the complex and multiscale cruise ports in the region. Similarly, Weeden et al. (2011) explained the synergy behind a wide range of social, economic, and environmental effects associated with the expanding cruise industry. Adding to these insights, Wood (2000) separated economic life from the constraints of geography as well as cultural and political environments in an industry confronted with global competition, capital mobility, and labor migration.

Yet another widely scrutinized issue is sustainable cruise tourism, which has become a principal locus of the debate on environmentally integrated tourism development in distinct regions (Copeland, 2010). One of the earliest explorations in this respect is that of Baker and Stockton (2013), who evaluated how cruise tourism in the Caribbean adheres to sustainability principles. The authors uncovered the negative effects of overcrowded port cities on ports of call and recommended that all stakeholders determine the realistic carrying capacity of ports and design efficient itineraries within these limits.

As has been described, in spite of the Caribbean's instrumental role in the cruise industry and, consequently, in the vast majority of Caribbean economies (BREA, 2017), little research has been carried out to delineate the intricacies of the Caribbean port network. The present study addressed this deficiency by applying SNA to the Caribbean port structure.

3. Methodology

One of the few initiatives in the port network-related issues is the study of Wilmsmeier and Hoffmann (2008), who used the standard gravity model to analyze the effects of port infrastructure and liner shipping connectivity on Caribbean freight rates. The authors concluded that distance matters only indirectly in the designation of freight rates by shipping operators given that it reflects neither market structure nor network configuration. Some studies applied SNA to shed light on cruise port selection. Jeon, Duru, and Yeo (2019), for instance, probed into the centrality of cruise ports in the Asian market, adopting the hub concept of Lohmann, Albers, and Pavlovich (2009) in identifying hub ports and analyzing the centrality of Asian cruise ports. Lekakou, Pallis, and Vaggelas

(2009) conducted a network analysis to identify the main benchmarks used by cruise companies in selecting a home port in Europe. Having a fully operational international airport emerged as the critical influencing factor for the selection of European home ports. SNA has likewise been used in seaport research, as was done by Lu, Park, and Yeo (2018), who studied the seaport network structure in Asia to identify ports with substantial impact and use the data to increase the port of Incheon's connectivity. Wang, Jung, Yeo, and Chou (2014) pinpointed the principal factors motivating cruise operators to select a particular port of call. The researchers asserted that the strongest determinants are tourism attractions, followed by connectivity and agility.

SNA was the method of choice in this research because of its understandability and generation of practical results. For instance, quantitative derivative data can be reflected in tables and graphs, thereby allowing for an overview of an entire network (Lovric, Da Re, Vidale, Pettenella, & Mavsar, 2018). The presentation of information in a visible format eases the comprehension of connections between the nodes of a network structure (Choi, Kim, & Im, 2011). The indexes in SNA, such as in-degree, out-degree, and betweenness centrality, are commonly used measures.

Degree centrality indicates the number of links that each node has with other nodes in a network (Freeman, 1977). In theoretical terms, connection centrality is calculated as the number of nodes linked to a determined point. Thus, a high connection centrality is directly proportional to a considerable number of connection points for each node. In-degree centrality concerns the number of nodes connected internally to a primary node, whereas out-degree centrality refers to the number of nodes linked externally from this node. If nodes i and j are connected, a_{ij} is assigned a value of 1; otherwise, a_{ij} takes on a value of 0 (Jia, Qin, & Shan, 2014):

$$C_{d(in)}(i) = \sum_{j=1}^n a_{ij}, \quad C_{d(out)}(i) = \sum_{j=1}^n a_{ij} \tag{1}$$

Betweenness centrality describes the role that a node plays in the structure of a network (Freeman, 1977). It can be calculated on the basis of the rate at which a node functions as an intermediary along the shortest path to forge a connection with other nodes. $C_b(i)$ is defined as the ratio of the shortest path to a node, g_{kj} denotes the shortest distance between two nodes, and $g_k(i)$ represents the number of shortest paths that are associated with node i (Song & Yeo, 2017):

$$C_b(i) = \sum_{j < k} \frac{g_{jk}(i)}{g_{jk}} \tag{2}$$

Because hub and authority centrality (HAC) prioritizes the degree of association among nodes, it was considered a supplement to degree centrality by Kleinberg (1999). The concept of a mutually strengthening association is used to calculate hub and authority weights per individual node. Mutual strengthening occurs when high-scoring hub centrality nodes are connected to high-scoring authority nodes and when high-authority centrality nodes are linked to high-hub centrality nodes (Lu et al., 2018). These variables are calculated as follows (Kleinberg, 1999):

$$\sum_{i \in S_\sigma} (x^{(i)})^2 = 1 \quad \text{and} \quad \sum_{i \in S_\sigma} (y^{(i)})^2 = 1 \tag{3}$$

A flow chart of the research is shown in Fig. 1.

