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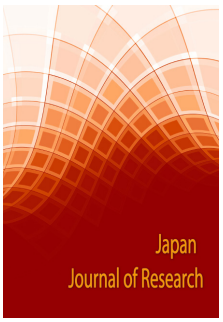

Research on the Dynamic Mechanism of Cruise Industry Chain Synergy Development Based on Value Chain

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Abstract

The cruise industry in China has experienced relatively slow growth compared to the global market, despite its increasing economic importance. This study aims to explore a more efficient mechanism for the synergistic development of the cruise industry chain in China by constructing a system dynamics model. The model evaluates the upstream, midstream, and downstream segments of the cruise value chain and examines the causal relationships among value nodes. By assessing the characteristics and inter-connections of each segment, the study qualitatively analyzes the synergies within the chain and develops a framework for collaborative development. Vensim software is employed to simulate the cruise industry's evolution in Shanghai, identifying the main factors influencing synergy across the chain. The findings offer theoretical and methodological guidance for enhancing coordination across industry sectors and improving policy-making. This paper contributes original insights into the interactions between different segments of the cruise industry chain and proposes a dynamic model for fostering collaborative growth. By quantifying interdependencies and simulating their economic impacts, the research provides actionable strategies to support integrated development. The proposed model supports strategic planning, enhances value creation, and lays the groundwork for more cohesive growth within China's cruise industry.

Introduction

The major businesses or industries in the cruise industry are connected to one another through a network of linkages that are based on technology [1], investment, and other technical and financial factors. This is known as the cruise ship industry chain. Cruise ship manufacturing, cruise operations, port services, and other businesses comprise an industrial value chain [2]. The cruise sector in China has experienced rapid growth and now accounts for 50 per cent of the total cruise passenger traffic in Asia. Additionally, it has become the primary driver of passenger growth in Asia as the global cruise market gradually shifts towards the east [3]. Currently, China's cruise ship industry development is still in its infancy, and the supporting industries of the entire cruise ship supply chain are in a discrete state, leading to a series of problems in the up-, mid- and downstream of the cruise ship industry chain. For instance, in the upstream of the cruise industry chain, the cruise ship construction and design industry is still in its infancy, and the capacity for cruise ship maintenance is inadequate. China's cruise ship construction industry is currently focused on mainstream ship manufacturing and has not yet mastered the key technologies required for luxury cruise ship construction. The global market for luxury cruise ships is mainly concentrated in Europe, resulting in an imbalance between supply and demand. Despite being the world's largest shipbuilding country, China's shipbuilding industry is primarily focused on middle and low-end ships, and has yet to establish a significant presence in the field of giant luxury cruise ships. In the middle of the cruise ship industry chain, there is a lack of local cruise companies and cruise fleets.

The infrastructure and auxiliary services of the cruise terminal are not perfect in the downstream port services. Additionally, the information transmission throughout the cruise ship industry chain in the up-stream, medium-stream and downstream has been poor due to the imperfect information platform, which has had a serious negative impact on the synergistic development of the chain and has even hindered the growth of China's cruise tourism industry. The purpose of this paper is to examine the causal relationships between the value nodes of the cruise ship industry, identify the critical nodes in the development of the chain, propose a mechanism for the cooperative growth of the chain, enhance the economic value of the industry, and thereby support the establishment and development of China's cruise ship industry chain.

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Some academics have already researched the relationship between various value issues in the cruise ship industry chain. For example, Vaggelasgk et al. [4] proposed a supply chain management model that is suitable for the cruise industry by analyzing the subjects in the cruise ship supply chain and their relationships to each other. Wang Gang [5] analyzed the current state of resources in the up-stream, medium-stream and downstream industrial chain of the cruise ship industry in the countries around the South China Sea, pointed out the factors restricting the development of resources in the cruise ship industry, and explored the process of integration of resources in the cruise ship industry from the integration, configuration and utilization of resources in the cruise ship industry at three levels, and put forward relevant opinions and suggestions.

Véronneau S et al. [6] concluded that the cruise ship supply chain is the key to improving service quality and made recommendations for improving the quality of services provided by cruise industry suppliers after analyzing the roles and attributes of each participant in the cruise travel service industry in the chain of supply. Adolf et al. [7] discovered that in order to attain sustainable growth, the environment and cruise industry stakeholders need to receive enough attention after examining the features of the sector. In order to optimize the cooperation method of upstream and downstream enterprises in the cruise sector, Tan et al. [8] investigated the strategic perspective of cruise operating companies and unexamined the vertically integrated growth of cruise operations. They can further enhance the competitiveness and scale effect of cruise enterprise operations, thus promoting the development of enterprises.

Xia Bin [9] analysed the composition and characteristics of the cruise ship industry chain from the industry link perspective, pointed out that the main body of the cruise ship industry link includes cruise ship manufacturing enterprises, cruise ship transportation enterprises and cruise ship operation enterprises, etc., and put forward countermeasures for the development of each link of the cruise ship industry chain. Ma, MZ et al. [10] investigated the factors influencing cruise lines' choice of homeports for their voyages and used a grey cloud clustering model for assessing the decision-making process. The result was an indicator system that included both quantitative and qualitative indicators. According to the findings, the approach could assist decision-makers choose cruise homeports more effectively. Ye Xinliang [11] explains the creation, circulation, amplification, maintenance, and source of value in the industry chain from a value analysis perspective. Pointing out the primary way in which the cruise industry adds value to the chain is by using it to further the development of the local economy. Ahn, J. et al. [12] examined the implications of predictive factors for the development of marketing strategies to improve favorable customer attitudes and behaviors toward cruise brands. They identified key factors critical to value creation by analyzing the effect of different kinds of experiences in terms of customer perceived value. Teng, YM et al. [13] used Delphi and hierarchical analysis to identify the key drivers driving the expansion of the cruise travel sector. This study's findings can be used as a beneficial guide by both cruise lines and government organizations.

Various methods have been employed by scholars to study the cruise industry chain. For instance, Sun Yan [14] used input-output tables to quantitatively analyze the relationship between the cruise industry and related industries in terms of both inputs and exchanges. The study aimed to explore the effects of the cruise links and interactions, and to analyze the value-added process within the cruise industry in order to better explain the interactions between the cruise industry and different industries. Nguyen, MAT, et al. [15] conducted a two-stage data envelopment analysis to examine the revenue efficiency of the cruise ship industry and its drivers, which was empirically analyzed using a dataset of 181 cruise ships, showing that the cruise ship industry ignores a significant amount of potential revenue, and that there is a relationship between the revenue efficiency of a cruise ship and its category and exogenous events. Chen, JM et al. [16] examined the direct economic impact of the cruise industry using conventional least square and meta-regression models. The study found significant positive coefficients between the amount of passengers, crew members, and cruise lines, and the direct economy. Similarly, positive coefficients were found between passenger and cruise line expenditures. The study also revealed that cruise lines have a significant influence on the amount of money spent by passengers and personnel at port locations. Wang et al. [17] designed a framework to quantitatively measure the value-added activities and economic impact of the cruise ship supply chain from the perspective of the value-added activities of the cruise ship supply chain, through which it is possible to accurately assess the creative value that the supply chain established by the cruise ship industry can bring to its stakeholders. Papachristou, AA et al. [18] analyzed the criteria used by cruise lines to select ports of call, using databases provided by cruise ship lines, port and cruise ship terminal operators and stakeholders.

Teng Ke et al. [19] analyzed the evolution of China's cruise industry structure and spatial layout from an industry chain perspective. They identified influencing factors and interaction mechanisms while adhering to metrics and units. Ros Chaos et al. [20] investigated whether the principles of economies of scale justified the growth in cruise ship tonnage. Their findings revealed that diseconomies of scale started to arise for larger tonnage cruise ships. Yuan Xumei et al. [21] developed a causal diagram and system flow chart based on system dynamics to examine the logistics system structure of the Jin-Hebei port cluster. They also created a generalized analytical model from the value chain perspective.

