

Instruments Used in Short Sea Shipping Research between 2002 and 2019

Amayrol Zakaria, Aminuddin Md Arof, Abdul Khabir



Abstract: *This study examines in what way SSS) has been researched through an inclusive review of papers published in well-known journals over the 2002–2019 period. Systematic exploration shows that Maritime Policy and Management plays a dominant role in publishing SSS research. At the same time, classification and identification of important on determinants and barriers for successful SSS has been found as the main research area, followed by attractiveness and competitiveness of SSS; policy and subsidizations in SSS and multimodal transportation network; energy efficiency, emission and environmental issue and protection; ports and transport system efficiency; cargo operations, inventory management, competitive SSS technology and ICT; potential demand, opportunity and competitive advantage; sustainable development and influence of meteorological and weather conditions on SSS operations as popular topics. Since 2002, the use of quantitative and qualitative analysis techniques has progressively increased in SSS in order to help researchers make decisions through selected scientific methods. With this work, present and prospective researchers can understand the contemporary development and popular research topics in SSS. By presenting a review on the common research instruments and techniques used in SSS research, this study is expected to seal the gap in the present literature through the collation of information on the research approaches in contemporary SSS studies.*

Keywords: *short sea shipping (SSS), information communication technology (ICT), quantitative analysis, qualitative analysis.*

I. INTRODUCTION

This paper is systematized as follows; first section identifies the main research area topics in SSS. Section 2 presents the collection of relevant papers and a review process. In the organized paper, data analysis techniques in Sections 2 and present a conclusions and discussion in Section 3.

II. BACKGROUND OF THE STUDY

Historically, the first academic meaning of SSS is more than 20 years old,

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* Correspondence Author

Amayrol Zakaria*, Universiti Kuala Lumpur, Malaysian Institute of Marine Engineering Technology, Lumut, Malaysia. amayrol@unikl.edu.my

Aminuddin Md Arof, Universiti Kuala Lumpur, Malaysian Institute of Marine Engineering Technology, Lumut, Malaysia. aminuddin@unikl.edu.my

Abdul Khabir, Mitrans / Faculty of Business Management, UiTM, Malaysia. abdulkhabir@uitm.edu.my

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when Balduini presented SSS an oceanic conveyance between seaports of a nation-state as well as concerning a countries harbor and the ports of bordering countries [13].

This classification comprises the type of facility, being cabotage or seaside within the seaports of a nation that may prolong the geographic coverage to adjacent nations. In 1992, the European Commission presented its initial SSS periodical that expresses SSS as a transport of passengers and cargoes by ocean among seaports situated on the continental of one-member state deprived of calling at islands, or services amongst seaports of one-member state wherever one or more ports are situated on islands and offshore supply services [25]. Consequently, the US Maritime Administration (MARAD) describe SSS as a marketable maritime conveyance that does not passage an ocean. It is additional method of commercial conveyance that employs coastal waterways and inland to transfer marketable freight from main local harbors to its destination [122]. Constant with the MARAD definition, [130] reveal the following basics to the above mentioned explanations: feeding, inter modals, inter-regional cargo, transshipment, spoke and hub networks and a substitute to road transport for trailers or container [130]. In a more inclusive approach, [5] indicate that SSS commonly involves the carriage of freight, vehicles and passengers by vessels beside the shores, to and from near islands, within internal waters such as rivers and lakes but deprived of route crossing an ocean.

For nation, SSS not only ensures the transportation of resources needed for production processes but also facilitates the transshipments of vehicles, which accumulates more advantages for the nation. It is argued by [110] that SSS has some advantages which are decreased environmental impact, better utilization of infrastructure, potential cost efficiencies and coastal economic development. Along similar line of argument, [3] reveals that a feasible SSS that could be alternately connected by road transport will minimize road congestion, reduce road construction and maintenance costs and improve the surrounding environment. On the other hand, since maritime conveyance compromises greater fuel economy and lesser emissions of risky pollutants, SSS has been measured among the most sustainable and parsimoniously competitive means of transport [72].

III. RESEARCH AREA IN SSS

The SSS sector has traditionally been regarded as an important component of a nation's economic system. Therefore, research on SSS has received a countless deal of attention from scholars worldwide.

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For instance, an impressive volume of studies have been conducted for classification and identification of important determinants for its successful undertaking ([89],[4], [6],[7],[36], [127],[63],[114], [10],[11],[72],[113],[88],[84], [86],[88],[14],[105],[73],[107],[16],[54], [65], [18], [17],[15],and [79]).