4. Case study

For the empirical analysis (Fig. 2), we collected data from 902 ports that represent the total number of cruise ports incorporated in

itineraries of the cruise industry. The network of cruise routes was modeled on the basis of data on each cruise line itinerary in 2018 (<http://crew-center.com/cruise-ships-ports-schedules-2019>).

SNA is an outstanding methodology that provides valuable data on in-degree, out-degree, betweenness, hub, and authority centrality. It enables the analysis of the entire structural characteristics of a principal's cruise ports in the Caribbean. Implementing SNA enabled us to interpret the centrality of 89 Caribbean ports that are part of the cruise route network in the region.

As shown in Fig. 3, Southampton enjoys a strong connection to the Caribbean network, as evidenced by its in-degree and out-degree centrality. This finding means that the North European port simultaneously functions as points of flow initiation and reception.

4.1. Out-degree, in-degree, and betweenness centrality

Table 1 lists the top 40 ports (out of 902 worldwide ports connected to the Caribbean region) in terms of out-degree centrality. The figures indicate that Southampton (0.073) is the main port of departure for cruises that have the Caribbean as part of their itineraries. The second most popular port of departure is Civitavecchia (0.059), and the third is Fort Lauderdale (0.051). These results suggest that European ports are obligatory out-degree points given that a vast number of cruise customers are concentrated in these areas. Southampton has achieved an essential position as the leading European cruise port for embarking passengers. It also serves as a home port for some 16 cruise ships operated by five cruise lines, rendering it the only cruise car parking provider for four of the major cruise lines (Southampton Harbour Authority, 2020). This explains why P&O and Cunard established their headquarters at Southampton. In Europe, Civitavecchia remains the primary cruise destination owing to its dynamic tourism, its well-coordinated network of cruise ports, and its provision of direct access to Rome and other attractive tourist cities inland of Italy (Gui & Russo, 2011). The appeal of Civitavecchia in the cruise industry is as an out-degree point for the market. Fort Lauderdale is also a crucial port of departure in the Caribbean because of its reputation as the cruise capital of America and its consequent provision of unique premium facilities for customers. Its contribution to the industry and its development stem from the fact that it has the highest arrival and departure rates worldwide. Copenhagen (0.046) and Miami (0.046) complete the top five list.

Table 2 presents the top 40 ports among 902 worldwide ports connected to the Caribbean region as regards in-degree centrality. Similar to the results on out-degree centrality, the findings emphasize the strong dominance of European ports in the industry. Southampton (0.062) again exhibits the highest performance given its function as a multifunctional gateway of the European cruise market through the English Channel. It offers extraordinary advantages, such as wide access to the vital railroads and road networks of Britain, providing direct access to a densely populated hinterland. These capabilities are further reinforced by a solid investment from the UK government in its four exclusive cruise terminals and surrounding infrastructural areas (Southampton Harbour Authority, 2020). Copenhagen (0.046), Barcelona (0.044), and Civitavecchia (0.044) rank among the top 10 busiest cruise terminals in Europe and, normally, attract a large number of travelers around the world. These locations host approximately 2.3 million cruise passengers annually (CLIA, 2018). Surprisingly, Philipsburg (0.047) registers the second highest in-degree centrality in the list. A tourism-dependent island with a privileged geographical location, Philipsburg offers exceptional advantages for cruise itineraries (McElroy, 2003), including premier large-scale facilities dedicated exclusively to the tourism industry, multiple one-day activities designed for cruise passengers, and the largest duty-free shops in

