



REVOLUTIONIZING MARITIME TRADE: UNVEILING THE INNOVATIVE SEA TOLL FRAMEWORK THROUGH ADVANCED LIVESTOCK FOLDING CONTAINER SHIP SCIENCE MAPPING

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ABSTRACT

Objective: This study aims to trace the evolution of literature concerning sea tolls and livestock folding containers from 2014 to 2023, focusing on understanding research trends, sources, influential countries, author contributions, and major research areas.

Method: Utilizing the Crossref database, the study collected 1000 relevant publications related to sea tolls and livestock folding containers. A science mapping approach, assisted by VOSviewers, was employed for analysis.

Research Findings and Discussions: The analysis revealed several key findings. Firstly, it identified the emergence of sea tolls and livestock folding containers as significant research areas, indicating their growing importance. Secondly, the study identified dominant research topics and areas of interest, categorized into frequent, moderate, and rare levels. Additionally, it highlighted influential countries and sources contributing to the literature in this field. Furthermore, the study provided insights into author contributions and collaboration patterns, shedding light on the collaborative nature of research in this domain.

Research Implications: This study provides a comprehensive roadmap of current research directions in the fields of sea tolls and livestock folding containers. The findings of this study can guide future research endeavors, facilitate interdisciplinary collaboration, and inform policy decisions aimed at enhancing maritime transportation and economic development.

Originality/Value: The significance of this study lies in its comprehensive analysis of literature related to sea tolls and livestock folding containers, spanning a decade from 2014 to 2023. By employing a science mapping approach, the study offers a systematic overview of research trends and contributions in this field.

Keywords: Sea Toll, Livestock Folding Container, VOSviewer.

REVOLUCIONANDO O COMÉRCIO MARÍTIMO: REVELANDO A INOVADORA ESTRUTURA DE PORTAGEM MARÍTIMA ATRAVÉS DO MAPEAMENTO CIENTÍFICO AVANÇADO DE NAVIOS DE CONTENTOR DOBRÁVEL DE PECUÁRIA

RESUMO

Objetivo: Este estudo visa traçar a evolução da literatura sobre portagens marítimas e contentores dobráveis para o período de 2014 a 2023, com foco na compreensão das tendências de investigação, fontes, países influentes, contribuições dos autores e principais áreas de investigação.

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Método: Utilizando a base de dados Crossref, o estudo recolheu 1000 publicações relevantes relacionadas com portagens marítimas e contentores dobráveis para gado. Uma abordagem de mapeamento científico, auxiliada por VOSviewers, foi empregada para análise.

Resultados da pesquisa e discussões: A análise revelou vários resultados importantes. Em primeiro lugar, identificou o surgimento de portagens marítimas e de contentores dobráveis para gado como áreas de investigação significativas, indicando a sua importância crescente. Em segundo lugar, o estudo identificou tópicos de investigação e áreas de interesse dominantes, categorizados em níveis frequentes, moderados e raros. Além disso, destacou países influentes e fontes que contribuem para a literatura neste campo. Além disso, o estudo forneceu insights sobre as contribuições dos autores e padrões de colaboração, lançando luz sobre a natureza colaborativa da pesquisa neste domínio.

Implicações de pesquisa: Este estudo fornece um roteiro abrangente das atuais direções de pesquisa nas áreas de pedágio marítimo e contentores dobráveis para gado. As conclusões deste estudo podem orientar futuros esforços de investigação, facilitar a colaboração interdisciplinar e informar decisões políticas destinadas a melhorar o transporte marítimo e o desenvolvimento económico.

Originalidade/Valor: A importância deste estudo reside na sua análise abrangente da literatura relacionada com portagens marítimas e contentores dobráveis para gado, abrangendo uma década de 2014 a 2023. Ao empregar uma abordagem de mapeamento científico, o estudo oferece uma visão sistemática das tendências de investigação e contribuições neste campo.

Palavras-chave: Pedágio Marítimo, Contêiner Dobrável para gado, VOSviewer.

REVOLUCIONAR EL COMERCIO MARÍTIMO: PRESENTACIÓN DEL INNOVADOR MARCO DE PEAJE MARÍTIMO A TRAVÉS DE UN MAPEO CIENTÍFICO AVANZADO PARA BUQUES CONTENEDORES PLEGABLES PARA GANADO

RESUMEN

Objetivo: Este estudio tiene como objetivo rastrear la evolución de la literatura sobre peajes marítimos y contenedores plegables para ganado de 2014 a 2023, centrándose en comprender las tendencias de investigación, las fuentes, los países influyentes, las contribuciones de los autores y las principales áreas de investigación

Método: Utilizando la base de datos Crossref, el estudio recopiló 1.000 publicaciones relevantes relacionadas con los peajes marítimos y los contenedores plegables para ganado. Para el análisis se empleó un enfoque de mapeo científico, asistido por VOSviewers.

Resultados y Discusión: El análisis reveló varios hallazgos clave. En primer lugar, identificó la aparición de los peajes marítimos y los contenedores plegables para ganado como áreas de investigación importantes, lo que indica su creciente importancia. En segundo lugar, el estudio identificó temas de investigación dominantes y áreas de interés, categorizados en niveles frecuentes, moderados y poco frecuentes. Además, destacó países influyentes y fuentes que contribuyen a la literatura en este campo. Además, el estudio proporcionó información sobre las contribuciones de los autores y los patrones de colaboración, arrojando luz sobre la naturaleza colaborativa de la investigación en este dominio.

Implicaciones de la investigación: este estudio proporciona una hoja de ruta completa de las direcciones de investigación actuales en los campos de los peajes marítimos y los contenedores plegables para ganado. Los hallazgos de este estudio pueden guiar futuros esfuerzos de investigación, facilitar la colaboración interdisciplinaria e informar decisiones políticas destinadas a mejorar el transporte marítimo y el desarrollo económico.

Originalidad/Valor: La importancia de este estudio radica en su análisis exhaustivo de la literatura relacionada con los peajes marítimos y los contenedores plegables para el ganado, que abarca una década desde 2014 hasta 2023. Al emplear un enfoque de mapeo científico, el estudio ofrece una descripción general sistemática de las tendencias de investigación y contribuciones en este campo.

Palabras clave: Peaje marítimo, Contenedor plegable para ganado, VOSviewer.



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1 INTRODUCTION

The implementation of Sea Toll presents opportunities to enhance and uplift the well-being of the Indonesian population, particularly those residing in underdeveloped, remote, outer, and border regions (Soedarno et al., 2020). President Joko Widodo introduced the maritime logistics transportation concept of Sea Toll. This initiative aims to connect vital ports throughout the archipelago, facilitating the smooth distribution of cargo to distant locations. Additionally, it strives to establish uniform pricing for logistics across all regions of Indonesia. Sea Toll is crafted to enhance both passenger and freight mobility, leading to more affordable transportation and logistics expenses and, ultimately, reduced prices.