Scholars have studied the growth of the cruise ship industry chain in different regions and proposed appropriate measures. For example, Chen Fuxiang [22] identified the direction of the cruise ship industry chain development in Qingdao by analyzing the development state of international and domestic cruise ships. Gan Shengjun [23] examines the issues that have arisen in the growth of each link of Shanghai's cruise ship chain, as well as the characteristics of the growth of the cruise line chain in Europe and the United States, and suggests a course of action for Shanghai's cruise industry chain. Gong L [24] incorporated the operational parameters of the Dalian cruise port and used a gray model to forecast the cruise port's future development patterns. Tan Shuxia [25] identified the main issues in the synergistic growth of port-side industries based on an analysis of the present situation of synergistic growth of port and port-side industries in Dalian, and proposed strategies to promote and improve synergistic expansion of port as well as port-side industries in Dalian at the macro, meso, and micro levels.

Xu Xing et al. [26] developed a cruise industry classification system that utilizes the international cruise line industry classification and the national economic industry classification, taking into account the growth direction of the domestic cruise

line industry, to serve as a reference for decision-making in improving China's cruise line industry. Wu et al. [27] developed a multidimensional decision-making method and applied it to assess the sustainability of cruise industry development in Xiamen. The studies found that this assessment method can effectively contribute to decision-making on the sustainability of cruise ship industry development. Qiu Antelope et al. [28] discovered in their value-added study of the cruise ship industry chain that the value-added process takes place in other service links, such as cruise ship construction and R&D, cruise ship operation and management, and cruise port operation, and that value creation is realized through information flow, logistics and capital flow between cruise ship industry chains. Gao Lujun et al. [29] examined the current state of development in each link of the cruise line chain, proposed the viability of vertical integration in the cruise industry, and made specific recommendations for the growth of the cruise industry chain. Robinson R [30] suggested a broader synergistic strategy for competing ports. Qu Chao et al. [31] examined the current state of the Hainan cruise liner industry chain and the feasibility of value-added development from the perspective of the entire industry chain, and identified a path for synergistic development of the Hainan cruise liner industries chain from the midstream and downstream of the cruise line industry. Liu Gang et al. [32] used synergistic development theory to analyze the dynamic game between various subjects in the cruise line chain, determine the benefit mechanism of synergistic development, and then make recommendations for the synergistic development of the cruise liner industries chain in Hainan.

In addition, various researchers have investigated the links between issues in the cruise line chain. For example, Sun L et al. [33] used a game theory model to determine the profit distribution of every element on the cruise service supply chain. They discovered that the overall profit and profit distribution of the cruise service supply network fluctuated when the cruise service supply chain's features changed by implementing various collaboration tactics. Chu AMC et al. [34] investigated the network relationship and power distribution between cruise lines as well as traditional travel agencies by using triangulation according to the tourism supply chain models and analyzed several business models of traditional travel agencies, which showed that unique business practices and customer preferences in mainland China led to an over-reliance on demand created by traditional agents. Wang L et al. [35] investigated the connection between municipal governments, cruise companies, and suppliers using a three-stage game model. They discovered that there is a direct association between supplier costs and cruise line operational costs, which supports government subsidy programs. They also proposed that government subsidy policies be designed in a manner that is consistent with the growth of the cruise industry as well as stresses the profitability of the connection of suppliers and cruise lines.

Huang LL et al. [36] used Bayesian updating theory to explore the optimal strategy for two-stage replenishment in cruise line operations, and they created a model with an objective of predicting two-stage profit maximization. Zeng Qingcheng et al. [37] developed a model for cruise sales strategy and sales channels, taking into account differences in tourists' willingness to pay across channels. They analyzed the impact of travel agencies on expanding market share for cruise companies and enhancing the competitiveness of the cruise supply chain. The study demonstrated that the selection of sales channels is influenced by several factors, for instance the capacity of the cruise ship's cabins and the growth in market size brought about by the travel agency channel. Qu, CR et al. [38] analyzed the profit relationship between cruise lines and service providers and used game theory to find a win-win cruise supply chain service plan between cruise lines and service providers. Heying Sun et al. [39] created the cruise market pricing model and a cruise homeport competitive model to investigate how subsidized players in the cruise chain of supply affect cruise homeports. Chen, KM et al. [40] designed a dual-channel pricing strategy using reinforcement learning methods to help cruise lines address the loss of revenue caused by over-reliance on indirect ticket distribution channels. The computational results demonstrated that this strategy outperformed the traditional marginal seat pricing strategy, providing a reference for cruise revenue management. Sun Yan et al. [41] investigated the cooperative growth of the cruise ship industry in the South China Sea littoral states and the construction of the equilibrium mechanism of the cruise ship industry stakeholders in the South China Sea littoral states from the perspective of the cooperative game, and put forward suggestions for the growth of the cruise ship industry in the South China Sea littoral states.

The value chain of cruise tourism involves multiple stakeholders, highlighting its systemic nature. Sun Yan [42] believes that Hainan's cruise expansion should not only rely on its geographical and resource advantages, but also expand the growth of cruise products and diversify the Cruise Ship industry's economic value chain. Qu Chao et al. [43] believe that as the degree of association and integration of each link of the chain improves, the additional value effect of the industrial chain gradually emerges, as does the synergistic effect between economic agents within or between chains. Chen Lin [44] demonstrates the significance of marketing activity to the growth of the cruise economy using the viewpoint of value chain administration, and analyzes the measures implemented by three cruise lines (CCL, RCL, and NCL) in terms of marketing model. Qiu Antelope et al. [45] stated that the value-added process of the entire cruise ship industry chain takes place within the cruise ship construction, research and development, cruise ship operation and management, cruise port operation and other services, and that the up-, mid- and downstream of the entire industry chain are interdependent and articulated with each other, so that the value-added of the cruise ship industry chain is realized through the exchange in terms of information flow, material flow and capital flow. Yang Ming et al. [46] offered a development route for Guangdong's cruise industry value chain by examining its intrinsic composition and extrinsic associations. Xu Jing [47] used value chain theory to evaluate and assess the benefits and drawbacks of Xiamen's cruise industry and value chain, and proposed countermeasures for its future development. Qu Chao [48] stated that in the value-added aspects of the cruise industry, China's provinces around the South China Sea should promote the horizontal extension of the cruise line chain as well as vertical expansion in order to increase the economic benefits of the cruise industry and the aggregator effect.

In conclusion, despite the abundant research undertaken by scholars both locally and globally on the cruise liner industry chain, there are still certain flaws. As a result, this paper investigates the interaction mechanism between the links of the cruise liner industry chain and the operation mechanism of the collaborative development of the cruise industry by studying

the composition of the upper, medium, and lower reaches of the cruise industry chain, analyzing the interrelationships and interactions between them, and constructing a collaborative development model of the cruise liner industry chain based on the value chain nodes. The paper discusses how the system dynamics method was used to create a collaborative development model of the cruise liner industry chain. It also discusses the cause-effect relationships between each value chain node and proposes implementation strategies for the synergistic growth of the cruise line industry chain by simulating to analyze the model.

Cruise industry-wide value chain node network construction

The value generation process of the economies inside the cruise line chain is mirrored in the intrinsic value activities of the nodes, which have complex industrial links. In other words, the activities that take place upstream, downstream, and in the middle of the cruise industry value chain reflect the process of creating value. According to the value operations inside the cruise line chain, this study divides the industry chain into three segments: upstream, midstream, and downstream, and studies each segment's value nodes separately.

