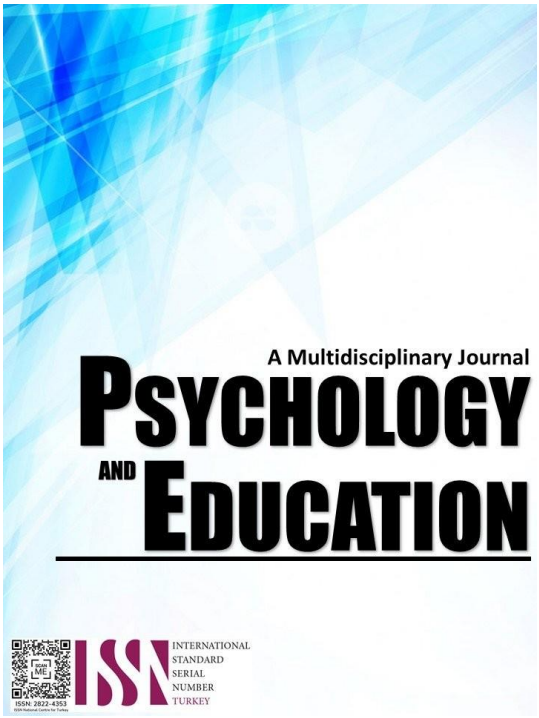
CHARTING A NEW COURSE: A RESEARCH METHODOLOGY GUIDE FOR THE MARITIME INDUSTRY



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Research Article

Charting a New Course: A Research Methodology Guide for the Maritime Industry

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Abstract

This study explores a range of methodological approaches in maritime research, including qualitative, quantitative, and mixed-methods designs. Qualitative methods provide in-depth insights into the lived experiences of seafarers, while quantitative approaches leverage statistical tools and large datasets to optimize maritime operations. Mixed-methods research integrates both paradigms, offering a more holistic understanding of complex maritime phenomena. For instance, a mixed-methods framework can effectively assess the impact of emerging technologies on seafarer well-being. This research also evaluates various data collection techniques and incorporates advanced analytical tools, such as machine learning, to enhance data interpretation. Ethical considerations, including privacy protection and informed consent, are prioritized throughout the research process. Furthermore, the study underscores the transformative potential of Industry 4.0 technologies—such as artificial intelligence, blockchain, and the Internet of Things (IoT)—in reshaping maritime practices. By synthesizing diverse research methodologies, scholars can gain deeper insights into the evolving maritime landscape and address its emerging challenges more effectively.

Keywords: *maritime sector, research technique, qualitative analysis, quantitative analysis, mixed methods analysis, data evaluation, ethical aspect*

Introduction

Every year, countless ships traverse the world's oceans, carrying billions of dollars of goods (UNCTAD, 2023). However, the maritime industry faces a myriad of challenges, from environmental concerns to operational efficiency. To address these issues, rigorous research is essential.

This section intends to function as an exhaustive resource for the maritime sector and scholars, offering a varied array of research The qualitative, quantitative, and mixed methodologies were examined and tailored to tackle the distinct issues and intricacies of the maritime sector. Further, this section explores quantitative methods, including the use of statistics, economic analysis, and data mining, illustrating their relevance in the examination of extensive datasets and the enhancement of maritime operations. Additionally, diverse qualitative approaches were examined, such as ethnographic research, case research, and analysis of discourse, to obtain a deep understanding of the societal, cultural, and human dimensions of marine activities. This section offers a thorough overview of research methodologies, enabling maritime researchers and industry to choose the most suitable approaches for their specific inquiries, thereby improving the rigor and validity of their findings and contributing to a more profound understanding of the complex challenges and opportunities in the dynamic maritime sector.