Utilizing a fleet of high-capacity vessels, Sea Toll emerges as a significant alternative bridging land and sea transportation modes, rendering essential goods more affordable for communities situated between Java Island and its neighboring islands. The smooth operation of Sea Toll holds the potential to foster more equitable economic growth. Consequently, the pivotal role of maritime transportation in Indonesia becomes crucial as it catalyzes economic development in remote areas.

A Livestock Container typically refers to a structure or containment unit utilized for the transportation or temporary housing of animals like cattle, sheep, goats, or pigs. These containers are specifically engineered to ensure a safe and secure environment for the animals during transit or short-term storage. A folding container, on the other hand, is a type of container that can be collapsed or folded when empty, enhancing its space efficiency for storage or return shipping. Such containers find application in various industries for transporting goods and can be constructed from diverse materials like metal, plastic, or fabric. In the context of livestock, a "livestock folding container" is a portable and collapsible enclosure uniquely designed for transporting animals. It can be conveniently folded or disassembled when not in use, offering practicality for agricultural purposes where farmers or handlers need to move the enclosure to different locations.

Essentially, the development of a livestock folding container for transporting cattle between islands involves adopting the standard container design approved by the Australian Maritime Safety Authority (AMSA). This established design has been utilized for shipping



various animals, including cattle, camels, and horses. The distinctive feature of this foldable container is its resemblance to a portable pen, allowing easy loading onto a ship, lifting onto a container truck, and folding when not in use. This characteristic contributes to a more efficient use of storage space for containers (Subiyantoro & Achmadi, 2016).

This research, spanning the years 2014 to 2023, seeks to address deficiencies in previous studies regarding sea tolls and livestock folding containers. Merely providing an intuitively crafted and presented body of scientific work is insufficient for mapping scientific boundaries and closing the existing gaps, necessitating the utilization of a science mapping approach in this study (Chen, 2013).

The objective of science mapping is to create a bibliometric map that illustrates the conceptual, cognitive, and social organization of particular disciplines, scientific domains, or research areas. Consequently, science mapping proves highly beneficial in comprehending the progression of literature in tandem with the development of the reviewed research (Cobo et al., 2011). In this study, science mapping was conducted utilizing VOSviewers software, and bibliometric data was collected through the Publish or Perish 8 tool using Crossref metadata. The research inquiries will involve examinations and discourse on the development of literary publications. This encompasses aspects like publication quantity, sources and types of publications, citation counts, author contributions, research themes, and significant study areas related to the subject being investigated.

2 THEORETICAL FRAMEWORK

Maritime trade has been a cornerstone of global commerce for centuries, facilitating the exchange of goods and resources across vast distances (Rodrigue & Notteboom, 2012). However, the traditional framework of maritime trade faces challenges such as inefficiencies in transportation, logistical complexities, and environmental concerns. This literature review explores the concept of revolutionizing maritime trade through the innovative Sea Toll Framework, which incorporates advanced technologies like Livestock Folding Container Ships (LFCS) and Science Mapping to enhance efficiency, sustainability, and profitability (Du et al., 2023; Adekoya et al., 2024).

The history of maritime trade dates back to ancient civilizations, but its modern form emerged during the Age of Exploration. Over the centuries, advancements in shipbuilding, navigation, and trade routes have transformed maritime trade into a global industry (Ojala & Tenold, 2017). However, traditional practices have become increasingly unsustainable and



inefficient in the face of growing demand and environmental pressures. Traditional maritime trade faces numerous challenges, including port congestion, lengthy transit times, high fuel consumption, and carbon emissions. Additionally, the transportation of livestock presents unique logistical and welfare concerns, often requiring specialized vessels and infrastructure.

LFCS represents a paradigm shift in vessel design, offering a solution to optimize livestock transportation while minimizing environmental impact (Miranda-de la Lama et al., 2014). Their modular containers and advanced systems ensure efficient logistics, reduced carbon emissions, and improved animal welfare standards (Garg et al., 2006). Coupled with Science Mapping, which facilitates the systematic analysis of knowledge networks within maritime trade, this framework enables stakeholders to identify emerging trends, prioritize research efforts, and foster interdisciplinary collaboration. By integrating LFCS and Science Mapping within the Sea Toll Framework, policymakers, industry leaders, and researchers can navigate the complexities of modern maritime trade with a holistic approach, promoting economic prosperity, environmental sustainability, and social responsibility (Ahn et al., 2023). The Sea Toll Framework represents a paradigm shift in maritime trade, aiming to address the limitations of traditional practices through innovation and collaboration. By leveraging advanced technologies and strategic partnerships, the Sea Toll Framework seeks to optimize supply chains, reduce costs, and minimize environmental impact.

LFCS are a revolutionary concept in maritime transportation, designed to enhance the efficiency and welfare standards of livestock shipping (Bongomin et al., 2020). These specialized vessels feature modular containers that can be adjusted to accommodate various animal species and sizes, ensuring optimal conditions throughout the voyage. LFCS also incorporate advanced ventilation, feeding, and waste management systems to safeguard the health and well-being of livestock while minimizing environmental impact (Pedrazzani et al., 2023). Science Mapping refers to the systematic analysis and visualization of scientific knowledge within a specific field or domain. In the context of maritime trade, Science Mapping can provide valuable insights into emerging trends, technological innovations, and areas for research and development (Du et al., 2023). By mapping the interdisciplinary connections between maritime trade, logistics, engineering, and environmental science, stakeholders can identify opportunities for collaboration and innovation within the Sea Toll Framework.

The integration of LFCS and Science Mapping within the Sea Toll Framework has the potential to revolutionize the maritime trade industry (Garg et al., 2006). By addressing key challenges such as transportation efficiency, animal welfare, and environmental sustainability, these innovations can unlock new opportunities for economic growth, social responsibility, and



global cooperation. However, further research and development are needed to fully realize the potential of these technologies and ensure their widespread adoption across the maritime trade ecosystem.

3 METHOD

This initiative consolidates research findings on maritime transportation and collapsible containers for livestock spanning the period from 2014 to 2023, utilizing Crossref data. The study employs the science mapping methodology with the VOSviewers program (Ariyatun et al., 2024). It is important to note that this publication does not offer an exhaustive review of all existing studies. Instead, it presents a quantitative summary of the present status and trends in the literature regarding sea toll and livestock folding containers. The aim is to help readers systematically grasp the evolution of publications, sources, publication types, contributions from countries of origin, citation trends, author contributions, fields of study, research subjects, and primary research areas.

The first phase of this research involves identifying literature-focused studies on sea toll and collapsible containers for livestock. This process brought to light deficiencies in existing literature, prompting the formulation of specific study objectives. The primary aim of this project is to systematically map the scientific landscape of sea toll and livestock folding containers. Subsequently, literature metadata was obtained from the chosen bibliographic database, leveraging Crossref. The acquired data was then examined and subjected to analysis using the VOSviewers software. Ultimately, a conclusive decision was reached.

