Systematic Review of Literature on Dry Port - Concept Evolution

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Dry port plays an important role in supply chain management and mitigates seaport problems. The aim of this paper is to review the dry port concept over the different phases. Today there are different types of dry ports, different interpretations on the dry port life cycle, and different relations with seaport. We will provide a clear vision on the concept development and the advantages that can be added to the seaport and transportation flow. Then, the study will show the evolution of the research community interest on the concept. In the first step, we will briefly present all the challenges faced by seaports today. Next, we will undertake a systematic literature review in order to provide a global vision able to answer questions concerning dry port concept, types, research evolution. Finally, we will present some research topics that open for us at the dry port seaport system.

KEY WORDS
~ Dry port
~ Seaport
~ Multimodal transport
~ Logistic
~ Systematic literature review
~ Inland port

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1. INTRODUCTION

Since the 1970s, the world has experienced an acceleration of interconnections between the different geographical zones of the world. Today it can be defined with the concept of globalisation. It summarizes all flows, capitals, information, technology and goods beyond the national level to form an interconnected global network (Hirst et al., 2009). The global economy today has broken several geographical, technological and political barriers, and gives the global supply chain the capability to be developed in a remarkable way, and to open a new dimension such as the internationalisation of industrial production. As the world has changed since 1970, the international market is becoming increasingly global because of many factors such as the positive evolution of the world economy and the internationalisation of industrial production (UNCTAD, 2018). This is subsequently reflected in the growing demand for the maritime transport services, which has also experienced an unprecedented evolution, as shown in Figure 1 (UNCTAD, 2018), by pushing the maritime transport structure to cope with the global economy (Haralambides and Gujar, 2011).

For this reason, the structure of maritime transport has gone through several transitional phases. One of the most significant phases is containerisation concept emergence, which has clearly contributed to the evolution of maritime transport (Berg and Langen, 2015).

Following the growth of the world economy, the volume of merchandise transported by sea is increasing every year (Figure 1). This can amplify the seaport challenges like the increasing difficulty of container management, lack of space, congestion at seaports access points, and negative environmental impacts.

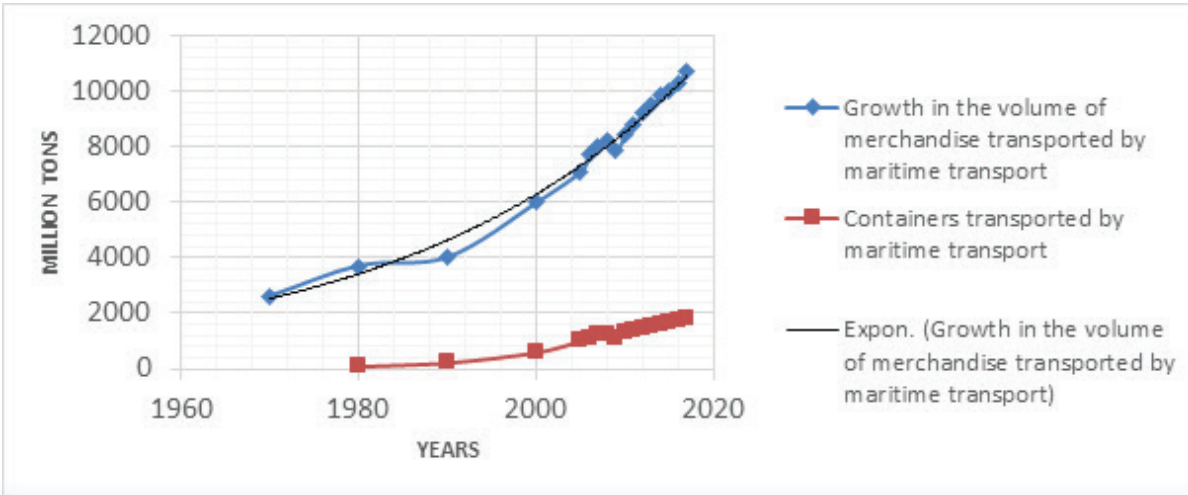

Figure 1.
Maritime transport services evolution (UNCTAD, 2018).

In the remainder of this paper, Section 2 presents an overview of seaport challenges. Dry port concept is defined in Section 3. In Section 4, we propose a systematic literature review in order to give a global vision about the concept development. The results of the research development are presented in Section 5. The concluding remarks and discussion are provided in Section 6.

2. AN OVERVIEW OF SEAPORT CHALLENGES

The seaport is the most important node in the international transportation chain. In general, with the growth of the world economy, the demand for the maritime transport services is increasing considerably (Figure 1), which raises challenges for the seaport.

As a result, it is normal to bring more importance on seaport evolution which becomes more and more critical (Mabrouki et al., 2014). Dry port existence has become a solution for seaport problems. Thus, dry port performance is linked to the seaport performance and with a large vision is linked to the dry port-seaport system (Bentaleb et al., 2015a).

In other words, the understanding of the seaport challenges leads us to recognise the dry port necessity and functioning. In Table 1, the most important seaport challenges are listed.

The critical role that seaport plays in the global supply chain requires an adequate solution to optimize the performance of its services in order to overcome these challenges (Table 1). Dry port can improve significantly the performance of the seaport. Therefore, the performance of the dry port seaport system raises (Bentaleb et al., 2015a). Consequently, in order to increase seaport performance, we need to develop more the dry port concept. It represents an intermodal terminal directly connected to the seaport, with high-capacity means of transport, where customers can leave/pick up their goods as if heading directly to a seaport (Roso et al., 2009; Wiegmans et al., 2015). This gives us a relevant solution for optimising seaport services and transforming it to a more efficient system such as the seaport dry port system.

The main purpose of this systematic literature review is to have a global vision of the dry port concept, and its advantages that can increase the efficiency of the seaport services and the whole transportation chain. We propose to achieve this objective by answering the following questions:

- What are the existing definitions of dry port concept?
- How has the dry port concept evolved over time?
- What are the functions and actors of dry port?
- What are the advantages provided by the seaport dry port system?
- How has the research on the concept of dry port developed?
- What are the methods that research focuses on when it deals with the dry port concept?
- Which countries are interested in the dry port concept and how?
- What are the journals and authors interested in the concept of the dry port?

Answering these questions will allow a deep understanding of e.g. dry port concept, role, functions, importance, interactions, and stakeholders.

Table 1.
The most significant seaport challenges.