Subsequently, the next popular SSS research area is on the attractiveness and competitiveness of SSS in a multimodal transport chain ([39], [131], [68], [35], [71],[114], [77], [66], [120], [34], [27], [37],[42], [87], [78], [20], [62], [95], [19], [103], [8], [21], and [9]). This is followed by research on policy, subsidization, funding and government assistance in SSS and multimodal transportation network as the third most popular area ([132], [44], [59], [60], [82], [114], [112], [12],[51], [81], and [92]).

The fourth research area involves energy efficiency, emission and environmental issue and protection ([123], [61], [116], [40], [70], [125], [116], [52], [47], [121], [58], [55], [106], [49], [48], [67], [53], [23], and [133]). This is followed by ports and transport system efficiency, cargo operations, inventory management, competitive SSS technology and ICT. ([137],[57],[33], [22], [41], [135], [108], [76], [28], [104], [83], [45], [100], [1], [114], [129], [26], [98], [31], [95], [107], as well as [56].

Number sixth research area covers potential demand, opportunity, competitive advantage and sustainable transport development ([38], [69], [101], [50], [90], [124], [32], [75], [110], [94], [74], [111], [70], [71], [58], [59], [109], [128], [119], and [126], [99], Eventually, only few studies can be traced that focus on the influence of meteorological or weather conditions on SSS operations ([43], and [29]).

Basically, such reviews are helpful to understand the contemporary development and popular research topics in SSS. By presenting a review of the major research instruments and techniques used in SSS studies, this study seals the gap in the current studies by collating information on the research approaches of contemporary SSS studies, whether through the qualitative or quantitative techniques.

Consequently, this study reviews the major data analysis techniques used in SSS research. Next, comparing the status of current research in SSS and it is found that excessive commitment has been given to shipping operations, port strategies and SSS developments, but few efforts have been made to research in meteorological or weather conditions, policy and government assistance. The next section will explain the most exciting instruments that have been employed and followed by rare instruments that can be traced employed in SSS study.

IV. COLLECTION OF RELEVANT PAPERS



Fig. 1 Distribution of SSS papers by journals

Based on the figure above, there are numerous studies on SSS that can be traced have been conducted between 2002 and 2019. Obviously, Maritime Policy and Management journal plays important role in publishing SSS study involving are 38 journal articles, followed by Maritime Economics and Logistics with 20 papers, International Journal of Shipping and Transport Logistics with 17 papers, Journal of Transport Geography with 11 papers, Transportation Research Part A 11 with papers, Marine Pollution Bulletin involves 8 papers, Transport Reviews 3 papers, The Asian Journal of Shipping and Logistics 3 papers, Journal of Navigation 3 papers, Transport Policy 3 papers, Transportation Research Part D 2 papers, Journal of Shipping and Trade 2 papers, Journal of Maritime Research 2 papers, Marine Policy 2 papers, Journal of Shipping and Ocean Engineering 2 papers, Transport and Telecommunication Journal 2 papers, International Journal of e-Navigation and Maritime Economy 2 papers and the last one is Naval Architect 2 papers. Thus, the next section will review the instruments used in SSS studies.

V. METHODOLOGY

This paper favors an appraisal of the related literature in relative to the focus of the study by thoroughly referring to numerous studies carried out elsewhere. This study also presents an academic review on SSS and its significant techniques, and method that utilized by the respective areas. Lastly, a systematic summary of the significant techniques and the gap that this study expects to fill are offered.

VI. FINDING AND DISCUSSION

Algorithm

Table. 1 Approaches of Algorithms in SSS

Instruments	Scholar	Area
Label-Setting Algorithm	[50]	Optimal Routes Optimal Size of Ships
Path finding Algorithm	[41]	Ship Routing
Algorithm and Meteo-Oceanographic Predications	[40]	Ship Routing
Guided Algorithm	[22]	Schedules of Ships
Multi objective Evolutionary Algorithm	[71], [70]	Fleets for The Sea Motorways
NSGA-II Algorithm	[70]	Optimization of Container Fleets
Frank-Wolfe Hybrid Algorithm	[96]	Carbon Emission Reduction
Algorithms	[52]	Energy Efficiency
L-Shaped Algorithm	[1]	Inventory Routing

Based on the table I above, there are several approaches of algorithms that have been used in open literature.

Different researcher utilized different level depending on the area that he or she had explored. For instance, [50] employed Label-Setting Algorithm in a study to conclude the optimum ways for daughter and mother ships, along with the best size of the daughter ships. [41] Employed Path finding Algorithm in ship routing and revealed the economic profits of spending ship routing in SSS through enthusiastic wave periods.