3.1 DATABASE SELECTION

In this manuscript, bibliography data in CSV and RIS formats, sourced from the Crossref database using the Publish or Perish 8 Tool, is employed. The investigation is guided by the keywords "sea toll" and "livestock folding container," extracted from titles, abstracts, and literature within the database. Moreover, the research scope is delimited to the field of civil engineering, specifically focusing on waterway transportation.



3.2 SCIENCE MAPPING

Science serves as a key avenue for comprehending humanity's place in the universe and forms the basis for societal and economic well-being (Chen, 2013). Employing the science mapping method allows for a comprehensive mapping of the evolution of science, which can evolve in tandem with scientific progress. This approach reveals the structural and dynamic dimensions of scientific research, offering a spatial representation of the interconnections among disciplines, fields, and authors (Bolivar et al., 2018). A sophisticated visual analytical domain presents promising avenues for exploration, with visual analytics representing the second generation of information visualization.

The process of science mapping involves three key conceptual steps aimed at creating an organic map (Chen, 2013). These steps encompass determining the magnitude of connections between units, elucidating the units and relationships in question within a low-dimensional space (typically employing two dimensions), and choosing analytical units composed of the fundamental components within the scientific domain under examination. Currently, scientific mapping can be executed through various software applications such as CiteSpace (2003), scientific Science Tool (2009), VOSviewers (2010), and SciMAT (2012) (Chen, 2013). For the purposes of this study, the mapping process was conducted using the VOSviewers software. VOSviewers is a widely recognized application known for its capability to process data gathered from Crossref. With VOSviewer, it is possible to construct networks involving researchers, research institutions, nations, as well as keywords or concepts (Van Eck & Waltman, 2017). This software facilitates the creation of maps through network visualization, overlay visualization, and density visualization based on the data within the network (Bolivar et al., 2018).

4 RESULTS AND DISCUSSIONS

4.1 ANNUAL PUBLICATION TRENDS OF RESEARCH TOPICS

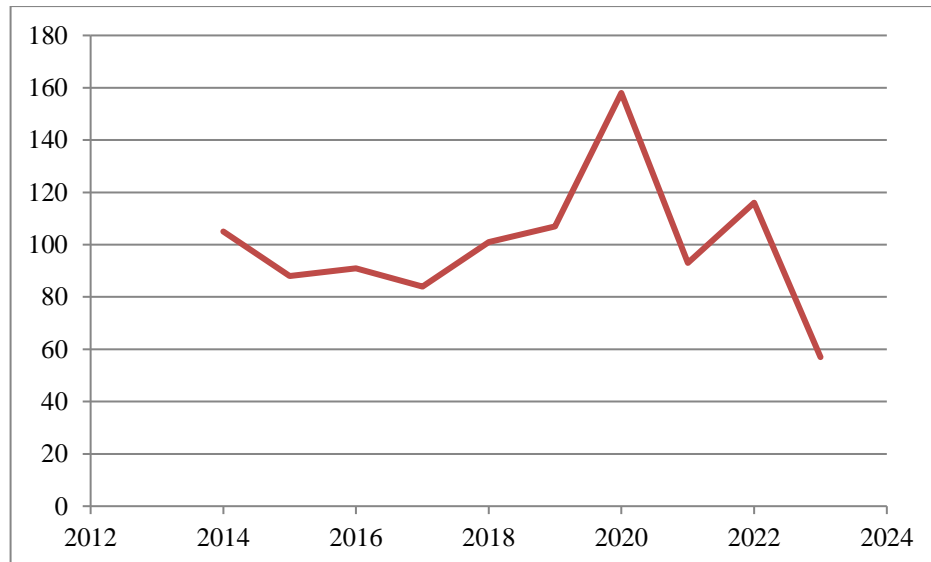
The rise of publications discussing sea toll and livestock folding containers can be traced to the year 2017 when the article titled "Comparison of Container Shipping Network Efficiency in Indonesia: Nusantara Pendulum and Sea Tollway" (Fahmiasari & Parikesit, 2017) was published. The evolution of publications related to sea toll and livestock folding containers from



2014 to 2023 is depicted in Figure 1. According to Crossref data, a total of 1000 documents were identified throughout this timeframe.

Figure 1

Publication Developments trends of research topics



From 2015 to 2017, there was a decline in the number of publications, falling below 100 documents. During this phase, numerous researchers concentrated on the initial challenges encountered by sea toll, as it was in its early stages of development and gaining global attention. Nevertheless, as time progressed, there was a gradual increase in publications discussing sea toll and livestock folding containers. This is evident from the notable surge in publications, particularly in the years 2019 to 2020.

4.2 TOP RESEARCH

From 2014 to 2023, according to Crossref metadata, among the 1000 identified publications, journal articles were the predominant source, accounting for the majority (58.7%) of contributions. This significant contribution has played a crucial role in advancing research within this field.



Table 1

Publication Type

Document Type	Documents	Percentage(%)
journal-article	587	58.7
book-chapter	187	18.7
proceedings-article	70	7
reference-entry	56	5.6
report	35	3.5
book	11	1.1
peer-review	11	1.1
component	11	1.1
posted-content	10	1
proceedings	5	0.5
monograph	5	0.5
other	5	0.5
edited-book	2	0.2
journal-issue	1	0.1
book-part	1	0.1
reference-book	1	0.1
dataset	1	0.1
database	1	0.1

Referring to **Table 1**, it is evident that journal articles, comprising 587 publications, represent the majority at 58.7%. Book chapters follow with 187 publications, contributing 18.7%, while proceedings articles contribute 70 publications, accounting for 7%. Reference entries constitute 56 publications (5.6%), reports contribute 35 publications (3.5%), and posted content comprises 10 publications (1%). Edited books account for 2 publications (0.2%), and publications categorized under book, peer-review, and component total 11 publications (1.1%). Proceedings, monograph, and other publications amount to 5 (0.5%), while journal issues, book parts, reference books, datasets, and databases contribute 1 publication (0.1%). This distribution highlights that researchers predominantly utilize journal articles and book chapters as the primary means to communicate their study results, thoughts, and opinions on this subject.

4.3 INFLUENTIAL COUNTRIES

The generation of academic papers is often viewed as a signal of the advancement of a scientific field (Wang et al., 2019). Variations in publication numbers can signify the evolution or shifts in research endeavors (Chen, 2013). Utilizing data from Crossref, a total of 56 countries made contributions between 2014 and 2023. Table 2 outlines the ranking of 55 countries based on their contributions to publications. The top 10 countries with the most substantial contributions are as follows: The United Kingdom (299 publications) leads in the number of publications, followed by the United States (148 publications), Denmark (84 publications),



China (76 publications), Spain (46 publications), India (41 publications), Indonesia (40 publications), Germany (27 publications), Russia (25 publications), and France (22 publications). Based on these figures, the United Kingdom (UK) stands out as the primary contributor to publications, playing a substantial role in the exploration of sea toll and livestock folding container studies. This prominence is evident through the significant volume of publications.