Research in the seafaring sector informs management and policymakers (Panayides, 2006). Crisis-resistant, the sector continues to provide complex and adaptable solutions for transportation (Nedelcu, 2022). Satellite-based navigable systems, electric propulsion, and advanced sensors have improved production, security, and sustainability (Aung Ye Kyaw, 2024). However, high startup costs, infrastructure constraints, and regulatory hurdles remain. Current research examines the technological, environmental, and economic impacts of the maritime industry on international trade (Sahdev et al., 2023). Maintaining research and development and stakeholder participation is essential to optimizing these technical advancements and solving new maritime sector issues (Aung Ye Kyaw, 2024).

Maritime research faces distinct problems and opportunities across domains. Domestic ferry difficulties include regulatory gaps, governance improvements, standardization issues, and capacity creation (Baig et al., 2024). Though understudied, ship-bridge simulators can be used in maritime research and innovation (Zghyer & Ostnes, 2019). Shipping alliances provide flexible operational frameworks for integration and risk management in maritime trade (Stakhov, 2023). Marine trade faces challenges and opportunities from the Belt and Road Initiative, which emphasizes port expansion, simpler trade procedures, and marine coordination among nations (Lu et al., 2018). Multifunctional route choice, transportation mobility, dry harbor location optimization, and global maritime network analysis help address marine sector difficulties and capitalize on opportunities (Lu et al., 2018).

Traditional maritime research methods have drawbacks. While increasingly popular, quantitative techniques have limitations when applied to complex maritime situations (Shi & Li, 2017). The interviewer's expertise might affect the gathering and interpreting of information in qualitative procedures like expert interviews (Sharma, 2023). Workplace health and global health issues have dominated maritime health research, which needs more diversified methods such as randomized controlled tests, longitudinal investigations, and qualitative investigations (Maclachlan et al., 2012). Though helpful, only eight maritime transportation studies used the Delphi-AHP method between 2004 and 2014 (Arof, 2015). These constraints demonstrate the necessity for more thorough and novel research methods to address the maritime industry's challenge of complexity and evolution.

Maritime research has many gaps and obstacles. Cyberattacks are poorly tracked, their economic impact is unclear, and marine experts

are poorly trained to handle them (Maweli & Caesar, 2023). Multi-risk and natural disaster impact evaluations on ports of call and cargo lack empirical data (Lam & Lassa, 2017). Lack of unanimity on cluster definition hinders maritime cluster research, and adjusting to changing contexts and establishing theories is difficult (Shi et al., 2020). Tracking, event detection, and trajectory forecasting are difficult with diverse maritime data integration and analysis (Claramunt et al., 2017). Contemporary national and international legislation cannot regulate marine cyberspace (Maweli & Caesar, 2023). Enhancing security at sea, processes, and profitability amid threats and difficulties requires closing these gaps.

Industry-academia gaps slow technical developments in several fields. These gaps are caused by outmoded technology, poor execution, and self-centeredness (Singh & Nirmal, 2017). Factor market segmentation and technology capability investments create intra-industry technological gaps (Battisti & Pietrobelli, 2000). Technology, markets, and institutions slow solar photovoltaic deployment (Theyel et al., 2011). Global experts highlighted important electronics industry development gaps (Rae et al., 2007). These gaps hinder innovation, advancement of systems, and industry growth. To increase industrial performance and technological advancement, mindset concerns, application-oriented approaches, and industry-academia collaboration must be addressed (Singh & Nirmal, 2017; Theyel et al., 2011).

This section covers maritime industry-specific research methods. This guide will help maritime researchers and industry to create robust and meaningful studies by studying qualitative, quantitative, and mixed research methods suited to the field. The section presents maritime research's particular difficulties and prospects, including established methodologies' limits and creative alternatives. Emphasize ethics and provide practical data gathering, analysis, and interpretation instruction. The authors hope that this paper will improve marine research and inform industry decision-makers by offering outstanding maritime research methodologies, including the outputs.