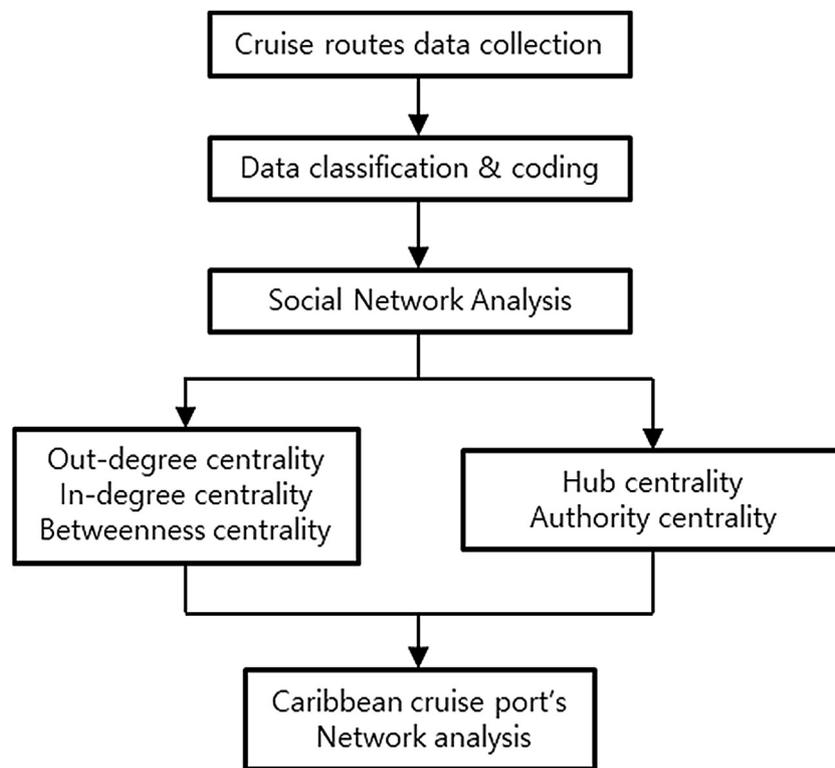


Fig. 1. Research flow chart.

Table 1
Out-degree centrality of cruise ports.

Rank	Port	Out-degree	Rank	Port	Out-degree
1	Southampton	0.073	21	La Valletta	0.032
2	Civitavecchia	0.059	22	Lisbon	0.032
3	Fort Lauderdale	0.051	23	Piraeus	0.032
4	Copenhagen	0.046	24	Reykjavik	0.032
5	Miami	0.046	25	St. Georges	0.032
6	Barcelona	0.043	26	Kiel	0.031
7	Philipsburg	0.043	27	Malaga	0.031
8	St. Johns	0.042	28	Stockholm	0.031
9	Basseterre	0.041	29	Tortola	0.031
10	Bergen	0.041	30	Cadiz	0.03
11	San Juan	0.041	31	La Romana	0.03
12	Bridgetown	0.037	32	Livorno	0.03
13	George Town	0.037	33	Tallinn	0.03
14	Palma De Mallorca	0.037	34	Venice	0.03
15	Nassau	0.036	35	Cartagena	0.029
16	Amsterdam	0.034	36	Oranjestad	0.029
17	Cozumel	0.033	37	Oslo	0.029
18	Montego Bay	0.033	38	Ponta Delgada	0.029
19	Cape Liberty NYC	0.033	39	Port Cañaveral	0.029
20	Warnemunde	0.033	40	Corfu	0.028

the eastern Caribbean (McElroy & de Albuquerque, 1998). As a consequence, the port receives 1 million passengers per year (Fig. 4).

Table 3 provides the top 40 ports with regard to betweenness centrality, which indicates the shortest trajectory between distant nodes. It also shows the rate at which cruises pass through a certain port en route to and from the Caribbean. Los Angeles (0.16) stands as the port with the highest betweenness centrality, and Fort Lauderdale (0.145), Singapore (0.144), Sydney (0.121), and Coco Cay (0.111) complete the top five of the list. Note that these ports, excluding Coco Cay, are not only located in large cities with an entire tourism infrastructure but also represent developed economies in their respective regions, being home to pre-eminent trade companies and enjoying stable financial support. Thus, the cruise industry deems these ports indispensable

as routes for connection to other ports in Asia, Oceania, or the Caribbean.

4.2. Hub and authority centrality

The analysis discussed in previous section was grounded in in-degree, out-degree, and betweenness centrality, which restricted the examination to the number of departing and arriving vessels at a cruise port. It thus provided limited clarity as to the influence of a port on entire network operations. To illuminate this issue, we also used HAC as an indicator.