Seaport challenges	Causes
The difficulties of managing goods today	- The growth of the world economy (Hirst et al., 2009). - The evolution of maritime traffic (UNCTAD, 2018).
Lack of space	- The steady increase in the volume of merchandise trade (UNCTAD, 2018). - The increase in containerisation and its negative effects such as the increase of the containers' number in distress (Berg and Langen, 2015; UNCTAD, 2018). - Urban growth at the entourage of seaports, which prevents seaport expansion. (Hanaoka and Regmi, 2011) -The different types of goods handled add their effect on the layout: The separation of different types of goods for safety purposes (dangerous goods and zones without dangerous goods), reefer containers, etc. (Santarremigia et al., 2018) -The higher these types of goods in a terminal, the lower are the space for other goods: containers with dangerous goods cannot be stacked as high as non-dangerous containers, and the same happens with empty containers. (Hervás-Peralta et al., 2019)
Congestion at seaport access at trucks' entrance	- The large number of containers accommodated and shipped at the same time. (Bentaleb et al., 2015b) - Loading and unloading time. - The insufficient number of access routes to the terminal service of certain seaports.
The increase of transport costs	Non-optimal management of transport flows between seaports and shippers (Lättilä et al., 2013).
Negative environmental impact	The high number of trucks that have a negative environmental impact. (Lättilä et al., 2013; Li et al., 2019; Roso, 2007).

3. DRY PORT CONCEPT

3.1. Definitions

Since the appearance of the dry port concept, researchers have mentioned several definitions with small differences that developed over time. It is e.g. the type of connection between dry port and seaport. Woxenius et al. (2004) in their definition claim the rail as the only type of connection between seaport and dry port. However, Jaržemskis and Vasiliauskas (2007) added the road as a connection in their definition. Then, Witte et al. (2019) used the waterway as a possible type of connection. Table 2 summarises the most cited definitions.

The past period of research on the dry port topic definitions have shown that the concept is visibly much more fertile than we expect.

Table 2.
The most cited definitions of dry port concept.

Source	Year	Definitions	Determinants
(UNCTAD, 1991)	1991	Dry port is located near inland from seaports. It is linked directly to seaport or, in the case of international land movement, is in contact with the sources of imports and destination of exports. Dry ports may be used either in a country that has seaports or in landlocked country, but only surface transport modes are involved in giving access to dry port.	Connected to seaport by surface transport modes.
(Woxenius et al., 2004)	2004	The dry port concept is based on a seaport directly connected with inland intermodal terminals by rail where goods in intermodal loading units can be turned in as if directly to the seaport.	Connected to seaport principally by rail.

(Jaržemskis and Vasiliauskas, 2007)	2007	A dry port is a port situated in the hinterland servicing an industrial/commercial region connected with one or several seaports by rail and/or road transport and is offering specialized services between the dry port and the transmarine destinations. Normally the dry port is containers and multimodal oriented and has all logistics facilities, which is needed for shipping and forwarding agents in a port.	Connected to seaport by rail and/or road transport and is offering specialized services.
(Roso et al., 2009)	2009	The dry port concept is based on a seaport directly connected by rail to inland intermodal terminals, where shippers can leave and/or collect their standardized units as if directly at the seaport.	Connected to seaport by rail and is offering same services as seaport.
(Ng and Girish, 2009)	2009	Dry port can be understood as an inland setting with cargo-handling facilities to allow several functions to carry out, for example, cargo consolidation and distribution, temporary storage of containers, custom clearance, connection between different transport modes, allowing agglomeration of institutions (both private and public) which facilitates the interactions between different stakeholders along the supply chain, etc.	Connected to seaport by different transport modes, allowing agglomeration of institutions both private and public.
(Witte et al., 2019)	2019	Inland ports or dry ports is an inland facility with or without an intermodal terminal and logistics companies, which is directly connected to the seaport(s) with high capacity transport mean (s) either via rail, road or inland waterways, where customers can leave/pick up their standardized units as if directly to a seaport	Connected to seaport by rail, road or inland waterways, same services as seaport.

Table 3.
Dry port advantages.

	Advantages of dry port
Seaport	Reduce congestion at access points; Facilitate inventory management; Positive influence on the cost of storage; Increase the storage capacity of goods; Facilitate and increase the speed of services.
City	Reduction of traffic congestion.
Environment	Reduction of influence of CO2 caused by emissions from trucks.
Shippers	Reduce transportation cost; Reduce storage cost; Facilitate access to seaports.
Country (society)	Develop commercial transport flows; More benefits for landlocked countries; More jobs in areas near the dry port.
Rail way companies	Diversification of the commercial offer.

3.2. Dry Port Roles

The establishment of the dry port brings a number of advantages to the seaport performance and touches upon other aspects. Table 3 sheds light on the advantages of the dry port.

As an option to decrease congestion, seaport challenges, and reduction in transportation cost, dry ports have a key role to play in advancing seaport connectivity.

3.3. Dry Port Functions

In general, the dry port functions are similar to the seaport except for the connection with the sea. They are replaced with other functions related to other transport means, essentially railway, but sometimes waterway or road are also considered. Figure 2 presents the major dry port functions.

According to Crainic et al. (2015), dry port can assume three main types within the transport chain: satellite terminal, load centre, and transhipment facility. In order for the seaport to function successfully, it is required to develop not only the seaport infrastructure, but also dry port functions.

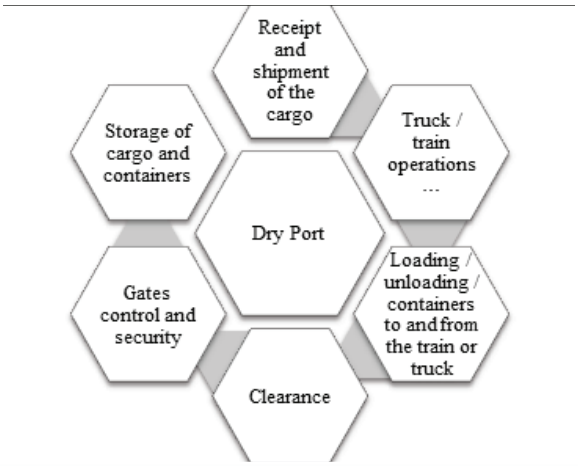

Figure 2.
Dry port functions (Hayut, 1980; Notteboom and Rodrigue, 2009; UNCTAD, 1991).

3.4. Dry Port Types

The research community distinguishes between three types of dry ports based on the distance between seaport and dry port. Thus, they are named close dry port, mid-range dry port, and distant dry port (Figure 3).

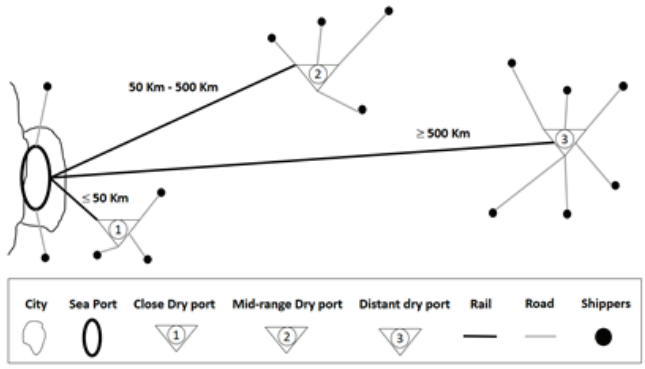

Figure 3.
Dry port types (Bask et al., 2014; Roso et al., 2009).