Analyzing the upstream value nodes of the cruise ship industrial chain

The upstream segment of the cruise industry chain is primarily responsible for designing and constructing cruise ships. This segment requires a significant amount of labor, materials, and financial resources for the design, construction, interior and exterior decoration, maintenance, and upkeep of large cruise ships. Regions and countries that focus on upstream activities tend to have greater competitiveness and added value in the cruise industry as a whole. Designing and constructing a cruise ship is a complex task. Shipyards typically carry out the design in accordance with client requirements and ship specifications, or it may be commissioned by ship design institutes. The construction of major components of cruise ships requires a large amount of specialized shipbuilding steel, which necessitates close cooperation with world-renowned steel companies. Cruise ships, as enormous boats, require highly reliable power and control systems. Cruise power systems are often obtained from world-renowned marine engine manufacturers, therefore designing and manufacturing of cruise ships is industry-specific. It is typically related with the ship design, steelworks, shipyards, maritime furniture, interior design, information technology, energy technology, lighting, and electrical installations sectors.

Analysis of the midstream value nodes in the cruise ship industry Chain

The intermediate reaches of the cruise line chain are primarily responsible for the operation of cruise lines. Cruise company operations are the most direct aspect of cruise tourism, with the closest interaction with passengers and the highest added value. Cruise lines create income by offering passengers a product, such as cruise tourism, and delivering related services. The cruise line also forms partnerships with major suppliers to obtain the necessary ingredients, supplies, and other goods for life on board. Additionally, partnerships are established with travel agents or other distribution companies to sell cruise tickets to individual consumers. Therefore, the operation of a cruise line is viewed as a process of capital concentration and dispersion, which results in the transfer and increase of value. It is crucial to highlight that the operation of a cruise ship includes not only nautical operations, but also hotel and culinary services, entertainment and creative activities, and commercial operations on the main street.

Analysis of the downstream value nodes in the cruise ship industry chain

The downstream segment of the cruise ship chain is primarily responsible for port terminal activities. These operations are heavily influenced by midstream cruise lines, with the volume of cruise ship calls and distance from the cruise ship's origin having a direct impact on their value. Investment in port terminals is often significant, requiring vast capital and long investment cycles to establish comprehensive support facilities, transport, surrounding attractions, and businesses. The capacity of a port is constrained by its physical space, operational hours, and local climate, which in turn limits its profitability. Despite this, a port terminal can still create substantial value by driving growth in surrounding industries and their supporting facilities. This segment also reflects the broader value of the cruise industry, which operates in related sectors. Upon disembarking, tourists typically opt for activities such as sightseeing, shopping, dining, and lodging. Due to the high concentration of visitors brought by cruise ships, onshore tourism activities can become quite crowded. The quality of services, attractions, and shopping experiences will directly impact the value generated in this segment.

Network Composition of value nodes in the cruise ship industry chain

From the above analysis, the value creation process in the cruise ship industry chain mainly occurs in the designing and manufacturing of cruise ships, the operation and management of cruise ships, the operation of cruise ports and other services, and the upstream, intermediate and downstream of the whole industry chain are interdependent and interconnected with each other, so as to realize the value added of the cruise ship industry chain through the exchange of information flow, logistics and capital flow.

In terms of importance and downstream and upstream links, the cruise industry chain is divided into core and supporting industries. In terms of fundamental businesses, the cruise line chain includes upstream cruise ship design and construction. It primarily consists of cruise ship design and development, material supply, processing and manufacturing, production and construction, equipment assembly, and ship loading and arranging, as well as some other related industries that are more technologically demanding, require a large capital investment, and are most likely to be monopolized by industry leaders in the three links of the cruise ship value chain. Midstream cruise operations segment. It is mostly carried out by cruise line operators and includes some support services such as cruise itinerary planning, cruise management, marketing and advertising, and passenger transportation. Downstream cruise ship port services, including commercial and tourism ties. It primarily focuses on port building and services, ship repair, tourism, transit and travel, leisure, and entertainment. Furthermore, there are some supporting industries in each link of the core industry that have no obvious difference in the midstream, upstream, and downstream of the cruise ship and are typically integrated with the core industry through integration into the various links of the cruise ship value chain.

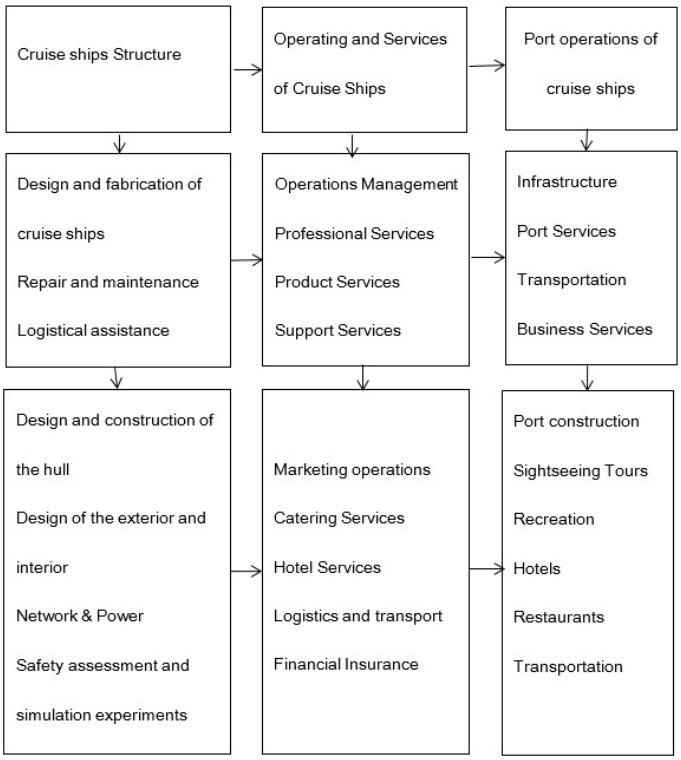

Figure 1. *Cruise industry value chain node network.*

The creation of a system dynamics model for the chain's synergistic development in the cruise ship industry

There are intricate and interdependent relationships between the upstream, medium and low end of the cruise ship industry, and the independent companies at each link in the chain are involved in a long-term strategic partnership that creates shared value and reflects the characteristics of economies of scale. This is achieved through strategic alliances between industries that are either the same or related, based on existing economic and technological relationships. The midstream cruise line operational vehicle is manufactured by cruise ship building and designing businesses upstream in the industrial chain. For the downstream industry chain, the operation and management of cruise port terminals must be based on the cruise ships provided by cruise lines. The increasing specialization in certain industries due to economic technological advancements has raised concerns about the anti-risk potential of enterprises. As a result, enterprises within the industry chain, as well as internal and external enterprises, must focus on strategic alliances to jointly face market risks and improve their chances of survival and growth. Therefore, the relationship between cruise industry chains involves interpenetration and interdependence.

This section presents a system dynamical model to analyze the mechanism of the role between the cruise line industry chain, explore the internal structure of its industry chain, find out the major influencing factors on the synergistic development of the cruise ship industry chain, in order to put forward relevant suggestions and recommendations, provide decision-making references for the government and enterprises, as well as foster improved growth between the cruise ship

System boundaries and assumptions of the model

The cruise liner industry chain development is a complex system with many influencing elements, and it is required to separate the key components from the complex system and concentrate on the mechanism of factors within the system boundary. Combined with the current state of cruise industry development and the connotation of industry chain synergistic development, this paper will begin with several major activities in the beginning, middle, and downstream of the cruise ship chain, focusing on interactions in the process of synergistic growth of the cruise ship industry chain. Based on this, this study makes the following assumptions, taking into account the availability of data, the model's operability, the complexity of the real system, and the current state of China's cruise market.