Contrarily, [40] employed Algorithm and Meteo-Oceanographic Predications to come out with the predictions of ship routing from a European perspective. Within similar research area, [22] employed Guided Algorithm and come out with the ideal energetic reorganization of schedules of further ships to encounter the demand once a vessel's restriction. From a Spanish and French perspective, [71], [70] employed Multi objective Evolutionary Algorithm and revealed that the greatest appropriate fleets for the Sea Motorways are Gijón-St.Nazaire and Vigo-St.Nazaire. Additionally, [70] employed NSGA-II Algorithm to investigate the relationship of external expenses on the optimization of container convoys and revealed that elevated ships are talented to deliver sustainable multimodal links than the transport-road. In a hybrid approach, [96] employed a FW Hybrid Algorithm

to investigate the scheme of shore line shipment services focus to carbon production lessening aims and public subsidy stages and offered a model that was useful to Bohai Bay in China.

In term of energy efficiency in SSS, [52] employed fuel consumption, operational and design specifications Algorithms and the outcomes demonstrate that even a traditional valuation is practiced it would central to a decrease in energy. Last but not least, from an African perspective, employed L-Shaped Algorithm to investigate the inventory transmitting difficult with stochastic navigating and port times. This study presented a computational revision based on actual-world examples. The following section will discuss the qualitative study but no specific instruments that have been employed in SSS study.

.Qualitative Research

Table. 2 Approaches of Qualitative Research in SSS

Instruments	Scholar	Area
survey	[38]	autonomous technologies
survey	[123]	environmental
survey	[44]	SSS network and finance model
Qualitative Methodology	[101]	Ro-Ro and Ro-Pax shipping
Qualitative Methodology	[51]	policy implications
Qualitative Methodology	[57]	barriers for SSS
survey	[89], [90], [91]	Current practices of China, Japan and Korean SSS.
survey	[21]	competitiveness of Turkish coaster merchant fleet
survey	[110]	food loss reduction in Northeast Asia

Based on table-II above, numerous of researchers employed a Qualitative Approach and it is difficult to identify whether they employed a specific qualitative instrument or techniques to reveal their findings. Among others, [38] conducted a survey to investigate autonomous technologies in SSS and revealed that autonomous technologies are practical to the shipping business that is problematic in crew budgets and skill deficiency. From the same perspective, [123] employed a survey to investigate an environmental friendliness of SSS towards road transport and presented a novel instrument to recognize the geographical choice where each another conveyance is further environmentally pleasant. Similarly, Hamilton [44] employed the same approach to investigate the SSS network and finance model and suggested that proper consultation with stakeholders and design of the implementation can mitigate constraints. [101] also employed the Qualitative Methodology when they investigated on deliberate steaming as part of SECA acquiescence strategies among Ro-Pax and Ro-Ro shipping businesses and accomplish that bunker rates, rough competition and greatest importantly dissimilar service value requirements have expressively limited the latent application of deliberate steaming.

Form both American and European point of view, [95] employed this instrument to investigate the SSS and its

prospects. This study concludes that SSS can improve technologically progressive solutions and customized that determination more assimilate it into the intermodal conveyance chain and advance its image between shippers. From the South American perspective, [51] employed Qualitative Approach to investigate potential and policy implications in Brazil and revealed that the cabotage law restricts the coastal and inland water trade to vessels flying its national flag. Additionally, [57] employed the same approach to investigate the barriers and enablers for SSS in Southern Africa and revealed that SSS has the theoretic latent to effort in the African region. Lastly, some other scholars also employed the same approach to investigate SSS in Asia.

For Northeast Asia, [89], [90], [91] conducted a survey to investigate the current practices of China, Japan and Korean SSS. Similarly, [21] conducted a survey and interview to investigate the effectiveness of Turkish merchant fleet and this study revealed that Turkish need to size small draft, box type vessels and river going to gain a competitive advantage.