Research Designs

Researchers in maritime studies can use qualitative, quantitative, or hybrid methods. Quantitative research employs statistical data and statistical analysis, while qualitative research uses descriptive and interpretive data (Creswell, 2010). Mixed methods help researchers comprehend the situation better (Christensen & Johnson, 2007). The choice relies on research goals and context, as each method has pros and cons (Taherdoost, 2022). Quantitative approaches include questionnaires and experiments, whereas qualitative methods include case investigations and ethnographic research (Creswell, 2010). Mixed techniques combine both quantitative and qualitative information sequentially or concurrently (Christensen & Johnson, 2007). Researchers must evaluate ethical, data-gathering, and analytic methods for each strategy (Creswell, 2010). A good study design is essential for maritime studies' validity and dependability.

The Qualitative Design. Qualitative research design is increasingly used in maritime studies to better comprehend the industry's complex concerns. It has been used to assess maritime education graduates' employability (Boonadir et al., 2022), identify autonomous vessel controller competencies (Emad & Ghosh, 2023), and explore complex security (McCall, 2020). Researchers can gather considerable data from seafarers, regulators, and instructors via comprehensive and specialized interviews (Emad & Ghosh, 2023; Boonadir et al., 2022). However, marine specialists' professional status may generate methodological issues while interviewing (Sharma, 2023).

Further, Qualitative research can bridge concepts with applications in technology, shipping, and social work. These methods reveal real-world work and living that quantitative methods may miss (Kasi, 2016; Harvey & Myers, 1994). Participant interviews and observation are beneficial for comprehending complex open systems and solving practice-related challenges in real-world situations (Floersch et al., 2012; Kasi, 2016). By involving practitioners as knowledge providers, qualitative research can meet academic and practical demands (Harvey & Myers, 1994). These methodologies enable researchers to apply theoretical concepts to field research by developing, performing, and analyzing them (Arar, 2017). Qualitative methods allow researchers to examine professional conduct and decision-making, offering a more complete picture of work practices (Kasi, 2016; Floersch et al., 2012).

Moreover, Qualitative research methods help understand complex phenomena, notably in maritime and safety fields. These methods help researchers understand complicated systems without predefined parameters, enabling a deeper analysis (Peshkin, 1988). Qualitative methods like personal narrative accounts and firsthand experiences help reconcile work-as-done and work-as-imagined, improving safety understanding in dynamic scenarios (McCall, 2020). Qualitative research's adaptability allows systematic examination of purposeful innovation trajectories and complex phenomena (Wenzel et al., 2016). Qualitative research, influenced by philosophical theories like Gadamer's hermeneutics may help measurement-based research understand complex healthcare and other projects (Thirsk & Clark, 2017). Qualitative methods reveal the richness and complexities of many phenomena, especially marine ones.

While not exhaustive, Wa-Mbaleka & Gladstone (2018) propose several qualitative research designs that are a suitable starting point for novice researchers. These designs will be explored in greater detail in subsequent discussions.

First, ***Phenomenology.*** According to Flood (2010) and Moryń (2018), phenomenology is a philosophical perspective and research method that analyzes consciousness and subjective experiences. Founded by Edmund Husserl, it emphasizes pure awareness and transcendental phenomenology to convey reality without assumptions (Moryń, 2018). This research design aims to uncover "experiential essences" to solidify reality (Berríos, 1989). Since J.H. Lambert first the phrase in 1764, it has grown into a "semantics palimpsest" with several levels of meaning from numerous philosophers (Berríos, 1989). Phenomenology uses specialized approaches to study inner subjectivity, acknowledging the interconnectedness of people and their environments (Flood, 2010). While popular in

therapeutic settings, phenomenologists seek a deeper understanding of consciousness rather than theory-neutral descriptions (Berríos, 1989; Moryń, 2018).

Recent phenomenological studies have explored the lived experiences of maritime professionals, revealing diverse challenges and adaptations in this evolving industry. Women leaders in maritime face gender-based obstacles but overcome them through job excellence and proving their worth (Paraggua et al., 2022). Maritime training incorporates embodied instructional practices, emphasizing the role of the lived body in preparing for emergencies (Viktorelius & Sellberg, 2021). Technological advancements have significantly transformed seafarers' professional lives, necessitating continuous learning and adaptation to new systems and communication tools (Aguilar et al., 2024). The COVID-19 pandemic presented unique challenges for seafarers, as exemplified by Ilonggo seafarers who found themselves unexpectedly stranded at home. These individuals demonstrated resilience by developing coping mechanisms and engaging in alternative activities during their forced hiatus (Garcia, 2024). These studies collectively highlight the dynamic nature of maritime professions and the importance of adaptability in navigating industry changes and unexpected disruptions.