Assumption 1. The system is totally closed, and no consideration is given to the influence of external interference on the industry chain's synergistic development. China's cruise industry is currently in development; all policies and regulations are being gradually improved, and local governments are actively promoting the growth of the cruise ship industry; thus, the impact of external factors on the expansion of the cruise ship industry chain is not being considered at this time.

Assumption 2. For the purpose to condense the model, this article just considers the economic value operations inside the cruise ship value chain. The cruise line chain generates value in two ways: socially and commercially. In general, social worth is established by how social culture and job rates interact. However, gathering this information is more difficult, hence the simulation model in this paper only contains the economic value offered by each link in the cruise ship value chain.

Assumption 3. This article does not take into account the system's latency for the purpose to allow for a more understandable analysis of the influence of cruise ship value chain components.

Assumption 4. The cruise industry chain's synergistic development is an ongoing activity. Since China's maritime defense strategy was formulated, the country's cruise industry has grown quickly and steadily to rank among the top economic growth priorities. The growth of enterprises associated to cruises has received encouragement from the state. As a result, this study makes the assumption that the cruise industry chain's synergistic impact operates continuously, unaffected by changes in legislation or other external circumstances.

Assumption 5. Within the chain of the cruise industry, upstream cruise ship production does not contribute to value creation. The argument is put forth based on the 2020 China Cruise Industry Development Report, which states that the country's cruise ship industry is still in its infancy and is essentially in an undelivered status despite currently taking certain orders. For example, in 2018, China Shipbuilding Group legally signed contracts with the United States' Carnival and Italy's Fincantini Group to build huge cruise ships, although they have yet to be delivered for operation.

Assumption 6. This research assumes that the value of cruise and port operations is reflected solely in the cruise industry's indirect economy. The value creation of the industrial chain is the income delivered into the local economy by all business activity in each link of the value chain. The mid-stream cruise business creates revenue for the cruise liner industry by utilizing e-commerce platforms, travel agents, hotels, and transportation. As a result, it is considered that the value of mid-stream cruise operations is based on their contribution to local economies.

Downstream port operations revenue is reflected in maintenance, berthing, and other expenses. All of these industries help to drive local economic development.

Causality map of the cruise industry chain synergy

The upper, middle, and lower reaches of the cruise line chain include cruise ship manufacturing, cruise operator firms, port operations, and related supporting sectors. Currently, however, the Chinese cruise ship growth remains in its early phases, with the bulk of domestic cruise ships relying on imports and the leading cruise industry focusing on the middle and downstream stages of the industry chain. It is also still in the early stages of cruise ship design and manufacture. As a result, this paper focuses on the intermediate and lower sectors of the cruise ship value chain, emphasizing causal connections and system flow diagrams. Furthermore, in the established system flow diagram, because there is no clear measurement system for value creation in the cruise industry's value chain, value creation in the cruise industry's value chain is embodied as economic value, and economic value is expressed by the cruise industry's contribution to the port city's GDP [49].

The cruise industry's value chain theory states that the middle and lower reaches of the chain are connected in a cause-and-effect relationship. The port's tourist throughput and output value have increased as the amount of cruise ships calling at the port has grown. The port's GDP has increased as a result of the tourists' spending in the neighborhood. But as the number of visitors rises, the port is under more and more strain. The port needs to increase its capacity in order to enhance visitor experiences and draw in additional cruise ships to dock there. It's critical to concentrate on enhancing the whole experience in order to draw additional cruise ships to the port. A causal relationship can be illustrated through a positive feedback-oriented loop diagram.

Cruise industry chain synergy development system flow chart

The causality diagram describes the relationship between variables qualitatively, while the system flow diagram can describe the relationship between variables quantitatively. From the model assumptions, the value creation of the midstream and downstream industries is combined and analyzed, with the final value reflected in the regional economic contribution to the cruise ship destination cities. Based on the causal loop sketch above, the stock-flow diagram model is further analyzed and illustrated in Figure 3.

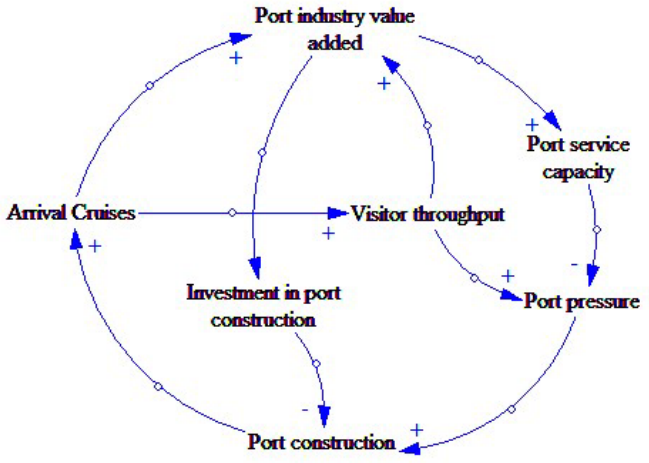

Figure 2. *Cause-effect diagram for developing synergies in the cruise chain*

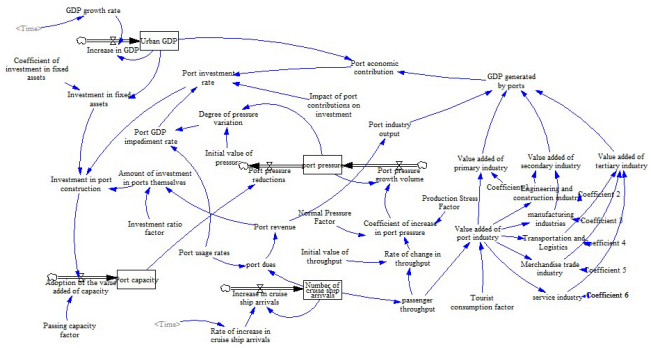

Figure 3. *Map of cruise industry synergy stock flows*

Numerical Simulation

Sample selection

Since Shanghai was the first Chinese city to engage in the cruise sector, the city has seen substantial growth. Today, the Shanghai Wusongkou International Cruise Terminal ranks fourth worldwide and as Asia's first cruise port. Shanghai was selected as the empirical sample data for this work because it is more representative and the research analysis has greater national significance. The Shanghai Municipal Statistics Bulletin, China Port Annual Report, and other original data are cited in this paper. The 2008–2018 Shanghai cruise industry and port data are used as samples. Value creation in the value chain links is simulated, the mechanism of each link's role is examined, and the major factors influencing the chain's development are identified.

Shanghai currently has two major cruise harbors: Shanghai Wusongkou International Cruise Port and Shanghai Port International Passenger Terminal (SPIPT), with SPIPT primarily receiving cruise ships with a gross tonnage of less than 70,000, both visiting ports and receiving small and medium-sized home the port cruise ships. The Shanghai Wusongkou Internationally Cruise Terminal is located in Gunmetal Bay on the Yangtze River shoreline in Wusongkou, Shanghai. It is situated at the junction of three river mouths, making it conveniently accessible by both marine and land traffic. The terminal has the distinct benefit of being able to accommodate medium and large cruise ships, making it Shanghai's sole dedicated terminal with this capability and a significant resource advantage. The Shanghai Cruise Port is worldwide recognized for its hardware construction and design idea, which has set a high standard for cruise port development both domestically and overseas. It also serves as a solid foundation for management and technical support in the growth of international cruise ports in accordance with Chinese regulations.

Determination of model parameters

Parameter estimation

According to the principle of parameter selection in system dynamics, the behavior of the system still exhibits the same pattern as the estimated parameters are within their tolerances, i.e., the behavior pattern and results of the dynamic model of the

system are mainly determined by the structure of the model rather than by the size of the parameters. When selecting parameters, the accuracy of the parameters is the minimum criterion to meet the basic requirements of the system simulation.