Table 2

Country Rankings by Number of Publications

No	Country	Documents	No	Country	Documents
1	UK	299	29	Argentina	2
2	USA	148	30	Bangladesh	2
3	Denmark	84	31	Croatia	2
4	China	76	32	Estonia	2
5	Spain	46	33	Mexico	2
6	India	41	34	New Zealand	2
7	Indonesia	40	35	Nigeria	2
8	Germany	27	36	Pakistan	2
9	Rusia	25	37	Portugal	2
10	France	22	38	Romania	2
11	Poland	21	39	Saudi Arabia	2
12	Turkey	15	40	Slovenia	2
13	Korea	14	41	Tanzania	2
14	Japan	13	42	Thailand	2
15	Australia	12	43	Armenia	1
16	Canada	11	44	Belgium	1
17	Italy	10	45	Bhutan	1
18	Netherland	9	46	Brasil	1
19	Ukraine	8	47	Colombia	1
20	Singapore	7	48	Eritrea	1
21	Egypt	5	49	Ethiopia	1
22	Iran	4	50	Georgia	1
23	Norway	4	51	Greek	1
24	Srilanka	4	52	Kenya	1
25	Switzerland	4	53	Senegal	1
26	Chile	3	54	Serbia	1
27	Hongkong	3	55	Slovak Republic	1
28	Hungary	3	56	Swedia	1

4.4 AUTHOR CONTRIBUTIONS

The assessment of authors' contributions employed co-authorship analysis, treating authors as the unit of analysis and employing the full counting calculation method. A threshold



was set, requiring a minimum of 5 documents authored by an individual and a minimum of 5 citations received by an author.

Based on the authorship mapping (Figure 2), 18 clusters comprising 22 authors were identified. Each cluster is distinguished by its own color. The top 10 contributors are David C. Barret (45 documents), April Taylor (20 documents), David Rendle (12 documents), Ricard Laven (11 documents), and David Barret (10 documents), James Breen (10 documents), Peter de Tender (8 documents), John Carr (7 documents), Russel Parker (7 documents), and Liu Yuan (6 documents). The top 10 authors with the highest number of citations are Stephen C Bishop (124 citations), Saber Qanbari (109 citations), Amir Hossein Gharehgozli (108 citations), Dusan Ku (60 citations), S.C. McClelland (55 citations), Craig Martin (47 citations), Hui Zhao (45 citations), Carolina Figueroa (35 citations), K.A. Saravanan (33 citations), and Morten Svindland (32 citations).

Figure 2

Authorship Network Visualization

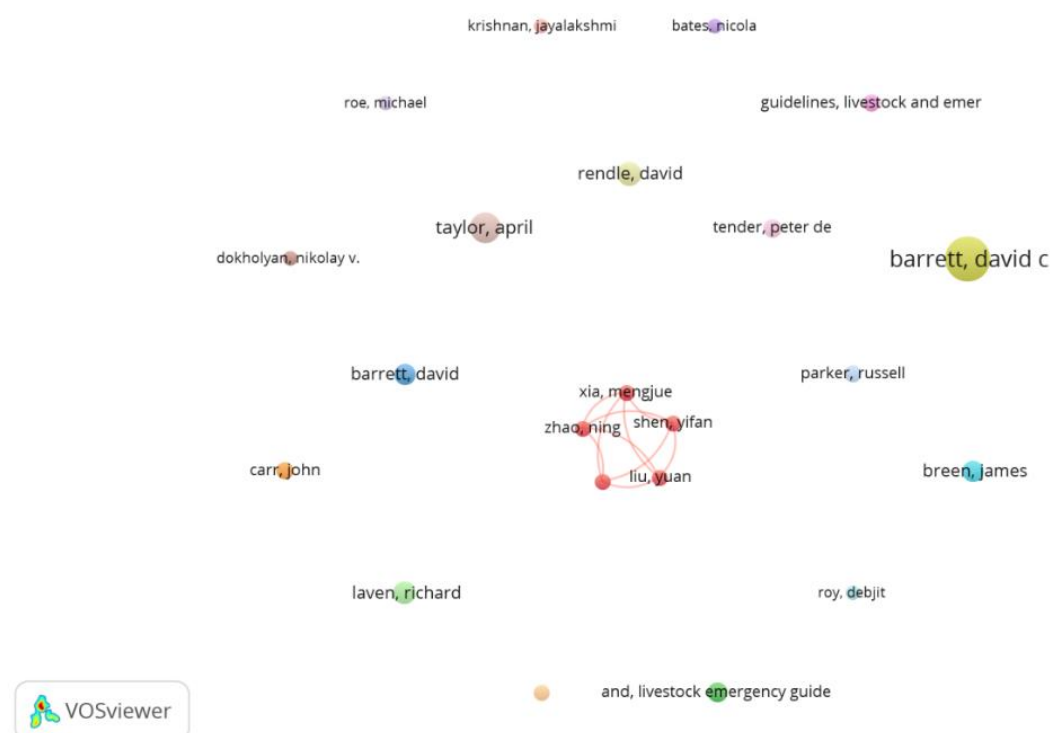


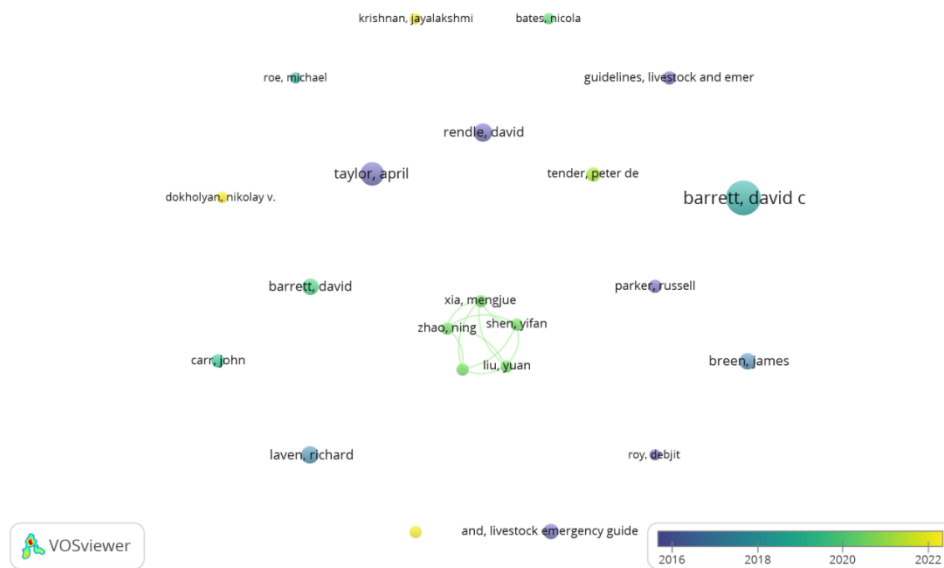
Figure 2. displays the outcomes of the overlay visualization mapping conducted by the authors. In the illustration, the node's color intensity signifies the age of the literature, with darker shades indicating older publications, while brighter yellow hues represent more recent



ones. The sequence commences with April Taylor, followed by David Rendle and Russel Parker, and publications associated with this field have been steadily expanding up to the present day.