In the Northeast Asia, [110] employed the same method to investigate the food loss reduction in emerging economies by exploiting SSS opportunities. This study facilitates the applicants in eliminating both unfruitful options with respect to business effectiveness and food loss reduction

Decision Support Systems (DSS), Discrete Event Simulation and Decision Networks

Table. 3 Approaches of Decision Support Systems (DSS), Discrete Event Simulation and Decision Networks in SSS

Instruments	Scholar	Area
Decision Networks	[136]	sustainability of SSS
DDS	[76]	cascading feeder vessels
Discrete Event Simulation	[126]	Sustainability of SSS.
DSS	[125]	ballast water risk

Based on the table-III above, there are four studies that were traced to have employed these instruments. All the studies are European based. Firstly, [136] employed Decision Networks to investigate the sustainability of SSS and revealed that the volume of regasification seaports for LNG, which was in structure and the modal spreading of internal water freight conveyance are the two greatest significant variables for the judgments to utilization liquefied natural gas (LNG) as fuel. Second, [76] employed the DDS to investigate the flowing feeder vessels and the justification of minor

container ports. The results of this research show that fleet currently laid up and very inadequate on directive, greater feeders with deeper drafts look positive to support at least closely of these routes. On the other hand, [126] employed Discrete Event Simulation to investigate sustainability development in SSS. Finally, [125] used DSS to investigate for the North Sea in a ballast risk indication and they concluded that exceptions are not suggested for the North Sea part

Multi-Criteria Decision Making (MCDM), AHP, Delphi, Fuzzy Dematel, Fuzzy Logic

Table. 4 Approaches of Multi-Criteria Decision Making (MCDM), AHP, Delphi, Fuzzy Dematel, Fuzzy Logic in SSS

Instruments	Scholar	Area
Multi-Criteria Decision Making	[71]	Motorways of the Sea
MCDM	[97]	Logistics network and externalities for SSS.
Delphi technique	[63]	Indicators of island transport services.
Delphi technique	[88]	Strengths and weaknesses of SSS
Delphi technique	[105]	potential for British coastal shipping
Delphi-Fuzzy DEMATEL	[127]	barriers to coastal shipping
Fuzzy Logic	[30]	Economic feasibility study of SSS
Delphi technique	[7]	SSS in Archipelagic Southeast Asia (ASEA)
Delphi-AHP	[6]	Interstate Ro-Ro in ASEA.
AHP	[4]	Ro-Ro SSS in Archipelagic Southeast Asia
AHP	[99]	Sustainability on the feeder service improvement in Malaysia

Based on the table-IV above, from European perspective, [71] employed Multi-Criteria Decision Making to analyze the Motorways of the Sea for France and Spain and come out with the most suitable Motorways of the Sea options. [97] also employed the same instrument to explore on the logistics link and externalities for SSS transport. This study disclose that savings in intermodal transportation costs and a slight decrease in externalities with respect to land transportation. On the other hand, there a pretty numbers of academia's that employed the same instruments under MCDM which are Delphi, Fuzzy Dematel and AHP (analytic hierarchy process).

From European perspectives, [63] employed the Delphi technique and presented a transport model using grading procedure study on important performance signs of island transportation services. With the same perspectives, [88] also employed the same method to investigate the strengths and weaknesses of SSS and proposed a new approach to clarify some concepts in SSS. Using the same technique, [105] explored on the latent for British coastline shipping in a multi chain and concluded that executives are in favor of multimodal expansions, in specific collaboration among road haulage and coastal shipping. In addition, [127] employed the

Delphi with Fuzzy DEMATEL to investigate the obstacles to coastal shipping expansion in India and recommended comforting cabotage procedures to inspire the inflow of foreign wealth in order to develop coastline shipping, enlightening the present port coordination through united

government exertions, customs and ports, and raising supply chain alliance. On the other hand, [30] employed the Fuzzy Logic to investigate an economic feasibility study of SSS and the results demonstrated that SSS has inspiring potential for more instructive its environmental performance by discouraging ship emissions at seaports.

In Asia, [7] employed this instrument to investigate the possible advantages and complications of interstate SSS in

ASEA and this study revealed that the hole in the current studies by concentrating in SSS for ASEA, mostly those connecting interstate Ro-Ro operations and covering the practice of Delphi technique to the empire of interstate SSS.

Subsequently, [6] employed this study together with AHP technique and this study concludes with the expansion of a decision-making model for interstate Ro-Ro ways in ASEA sub-region.

For AHP, [4] employed this instrument to develop a model Ro-Ro SSS in Archipelagic Southeast Asia and come out with an improvement of a model that an appropriate for interstate Ro-Ro SSS routes in the ASEA sub-region. With the same region, [99] employed this instrument to investigate influences of the feeder service expansion in Malaysia concerning its sustainability and this study revealed that the service sub-criteria is the most important feature on the feeder service improvement in Malaysia.