Each type has its own characteristics. Table 4 explains the particularities and the advantages (Crainic et al., 2015; Tsao and Thanh, 2019; Woxenius et al., 2004).

There are different dry port types that correspond to different seaport configurations. Hence, different types of dry port have been developed in different regions (Rodrigue and Notteboom, 2012; Santarremigia et al., 2018). The types of dry ports play an essential role in the development process. As shown in Table 4, there are a number of competitive advantages that dry ports can supply to maintain seaport development.

Table 4.
Dry port type particularities.

Type	Distance to seaport	Advantages
Distant dry port	More than 500 kilometres	Transhipment -Transport over long distance; -Reduce traffic congestion (Roso et al., 2009); -The distance factor plays a remarkable role on reducing the transportation costs and the negative impact on the environment. (Bask et al., 2014; Crainic et al., 2015; Roso et al., 2009; Tsao and Thanh, 2019; Woxenius et al., 2004)
Mid-range dry port	Between 50 and 500 kilometres	Load centre -Reduce transportation costs (Roso et al., 2009), -Reduce traffic congestion; -Have positive environmental impact. -Represent effective point for consolidation (Tsao and Thanh, 2019; Woxenius et al., 2004)
Close dry port	Less than 50 kilometres	Satellite terminal - Offer large storage space for seaports;(Bask et al., 2014; Crainic et al., 2015; Tsao and Thanh, 2019) - Offer greater possibilities for buffering containers around seaport to reduce local traffic (Bask et al., 2014; Tsao and Thanh, 2019) -Offer consolidation of transport flow to and from seaport. (Crainic et al., 2015)

3.5. Dry Port Life Cycle Development

In the earliest research on the dry port seaport system, the first mention of a graphic modelling of the system was in 2011, when Wilmsmeier et al. (2011) presented a model that clarifies the spatial evolution of the relation structure between the dry port and the seaport (Figure 4). This model presents two types of connections. The inside-out development begins from the dry port, and the outside-in development starts from the seaport.

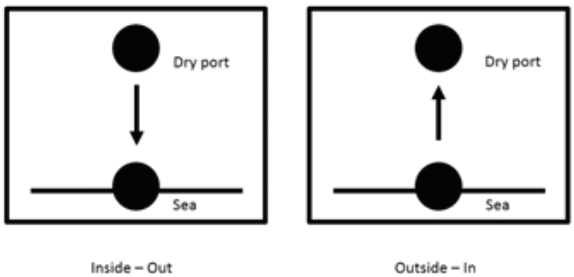

Figure 4.
Wilmsmeier et al. (2011) model.

In addition, Bask et al. (2014) linked the model of Wilmsmeier et al. (2011) with the time factor in order to give a model of three phases: 1) Pre-phase, 2) Start-up phase, and 3) Growth phase, as shown in Figure 5.

Pre-phase is the phase of the dry port creation, where several basic questions arise, e.g. Is the existence of the dry port important? Is there a robust infrastructure and strategy that supports the creation of the dry port?

Start-up phase is the opening. It is the first step in the implementation of the dry port plans. At this stage, the actors involved discuss the execution process and the investment on the direction development.

Growth phases is the development of the dry port in an operational direction, e.g. the introduction of a diversity added-value activities and the increase of relations between the actors involved.

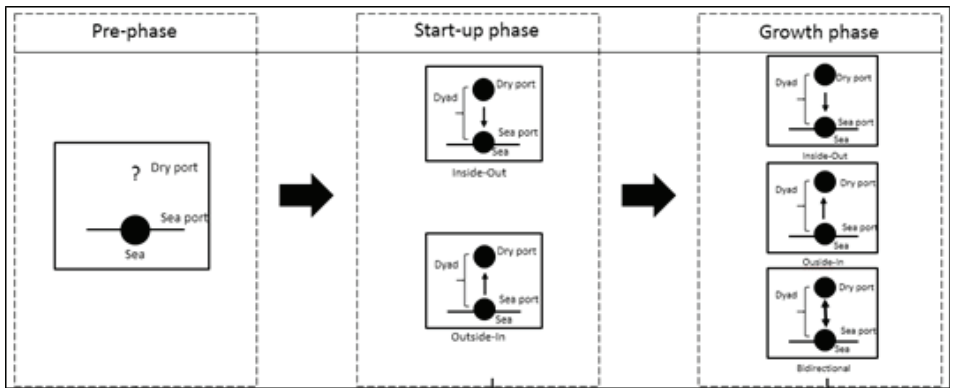

Figure 5.
Bask et al. (2014) model.

In 2016, Bentaleb et al. (2016) apply the Vernon (1966) theory of product life cycle to the dry port-seaport system, which involves a description of its phases as follows:

Development phase: The recognition of dry port in the transportation structure is prepared. The first questions asked at this stage are about the necessity of the dry port. The managers of the dry port put together an implementation plan. The plan should define the targets and goals of the dry port over the short, intermediate, and long term.

Introduction phase: The introduction of a dry port position in the transport system with some services is finished. Activities are elementary. The geographic reach is limited to the adjacent city.

Growth phase: The dry port's services increase. Standardisation and process innovation are addressed and implemented. The dedicated regions of the dry ports increase. Dry port develops in the operational direction.

Maturity phase: The dry port activity increases at a slower rate. Competition in the market augments as the number of dry ports augments. The external competition increases simultaneously and in proportion with increased maturity. This phase includes three sub-phases, i.e.:

Sub-phase (4.1): inside-out or outside-in (the case of one seaport with many dry ports). In this sub-phase, we witness the start of limited connections between the seaport and other dry ports, which represents a spatial development of one seaport with several dry ports.