Parameter estimation methods

The relevant parameters of the model defined in this paper were determined primarily through data collection, research in the scientific literature, mathematical calculation and evaluation of the variables, and consultation with relevant experts to reconstruct the model.

Determination of main parameters

The model created in this paper divides the parameters into state variables, auxiliary variables, velocity variables, and constants. The values of the state variables, additional variables, and constants need to be determined in the model.

City GDP

In this paper, based on the Shanghai Statistical Yearbook for each year, Shanghai's GDP growth trend graph from 2008 to 2018 was collected and collated, as shown in Figure 4.

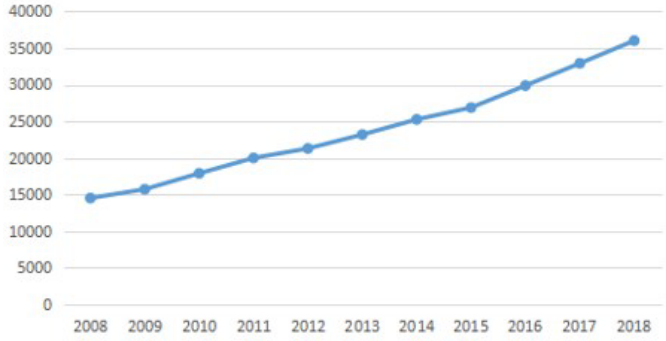

Figure 4. *The GDP growth trend in Shanghai from 2008 to 2018*

Number of cruise ships arriving in port

In this article, based on the Shanghai Statistical Yearbook and the Report on the Growth of the cruise ship Industry in each year, the growth tendency of the number of cruise ships arriving in Shanghai from 2008 to 2018 was gathered and grouped to produce the graph displayed in Figure 5.

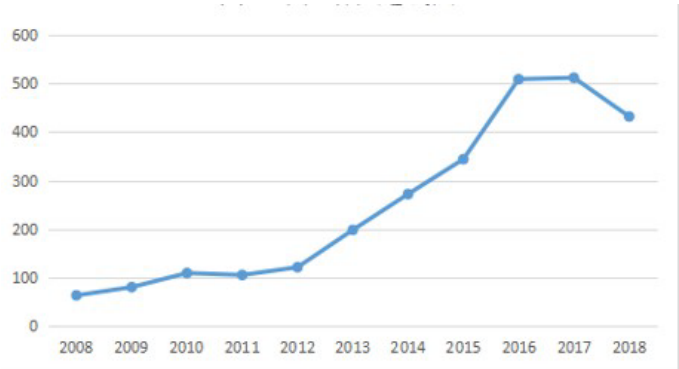

Figure 5. *Growth trend of cruise ship arrivals in Shanghai from 2008 to 2018*

Passenger Output

A key metric in the cruise industry's business model is passenger throughput. A passenger throughput function of y=0.6708x-45.583 was obtained in order to suit the data of the number of cruise ship arrivals and passengers in Shanghai from 2008 to 2018, as illustrated in Figure 3.6.

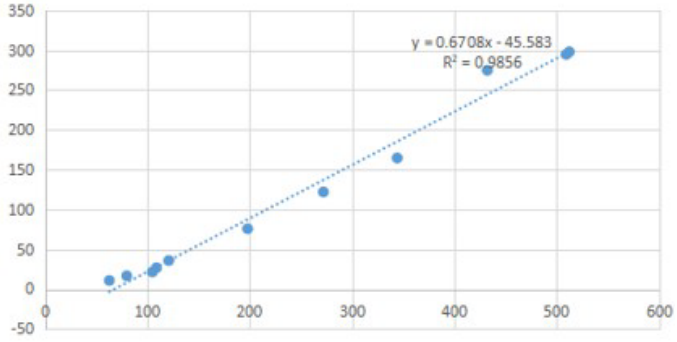

Figure 6. *Fitting data from 2008 to 2018 on the amount of cruise ships that arrive in Shanghai with the number of passengers*

Impact factor of production pressure

The Production Pressure Impact Factor is the port passenger traffic ratio to theoretical port capacity. Based on the port's operational experience, the standard range of the production load factor is 0.8 to 1.2. Therefore, the production pressure impact factor is set at 0.8, considering the actual development of Shanghai Port.

Port throughput capacity

As investment in port construction increases, the port's infrastructure measures will be gradually improved, especially the optimization and upgrading of traffic diversion, terminal design, commercial support, and shore power system, increasing the port's throughput capacity. Therefore, the initial value of the port service level is set at 150,000 passengers, considering the development and operation of Shanghai Port and drawing on expert opinions.

Port Pressure

Indicators such as port pressure load are challenging to identify. Still, this paper defines relevant port pressure indicators through research and expert consultation and thoroughly examines indicators such as port throughput, port transshipment capacity, and port operation status, finding that the higher the port pressure, the worse the port development. After conducting a thorough review of the development and operation of Shanghai Port, the initial value of port pressure was set at 100.

As for the values of other parameters in this paper's model, some were determined by means, averages, and regression analysis after data collection and classification. Some are determined by trend analysis, historical experience, expert advice, and expert opinion. Due to space limitations, other relevant parameters of the model are not presented here.

Main system equations of the model

Mathematical modeling is one of the essential steps in constructing a system dynamics model, with each mathematical equation representing a link between the variables in the flowchart. Some of the critical model equations in this paper are listed below.

1. INITIAL TIME=2008.The initial time of the simulation
2. FINAL TIME=2018.End time of the simulation
3. TIME STEP=1.The time step of the simulation
4. Urban GDP=INTEG (Urban GDP value-added, Urban GDP initial value), Units: billion.
5. Value added urban GDP=Urban GDP*GDP growth rate, Units: billion.
6. GDP growth rate=WITH LOOKUP (Time, Lookup([(2008, 0) - (2018, 0.295)], (2008, 0.082), (2008, 0.082),(2009, 0.138), (2010, 0.116), (2010, 0.064), (2012, 0.089), (2013, 0.089), (2014, 0.064), (2015, 0.115), (2016, 0.101), (2017, 0.093), (2018, 0.079))), Units: dimensionless.
7. Rate of increase in cruise arrivals = WITH LOOKUP (Time, Lookup([(2008, 0) - (2018, 0.395)], (2008, 0.271), (2009, 0.382), (2010, -0.036), (2011, 0.156), (2012, 0.639), (2013, 0.373), (2014, 0.264), (2015, 0.479), (2016, 0.008), (2017, -0.146), (2018, -0.402))), Units: dimensionless.
8. Port throughput capacity=INTEG (increase in throughput capacity, initial value of throughput capacity), Units: million passengers.
9. Value added throughput capacity=Port construction investment * throughput capacity factor, Units: million passengers.
10. Port pressure = INTEG (port pressure growth, initial value of port pressure), Units: dimensionless.
11. Port Pressure Growth = Port Pressure * Coefficient of Increase in Port Pressure, Units: dimensionless.
12. Rate of change in throughput = port throughput/initial value of throughput, Units: dimensionless.
13. Fixed Assets Investment = Urban GDF*Fixed Assets Investment Factor, Units: billion.
14. Port GDP hindrance rate = Port usage rate * Port pressure, Units: dimensionless.
15. Port construction investment = amount of investment in fixed assets * port investment rate + amount of investment in the port itself, Units: billion yuan.
16. Berthing fee port revenue = several cruise ships arriving in port * port usage rate, Units: dimensionless.