Table 4 presents the top 40 ports in terms of hub centrality. A high hub centrality means that a port has network connections to high-impact ports. HAC is considered a complement to the other

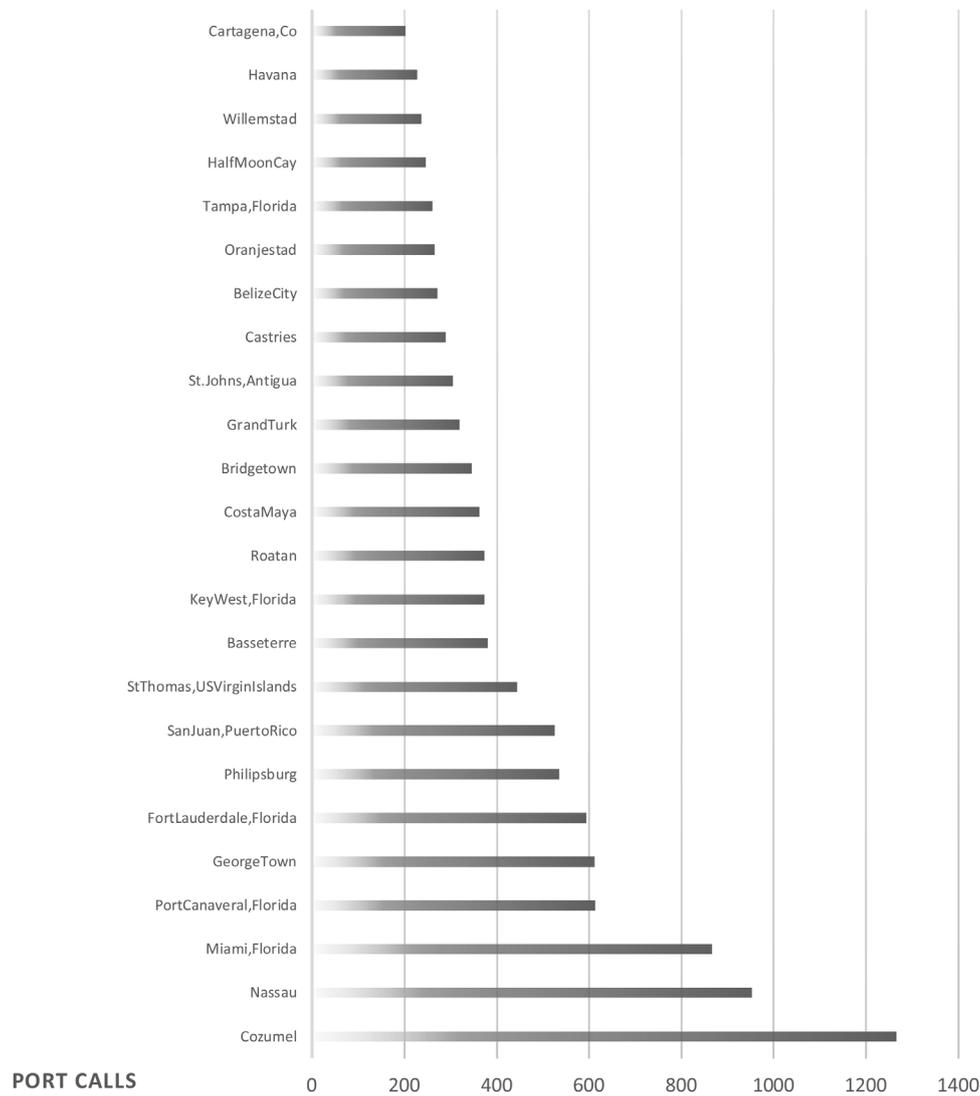


Fig. 2. Top 25 cruise ports in the Caribbean by total port calls (Source: CLIA, 2018).

Table 2
In-degree centrality of cruise ports.

Rank	Port	In-degree	Rank	Port	In-degree
1	Southampton	0.062	21	Stockholm	0.036
2	Philipsburg	0.047	22	PalmaDeMallorca	0.034
3	Copenhagen	0.046	23	Stavanger	0.033
4	Barcelona	0.044	24	Tallinn,	0.033
5	Civitavecchia	0.044	25	Gibraltar	0.032
6	Miami	0.044	26	Port Cañaveral	0.032
7	Basseterre	0.043	27	Kiel	0.031
8	Fort Lauderdale	0.043	28	Cozumel	0.03
9	Lisbon	0.043	29	Halifax	0.03
10	Montego Bay	0.042	30	Livorno	0.03
11	Bergen	0.041	31	Nassau	0.03
12	St. Johns	0.041	32	St. George	0.03
13	Cartagena	0.039	33	Grand Turk	0.029
14	Warnemunde	0.039	34	Kotor	0.029
15	George Town	0.038	35	Malaga	0.029
16	Cape Liberty NYC	0.037	36	Marseille	0.029
17	Bridgetown	0.036	37	Piraeus	0.029
18	Dubrovnik	0.036	38	Tortola	0.029
19	La Valletta	0.036	39	Venice	0.029
20	San Juan	0.036	40	Cadiz	0.028