Sub-phase (4.2): bidirectional development (the case of one seaport with many dry ports). This sub-phase represents the operational development direction of one seaport with many

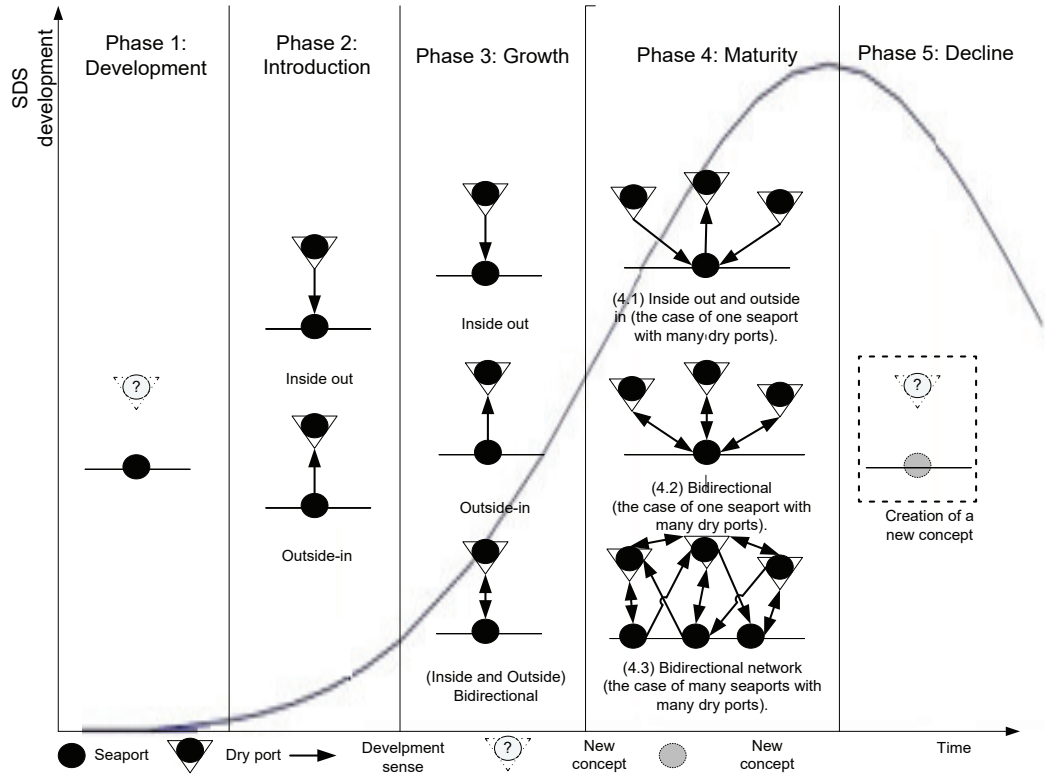

Figure 6.
Bentaleb et al. (2016) model.

dry ports, such as the development of a variety of added-value services, which makes the connection between seaport and the other dry ports more efficient.

Sub-phase (4.3): bidirectional network (i.e. the case of many seaports with many dry ports). This sub-phase represents the operational development direction of many seaports with many dry ports.

Decline phase: This happens eventually when we arrive to the point of the limitations in feasible rationalization or when the improvement process in general is achieved.

In this phase, we can announce the decline of this system, and maybe a new concept will be created, which could be a direction of future research.

The life cycle of the dry port concept will help to make the research more comprehensive. However, as shown above, our literature research is still based on individual case studies. It is essential to conceptualise the progress of the dry port in a more systematic approach. Therefore, this review paper shows a systematic review of journal papers on the dry port progress between 1980 and 2020. We try to organise the concept of the dry port on different investigative levels.

4. SYSTEMATIC LITERATURE REVIEW

Dry port development has had additional consideration by researchers and academics all over the world. A systematic review by Bentaleb et al. (2015a) of the dry port development between 1986 and 2015 revealed that there is a lack of studies relating literature review of the dry port concept. We followed a process of seven steps (Figure 7). This facilitates the analysis of the review and provides possible answers to the questions.

- **Step 1: Establishment of the time period**

In this step, we chose a time interval that starts from 1980 to 2020. The reason behind this choice is to have a more global vision on the concept of dry port, and because of the fact that before 1980 we did not find articles clearly related to the dry port concept.

- **Step 2: Definition of the keywords**

Here we chose three keywords, i.e. Dry Port, Inland Port, and Inland Intermodal Terminal, which define the same concept. Since each author uses one of these keywords to describe the concept of the dry port, we chose these three words to globalize research and increase the number of articles collected.

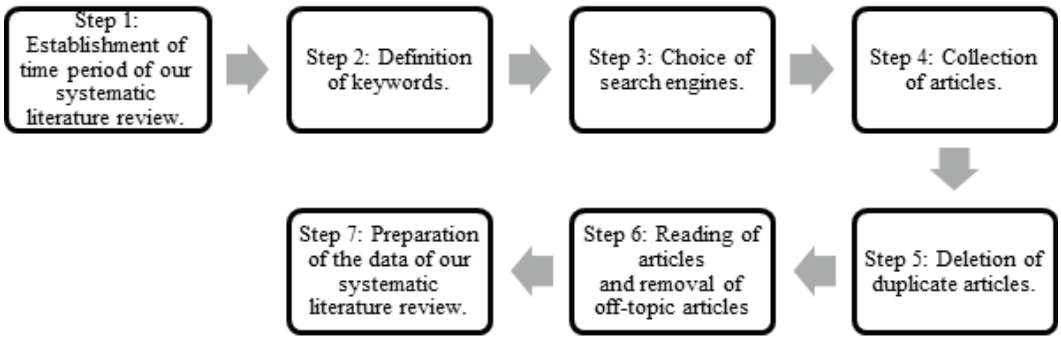

Figure 7.
Systematic literature review process.

- **Step 3: Choice of search engines**

The choice of search engines in the literature review remains as a very important step. In our case, we chose seven engines, i.e. Web of Science, Science direct, Google Scholar, IEEE Explore, Taylor & Francis, Jstor and Springer link, to expand the research scope of the literature review.

- **Step 4: Collection of articles (674 articles)**

In this step, we started the collection of articles with two conditions. The first condition was that the document was a qualified journal article or a chapter (we did not include conference paper), and the second condition was that the title and the abstract of the document collected should be linked with one of the three chosen keywords.

When we typed a keyword in the search engines, each search engine displayed a certain number of results found in a limited number of pages. Table 5 presents the number of articles collected in each search engine whose titles and their abstracts directly related to the concept of the dry port, to arrive at a total of 674 documents collected.

- **Step 5: Deletion of duplicate articles (297 remained articles)**

The keywords used (Dry Port, Inland Port, Inland Intermodal Terminal) are very similar, which justifies the high number of duplicate articles of the total number of documents collected. Therefore, in this step we deleted the duplicate articles.

- **Step 6: Article reading and removal of the off-topic articles (125 removed articles)**

This step required accurate reading of each document to eliminate off-topic articles.

- **Step 7: Preparation of data on systematic literature review (172 retained articles)**

This step represents the final phase of the data structuring process. It facilitates the analysis of the data, and provides the most important information about it. Due to this step, we can have a global idea about the dry port concept and answer the above mentioned questions easily.

Table 5.
Number of articles collected in each search engine.