Computer simulation and analysis of results

Based on the above models and equations, the simulation results are analyzed through validity testing. Model validity testing refers to checking whether the model can reasonably simulate the development trend and internal logic of the system, which is an indispensable step in SD modeling [50]. To validate the validity and scientificity for the model operation findings, this study relies on the building of the cruise industry chain co-development model and employs an error measure to compare simulation and real data for important variables. This work compares and analyzes the Vensim software simulation findings to the real numbers. The contrasting findings are shown in Table 1.

The test results show that the average error is less than 5%. This indicates that the system dynamics model of cruise industry chain synergy development is valid. Next, the model simulation study is further conducted by modifying the visitor consumption coefficient and investment share coefficient, and the simulation results are analyzed and summarized.

Tourist consumption coefficient expanded by 5%: This article does a simulation analysis under the assumption of a visitor consumption coefficient to investigate the impact of the cruise ships industry's middle segment on the expansion of downstream ports. To examine the effects of variations in visitor consumption on port development, the visitor consumption coefficient is raised by 5% while maintaining the other model parameters constant. Figures 7-10 show how the port sector, primary industry, intermediate industry, and tertiary industry's value added changed as the tourist consumption coefficient was adjusted.

Table 1. *Analysis of simulation results*

Year	Total GDP (Billion Yuan)			Number of cruise ships arriving in port (million ships)		
	Simulation values	Actual value	Deviation rate (%)	Simulation values	Actual value	Deviation rate (%)
2008	14536.9	14536.90	0.00	63	63	0.00
2009	15728.9	15742.44	-0.086009539	80.547	80	0.0875
2010	17899.5	17915.41	-0.088806229	110.309	109	1.52293578
2011	19978.9	20009.68	-0.153825548	106.942	105	1.59047619
2012	21504	21305.59	0.931257947	123.147	121	1.909090909
2013	23417.9	23204.12	0.921301907	203.147	198	2.075757576
2014	25502.1	25269.75	0.919478823	279.529	272	2.022058824
2015	27134.2	26887.02	0.91932836	353.936	344	1.968023256
2016	30254.6	29887.02	1.229898464	524.086	509	1.923379175
2017	33310.3	32925.01	1.170204656	527.326	512	2.13671875
2018	36408.2	36011.82	1.100694161	445.69	432	3.377314815
Average error	0.623		1.69			

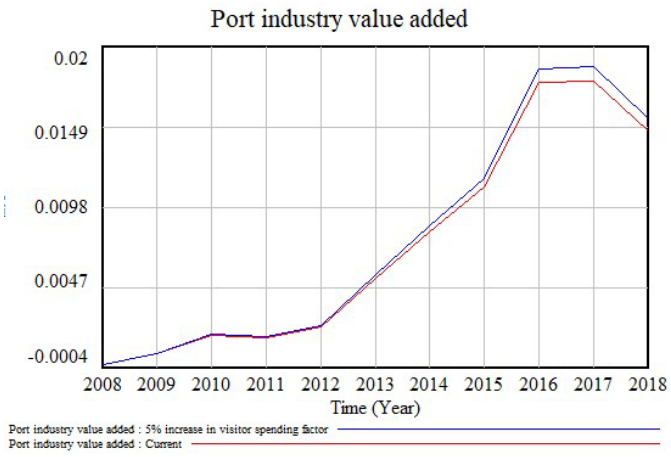

Figure 7. *Graph of changes in value added in the port industry*

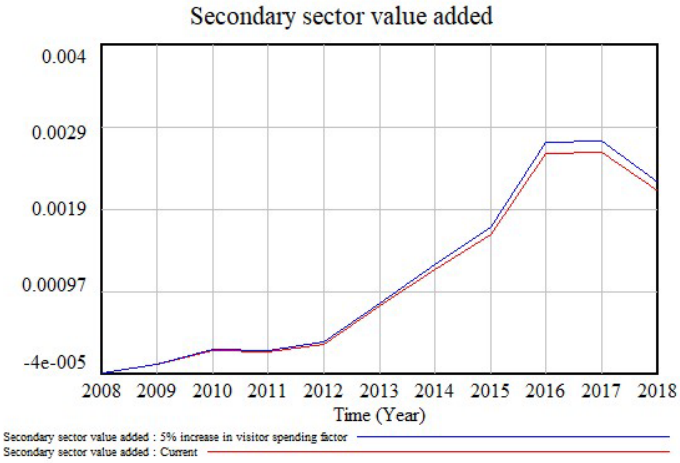

Figure 9. *Graph of the changes in value added in the secondary sector*

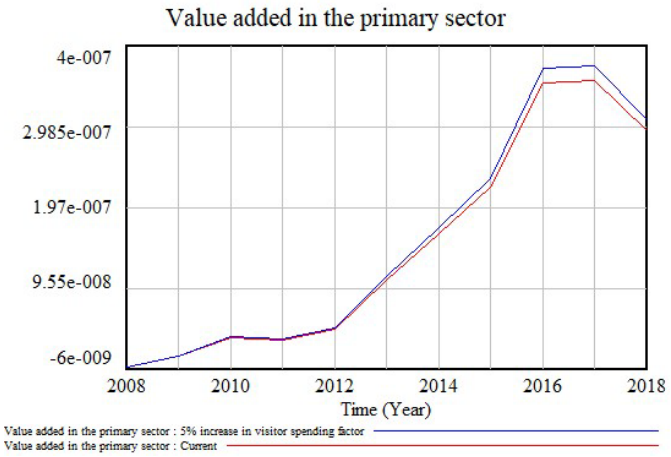

Figure 8. *Graph of change in value added in the primary sector*

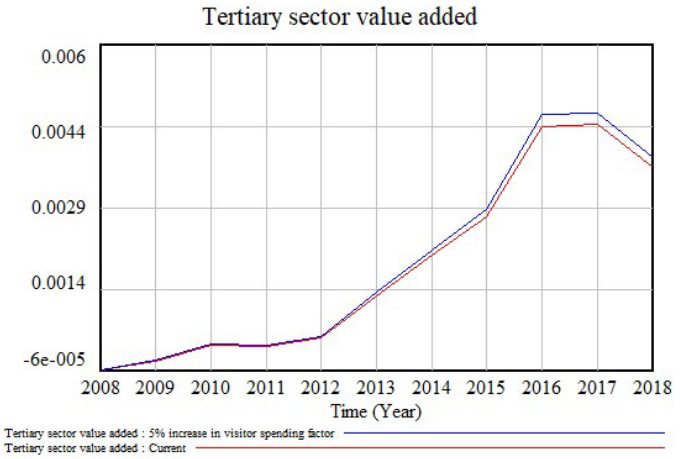

Figure 10. *Graph of the changes in value added in the tertiary sector*

The aforementioned simulation results demonstrate that, following the expansion of the tourist consumption coefficient, the port industry's value added, the primary, intermediate, and tertiary industries' value added, as well as the GDP produced by the port, all show relatively noticeable growth. This suggests that fluctuations in tourist consumption have a particular impact on the downstream port's development. The rise of the cruise industry's midstream economy can drive the growth of the downstream port industry's value added, as well as the port's mainline, secondary, tertiary, and total GDP. This, in turn, can encourage the port's total development, proving a direct correlation between tourism levels and cruise port development, as well as the downstream economy being propelled by the rise of the cruise ships industry's midstream economy. This suggests that the growth of the cruise ships industry's midstream economy may result in the establishment of downstream industries linked to cruise ports.

The investment share coefficient is increased by 10%: This paper investigates the role of ports in the midstream growth of the cruise line chain by assuming changes in port construction investment intensity and running simulations with an adjusted investment ratio coefficient to analyze the impact of downstream port development of construction on cruise ship midstream development. To investigate the effects of a change in investment intensity on port expansion and midstream growth of the cruise line chain, the investment ratio coefficient is increased by 10% while the model's other parameters remain constant. Figures 11-12 show the changes in port pressure and throughput capacity after adjusting the investment ratio coefficient.