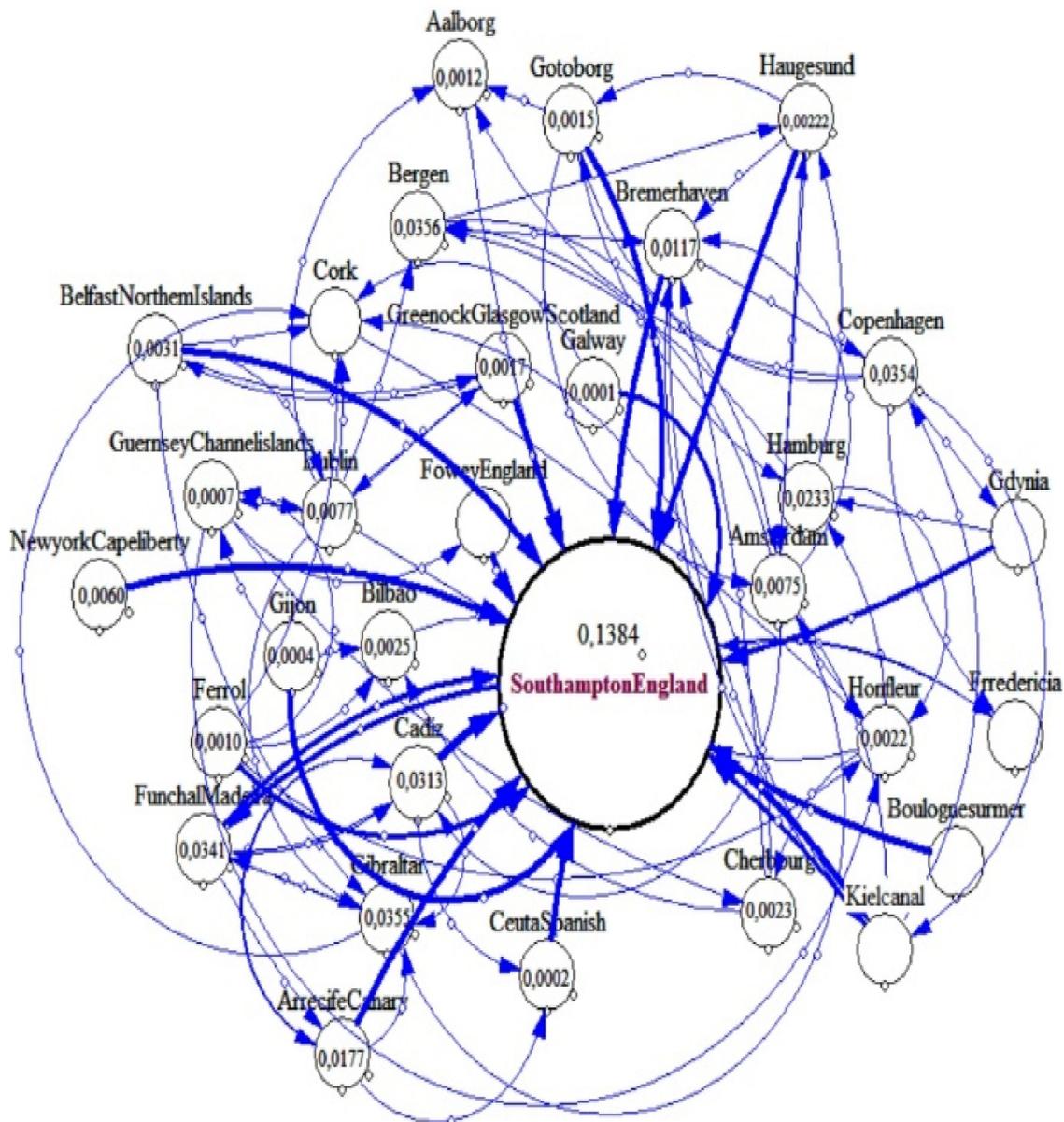


Fig. 3. Port network associated with Southampton.

Table 3
Betweenness centrality of cruise ports.