Figure 3

Authorship Overlay Visualization



4.5 REFERENCES WITH STRONGEST CITATION

The count of citations for publications related to research themes exhibits a consistent increase annually. Utilizing the dataset spanning the observation years (2014–2023), we identified 20 documents that garnered the highest citation numbers, as illustrated in Table 3. Among the countries of origin for these top-cited publications, the United Kingdom, China, Germany, and Hong Kong each contributed 3, 3, 3, and 2 documents, respectively. Additionally, the United States, the Netherlands, New Zealand, Norway, Chile, Turkey, Japan, India, and Nigeria were represented with one document each.



Table 3

Top 20 References with Strongest Citation

Document	Publication Year	Country	Total Citations
Genomics and disease resistance studies in livestock (Bishop & Woolliams, 2014)	2014	UK	124
Mapping signatures of positive selection in the genome of livestock (Qanbari & Simianer, 2014)	2014	Germany	109
Sea container terminals: New technologies and OR models (Gharehgozli et al., 2016)	2015	Netherlands	108
Container relocation problem with time windows for container departure (Ku & Arthanari, 2016)	2016	New Zealand	60
Type and number of environmental impact categories used in livestock life cycle assessment: A systematic review (McClelland et al., 2018)	2018	USA	55
shipping container (Martin, 2016)	2016	UK	47
Study on China-EU container shipping network in the context of Northern Sea Route (Zhao et al., 2016)	2016	China	45
Coinfection takes its toll: Sea lice override the protective effects of vaccination against a bacterial pathogen in Atlantic salmon (Figueroa et al., 2017)	2017	Chile	35
Selection signatures in livestock genome: A review of concepts, approaches and applications (Saravanan et al., 2020)	2020	India	33
The environmental effects of emission control area regulations on short sea shipping in Northern Europe: The case of container feeder vessels (Svindland, 2018)	2018	Norway	32
Economic feasibility of an NSR/SCR-combined container service on the Asia-Europe lane: a new approach dynamically considering sea ice extent (Xu et al., 2018)	2018	Hongkong	30
LNG-fuelled container ship sailing on the Arctic Sea: Economic and emission assessment (Xu & Yang, 2020)	2020	Hongkong	29
Perceptions of antibiotic use in livestock farming in Germany, Italy and the United States (Busch et al., 2020)	2020	Germany	29
Scheduling of container-handling equipment during the loading process at an automated container terminal (Luo & Wu, 2020)	2020	UK	28
Berth allocation in container terminals that service feeder ships and deep-sea vessels (Emde & Boysen, 2016)	2016	Germany	26
Haematological changes and plasma fluid dynamics in livestock during thermal stress, and response to mitigative measures (Habibu et al., 2018)	2018	Nigeria	25
The feeder network design problem: Application to container services in the Black Sea region (Polat et al., 2014)	2014	Turki	24
Energy-Saving Potential and an Economic Feasibility Analysis for an Arctic Route between Shanghai and Rotterdam: Case Study from China's Largest Container Sea Freight Operator (Wan et al 2018)	2018	China	24
Combinable containers: A container innovation to save container fleet and empty container repositioning costs (Shintani et al., 2019)	2019	Japan	23
A simulation optimization method for deep-sea vessel berth planning and feeder arrival scheduling at a container port (Jia et al., 2020)	2020	China	23

From the citation counts presented in Table 3, it is evident that the exploration of livestock remains a compelling area of study, drawing considerable attention from numerous researchers. Similarly, the discourse on sea containers has also attracted substantial interest, as indicated by



the significant number of citations associated with titles delving into this topic. Examples include "*Genomics and disease resistance studies in livestock*" (Bishop & Woolliams, 2014) accruing 124 citations, "*Mapping signatures of positive selection in the genome of livestock*" (Qanbari & Simianer, 2014) garnering 109 citations, and "*Sea container terminals: New technologies and OR models*" (Gharehgozli et al., 2016) receiving 108 citations.

4.6 MAIN SUBJECT AREA OF RESEARCH

This article examines five research subjects within the field, namely transportation, animal husbandry, economics, industrial engineering, and others. Table 4 provides an overview of the number of publications and the corresponding percentage contributions associated with each subject area. From 2014 to 2023, the predominant subject areas in publications addressing sea toll and livestock folding containers were animal husbandry, contributing 398 documents, followed by transportation research with 174 documents, others with 308 documents, economics with 62 documents, and industrial engineering subjects with 58 documents.

Table 4

Subject of Research Area

Subject Area	%
animal husbandry	39,8
transportation	17,4
others	30,8
economics	6,2
industrial engineering	5,8

The distribution of subject areas contributing to publications relevant to sea toll and livestock folding containers indicates that animal husbandry constitutes the largest proportion at 39.8%, succeeded by others at 30.8%, transportation research at 17.4%, economics at 6.2%, and industrial engineering at 5.8%. This situation underscores the potential to explore additional opportunities for studies by employing various perspectives, scenarios, and approaches from different scientific fields.

4.7 MAJOR RESEARCH AREAS (ANALYSIS OF KEYWORDS CO-OCCURRENCES)

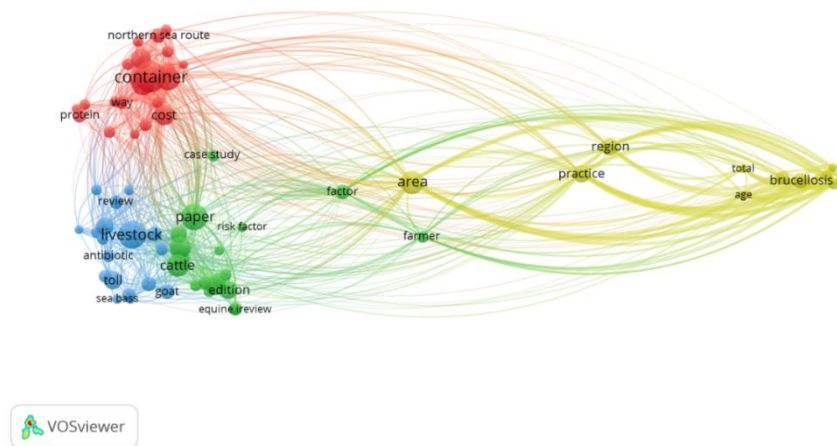
Mapping all keywords can offer an overview of the primary research areas investigated (Wuni et al., 2019). In this study, a total of 5893 keywords related to the sea toll and folding livestock container phase were identified. However, to conclude the research, the number of



keywords was constrained using specific criteria: co-occurrence analysis, full counting calculations, considering all keywords as an analytical unit (Oraee et al., 2017)(Jin et al., 2018)(Hosseini et al., 2018), and employing a keyword occurrence threshold of 10. Following these parameters, 70 keywords meeting these criteria were identified and organized into four clusters, as illustrated in Figure 4.