Econometric Analysis, Cost Benefits Analysis (CBA), Economic Analysis, Cost Model and Monetary Cost, and Costs and Transit Time Model

Table. 5 Econometric Analysis, Cost Benefits Analysis (CBA), Economic Analysis, Cost Model and Monetary Cost, and Costs and Transit Time Model in SSS

Instruments	Scholar	Area
CBA	[133]	Regulation And Fuel Prices
Economic Analysis	[131]	Container And Ro-Ro Shipping
Economic Analysis	[68]	analysis of SSS container
Cost and Transit Time Model	[132]	Costs of averting modal shifts
Cost and Transit time	[35]	Competitiveness of SSS.
Cost Model	[71]	Fleets for Sea Motorways..
CBA	[112]	Sustainable transportation.

Costs and Transit Time	[74]	Container transport.
Econometrics and Spatial Shift-Share	[111]	SSS services.
Costs and Transit Time	[109]	Demand in SSS.
Approximate Analysis and Assessing External Costs	[58], [59], [60]	Role of SSS in sustainable development.
CBA with SWOT analysis	[80], [81]	Nigerian coastal and inland shipping cabotage policy.
CBA	[134]	Ro-Ro SSS network.

Based on the table V above, in terms of financial analysis, [133] employed Cost Benefit Analysis (CBA) to investigate the important of fuel prices and regulation. The study show that there are important consequences of the new sulfur confines to the reimbursement period of emissions reduction investments, mainly following the unpredicted decrease in fuel prices. From a European perspective, [131] employed the same approach by using economic statistical analysis to investigate in the international logistics development spillover over Ro-Ro shipping and container in North Europe SSS. This study concludes that SSS in North Europe tends to divide into two different ways, participating in competition as a logistics provider, or strengthening their own position as a pure carrier. With the same approach, [68] investigate the analysis of SSS container routes in the Black Sea and the Mediterranean. Their study revealed that the Italian foreign trade is becoming more oriented to high value goods.

From the same perspectives, [132] employed Cost and Time Model to investigate the costs of averting modal shifts in the European SSS Sector and come out with the proposed measures that can effectively decrease the undesirable effects of the guideline. [35] Also employed the Monetary Cost and Transit time to explore in the competitiveness of SSS and the study revealed that the road choice is costlier than the greatest SSS choice accessible for the exportations from Southern Catalonia and Jaén, respectively. [71] also employed the Cost Model instruments to explore the optimal fleets for Sea Motorways. This study concludes that the best suitable fleets for the Sea Motorways are Gijón-St.Nazaire and Vigo-St.Nazaire. Similarly, [112] also employed CBA to examine the application of "ecobonus" development in Croatia and afford to the political initiatives of the European Union for the European maritime without limits, and encourages sustainable shipping and transportation.

In North America, [74] employed the Costs and Transit Time model to scrutinize the method in small distance hinterland container transport. The outcomes of the research suggest that, to improve a further modal shift, operators should attempt to deliver daily services at a competitive price, with an emphasis on providing more consistent services than road transport. [111] furthermore employed the Spatial Econometrics and Spatial Shift-Share to investigate SSS along the Atlantic Arc. The conclusion of this study shows that along the Atlantic facade of the Iberian Peninsula, there are growing nodes with great potential to enable the increase in their throughput, in terms of inner competitiveness or by establishing new SSS services between neighboring positions. [109] also employed the Costs and Transit Time model to investigate a modeled transportation demand in SSS. This model produces the amounts of cargo that could potentially be carried annually through each transport solution, for different freight rates and ship speeds.

On the other hand, [58], [59], [60] employed the Approximate Analysis and Assessing External Costs to investigate the role of SSS in sustainable development and came out with a model that can be applied to evaluate external benefits of infrastructure investment or a new shipping line. From an African point of view, [80], [81] employed the CBA with SWOT analysis to investigate the benefit of maximizing criteria from the Nigerian coastal and inland shipping cabotage policy. The study reviews government policies affecting investments in ship sizes operating in lakes, rivers canals, inland waters and coastal waters of the maritime state. Last but not least, [134] employed the CBA to investigate the establishment of a Ro-Ro SSS network connecting Southeast Asian countries.

Factor Analysis, Sensitivity Analysis, Statistical Techniques, OLS Regression, Concentration Analysis

Table. 6 Factor Analysis, Sensitivity Analysis, Statistical Techniques, OLS Regression, Concentration Analysis in SSS

Instruments	Scholar	Area
Factor Analysis	[128]	Customer segmentation
Univariate and Multivariate Statistical Techniques	[20]	Domestic SSS services in Brazil
Regression Analysis (OLS Regression)	[82]	over-exertion in Swedish SSS
Statistical Techniques	[28]	Ro-Ro connectivity.
employed the Statistical Techniques and Secondary Data	[104]	Cargoes in tramp shipping.
Statistical Method and used Correlation Analysis	[23]	Environment. costs and transportation.
Statistical Method and used Correlation Analysis	[36]	Ferry service in SSS.
sensitivity analysis	[24]	Transport mode
Concentration Analysis	[116]	Port rationalization and port systems.