Rank	Port	Rank	Port
1	Los Angeles	21	George Town
2	Fort Lauderdale	22	Cadiz
3	Singapore	23	Puerto Quetzal
4	Sydney	24	Malaga
5	Coco Cay	25	Barcelona
6	Brisbane	26	Kiel
7	Southampton	27	Aqaba
8	Civitavecchia	28	Lisbon
9	Tenerife	29	Nuuk
10	Puntarenas	30	Panama Canal
11	Komodo Island	31	Qaqortog
12	Miami	32	Vancouver
13	Cartagena	33	Hilo
14	Walvis Bay	34	Cape Liberty NYC
15	Ponta Delgada	35	Bridgetown
16	Palma De Mallorca	36	Piraeus
17	Hong Kong	37	Shanghai
18	Manila	38	Reykjavik
19	Cape Town	39	Stockholm
20	San Diego	40	Cork



Fig. 4. Allocation of the most relevant ports on the basis of the in-degree and out-degree indexes.

Table 4
Hub centrality of cruise ports.

Rank	Port		Rank	Port	
1	Fort Lauderdale	0.214	21	Cozumel	0.125
2	Basseterre	0.194	22	Samana	0.125
3	Philipsburg	0.193	23	Copenhagen	0.119
4	St. Johns, Antigua	0.19	24	Castries	0.117
5	Miami	0.185	25	Willemstad	0.114
6	San Juan	0.178	26	Stockholm	0.11
7	Southampton	0.158	27	Warnemunde	0.11
8	Tortola	0.149	28	Kralendijk	0.109
9	George Town	0.147	29	Ocho Rios	0.109
10	St. Georges	0.146	30	Key West	0.108
11	Nassau	0.145	31	Half Moon Cay	0.104
12	Montego Bay	0.143	32	Cartagena	0.102
13	Bridgetown	0.14	33	Roseau	0.099
14	Oranjestad	0.137	34	Helsinki	0.098
15	La Romana	0.133	35	Tallinn	0.098
16	Port Cañaveral	0.129	36	Fort de France	0.096
17	St. Thomas	0.129	37	Ponta Delgada	0.094
18	Grand Turk	0.128	38	Havana	0.093
19	Cape Liberty NYC	0.128	39	Pointe A Pitre	0.093
20	Amber Cove	0.125	40	Puerto Limon	0.091

measures of degree centrality (Kleinberg, 1999) and is derived on the basis of in-degree and out-degree centrality values. HAC is hence reflective of a mutual and solid link. The HAC findings in this work indicate that Caribbean ports extensively dominate and mostly serve as the core of the cruise industry.

The highest-ranking hub is Fort Lauderdale (0.214), followed by Basseterre (0.194), Philipsburg (0.193), St. John's (0.19), and Miami (0.185). The network of the port of Fort Lauderdale is illustrated in Fig. 5. It exerts the strongest influence on the Caribbean and global cruise industry (Yang, Xinliang, & Younong, 2014). Its identification as a hub is anchored in the fact that 39 cruise ships operated by 11 cruise lines use the location as a destination (Port Everglades Port Authority, 2020). The port is an embarkation cen-

ter for the North American market, making it the backbone of the Caribbean's cruise industry (Hilaire, 2007). Additionally, it has direct access to one of the busiest airports, Miami International Airport, on the east coast. This status has earned Fort Lauderdale global renown, being conferred awards by multiple organizations for its modern, guest-friendly facilities and excellent customer service (Yang et al., 2014). Owing to its status as a key logistical service provider to cruise vessels, as well as their passengers and crew, Fort Lauderdale directly interacts at a high in-degree and out-degree centrality with European ports such as Southampton, Civitavecchia, and Barcelona.

Because nearly all Caribbean countries strongly depend on the tourism industry, governments extend tremendous efforts to offer