Figure 4

Keyword – Network Visualization



As depicted in Figure 4, cluster 1 encompasses a set of 22 elements, including abstract, cargo, competitiveness, container, container transportation, cost, demand, influence, northern sea route, organization, port, protein, protein folding, sea toll, sea transport, ship, simulation, size, transportation, vessel, way, and world. Meanwhile, cluster 2 comprises 19 elements, such as calf, case study, cattle, cattle review, control, cow, edition, equine review, factor, farm, farmer, lameness, management, paper, risk factor, and veterinary surgeon. Cluster 3 is made up of 18 items, including antibiotic, Australia, climate change, environment, exposure, genome editing, goat, livestock, plant, production, receptor, review, sea bass, sheep, toll, treatment, water, and welfare. Finally, cluster 4 consists of 11 items, including age, area, brucellosis, comprehensive knowledge, Eritrea, good practice, knowledge, livestock owner, practice, region, and total.



Figure 5

Keyword – Overlay Visualization

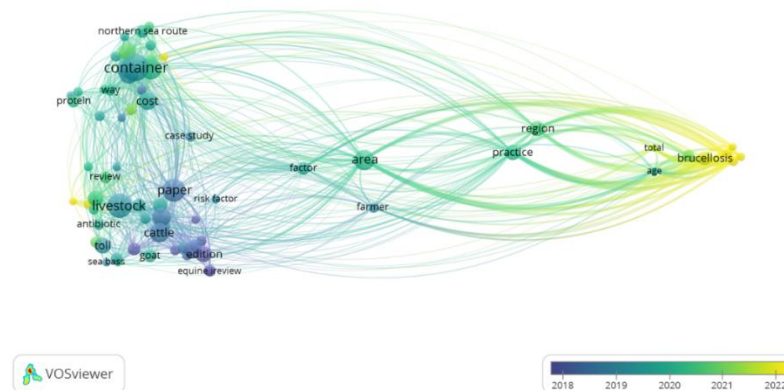


Figure 5 shows the development of keywords within the period of 2014–2023. In the early years (2014–2019), major research areas were around cattle review, edition, equine review, calf, treatment, management, paper, veterinary surgeon, lameness, and size. In the middle period (2019–2021), many studies on livestock, farm, container, ship, toll, sea bass, case study, risk factor, welfare, control, sea transport, cost, vessel, sheep and plant were conducted. Meanwhile, in the last few years (2021–2022), the research areas began to move towards area, port, transportation, practice, region, brucellosis, climate change, genome editing, transportation, organization, way, competitiveness, water, world, region, practice, comprehensive knowledge, good practice and livestock owner.

In this research, the primary research areas are categorized into three groups based on the frequency of keyword occurrences (Table 5). The first group, Group 1, comprises keywords frequently used with an occurrence level $X > 26$. Group 2 represents a medium category with keyword occurrences falling within the range of $15 < X < 27$. Group 3 encompasses keywords categorized as rarely used, specifically those with occurrences of $X < 16$.

Group 1, designated as the frequent category, encompasses 24 keywords, including container, livestock, paper, port, area, ship, cattle, management, vessel, transportation, cost, cattle review, edition, toll, production, farm, region, practice, control, brucellosis, container transportation, goat, sheep, and treatment. Group 2, classified as the medium category, comprises keywords commonly found in the literature, such as northern sea route, factor, cattle review, protein, equine review, knowledge, plant, review, receptor, cow, way, calf, case study, farmer, lameness, antibiotic, environment, sea toll, cattle review, welfare, demand, influence, world, comprehensive knowledge, and livestock owner. Lastly, Group 3, categorized as the rare category, includes keywords like abstract, cargo, competitiveness, equine review, water,



simulation, size, genome editing, protein folding, age, sea transport, risk factor, veterinary surgeon, Australia, sea bass, good practice, organization, climate change, exposure, total, and Eritrea.

Table 5

Keyword Grouping

Keyword	Occurrences (X > 26)	Total Link Strength	Keyword	Occurrences (15 < X < 27)	Total Link Strength	Keyword	Occurrences (X < 16)	Total Link Strength
container	117	384	northern sea route	26	178	livestock owner	16	726
livestock	94	420	factor	26	279	abstract	15	145
paper	86	430	cattle ireview	25	98	cargo	15	144
port	73	331	protein	24	39	competitivenes	15	165
area	67	910	equine review	24	63	equine ireview	15	45
ship	62	346	knowledge	24	826	water	15	178
cattle	61	278	plant	23	179	simulation	14	82
management	55	218	review	23	105	size	14	92
vessel	52	294	receptor	21	45	genome editing	14	164
transportation	51	524	cow	20	76	protein folding	13	34
cost	50	356	way	19	180	age	13	461
cattle review	45	160	calf	18	49	sea transport	12	125
edition	44	148	case study	18	57	risk factor	12	59
toll	43	83	farmer	18	220	veterinary surgeon	12	32
production	40	239	lameness	18	128	australia	12	90
farm	38	186	antibiotic	18	150	sea bass	12	34
region	37	701	environment	18	178	good practice	12	588
practice	36	865	sea toll	17	156	organization	11	112
control	34	206	cattleireview	17	54	climate change	11	131
brucellosis	32	1298	welfare	17	115	exposure	11	101
container transportation	30	323	demand	16	126	total	11	324
goat	27	176	influence	16	98	eritrea	10	456
sheep	27	188	world	16	142			
treatment	27	171	comprehensive knowledge	16	762			