Second, ***Grounded Theory.*** This investigation method generates theory via systematic data analysis (Noble & Mitchell, 2016). It entails choosing a topic, eliminating theoretical biases, and employing analytical and sampling methods (Noble & Mitchell, 2016). Research generally includes comprehensive interviews, inquiries, and focus sessions (Noble & Mitchell, 2016; Balasubramanian & Mathias, 2020). Coding, continual contrast, and memo writing are involved (Vollstedt, 2015, 2019). Develop categories and notions using In-Vivo, theoretical, and conceptual codes and open, axial, and chosen codes (Vollstedt, 2015, 2019). Theoretical sampling continues until saturation (Noble & Mitchell, 2016; Balasubramanian & Mathias, 2020). An emergent theory of substantive acts is desired (Balasubramanian & Mathias, 2020). GT can be used in nursing, medicine, and other healthcare research (Balasubramanian & Mathias, 2020).

Grounded Theory has been used in maritime studies to create complete frameworks and theories. Turedi & Ozer-Caylan (2021) developed a framework of national marine policies that prioritized safety, security, and the environment to guide policymakers. Flatman (2003) proposed bringing larger archaeological ideas to maritime archaeology, including engendered and Marxist viewpoints. The concise abstract of William's (1973) sociological method for maritime studies lacks specifics. These studies demonstrate Grounded Theory's diversity in marine research, from policy formation to archaeological exegesis and sociological analysis.

Third, ***Ethnography.*** Direct experience and participant observation underpin ethnography (McGranahan, 2018; Imilan & Marquez, 2019). You write about people, cultures, and societies from the "native's point of view" to understand the world (McGranahan, 2018; Imilan & Marquez, 2019). After its inception in anthropological research, ethnography has spread to various fields, exposing distinct communities and their organization in cities. The phrase encompasses both research and its output (Hammersley, 2005). Researchers disagree on ethnography's definition and practice, but they agree that it entails personal experience in the research context and interpreting the respondents' viewpoints (Weeks, 2004). However, its scientific nature, quality, and differences from journalism are still debated (Weeks, 2004).

Ethnography in nautical research provides significant understanding regarding the social, cultural, and economic dimensions of coastal communities. Studies have investigated the influence of marine heritage on feelings of community and identity in locations such as Bermuda (Andrews, 2012). Comparative assessments of South Asian communities who fish have uncovered distinctive traits regarding class, social strata, gender, and economic transformations, hence contesting simplistic interpretations of modernity (Gupta, 2003). Ethnographic research in Indonesia has underscored the significance of seafaring experiences in fostering geo-socio-cultural unity throughout the archipelago, highlighting the notions of shared property and cultural variety (Lampe, 2021). The utilization of ethnography in marine affairs is seen as essential for comprehending the interaction between tradition and marine policy, perceiving marine societies as networks of diverse stakeholders (Miller, 1983). These works jointly illustrate the importance of ethnographic methods in understanding the intricate dynamics of maritime civilizations and guiding policy decisions.

Fourth, ***Case Study.*** This design entails a comprehensive analysis of a particular occurrence or event (Heale & Twycross, 2017). It is especially beneficial for examining intricate real-world processes and procedures (Khairul Baharein Mohd Noor, 2008). Despite criticism over their generalizability, case studies yield valuable data and insights that may be unavailable through alternative methodologies (Morland et al., 1991). The method is adaptable, relevant to several social scientific fields, and capable of incorporating numerous data collection methodologies, hence enhancing findings through corroboration (Khairul Baharein Mohd Noor, 2008). Case studies help elucidate social issues including church participation, gender stereotypes, and destitution (Morland et al., 1991). Gerring (2006) contends that case study research can effectively integrate several methodologies, particularly experimental, qualitative, and quantitative approaches. Notwithstanding persistent discussions regarding its scientific validity, case study research continues to serve as a significant instrument for enhancing empirical comprehension of social existence (Morland et al., 1991).