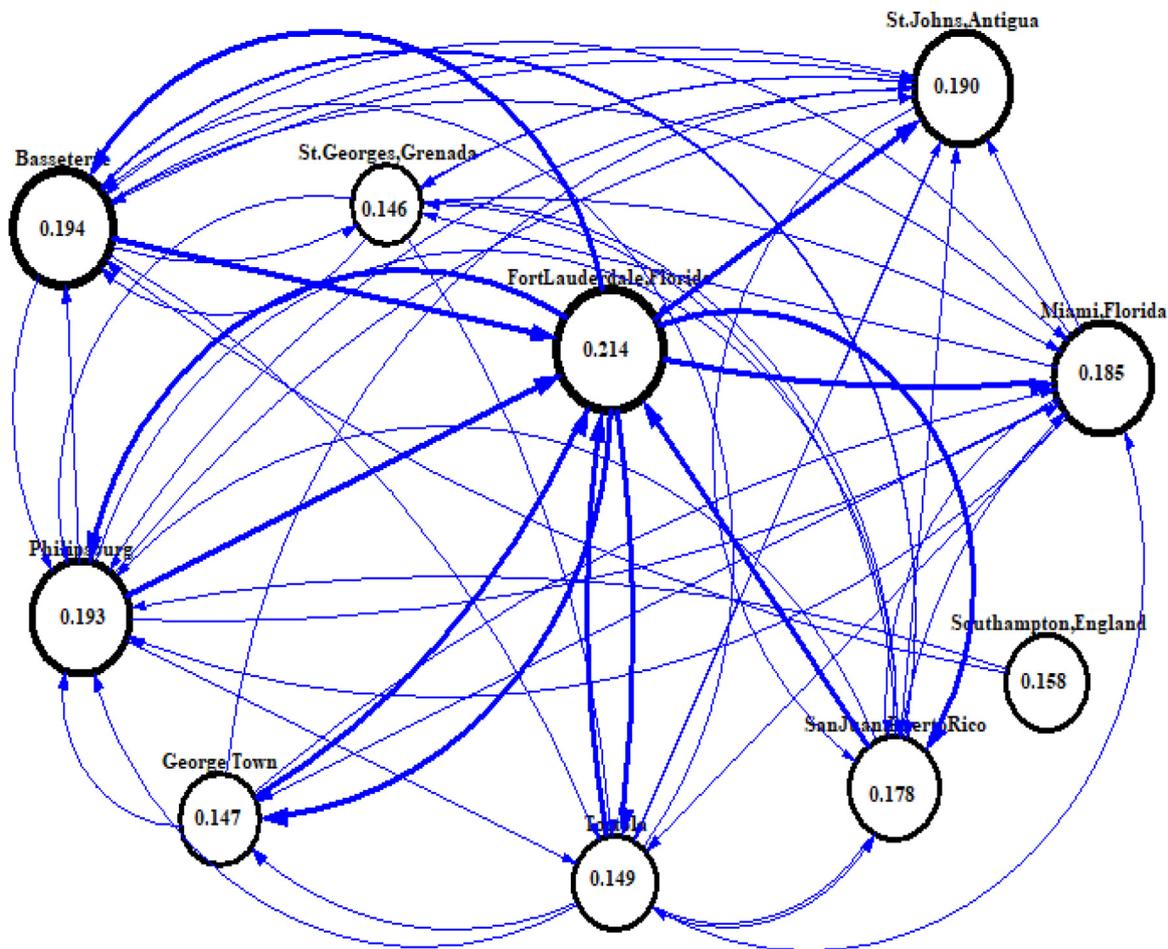


Fig. 5. Port network associated with Fort Lauderdale.

the best conditions to cruise businesses (McElroy, 2003). As a result, these ports can be used as hubs for all cruise lines.

Table 5 shows the results of the authority centrality. The findings are very similar to those of the hub centrality examination, but the rankings are slightly different. Florida home ports are ranked among the top five cruise destinations in the world (Gibson, 2006). Philipsburg (0.221) ranks highest in terms of authority, with the port functioning as the commercial center of Saint Martin Island and the largest hub of cruise tourism expenditure in the eastern Caribbean (McElroy & de Albuquerque, 1998). Even though Philipsburg may differ only moderately from other ports with similar land extensions and route positions in geographical terms, Saint Martin’s port authorities regard it as essential in the industry mostly because of its willingness to maintain long-term business relationships with major cruise lines through aggressive promotions, aid-financed transport/utility systems, and investment tax incentives (McElroy & de Albuquerque, 1998). Saint Martin also collaborates as an active member of multiple associations, such as the Organization of the Eastern Caribbean States, in an endeavor to capitalize on the industry. The second highest-ranking port in terms of authority is Fort Lauderdale (0.195), followed by Basseterre (0.192), which is considered the financial center in the Eastern Caribbean primarily because it attracts the most reputable banks of the Caribbean. Miami (0.191), and St. John’s (0.186) complete the top five rankings. We can conclude that these ports have not only maintained a complete port infrastructure but are also key actors in tourism in the region. Florida ports are undoubtedly the most favored because of their proximity to the largest cruising area in the world in terms of passengers (i.e., the Caribbean) and their pre-

mium infrastructure for the provision of services, connectivity, and maintenance for a growing industry (Pallis, 2015).