The simulation results show that when the investment ratio coefficient increases, so does port capacity, while port pressure decreases. This indicates how increasing port construction investment boosts port capacity, which attracts more cruise ships and passengers; in other words, increasing port construction spending promotes the growth of linked sectors in the center of the cruise liner industry chain. As a result, the expansion and construction of downstream cruise ports helps to accelerate the growth of the midstream cruise ship chain.

The model simulations and analysis of their findings allow us to draw the following conclusions: the growth of the cruise ships industry's midstream economy can encourage the growth of downstream ports, and the growth of downstream ports can encourage the growth of the cruise ships industry's midstream economy. On the other hand, as the cruise ship midstream sector grows, the downstream ports must also develop to a certain amount; otherwise, the cruise ship midstream industry's

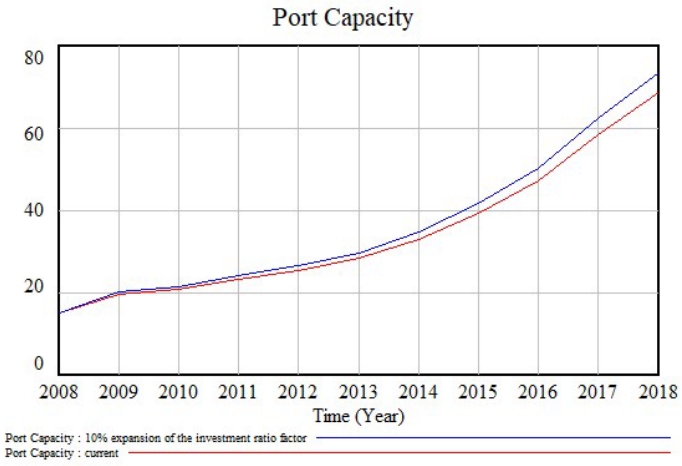

Figure 11. *Chart of changes in port throughout capacity*

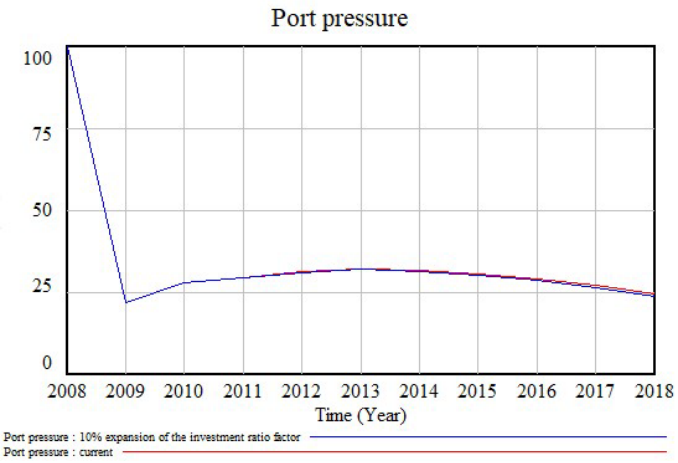

Figure 12. *Port Pressure variatioin graph*

economy will suffer. That is, the growth of the cruise industry's midstream economy is inextricably linked with the expansion of the port, and the development of downstream ports cannot be separated from the growth of the cruise ships industry's midstream economic development; the two are complementary and mutually reinforcing, ultimately leading to the goal of integrated growth of the cruise ship value chain

Organizational Synergy Mechanisms

The goal of the cruise line chain's synergistic development is to reduce barriers to cooperation in order to achieve the cruise ships industry chain's synergistic development goal and to increase the power of synergistic development between the chain's top, middle, and bottom regions. Although China's cruise ship design and manufacturing are still in their early stages, the country's cruise ship sector will expand greatly as the policy of reinforcing the nation with water is implemented. Thus, this study proposes for achieving a coordinated growth of the cruise line chain from the organizational synergy mechanism, the information synergy mechanism, and the interest coordination mechanism by integrating simulation and analysis of the industry chain.

Organizational synergy mechanisms

The role of organizational synergy in developing the cruise industry chain is self-evident, as only an industry chain with unified cultural values and corporate norms and standards can operate efficiently, while an industry chain without organizational synergy is like a scattered piece of sand. Organizational synergies include strategic goals, standards, and values.

Strategic goal synergy mechanism

Enterprise collaboration necessitates a synergy of strategic goals, which is critical for organizational development. To do this, the key industries in the top, medium, and lower tiers of the cruise ship industry must have a shared development vision for mutual communication and input, as well as clarify the overall development goals and plans throughout the cruise ship industrial chains. The key enterprises in each aspect of the cruise line industry chain must be unable not only to adapt their organizational structure and operation methods to meet the requirements of the synergistic exploitation of the cruise line industry chain according to the strategic requirements of the system construction of the cruise line industry chain, but also to maintain consistent strategic objectives among the key enterprises in each aspect of the cruise line industry chain, so as to ensure the stability of the synergistic exploitation of the cruise line industry chain and the long-term growth of the enterprise organization.

Standard specification synergy mechanism

Cooperation across many subjects is challenging in the cruise line chain, which includes numerous interconnected topics and businesses. By planning and designing the cruise line chain's planning standards, developing unified technical standards, workflows, and management systems, and ensuring that the products and technologies of the relevant subjects in the cruise line industry chain are compatible, conflicts or differences in the growth of the cruise line industry chain can be avoided or minimized due to inconsistent standards. This will improve the efficiency of manufacturing and operation at each link in the cruise line chain, maximizing its benefits. This will maximize the benefits of synergy in the growth of the cruise line industry chain while also improving the efficiency of production or operation at each link in the chain. For example, the ecological expansion of cruise ports must be considered while constructing and developing cruise ships, as must environmental norms.

Values synergy mechanism

Value synergy ought to be the primary emphasis of the cruise line chain's development process. Among all pertinent parties in the cruise industry chain, an effective synergy of values can lessen conflicts and inconsistencies brought on by disparate behavioral norms and value orientations of the industry. The establishment of mutual trust among the relevant subjects in each link, as well as compatibility in business management and culture among the leading enterprises in each link, are necessary for the consistency of industry values among all pertinent subjects of the top, middle, and lower parts of the cruise line industry chain. To reduce transaction costs and operational risks while ensuring the continued cooperation of the various organizations in the chain, the cruise line industry must consider the rights and interests of the relevant subject owners throughout the chain's development, with mutual trust serving as the cornerstone. However, the values of the cruise line chain's

synergistic development allow for a specific range of different cultures to meet the development needs of all relevant industrial sectors, thereby promoting an organized growth of the cruise ship chain. Instead of mandating all relevant industries in the chain to adhere to the same corporate philosophy and social culture.

Information synergy mechanisms

Effective communication of timely information is critical for the practical connection between the top, middle, and bottom tiers of the cruise line industry chain. As a result, establishing an appropriate information coordination structure is critical to ensuring that all sorts of information in the cruise line chain are exchanged and handled in a timely and effective manner. The information synergy mechanism consists mostly of information sharing and monitoring components.

Information sharing mechanism

Effective information synergy enables relevant industries in the cruise industry chain's initial, intermediate, and downstream divisions to identify and resolve issues more quickly. It also assists these sectors in successfully managing business risks arising from diverse uncertainties, promotes the synergistic expansion of the cruise line industry chain, and improves the value creation and innovation of the primary industries associated with the industry's chains. Through the industry chain synergistic information platform, relevant subjects in each link in the chain of the cruise line industry can access information resources such as the level of development of cruise ship build and design the status of cruise companies' operations, the construction of cruise ports, etc., and update and amend the information of their respective relevant industries, ensuring that the information on the platform is updated in real time and that the relevant subjects in each link in the chain of the cruise industry can dynamically adjust in response to industry information at any time, improving the adaptability of the relevant subjects in each link in the industry chain.