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Based on the table VI, in terms of statistical technique, there are few studies that were traced to have employed Factor Analysis as an instrument in SSS. In North America, [128] employed Factor Analysis to investigate on customer separation of cargo forwarders and influences on the competitive locating of marine transporters in the southern China–Taiwan trade lane. This study funds to a management consequences and instructions for upcoming research. From South America, [20] employed Univariate and Multivariate Statistical Techniques to investigate the domestic SSS services in Brazil. This study reveals that cabotage operators target to improve the mixing of logistics among transport modes and to implement modal shift approaches if superior services could be delivered, counting a real-time data system, minor transit times and cargo delivery on a door-to-door foundation. In the same research area, [82] employed a Statistical Technique focusing in Regression Analysis (OLS Regression) to explore on organizational burden and over-exertion in Swedish SSS and revealed that highest levels of exertion were informed by employees usually related with great organizational burden. [28] Also employed the Statistical Techniques to explore on port connectivity indices and revealed that for Ro-Ro connectivity, neither the amount of links nor the link quality harshly lead the consequences of their suggested factor. [104] employed the Statistical Techniques and Secondary Data to come out with a mixed method to explore in the possibility of part cargoes in tramp shipping and this study gives a superior thoughtful of possible hazards and advantages associated to application of part cargo operations. In Asia, [23] employed Statistical Method and used Correlation Analysis to investigate the impact of rearrangement transport, manufacture and supply on environment and costs. This study contributes to the Thai rubber industry as a whole. Additionally, [36] employed these instruments to explore the serious success issue of the ferry transport service in SSS and this study offers some consistent reference ideas about commissioned service for ferry organizations. From South East Asia, [24] employed sensitivity analysis to investigate the shippers exercise in gathering transport mode and this study conclude that shippers influence change to the SSS mode when the reputation weights of CO₂ emission rise, and cost when the burden of time drops. For Concentration Analysis, [116] employed this instrument to investigate a seaport rationalization. And the progression of regional port structures and revealed that persistent conversation of reform in Norway regarding regional port control, equivalent to other European nations, might eventually result in such rationalization.

Modal Choice Model, Discrete Choice Models and Preferences of Modal Choice Decision, Employed International Competition Model

Table. 7 Modal Choice Model, Discrete Choice Models and Preferences of Modal Choice Decision, Employed International Competition Model in SSS

Instruments	Scholar	Area
Modal Choice Model	[37]	Transport policy and SSS.
International Competition Model	[114]	SSS as an intermodal.
Modal Choice Model	[19]	Atlantic Canadian shippers.

Discrete Choice Models	[103]	competition concerning services in SSS
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Based on the Table-VII above, In Europe, two studies have been traced to have employed these instruments. [37] Employed Modal Choice Model to investigate the European common transport policy and SSS. This study revealed how significant politico-economic assessment in a European perspective. Second, [114] employed International Competition Model to investigate the SSS as an intermodal competitor and this study concludes that EU as an entire necessities to highlighting on transport system and ports efficiency in order to compete successfully in the cargo transport market. Form a North American perspective, [19] employed the Modal Choice Model to investigate the requirements of Atlantic Canadian shippers and suggested for a novel method of gathering data on how organizations fragmented business in the choices.

In addition, [103] employed Discrete Choice Models to explore the competition among Lo and Ro–Ro services in SSS market in Mediterranean nations. This study revealed that the significant component that arises, in universal terms, is the separation of the market in relative to the distances current among each chain of nations.

Comparison of Data Collected, Comparative Analysis, Destination (OD) Matrices

Table. 8 Comparison of Data Collected, Comparative Analysis, Destination (OD) Matrices in SSS

Instruments	Scholar	Area
Comparison of Data Collected	[69]	SSS Container Routes
Comparison and Forecasting Calculations	[43]	Vessel speed on bunker cost in SSS..
Comparative Analysis mixed with Destination (OD) Matrices	[116]	Emission control in SSS

Under this category, table VIII shows that [69] employed Comparison of Data Collected instrument to investigate the SSS container ways in the Black Sea and in the Mediterranean. This study concludes that the greatest significant Italian port collection is the Liguria. On the other hand, [43] employed the Comparison and Forecasting Calculations to investigate the influences of ship speed on bunker budget in SSS. Their study revealed that the undesirable economic influences of the oil price disparity can be alleviated to some level by using lesser ship speeds. Additionally, [116] also employed the Comparative Analysis mixed with Destination (OD) Matrices to investigate the environmental impacts of emission control area guidelines on SSS in Northern Europe concentrating on container feeder ships. This study effectively illustrates how empirical data supports the necessity of stricter SO_x regulations in order for maritime operations to uphold a green image set up against competing transport modes.