5. Conclusion

The Caribbean cruise tourism has an enormous influence on most of the island’s economies. Several countries have praised the industry’s efforts to improve principal ports to evolve into an engaging destination for cruise routes amid an expanding and competitive yet compact market. Understanding the cruise network in the region is indispensable to the endeavors of every port of call to maintain economic development.

This case study uncovered network connections in the Caribbean region by applying SNA, which was directed to 902 ports that are included in global cruise itineraries. The results are summarized as follows. First, the ports are highly similar as regards in-degree and out-degree centrality. Notably, the port of Southampton topped both rankings by a reasonable margin (in-degree centrality = 0.062, out-degree centrality = 0.073). The top five rankings for in-degree centrality are completed by the ports of Philipsburg (0.047), Copenhagen (0.046), Barcelona (0.044), and Civitavecchia (0.044), whereas the top five in respect of out-degree centrality is rounded up by the ports of Civitavecchia (0.059), Fort Lauderdale (0.051), Copenhagen (0.046), and Miami (0.046). These results point to a direct influence on cruise route planning for the Caribbean region, with the largest ports located on the other side of the Atlantic Sea—Europe. As a consequence, five of the largest European ports, three on the East Caribbean, and the two main Florida

Table 5
Authority centrality of cruise ports.

Rank	Port		Rank	Port	
1	Philipsburg	0.221	21	Bridgetown	0.122
2	Fort Lauderdale	0.195	22	Tallinn	0.12
3	Basseterre	0.192	23	Ocho Rios	0.118
4	Miami	0.191	24	Roseau	0.118
5	St. Johns, Antigua	0.186	25	Pointe A Pitre	0.117
6	SanJuan	0.16	26	La Romana	0.116
7	Grand Turk	0.147	27	Stockholm	0.115
8	George Town	0.145	28	Amber Cove	0.114
9	Tortola	0.145	29	Ponta Delgada	0.114
10	Copenhagen	0.144	30	Cozumel	0.113
11	Cape Liberty NYC	0.143	31	Key West	0.113
12	Montego Bay	0.141	32	Willemstad	0.113
13	Cartagena	0.14	33	Fort de France	0.108
14	St Thomas	0.136	34	Castries	0.106
15	Port Cañaveral	0.134	35	Bergen	0.099
16	St. Georges	0.133	36	Lisbon	0.099
17	Nassau	0.127	37	Half Moon Cay	0.098
18	Warnemunde	0.127	38	Kiel	0.096
19	Southampton	0.126	39	Samana	0.094
20	Oranjestad	0.125	40	Stavanger	0.093

ports coincide in both centrality lists, with a marginal difference in position.

By contrast, the HAC values show the considerable dominance of Caribbean ports in both indexes. Nine of the top 10 ports in this regard are located in the Caribbean region. In terms of hub centrality, Fort Lauderdale (0.214) exhibits the highest value, with a considerable margin separating it from the second-ranking Basseterre (0.194). Philipsburg (0.193), St. John's (0.190), and Miami (0.185) complete the rankings. In respect of authority centrality, the highest ranking is Philipsburg (0.221), followed by Fort Lauderdale (0.195), Basseterre (0.192), Miami (0.191), and St. John's (0.186). On these bases, ports located in the Caribbean predominate on cruise itineraries, and the vast majority have redesigned their business models to achieve consideration as a primordial port of call in a demanding and dynamic industry.

This study presents implications for the academic and industrial fields. In the academe, studies have focused on tourism and its ramifications in Caribbean ports, the economic benefits gained by stakeholders, and the environmental impact on the industry; however, the present study utilized SNA methodology to analyze the interaction between Caribbean ports and other ports in different regions. Focusing on their influence in the region by analyzing their most relevant features that can be replicated on other ports to create new route connections and, as a consequence, to improve competitiveness in the industry. In terms of industry, this research offers several suggestions to the port authorities, as well as for the policy makers of the Caribbean ports. First, a list of ports that have a significant impact on the rest of region by considering their most significant attributes to optimize their interaction with the cruise industry. Second, to maximize the affluence of passenger, five ports were suggested as the best port candidates to establish new route connections: Fort Lauderdale, Philipsburg, Basseterre, Saint Johns, and Miami.

Although SNA enables a satisfactory examination of Caribbean networks, it is limited in that it relies on data and information associated with the current situation described in this case study. Future studies should include other decisive factors associated with the industry, such as a political determinants, customer trends, and global business issues that bear on the cruise industry. Such initiatives are expected to clear the way for a more comprehensive and accurate description of the relevance of ports and industries.

Conflict of interest

None declared.

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