Key Words	Search engines	Articles collected
Dry Port	Science direct	**52 articles**
	Google scholar	**97 articles**
	IEEE	**1 articles**
	Taylor and Francis	**20 articles**
	Springer	**10 articles**
	Jstor	**4 articles**
	Web of Science	**98 articles**
Inland intermodal terminal	Science direct	**31 articles**
	Google scholar	**73 articles**
	IEEE	**4 articles**
	Taylor and Francis	**10 articles**
	Springer	**12 articles**
	Jstor	**2 articles**
	Web of Science	**18 article**
Inland port	Science direct	**35 articles**
	Google scholar	**134 articles**
	IEEE	**1 articles**
	Taylor and Francis	**13 articles**
	Springer	**6 articles**
	Jstor	**3 articles**
	Web of Science	**51 articles**
Total:		**674**

5. REVIEW ANALYSIS

5.1. Research Evolution

The goal of this section is to understand the evolution and to study tendency research about the dry port concept within the researchers' community. Consequently, based on the publication evolution of the selected papers, we can distinguish three major phases (Figure 8). Due to the limited number of published articles, we determine the first phase between 1980 and 2003. In this first phase, the treatment of the dry port concept is modest; we can explain this reticence by a lack of necessity of the dry port role. The second phase is between 2004 and 2010. It represents a remarkable point of evolution. The number of articles starts to increase clearly due to the increase in interest for the dry port role. Finally, the third phase is from 2011 until 2019. In this stage, the production of the articles related to the dry port concept significantly increases.

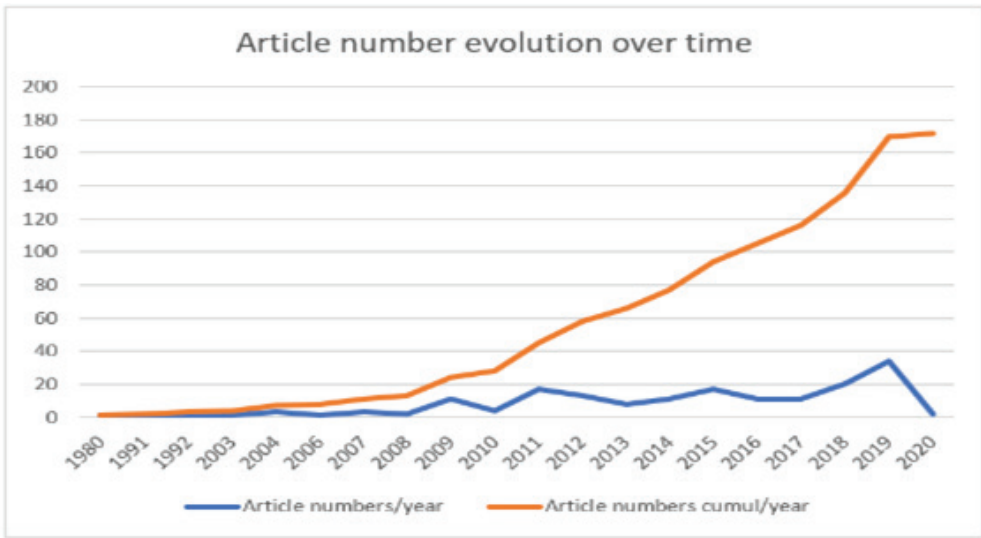

Figure 8.
Evolution of articles' number over time.

We can interpret this result by saying that the concept of the dry port becomes more important each year (Do et al., 2011; Witte et al., 2019). It shows that each year the researchers gain knowledge of the importance of the dry port concept and how it represents a perfect solution of seaport problems.

5.2. Dry Port Research Themes Evolution

We made a classification of the selected articles according to eight topics (see Table 6). These topics came as results of brainstorming done by our research team in order to establish

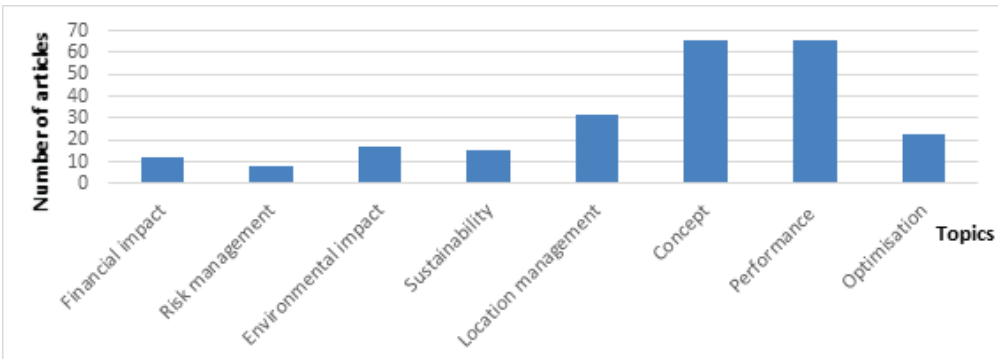

Figure 9.
Number of articles' classification according to different research topics.

the most important topics that we could find in our systematic literature review to reinforce our future research on seaport dry port system.

The point from this classification is to have a vision on the most important topics or themes assessed in the dry port papers. We found that optimization, performance, concept, location management, sustainability, environmental impact, risk management, and financial impact are the most important topics in the systematic literature review.

Moreover, we can note that sometimes we found many themes in the same article.

However, as Figure 9 shows, the majority of the articles cover two topics, concept and performance of the dry port. That is due to the concept novelty, which explains some differences in the definitions of the dry port concept. In addition, researchers try to understand better the dry port performance and its impact.

In the articles that assess location management, we found that most of the criteria used are economic criteria, which focus primarily on the reduction of the cost of transport. Environmental criteria mainly deal with the positive impact of installing a dry port. Geographical or spatial criteria focus on the geographical accessibility and limitation. Social criteria assess the availability and skill level of the workforce, the policy that focuses on the policy of the country related to the chosen place and other criteria that change according to the context assessed in the article (Awad-Núñez et al., 2016; Bentaleb et al., 2016; Komchornrit, 2017; Nguyen and Notteboom, 2016; Roso et al., 2015, 2015). Because of the multiple criteria of the location management problem, we noticed that most articles treated the location management of the dry port using hybrid approaches based on MCDM (multi-criteria decision making) methods like AHP, ELECTRE, Fuzzy ANP or MACBETH (Abdoulkarim et al., 2019; Bentaleb et al., 2016; Ka, 2011; Komchornrit, 2017; Roso et al., 2015; Wei et al., 2010).

Subsequently, we realized the time projection of the themes, which gave us a vision on the temporal progress of each theme in the systematic literature review. Figure 10 shows the evolution of articles about the dry port concept over time and their domain of studies. However, after the year 2010, the number of articles that touch the performance aspect increased in a remarkable way. It could be explained by changing the research angle of vision. In the beginning, research treated the concept in a general way; then, we noticed a development of the topics treating other aspects of the dry port concept over time, e.g. dry port performance.