Studies, like the Deepwater Horizon oil leak exposed ecological catastrophes and worldwide humanitarian crimes outside territorial sovereignty concerns in marine security (Robertua & Damayanti, 2021). Over 34 years, World Maritime University examined how gender equality policies affected learner and staff statistics, curriculum, and events in the shipping sector (Lares, 2017). A West Coast shipping company case study of interunion disputes revealed union rivalries and steward representation rights, demonstrating the constantly changing structure of nautical employment relations (Record, 1956). These studies show that marine issues range from

environmental disasters to equal treatment for women to labor disputes, stressing the necessity for multifaceted solutions.

Fifth, ***Action Research.*** Action research evaluates and improves practice through research and action (O'Grady, 2018). The process includes problem identification, data collecting, thinking through, analyzing, and intervention (Vo Dai Quang et al., 2008). Action research, developed by John Dewey and Kurt Lewin, seeks to improve organizations (Acharya & Mohanty, 2019). This method is a person research, collaboratively approach, and influencing wider systems (O'Grady, 2018). Unlike formal research, action research emphasizes practical solutions and is useful in language instruction and technological environments (Vo Dai Quang et al., 2008; Bødker & Munkvold, 2011). It helps practitioners integrate their ideals, do systematic research, and share their knowledge (O'Grady, 2018). In action research, the application of technology in real-world contexts and its practical effects are examined (Bødker & Munkvold, 2011).

Action research has become useful in maritime studies, covering several topics. Incorporating the concepts of human factors and Design that focuses on humans has improved maritime design education (Abeysiriwardhane et al., 2020). In ICT, ethnographic action research has increased engagement and empowered seafarers (Pan, 2021). Computers in maritime studies have grown, especially in environment, transport, and modeling (Chaichana, 2019). According to Velentza (2022), maritime archaeological research may support sustainability and climate resilience projects, harmonizing with the UN Sustainable Development Goals. These studies show that action research can be used for educational initiatives, technical developments, and environmental concerns in maritime environments, demonstrating its usefulness in tackling marine sector difficulties.

The Quantitative Research Design. Quantitative methods of study have gained prominence in marine studies, addressing multiple facets of the business. These designs have been utilized to investigate topics in transport-related research (Wenming & Kevin, 2017), evaluate risks in nautical waterways (Li et al., 2012), assess communication methods on vessels (Koyuncu & Tavacioglu, 2019), and analyze market-based strategies for transportation carbon reductions (Chen et al., 2023). Researchers have utilized several quantitative methodologies, including systematic examinations, bibliometric evaluations, and statistical techniques such as ANOVA and analysis of factors. These methodologies have been employed to examine subjects such as shipping markets, port administration, and marine safety. Nevertheless, several domains, such as maritime financing and port security, continue to be inadequately researched (Wenming & Kevin, 2017). The measurement of errors made by humans in models for risk assessment has been recognized as significant.

Quantitative research methodologies in maritime studies include diverse approaches. Shi & Li (2017) emphasize the growing application of quantitative analysis methodologies in marine transportation research since 2000, facilitating decision-making processes. Prevalent research domains encompass shipping, port administration, and terminal studies, but there is comparatively less focus on maritime economics and port security. Seers and Critelton (2001) present a comprehensive analysis of empirical study designs pertinent to healthcare and nursing, examining their advantages and disadvantages. Koyuncu & Tavacioglu (2019) utilize quantitative methodologies, including statistical methods such as ANOVA, and factor analysis, to examine the efficacy of marine Sign Language in improving shipboard communication and safety within marine communication. Their research employs a questionnaire that respondents completed themselves to gather information regarding seamen's experiences and communication competencies. These publications collectively illustrate the varied implications of quantitative research methodologies in marine studies, encompassing transport logistics and onboard communication.