Energy Efficiency Design Index, Analysis of the Sea, Advanced Modelling Approach, So 2 Emission Calculations.

Table. 9 Energy Efficiency Design Index, Analysis of the Sea, Advanced Modelling Approach, So 2 Emission Calculations in SSS

Instruments	Scholar	Area
Advanced Modeling Approach	[61]	hybrid SSS
Energy Efficiency Design Index	[121]	Ro-Pax

In terms of environmental, Table-IX shows that [61] employed the Advanced Modeling Approach to investigate the methodology of power distribution system scheme for hybrid SSS and this study offered a modeling methodology for dimensioning marine ship hybrid PDS and ES components. On the other hand, [121] employed the Energy Efficiency Design Index to examine passenger and Ro-Pax ships in Greece and demonstrated that the EEDI baseline calculation is extremely influenced by ship design and operational features, ordering the need for close checking of the EEDI efficiency in this subdivision.

Strength-Weaknesses-Threats-Opportunities (SWOT) Analysis

Table. 10 Strength-Weaknesses-Threats-Opportunities (SWOT) Analysis in SSS

Instruments	Scholar	Area
SWOT Analysis	[102]	The rewards of SSS
SWOT Analysis	[81]	Benefit maximizing criteria

From European perspective, table-X shows that [102] employed SWOT Analysis to analyses the rewards of SSS in Croatia as well as the environmental concerns related to shipping in worldwide and SSS specific. This study revealed that opportunities and strengths positively decrease the implication of weaknesses and threats. From Africa, [81] employed (SWOT) Analysis to investigate the advantage maximizing standards from the inland shipping and Nigerian coastal. The study shows that in the assessment of marine rule, unique instrument that has been very supportive is the social costing method.

Job Demands–Resources (JD-R) Model

Table. 11 Job Demands–Resources (JD-R) Mode in SSS

Instruments	Scholar	Area
JD-R Model	[94]	Shipping lines
JD-R Model	[93]	Short sea cargo

In general perspective, table-XI shows [94] employed a JD-R Model to examine the seafarer’s insights of job burdens of SSS shipping lines and their special impacts on life on board and work. Thus, this study concludes that a best working environment was crucial in countering undesirable emotions and collaboration and supporting motivation. In another research, [93] investigated special effects of social interactions and job demands on exhaustion in SSS cargo shipping and focus on the significance of considering social connections to improve our thoughtful of strain and stressors in oceangoing.

Data Envelopment Analysis (DEA)

Table. 12 Data Envelopment Analysis (DEA) in SSS

Instruments	Scholar	Area
DEA	[47]	Freight route
DEA	[115]	Time spent at ports in SSS

Based on the table-XII, [47] employed a Data Envelopment Analysis (DEA) to investigate the environmental demands and the upcoming of the Tallinn–Helsinki cargo route. This study revealed that present logistic provider and semi-trailer-based transport is confronted by containers, regardless of how they are carried. [115] also employed the same instruments to investigate the time spent at seaports in SSS. This study concludes that time in effectiveness analysis can alter the outcomes resulting from a more traditional method based just on numbers.

Data-Mining Techniques

From the European perspectives [39] employed the Data-Mining Techniques to evaluate liquid natural gas (LNG) utilization in SSS. This study found that the capacity of LNG regasification depots under structure and modal distribution of freight transport by inland waters are the dual core nodes of the linkage.

Porte’s Five Force Model

[86] Employed Porter`S Five Force Model to investigate the Motorway of the Seaports necessities. The study revealed that the perspective of port authorities concerning this difficulty and suggested a list of 21 pre-requisites that seaports can practice to measure their potential.

Assessing External Costs

In Europe, [60] employed the Assessing External Costs instrument to explore the important of SSS in sustainable growth of transportation and this study proposed a model that can be applied to assess external welfares of organization investment or a novel shipment line.

Impact Pathway & Top-Down Approaches

In Northeast Asia, [62] employed this instrument to explore in the management of empty container movements over SSS and provincial port arrangements. This study found that SSS symbolises a practical approach in the execution of a regional port system growth plan.