The main reason behind this development is that at first the concept was ambiguous and unknown. However, over time the importance of the dry port has become more interesting for the researchers, who revealed other themes of research, e.g. performance, in Bentaleb et al. (2015a), Li and Jiang (2014); location management, in Bentaleb et al. (2016), Ka (2011), Nguyen and Notteboom (2016); life cycle, in Bask et al. (2014), Wang (2014); risk management, in Bentaleb et al.(2015b), Gong and Liu (2020).

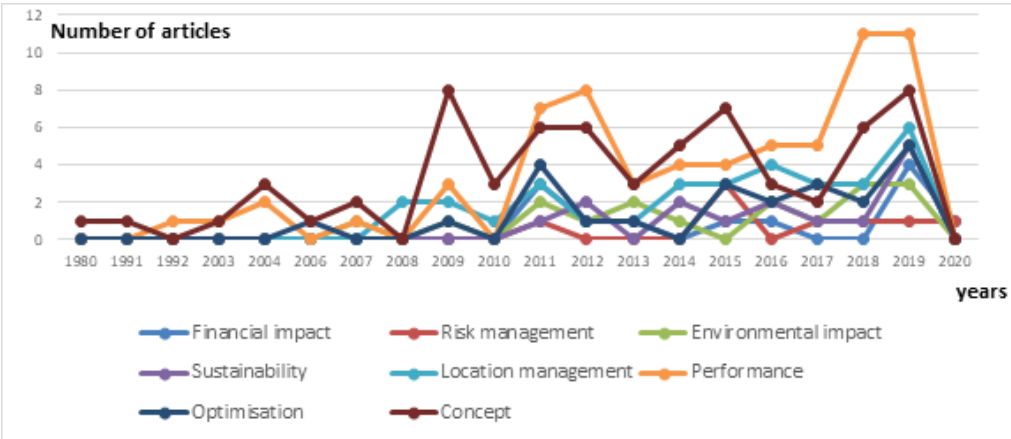

Figure 10.
Evolution of papers' number on dry port theme over time.

5.3. Dry Port Research Methods' Evolution

In this section, a classification is made according to eight sets of methods (Table 6). Each set represents a category of methods used. The goal is to clarify the methods used by the authors of the selected articles.

The eight sets of methods are:

Table 6.
Eight sets of methods used in dry port articles.

Sets	Set description	Methods or types	Papers number
A	Articles dedicated entirely to literature review (4 Articles) Articles contain sections of literature review or about reviews (69 Articles).	Literature reviews and previews.	73
B	Case studies, where the treatment focused on a certain dry port, region or a precise country.	Case studies.	143
C	Articles using graphic modelling methods.	Graphic modelling.	10
D	Studies based on interviews or/and survey.	Interviews and survey	58
E	Articles that use mathematical modelling or optimization methods.	Mathematical models.	71
F	Studies based on the database, reports or archives.	Database, reports or archives analysis.	66
G	Articles based on computer software, numerical analysis or computer languages. For example, Cortés et al. (2007) present a simulation using Arena software in order to simulate the inland port of Seville; Henttu et al. (2011) used an optimisation software CPLEX in their research on the optimal impact of dry port on environment, etc.	Computer languages and computer software	11
H	Articles that contained other analytical methods.	Other analytical methods	14

In this section, we made a time projection (Figure 11) of the method sets (Table 6). The point is to have a clear idea about the used methods' evolution. Moreover, as we can notice in Figure 11, most researchers relate their articles to some region, country or a precise dry port (set B) in order to give their research certain legitimacy which makes the set B the most dominant set over all the period of the systematic literature review.

In 2009, the sets of reviews and previews (A) using interviews/questionnaires (D) and databases, archives or reports (F) rank as the most used methods after the set of case studies (B). Then, the other sets of mathematical methods (E), computer software or computer languages (G), Graphic modelling (C), and the set of methods like SWOT/ benchmarking… (H) started to increase over time.

We can explain this order by the nature of development of the topics in Figure 10. In order to provide a clarification of the concept of the dry port, we return to literature review and archives. If we want to deal with the performance of the dry port or any other theme, interviews, mathematical methods, and other methods like SWOT, graphic modelling, etc. are used.

One of the most important findings that we noticed through our systematic literature review is the existence of four articles entirely dedicated to the dry port literature review (Roso and Lumsden, 2010; Bentaleb et al., 2015c; Rožić et al., 2016; Witte et al., 2019). Each article gives us a different angle of view on the dry port concept (Table 7) starting in 2010 with Roso and Lumsden (2010). They present a literature review that gives us a clear vision of the concept of the dry port and the world's existing dry ports, which represents a good opportunity for any new practitioner or researcher who wants to start discovering the dry port concept. Then, in 2015, Bentaleb et al. (2015c) give us a systematic literature review based on five steps: 1) problem definition; 2) selection of journals based on the time period between 1986 and 2015, taking in consideration four research engines (Jstor, Sciencedirect, Scopus and Google Scholar); 3) selection of studies; 4) critical evaluation, and 5) synthesis that treats the concept of dry port. The most important points of this systematic literature review are the detailed description of the development of the decision level and an illustration of all the countries where researchers were interested in the dry port concept. Furthermore, in 2016, Rožić et al. (2016) focuse on four pillars in their literature review: 1) the development of the dry port concept; 2) classification and function type of the dry port and the functions that can add value to seaports; 3) technological processes that represent the activities at the terminal, which are conducted with the aim of better quality of cargo handling, and which require appropriate technological elements and real-time work; 4) location determination of inland terminals presenting some methods and criteria used to determine the location of inland terminals. Finally, Witte et al. (2019) present a systematic literature review based on four steps: 1) They define the criteria for inclusion or exclusion of papers; 2) They made a systematic search of the scientific literature based on criteria determined; 3) They analysed the papers and retrieved the relevant information for the review; 4) They performed data analysis and synthesis. The most important points mentioned are: papers published across journals over time; a good view made on the papers published over time; papers by geographical focus over time, where they

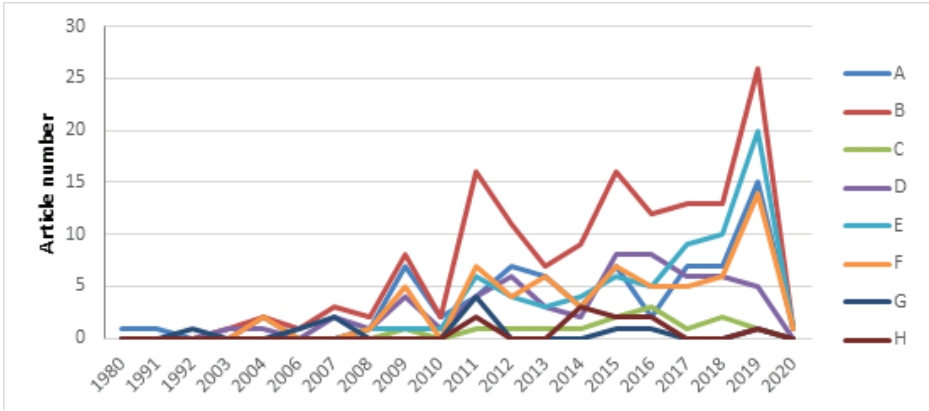

Figure 11.
Methods used evolution over time.

give us an idea about geographical focus; papers by type of methodology over time, dividing the methodology types into six categories: case study, conceptual study, quantitative (modelling), quantitative (empirical), literature reviews and editorials; papers by type of definitions over time; 5) key authors and network collaborations, where they mention most authors contributing in the dry port research; 6) key themes and conceptual approaches over time, where they present tree major periods crossed with four main conceptual approaches globalization/supply chain, port regionalisation, directional development, and institutional governance.