The ***Mixed-Methods.*** Mixed methods research (MMR) has developed as a viable methodology in maritime studies, integrating quantitative and qualitative techniques to yield broader perspectives (Caesar, 2024; Jeevan et al., 2019). This architecture overcomes the constraints of single-method techniques and provides more comprehensive and resilient research results (Caruth, 2013). MMR has garnered acceptability among academics and can address a broader spectrum of research inquiries (Caruth, 2013; Neupane, 2019). MMR has been utilized in marine environments to examine matters that involve marine operator attrition along with dry handling of ports (Caesar, 2024; Jeevan et al., 2019). The explanatory sequential approach has been employed to investigate the employer and worker viewpoints in the shipping sector (Caesar, 2024). Researchers are urged to explicitly articulate their rationale for employing MMR and to possess expertise in qualitative as well as quantitative techniques (Caruth, 2013). MMR represents an innovation in research, providing the opportunity for improved knowledge development in marine studies (Neupane, 2019).

In addition, there are many different designs under MMR, such as sequential, concurrent, multiphase, and multilevel designs (Almeida, 2018). For example, the explanatory sequential approach has been successfully utilized in the process of examining the retention of ship officers (Caesar, 2024). According to Johnson and Onwuegbuzie (2004), mixed-methods research is distinguished by its methodological diversity, which frequently leads to greater research outputs when compared to single-method approaches. When conducting mixed methods research, qualitative methods are an essential component since they provide support for quantitative data and contribute to an overall improvement in the quality of the research (Boivin, 2021). Even though it is effective, there is a requirement for an increasing application of mixed approaches in the field of maritime research (Caesar, 1920). To gain deeper insights and address complicated research topics in a variety of domains, researchers ought to give serious consideration to the adoption of mixed methods designs.

Data Collection

Maritime data collection involves many methodologies and legal implications. Maritime studies, questionnaires, operations nautical science, and exploration are independent categories governed by unique legal frameworks (Roach, 2009). Data collecting techniques

encompass autonomous maritime vehicles to improve communication coverage and facilitate data acquisition (Zhao & Bai, 2024). The maritime data value chain encompasses the gathering, pre-processing, storage, and utilization of various data kinds (Herodotou et al., 2020). Human and organizational elements are essential to maritime safety, employing methodologies such as HFACS for identifying mistakes and CREAM for probability characterization (Wu et al., 2021). Challenges in maritime research encompass data acquisition, individual variables, and the rise of autonomous ships (Wu et al., 2021). Future research may concentrate on devising methods for adaptation to intricate circumstances, including sensor malfunctions, oceanic dynamics, and heterogeneous systems (Zhao & Bai, 2024). Efficient management and analysis of extensive marine data are crucial for enhancing multiple facets of the maritime sector (Herodotou et al., 2020).

Primary Data Collection Techniques. Marine data collecting includes research for science, questionnaires, operations marine science, and explorations (Roach, 2009). Autonomous maritime vehicles (AMVs) are essential for improving network coverage and data collecting, with route selection being a vital concern for effective and secure data acquisition (Zhao & Bai, 2024). Prevalent primary data collection techniques encompass focus groups, interviews, surveys, assessments, and analyses of media (Heap & Waters, 2019). Expert interviews hold significant value in marine research; yet they pose distinct methodological issues when the interviewer possesses expertise in the same domain (Sharma, 2023). These techniques enhance multiple facets of marine studies, including hydrographic and military surveys, operational oceanography, and exploration. As the discipline advances, researchers are formulating methodologies to tackle increasingly intricate situations and enhance data-collecting efficacy in maritime settings (Zhao & Bai, 2024).