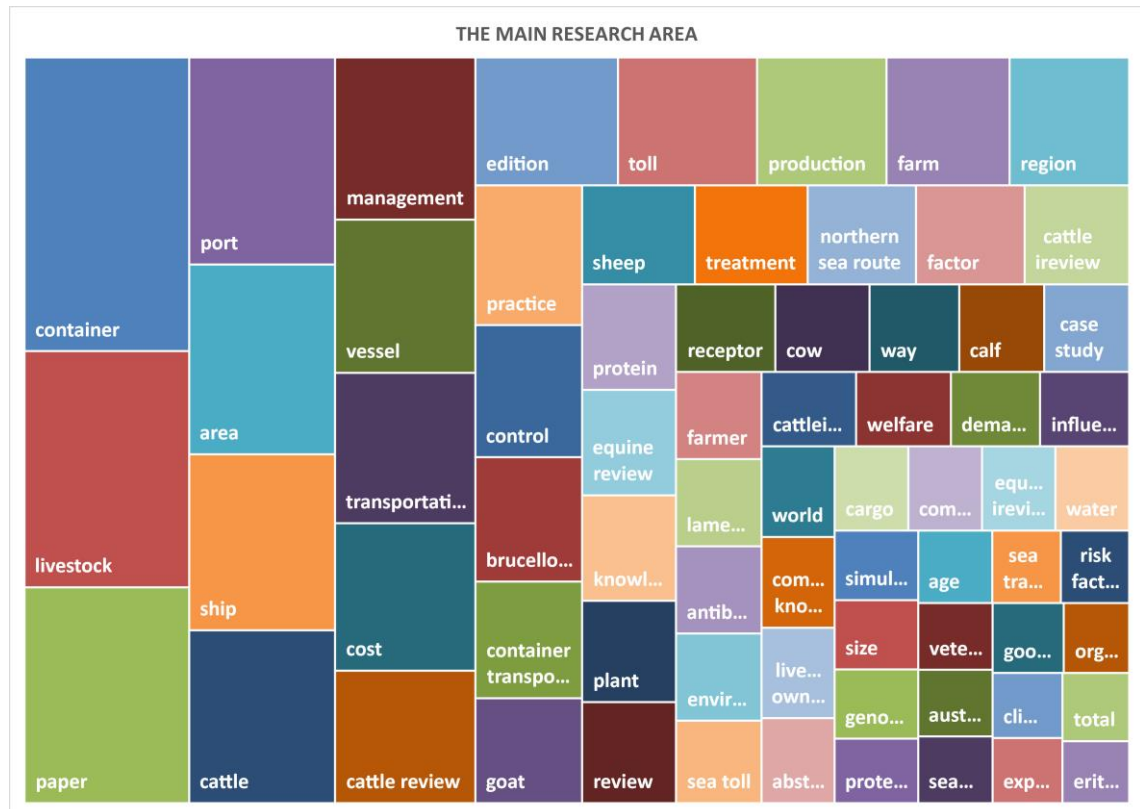
Figure 6 illustrates a tree map depicting the primary research areas. Container, livestock, paper, port, and area emerge as the focal points that attract a substantial and increasing share of attention in discussions related to sea toll and livestock folding containers. In contrast, research areas such as organization, climate change, exposure, total, and Eritrea appear to be underdeveloped or garner a comparatively smaller proportion of attention during the observed period. The core research theme is constructed by utilizing information from the categorization of keywords, determined through the division into groups and the representation in the column chart. The proportion of research keywords is assessed by considering the frequency with which



scholars employ them in their studies, categorized as frequent, medium, or rarely used. One of the objectives of this study is to encourage the emergence of new research endeavors to complement existing studies, facilitating the ongoing advancement of the research area and the identification and resolution of existing gaps (Retno et al., 2021).

Figure 6

Tree Map Main Research Area



5 CONCLUSION

The science mapping process spanning from 2014 to 2023 has identified 1000 publications related to sea toll and folding livestock containers, predominantly in journal articles, book chapters, and proceedings articles. These contributions originate from 56 countries, with the United Kingdom, the USA, and Denmark leading in publication output. Notable authors include David C. Barret, April Taylor, and David Rendle, while highly cited publications focus on genomics in livestock, positive selection mapping, and advancements in sea container terminals. Research areas primarily concentrate on animal husbandry, transportation, and economics, with keyword analysis revealing shifts in focus over time. The study underscores the need for further advancement in understanding the transportation model



for livestock folding container ships supporting sea tolls, offering valuable insights and paving the way for future research to address existing gaps in the literature. Limitations include a restricted depth of analysis and reliance on Google Scholar as the primary data source.

REFERENCES

- Ahn, J., Sinka, M., Irish, S., & Zohdy, S. (2023). Modeling marine cargo traffic to identify countries in Africa with greatest risk of invasion by *Anopheles stephensi*. *Scientific Reports*, 13(1), 1–12. <https://doi.org/10.1038/s41598-023-27439-0>
- Ariyatun, Sudarmin, Wardani, S., Saptono, S., & Winarto. (2024). Bibliometric Analysis of Environmental Literacy in Sustainable Development : A Comprehensive Review Based on Scopus Data From 2013 to 2023. *International Journal of Educational Methodology*, 10(1), 979–995.
- Bishop, S. C. & Woolliams, J. A. (2014). Genomics and disease resistance studies in livestock. *Livestock science*, 166, 190-198.
- Bongomin, O., Yemane, A., Kembabazi, B., Malanda, C., Chikonkolo Mwape, M., Sheron Mpfu, N., & Tigalana, D. (2020). Industry 4.0 Disruption and Its Neologisms in Major Industrial Sectors: A State of the Art. *Journal of Engineering (United Kingdom)*, 2020. <https://doi.org/10.1155/2020/8090521>
- Busch, G., Kassas, B., Palma, M. A., & Risius, A. (2020). Perceptions of antibiotic use in livestock farming in Germany, Italy and the United States. *Livestock Science*, 241, 104251.
- C. Chen. (2013). "Mapping Scientific Frontiers : The Quest for Knowledge Visualization". Second, vol. 9781447151, no. Springer-Verlag London Ltd.
- D. Soedarno, B. Ranti and W. S. Nugroho. (2020). "Use of Physical Internet System to Increase Effectiveness of Sea Toll Logistics Operations in Indonesia". 6th International Conference on Interactive Digital Media (ICIDM). Bandung. Indonesia. pp. 1-6, doi: 10.1109/ICIDM51048.2020.9339641.
- D. P. Retno, M. A. Wibowo, and J. U. D. Hatmoko. (2021). "Science Mapping of Sustainable Green Building Operation and Maintenance Management Research," *Civ. Eng. Archit.*, vol. 9, no. No.1, pp. 150–165.
- Du, S., Zhang, H., & Kong, Y. (2023). Sustainability Implications of the Arctic Shipping Route for Shanghai Port Logistics in the Post-Pandemic Era. *Sustainability*, 15(22), 16017. <https://doi.org/10.3390/su152216017>
- Emde, S., & Boysen, N. (2016). Berth allocation in container terminals that service feeder ships and deep-sea vessels. *Journal of the Operational Research Society*, 67(4), 551-563.
- Fahmiasari, H. & Parikesit, D. (2017). Container shipping network efficiency comparison in Indonesia: Nusantara Pendulum and Sea Tollway. *The Asian Journal of Shipping and Logistics*, 33(2), 79-84.
- Figuerola, C., Bustos, P., Torrealba, D., Dixon, B., Soto, C., Conejeros, P. & Gallardo, J. A.