Table 7.
Dry port literature reviews.

Literature reviews	Date	Period time	Systematic (yes or no)	Research methodology	Research engines	Number of articles studied
Roso and Lumsden (2010)	2010	Not specified	no	1) List of dry ports obtained from journals, internet base documents, containerisation International and World Cargo News. 2) After identifying the list of dry ports, interview starts on the dry ports, based on telephone survey and questionnaires sent to emails. 3) Synthesis.	Not specified	Not mentioned.
Bentaleb et al. (2015c)	2015	1986-2015	yes	1) problem definition; 2) selection of journals; 3) selection of studies; 4) critical evaluation; 5) synthesis.	Jstor, Sciencedirect, Scopus, Gooogle Scholar	109
Rožić et al. (2016)	2016	1980-2015	no	Not mentioned.	Not specified	more than 60
Witte et al. (2019)	2019	1992-2017	yes	1) Defining different selection criteria for inclusion or exclusion of papers. 2) A systematic search of the scientific literature based on the criteria. 3) Analysis of the papers and retrieval of the relevant information for the review. 4) Data analysis and synthesis performed.	www.scopus.com	80

However, if we take all the literature reviews found until now on the dry port concept including this paper, we will notice that there are some common points, e.g. the development of the concept of the dry port or the published papers over time.

On the other hand, all these literature reviews complement each other. Each paper gives a different view on the dry port concept: Roso and Lumsden (2010) give a good overview on the existing dry ports; Bentaleb et al. (2015c) give the decision level of the articles between 1986 and 2015, and a detailed geographical description on the dry port concept research. Rožić et al. (2016) add a detailed description of the methods and criteria used to locate the dry port. Witte et al. (2019) illustrate the key themes and conceptual approaches over time. In our paper, we try to give another vision of the themes used in the dry port research.

We add an overview of the life cycle of the dry port development and we try to optimise our systematic methodology of research. We choose our time interval between 1980 and 2019; then, we determine six research engines in order to have more articles evaluating the dry port concept. Therefore, we recommend for all future researchers or practitioners to start with these literature reviews in order to have a clear and complete vision on this interesting concept.

A literature review on the dry port concept contributes to defining the most important flows in the dry port research. Recent studies have shown that the concept is visibly more diversified and much more fertile. Still, as much of the literature is principally based on individual case studies, the research of dry ports has proven to particularly need more focus on operational aspect search, e.g. risk management, performance management, etc.

5.4. Relation Between Topics and Methods

In addition, a cross between the sets of methods and the topics/themes has been realised to get a clear vision of the methods used in each topic (Figure 11). This gave us a great combination in each topic/theme, e.g. in the topic of "concept" we found that the first set of methods used is B (case studies) in order to give legitimacy and realistic aspect to research in this theme. After that, the sets A (literature reviews) and F (return to archives) follow the set B to make a connection between the past and the present in the treatment of the dry port concept. The same reasoning goes for the other themes to make a clear vision on the most used methods in each theme.

Regarding the content of the articles about the relation between topics and methods, Figure 12 shows that cases studies (Set B) are the most treated topics that evoke performance, concept and localization aspects. Furthermore, we observe an important use of methods in relation with performance, concept and localization aspects. With regard to the topic graphic modelling (set C), computer software or computer languages (set G) and other analytical methods (set H) have not been a priority for the research community up to now.

Therefore, most documents are case studies focusing on dry port performance, followed by studies on concepts and localisation.

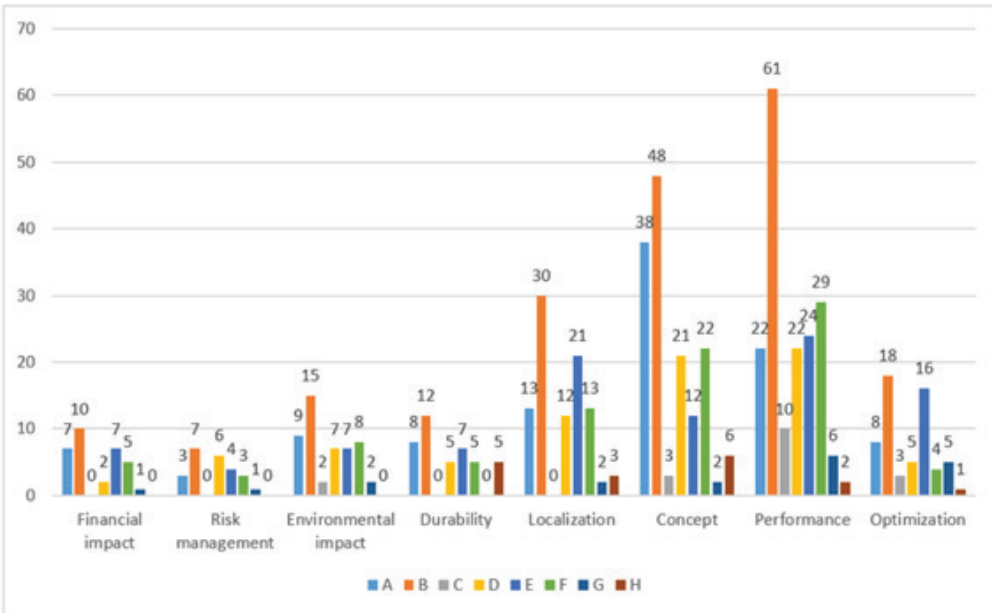

Figure 12.
Methods used in each topic.

5.5. Dry Port Journals and Countries' Trending

In this section, the goal is to identify the most productive journals (Table 8) and countries (Table 9) in relation with the dry port concept. We made a classification of journals and countries according to the number of articles in the systematic literature review. Table 8 shows the most relevant journals found.

This part contains the dry port documents in different countries. Different dry port types were developed in different regions and countries. We accumulate papers from a geographic angle. Table 9 shows the top 20 countries in terms of contribution in the selected documents in the systematic literature review.