Secondary Data Collection Techniques. Recent studies on nautical data collection methodologies underscore various strategies and obstacles. Social media has become a potent instrument for marine discourse in English (Natsir & Bahagia Saragih, 2023). Path-planning methodologies for driverless marine vehicles are essential for effective maritime data collection, with forthcoming research concentrating on adaptation to intricate circumstances (Zhao & Bai, 2024). The examination of human and organizational aspects in maritime transportation utilizes many methodologies, such as the Human Factors Analysis and Classification System (HFACS) for error detection and the Cognitive Reliability and Error Analysis Method (CREAM) for likelihood assessment, although data gathering continues to provide a considerable issue (Wu et al., 2021). A thorough examination of maritime shipping research from 2000 to 2014 indicates that 'shipping' is the predominant focus, accompanied by a growing application of quantitative analysis methods. Nevertheless, certain subjects such as maritime economics and port security continue to be inadequately researched (Shi & Li, 2017). These studies collectively underscore the significance of novel data collection methodologies and analytical tools in progressing maritime research.

Data Analysis

Quantitative Data Analysis Technique. The maritime sector increasingly depends on analytical data analysis methods to enhance operations and refine decision-making. Big Data analytics techniques are used to examine extensive quantities of ship operation and navigation data, facilitating operations efficiency, security advancement, and improving energy efficiency (Mirović et al., 2018). Spatiotemporal data analytics, integrating spatial and temporal data points, is especially beneficial for applications including route planning, environmental conservation, collision prevention, container monitoring, and terminal call efficiency (Schmitt et al., 2020). Since 2000, there has been an increasing trend in the application of statistical methods in maritime transport research, with shipping-related subjects predominating the area (Shi & Li, 2017). Nonetheless, obstacles persist in the implementation of Big Data systems within the maritime sector, encompassing issues of data effectiveness, integration, and security (Mirović et al., 2018). The developments in data analytics are essential for the maritime industry to swiftly adapt to evolving situations and make educated decisions based on several metrics.

Since 2000, the marine industry has experienced a notable rise in the application of quantitative data analysis methodologies, facilitating processes for making decisions (Wenming Shi & Kevin X. Li, 2017). These strategies are utilized in diverse domains, encompassing maritime markets, port administration, and terminal analyses. The amalgamation of the online world of Things (IoT) and Big Data analytics has significantly revolutionized the industry, facilitating enhancements in operational effectiveness, security, and environmental conservation (Irmina Durlik et al., 2023; M. Mirović et al., 2018). Spatiotemporal data analytics, integrating spatial and temporal data points, has become an effective instrument for applications including route planning, environmental conservation, collision prevention, cargo monitoring, and port call optimization (Patrick Schmitt et al., 2020). Notwithstanding the exciting opportunities, obstacles persist regarding information difficulty, protection, and accessibility (Irmina Durlik et al., 2023). As the maritime sector increasingly adopts new technologies, surmounting these hurdles will be essential for fully using the capabilities of data analysis.

Qualitative Data Analysis Technique. Over the past two decades, qualitative data analysis methodologies have been widely utilized in maritime studies. Text mining and topic modeling techniques, including Latent Dirichlet Allocation (LDA), are being employed to examine sustainability literature within seafaring studies (Sung-Ho Shin et al., 2018). Network statistical analysis and information mining have been utilized to investigate the progression of maritime transportation studies, uncovering emerging themes such as neural networks and digital archives (Shankar et al., 2021). Since 2000, statistical methods have become increasingly prevalent in maritime transport studies, aiding stakeholders in making informed choices (Shi & Li, 2017). Qualitative disaster research, originating from marine studies, provides unique perspectives into the response, preparedness, mitigation, and recovery dimensions of disasters. This methodology encounters obstacles in field investigations, ethical implications, and emotional effects on researchers (Phillips, 2014).

The amalgamation of qualitative and quantitative methodologies can yield a thorough comprehension of maritime and disaster-related challenges.