- (2017). Coinfection takes its toll: Sea lice override the protective effects of vaccination against a bacterial pathogen in Atlantic salmon. *Scientific reports*, 7(1), 17817.
- Garg, V. K., Yadav, Y. K., Sheoran, A., Chand, S., & Kaushik, P. (2006). Livestock excreta management through vermicomposting using an epigeic earthworm *Eisenia foetida*. *Environmentalist*, 26(4), 269–276. <https://doi.org/10.1007/s10669-006-8641-z>
- Gharehgozli, A. H., Roy, D., & De Koster, R. (2016). Sea container terminals: New technologies and OR models. *Maritime Economics & Logistics*, 18, 103-140.
- Habibu, B., Dzenda, T., Ayo, J. O., Yaqub, L. S., & Kawu, M. U. (2018). Haematological changes and plasma fluid dynamics in livestock during thermal stress, and response to mitigative measures. *Livestock Science*, 214, 189-201.
- I. Y. Wuni, G. Q. P. Shen, and O.-K. R. (2019). “Scientometric Review of Global Research Trend on Green Buildings in Construction Journals from 1992 to 2018,” *Energy Build.*, vol. 190, pp. 69–85.
- Jia, S., Li, C. L., & Xu, Z. (2020). A simulation optimization method for deep-sea vessel berth planning and feeder arrival scheduling at a container port. *Transportation Research Part B: Methodological*, 142, 174-196.
- Ku, D., & Arthanari, T. S. (2016). Container relocation problem with time windows for container departure. *European Journal of Operational Research*, 252(3), 1031-1039.
- Luo, J., & Wu, Y. (2020). Scheduling of container-handling equipment during the loading process at an automated container terminal. *Computers & Industrial Engineering*, 149, 106848.
- Martin, C. (2016). *Shipping container*. Bloomsbury Publishing USA.
- McClelland, S. C., Arndt, C., Gordon, D. R., & Thoma, G. (2018). Type and number of environmental impact categories used in livestock life cycle assessment: A systematic review. *Livestock Science*, 209, 39-45.
- Miranda-de la Lama, G. C., Villarroel, M., & María, G. A. (2014). Livestock transport from the perspective of the pre-slaughter logistic chain: A review. *Meat Science*, 98(1), 9–20. <https://doi.org/10.1016/j.meatsci.2014.04.005>
- M. J. Cobo, A. G. Lopez-Herrera, E. Herrera-Viedma, and F. Herrera. (2011). “Science Mapping Software Tools: Review, Analysis, and Cooperative Study Among Tools,” *J. Am. Soc. Inf. Sci. Technol.*, vol. 62, no. 7, pp. 1382–1402.
- M. Oraee, M. R. Hosseini, E. Papadonikolaki, R. Palliyaguru, and M. Arashpour. (2017). “Collaboration in BIM-based construction networks: A Bibliometric-qualitative Literature Review,” *Int. J. Proj. Manag.*, vol. 35, no. 7, pp. 1288–1301.
- M. P. R. Bolivar, L. A. Munoz, and M. J. Cobo. (2018). “Analyzing the Scientific Evolution and Impact of e-Participation Research in JCR Journals Using Science Mapping,” *Int. J. Information Manag.*, vol. 40, pp. 111–119.
- M. R. Hosseini, I. Martek, E. K. Zavadskas, A. A. Aibinu, M. Arashpour, and N. Chileshe.



- (2018). "Critical Evaluation of Off-site Construction Research: A Scientometric Analysis," *Autom. Constr.*, vol. 87, pp. 235–247, 2018.
- M. Wang, P. Liu, Z. Gu, H. Cheng, and X. Li. (2019). "A Scientometric Review of Resource Recycling Industry." *Int. J. Environ. Res. Public Health*, vol. 16, no. 23.
- N. J. van Eck and L. Waltman. (2017). *VOSviewer Manual*. Netherland: Universiteit Leiden.
- Ojala, J., & Tenold, S. (2017). Maritime trade and merchant shipping: The shipping/trade ratio since the 1870s. *International Journal of Maritime History*, 29(4), 838–854. <https://doi.org/10.1177/0843871417724692>
- Oladipo Olugbenga Adekoya, Adedayo Adefemi, Olawe Alaba Tula, Aniekan Akpan Umoh, & Joachim Osheyor Gidiagba. (2024). A comprehensive review of Liquefied Natural Gas (LNG) market dynamics: Analyzing the current trends, challenges, and opportunities in the global LNG market. *World Journal of Advanced Research and Reviews*, 21(1), 058–074. <https://doi.org/10.30574/wjarr.2024.21.1.2686>
- Pedrazzani, A. S., Cozer, N., Quintiliano, M. H., Tavares, C. P. dos S., da Silva, U. de A. T., & Ostrensky, A. (2023). Non-Invasive Methods for Assessing the Welfare of Farmed White-Leg Shrimp (*Penaeus vannamei*). *Animals*, 13(5), 1–31. <https://doi.org/10.3390/ani13050807>
- Polat, O., Günther, H. O., & Kulak, O. (2014). The feeder network design problem: Application to container services in the Black Sea region. *Maritime Economics & Logistics*, 16, 343–369.
- Qanbari, S. & Simianer, H. (2014). Mapping signatures of positive selection in the genome of livestock. *Livestock science*, 166, 133–143.
- Rodrigue, J. P., & Notteboom, T. (2012). Dry ports in European and North American intermodal rail systems: Two of a kind? *Research in Transportation Business and Management*, 5, 4–15. <https://doi.org/10.1016/j.rtbm.2012.10.003>
- R. Jin, S. Gao, A. Cheshmehzangi, and E. Aboagye-Nimo. (2018). "A Holistic Review of Off-site Construction Literature Published Between 2008 and 2018," *J. Clean Prod.*, vol. 202, no. pp. 1202–1219.
- Saravanan, K. A., Panigrahi, M., Kumar, H., Bhushan, B., Dutt, T. & Mishra, B. P. (2020). Selection signatures in livestock genome: A review of concepts, approaches and applications. *Livestock Science*, 241, 104257.
- Shintani, K., Konings, R., & Imai, A. (2019). Combinable containers: A container innovation to save container fleet and empty container repositioning costs. *Transportation Research Part E: Logistics and Transportation Review*, 130, 248–272.
- Subiyantoro, C. & Achmadi, I. T. (2016). Pengembangan Desain Peti Kemas Konvensional Menjadi Peti Kemas Lipat Khusus untuk Alat Angkut Sapi. Institut Teknologi Sepuluh Nopember Surabaya.
- Svindland, M. (2018). The environmental effects of emission control area regulations on short sea shipping in Northern Europe: The case of container feeder vessels. *Transportation*



Research Part D: Transport and Environment, 61, 423-430.

Wan, Z., Ge, J., & Chen, J. (2018). Energy-saving potential and an economic feasibility analysis for an Arctic route between Shanghai and Rotterdam: Case study from China's largest container sea freight operator. *Sustainability*, 10(4), 921.

Xu, H. & Yang, D. (2020). LNG-fuelled container ship sailing on the Arctic Sea: Economic and emission assessment. *Transportation Research Part D: Transport and Environment*, 87, 102556.

Xu, H. Yang, D. & Weng, J. (2018). Economic feasibility of an NSR/SCR-combined container service on the Asia-Europe lane: a new approach dynamically considering sea ice extent. *Maritime Policy & Management*, 45(4), 514-529.

Zhao, H. Hu, H. & Lin, Y. (2016). Study on China-EU container shipping network in the context of Northern Sea Route. *Journal of Transport Geography*, 53, 50-60.