Longitudinal Analysis

Through this instrument, [46] investigated the growing trade of unitized SSS for Germany and Finland and this study discovered that development of centralized maritime freight flow has faced complications after Global Financial Crisis between Finland and Germany.

Formal Concept Analysis (FCA) Method

[64] Employed this instrument to investigate revitalization of SSS through slender, simplified and standardized designs and indicates that important cost savings and fuel can be realized by building slender and designing, standardized and simplified SSS ships.



The savings might be of a related magnitude as the traditional markets of scale welfares which are reachable by expanding the ship size.

Novel Methodology

[108] employed Novel Methodology to examine the methodology for fleet sizing and Ro-Ro ship with application to SSS that allows the determination of the greatest suitable vessel and fleet sizes for dissimilar market penetration stages.

Simulation Modelling Method

[83] Employed the Simulation Modeling Method in an analysis of Ro-Ro terminals and shows that the variable that frequently affect seaport volume is amount of lorries incoming to seaport.

Two-Phase Hybrid Matheuristic

[45] Employed a Two-Phase Hybrid Matheuristic to analyze the multi-product SSS inventory-routing problematic and come out with an adaptive great neighborhood search to resolve the resultant scheduling problem and ship routing.

Bi-Objective Optimisation, Mathematical Model

In Europe, [100] employed Bi-Objective Optimization and Mathematical Model in a study of container transportation movement of containers imports and offered a mathematical model that can decrease the transportation costs and transit time of container imports to Serbia.

Theoretical Intermodal Competition Model

Eventually, [115] employed the Theoretical Intermodal Competition Model in the topic of SSS as intermodal competitor and the study concludes that the EU necessities to emphasis on transport system efficiency and ports as a whole in order to compete efficiently in the cargo conveyance market. Thus, discussion on the papers that have been review and a conclusion will be simplified for the next section.

VII. CONCLUSION

This study reviews a thorough literature review of data analysis techniques used in SSS between 2002 and the middle of 2019. It shows how SSS research has been undertaken to give researchers a superior understanding of the present state of exploration and research in the realm of SSS. Throughout the review period, there has been an increasing tendency in the utilization of both the quantitative and qualitative instruments for SSS research. More academic and research publications have also been consistently published throughout the period of consideration. The advance in SSS research is attributable to the fact that SSS has traditionally been regarded as an important element of a nation's economic system. During the review period, MPM journal has maintained a dominant position in publishing research in the various areas involving SSS. Today, experience is greater than before by expert analysis and informed by research findings made using a variety of quantitative and qualitative instruments or mix method then become quasi to come out with the inspiring research contribution. As a whole, quantitative instruments have been used more often as compared to the qualitative approaches. The popularity of quantitative approaches is associated with the introduction and application of computer science, statistics, and

mathematics in social science research. Despite the comprehensive approach, this study retains some limitations. For instance, this study considered only journal articles that visibly revealed their instruments because a clear understanding is essential to simplify the exact instruments that have been used by some scholars. Nonetheless, this study is suggestive and offering researchers a deep exploration of the present situation of SSS research.

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AUTHORS PROFILE



Amayrol Zakaria. He received his Bachelor in Maritime Operations, MBA from University of Sains Malaysia. He is currently pursuing PhD in the area of SSS at the University of Kuala Lumpur. His primary research interests are in the field of transportation, clientele management and financial statement analysis.



Aminuddin Md Arof is an Associate Professor at Universiti Kuala Lumpur, Malaysian Institute of Marine Engineering Technology. Before joining UniKL in 2007, he served the Royal Malaysian Navy and as a lecturer with Universiti Teknologi Malaysia. He holds a PhD in Transport and Logistics from the Universiti Teknologi Mara, Malaysia and a Master of Arts in Maritime Policy from University of Wollongong, Australia. His research interests include SSS, liner shipping, cabotage regime, navigational rights and freight logistic.



Abdul Khabir Rahmat is a Senior Lecturer at Universiti Teknologi Mara, Malaysia. Received his PhD in Logistics and Transport in 2018. He also holds a Master of Science in Business Administration. His publications and research interest are in the field of Logistics Management, Maritime level of service, Rail and International Conventions, Public transportation service excellence, National Culture, Manufacturers Satisfaction, and Logistics operation excellence. He won gold medal in Malaysian Private University Invention competition (PERINTIS) 2018 and was among the top 10 winners of the Selangor Research and Development Innovation Competition.