Recent investigations in maritime studies have concentrated on diverse qualitative data analysis methodologies to examine long-term viability topics of study and team efficacy. Analysis of text and topic modeling has been employed to examine sustainability literature and discern key developments in seafaring studies (Sung-Ho Shin et al., 2018). Bibliometric analysis has identified prominent study domains including transport, port administration, and terminal studies, while underscoring the rising application of quantitative analysis methodologies (Wenming Shi & Li, 2017). Data analysis in marine IoT has demonstrated the potential to enhance operational effectiveness, safety, and sustainability, notwithstanding obstacles related to data accuracy and safety (Durlik et al., 2023). Qualitative research methodologies, such as foundational theory, have been utilized to build models for on-board team success, focusing on challenges pertinent to multicultural seafaring teams (Jha, 2020). These studies collectively illustrate the several methodologies employed in qualitative data analysis within maritime research.

Mixed Method Data Analysis Technique. Meta-analysis and systematic reviews have assessed the effectiveness of technology in the marine sector, demonstrating the influence of methodology and research attributes on outcomes (Saravanan Venkadasalam, 2022). In marine Internet of Things (IoT) applications, data analysis methodologies encompass predictive maintenance, artificial intelligence, and machine learning; however, difficulties like as data quality and security remain (Durlik et al., 2023). The integrated Delphi-AHP technique has been utilized in a restricted scope of marine transport research, mostly within the maritime and terminal sub-sectors (Arof, 2015). A thorough examination of maritime logistics research from 2000 to 2014 indicates an upsurge in quantitative analysis methodologies, with shipping emerging as the predominant study domain. Nevertheless, certain subjects such as maritime economics and port security continue to be inadequately researched (Shi & Li, 2017). These varied methodologies provide significant information for making decisions in the maritime industry.

Ethical Considerations

Ethical considerations in nautical research include safety, aquatic mammal studies, technological breakthroughs, and ocean governance. In marine cybersecurity research, cognizance of ethical considerations and direction for prudent decision-making is essential to prevent possible damage (Oruc, 2022). Ethical evaluations and transparency are crucial in marine mammal research, especially when it entails invasive methods or partnerships with commercial whaling enterprises (Papastavrou & Ryan, 2023). The swift technological progress in marine security requires a measured approach, weighing both advantages and threats while conforming to ethical principles like the principle of proportionality requirement, and the rights of people (Islam, 2024). Ethical considerations significantly influence legislation and procedures that promote the environmentally sound growth and safeguarding of marine resources in the context of international maritime law and maritime governance (Marko, 2018). These findings underscore the necessity of including ethical considerations in marine research across diverse fields.

Future Trends in Maritime Research

Recent studies on maritime changes underscore numerous critical areas of emphasis. The rise of Industry 4.0 and digitization are prominent issues, with research investigating technologies such as the Internet of Things and blockchain in seafaring industries (Razmjooei et al., 2023). Enhancing energy efficiency in vessels and tackling design issues for offshore energy infrastructures are significant trends (Pedersen, 2015). Research topic analysis indicates a transition from regulatory and policy issues to productive, connected, and sustainable maritime transportation (Bai et al., 2021). Terminal administration, intermodal business processes, and marine shipping management continue to be critical fields of study. Moreover, there is increasing fascination with nautical, shipping, and marine tourism, with scholars introducing the term "blue travel" to encompass sea-related recreational pursuits (Martínez Vázquez et al., 2021). These studies underscore the necessity for sophisticated analytical tools, enhanced maritime education, and international collaboration to tackle forthcoming issues in the marine sector.

Conclusions

Maritime sector research is a difficult domain requiring various techniques to tackle intricate challenges. This analysis illustrates the significance of choosing suitable research designs, data-gathering methods, and analytical procedures according to the individual research topic and objectives. The amalgamation of quantitative and qualitative techniques, along with concerns about ethics and the integration of developing technology, will be essential for enhancing knowledge and meeting the dynamic requirements of the maritime sector. As the marine sector evolves, researchers must adjust their methodology and adopt creative approaches to effectively tackle the forthcoming challenges and opportunities.

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