Simultaneously, it assists each industry chain link's pertinent topics in avoiding certain business risks or losses brought on by knowledge asymmetry. Additionally, the cooperative management platform for the cruise industry can be updated by the pertinent subjects of each link in the chain, allowing for the uploading of pertinent information such as business concepts and technological innovations. This facilitates information exchange and resource sharing within the chain, thereby promoting the growth of the cruise line chain as a whole.

Information monitoring mechanism

To facilitate the cruise line chain's collaborative management platform, cruise resource information must be shared across key topics, as well as tracked, analyzed, and reviewed. All information should be organized into data analysis reports by category and time period. This will allow the platform to detect and respond to aberrant information in a timely manner, as well as generate accurate analysis reports to support the optimization and adjustment of the entire cruise line industry chain and its important issues.

Once the information collaborative management platform monitors abnormal information, it can directly connect to the relevant main enterprises in the industry chain, send information to warn of deviations, and promptly help the relevant main enterprises to re-examine the information and upload corrections to it. The cruise industry chain can be set up with comprehensive industry chain collaborative information coordination, contract systems and evaluation systems, and other regulatory standards to ensure the effective operation of information and the overall system of the cruise liner industry chain, and to achieve the goal of information collaboration and resource sharing between cruise liner industry chains. The cruise liner industry chain collaborative information standard should consider the timeliness and compatibility of information transmission and exchange to effectively reduce the distortion in the industry chain transmission and improve the utilization of information resources between industry chains.

The cruise industry chain collaborative information monitoring and management system should clarify the objectives, rewards, and punishments of the main body of information collaboration and the distribution of benefits and specify the responsibilities and obligations that each relevant main body of the industry chain should bear in the information exchange so that it can monitor the industry chain collaborative information mechanism, provide timely feedback on the problems that exist in the operation of the information collaboration mechanism and solve problems, and ensure the accuracy and smoothness of information transmission between industry chains. The information exchange between the industry chains should be monitored, and the problems in the operation of the information coordination mechanism should be reported and solved promptly to ensure the accuracy and smooth transmission of information between the industry chains.

Benefit synergy mechanisms

Based on organizational and information synergy, as well as an analysis of the connection between the higher, medium, and lower levels within the cruise line chain, it is clear that each link in the chain has a vested interest and interacts with the others. As a result, developing an effective benefit synergy mechanism has the potential to increase overall profitability in the cruise business. The interest synergy process is made up of three components: interest guidance, interest expression, and interest coordination.

Interest-led mechanism

In the growth of the cruise ship value chain, interest induction functions as a navigation system for the relevant themes in each link. It directs the pursuit and integration of interests in the appropriate topic industries throughout the industry chain. Every connection in the cruise liner industry chain that is tied to a certain industry has its own set of interests. The size of the action force paid by associated subjects is determined by the amount of interest received. This can lead to relevant subjects refusing to join in collaborative efforts to grow the industry chain due to a lack of enthusiasm. To address this issue, an interest guidance mechanism can be used to give a motivating factor for interest.

The creation of a scientific and reasonable process for generating interest can organize the different interests of the relevant parties at every step for the cruise line chain, resulting in the integration of interests and the promotion of synergistic development. When developing a method for inducing benefits, it is critical to examine each party's unique benefit demands, strength gaps, business philosophies, and other pertinent aspects. It is critical to assist each party toward building a sense of community of interests in order to achieve the objectives of each party and the cruise ship industry chain, thereby promoting a win-win situation for the cruise ship industry.

The mechanism for expressing interests

The expression of interests is the foundation of the interest-driven mechanism, indicating the ability of relevant subjects at each link in the cruise line business chain to collectively construct their own interests. Contradictions and disagreements between the subjects of each link will unavoidably arise during the cooperative growth of the cruise line chain owing to competing interests, stymieing the process.

To resolve contradictions and conflicts of interest among industry chains, establish a good interest-driven system, as well as promote the coordinated growth of the cruise line chain, an interest expression mechanism ought to be established during the growth of the cruise line business. This will allow the appropriate subjects in every step of the industry chain to express their opinions and negotiate their interests in order to align them with the overall interests of the industry chain. By guaranteeing the long-term viability of the cruise line chain's coordinated development, it is possible to establish an interest communication platform that will allow relevant industry stakeholders to express their interests in a reasonable and legal manner, as well as actively participate in the management of the interest expression mechanism.

The mechanism for coordination of interests

Establishing an interest coordination system is a prerequisite for appropriately dealing with the maximizing of interests, which is both the driving force and the primary impediment to the collaborative growth of the cruise ship industry chain. To adequately address this issue, an interest coordination structure must be established as part of the cruise ship industry chain's participatory growth process. The coordination system for managing interests can effectively prevent conflicts among the many stakeholders in the cruise line chain. This assures that all parties involved profit from the synergistic growth of the industry chain, resulting in mutually beneficial and win-win outcomes.

Interests can be coordinated in three ways: through institutional coordination mechanisms, the fairness principle, and interest compensation systems. To accomplish this, industrial regulations and industry structures must be modified to encourage the integration of the cruise ship value chain. This will allow each industry to consider the interests of all parties from a global viewpoint, resulting in the distribution of economic gains. A method for benefit sharing will be devised in accordance with the notion of fairness. A benefit-sharing model will be utilized to create a benefit-sharing strategy that ensures fair benefit sharing and a win-win outcome. In terms of benefit compensation, a fund will be formed to promote the growth of cruise ship chain synergy. To promote the effectiveness of the cruise ship industry chain synergy development, a reasonable compensation scheme will be developed to compensate the parties involved within every link whose interests are impacted during the process.

Conclusions

This This chapter examines the cruise sector's value chain, beginning with value generation and focusing on the upriver, middle, and downstream segments of the chain, analyzing the components of each value chain node and building the cruise sector's value chain node network. Second, using the value node network, we investigate the causal relationship between the cruise industry chain's nodes. We clarify the link and relationship between the cruise industry's initial, intermediate, and downstream segments. The cruise ship industry chain synergistic development mechanism model was created using Vensim system dynamics software to identify correlations between value nodes and the industry chain's role. Simulation analysis was then performed on the role mechanism of cruise sector worth nodes, using Shanghai as a sample.

The simulation results show that the development of the intermediate segment of the cruise liner industry chain encourages the construction of downstream cruise ports. In turn, the construction and development of these ports has the potential to support economic growth in the cruise ships industry's middle segment. Finally, this article presents a plan for implementing the cruise industry chain's synergistic development power mechanisms. The method focuses on three key areas: organizational synergy, information synergy, and benefit coordination. The three synergistic mechanisms will help to improve the cruise liner industry chain structure and create a synergistic development system for the cruise industry. This will significantly increase the economic worth of the cruise line chain's collaborative development.

Author Contributions

Conceptualization, Lu Qingwen and Chen Hongzhuan; methodology, Lu Qingwen and Chen Hongzhuan; software, Lu Qingwen; validation, Lu Qingwen, Chen Hongzhuan, and Md Ahad Un Nabi; formal analysis, Lu Qingwen; investigation, Lu Qingwen; resources, Lu Qingwen; data curation, Lu Qingwen; writing—original draft preparation, Lu Qingwen, and Md Ahad Un Nabi; writing—review and editing, Lu Qingwen, and Md Ahad Un Nabi; visualization, Lu Qingwen; supervision, Chen Hongzhuan; project administration, Lu Qingwen; funding acquisition, Chen Hongzhuan. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Not applicable

Informed Consent Statement

Not applicable.

Data Availability Statement

All data are presented in the paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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