Within this trend, interest for the dry port is expanding mutually across the variety of journals covered as well as geographical level. As the recognised research gaps demonstrate, more attention could be covered in terms of further practical studies on the dry port topic.

Table 8.
Journals' trending in dry port topic.

Journals	**Number of articles**
Journal of Transport Geography	**15**
Maritime Policy and Management	**12**
Maritime Economics and Logistics	**9**
Research in Transportation Economics	**9**
Transportation Research Part E	**7**
Research in Transportation Business and Management	**6**
Procedia - Social and Behavioral Sciences	**5**
Sustainability	**5**
the Asian journal of shipping and logistics	**5**
Transportation Research Part A	**4**

Table 9.
Top 20 countries in terms of contribution in the selected documents in the systematic literature review.

Countries	Articles with all the authors from the same country	Articles with authors from different countries	Total number of articles
China	31	16	47
Sweden	9	8	17
The United States of America	7	9	16
The Netherlands	8	7	15
United Kingdom	4	10	14
Spain	10	2	12
Italy	8	1	9
Australia	4	4	8
Belgium	2	6	8
Morocco	5		5
Canada	2	3	5
Croatia	2	3	5
Finland	3	2	5
Malaysia	4	1	5
Chile		4	4
French	2	2	4
Germany	2	2	4
Singapore	2	2	4
Czech Republic	3		3
India	3		3
Russia	3		3

6. CONCLUSION AND DISCUSSION

Over time, the dry port concept has changed from a simple infrastructure exchange point to a real solution for the maritime transport. Dry port studies have also evolved in similar ways. In the end, we found out that the dry port seaport system has become a very interesting subject due to its important contribution in the intermodal transport and its advantages that it can add to the global supply chain management. As this paper reveals, each year the dry port is becoming increasingly attractive for researchers. This is reflected in the development of the dry port concept and the appearance of the dry port types. This evolution has generated a number of implications with regard to the dry port role and functions. The past period of research on the dry port topic definitions have shown that the concept is visibly much more fertile than we expect.

One rising and significant topic emphasised by this study concerns the investigation about dry port case studies and their relationship with the dry port performance. Therefore, this review paper shows a systematic review of journal papers on the dry port progress between 1980 and 2020 (172 considered articles). We have tried to organise the concept on different investigative levels. Based on the evolution and study tendency research as well as the publication evolution of the selected papers, we can distinguish three major phases. First, the research treats the concept in a general way; then, we note a development of topics related to other aspects of the dry port concept over time, like dry port performance. The main reason behind this development is that at first the concept was ambiguous and unknown. Still, over time the importance of the dry port has become more interesting. Within this trend, interest for the dry port as well as the geographical level is increasing mutually in a variety of journals covered. As the recognized research gaps demonstrate, more attention could be expected in terms of further practical studies on the dry port topic. However, as we notice in this paper, despite the development of research, some topics have not been considered adequately, e.g. risk management, environmental impact or the financial influence of the dry port. We notice that there are some gaps in the research about the dry port. Additionally, this article recommends researchers, academics, and professionals to focus more research on the dry port, opening some opportunities for future research on the dry port concept. Finally, it is also essential to present some limitations of this systematic review. A major aspect is the concentration of studies in journals without inclusion of conference papers.

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SUPPLEMENT

Theme	Number of articles	Articles
Financial impact	12	(Haralambides and Gujar, 2011), (Henttu and Hilmola, 2011), (Henttu et al., 2011), (Lättilä et al., 2013),(Panova and Hilmola, 2015), (Smid et al., 2016), (Facchini et al., 2020), (Qiu and Lee, 2019), (Whitman et al., 2019), (Qiu and Xu, 2019), (Iannone, 2012), (Chang et al., 2019a).
Risk management	8	(Schindlbacher et al., 2011), (Panova and Hilmola, 2015), (Bentaleb et al., 2015c), (Molero et al., 2017), (Santarremigia et al., 2018), (Ng et al., 2015), (Gong and Liu, 2020), (Yosef et al., 2019).
Environmental impact	17	(Roso, 2007), (Roso, 2009), (Hanaoka and Regmi, 2011), (Henttu and Hilmola, 2011), (Haralambides and Gujar, 2012), (Dooms et al., 2013), (Lättilä et al., 2013), (Wu et al., 2014), (Muravev and Rakhmangulov, 2016), (Seguí et al., 2016), (Vejvar et al., 2018), (Tsao and Linh, 2018), (Pham and Lee, 2019), (Chang et al., 2019a), (Li et al., 2019), (Wei and Sheng, 2017), (Qiu and Lam, 2018).
Durability/Sustainability	15	(Cullinane and Wilmsmeier, 2011), (Beresford et al., 2012), (Rodrigue and Notteboom, 2012), (Wu et al., 2014), (Wang, 2014), (Awad-Núñez et al., 2015), (Awad-Núñez et al., 2016a), (Awad-Núñez et al., 2016b), (Vejvar et al., 2018), (Muravev et al., 2019), (Ližbetin, 2019), (Tsao and Thanh, 2019), (Wei and Sheng, 2017), (Hui et al., 2019), (Wiercx et al., 2019), .
Location management	32	(Roso, 2008), (Rahimi et al., 2008), (Rosa and Roscelli, 2009), (Ng and Girish, 2009),(Wei et al., 2010), (Chang et al., 2011), (Flämig and Hesse, 2011), (Bentaleb et al., 2016a), (Ka, 2011), (Feng et al., 2013), (Rožić et al., 2014), (Ambrosino and Sciomachen, 2014), (Awad-Núñez et al., 2014), (Chang et al., 2015), (Awad-Núñez et al., 2015), (Roso et al., 2015a), (Awad-Núñez et al., 2016a), (Awad-Núñez et al., 2016b), (Muravev and Rakhmangulov, 2016), (Nguyen and Notteboom, 2016), (Wang et al., 2018), (Komchornrit, 2017), (Monios and Wilmsmeier, 2012a), (Santos and Guedes Soares, 2017), (Raimbault, 2019), (Ližbetin, 2019), (Van Nguyen et al., 2019), (Chang et al., 2019a), (Gonzalez-Aregall and Bergqvist, 2019), (Owusu Kwateng et al., 2017), (Black et al., 2018), (Sun and Wang, 2018), (Abdoulkarim et al., 2019b).
Concept	66	(Hayut, 1980), (UNCTAD, 1991), (WALTER and POIST, 2003), (Wood, 2004), (Woxenius et al., 2004), (Walter and Poist, 2004), (Jaržemskis and Vasiliauskas, 2007), (Roso, 2007), (Roso et al., 2009), (Ng and Girish, 2009), (K. Y. A. Ng and Gujar, 2009), (Roso and Lumsden, 2009), (Notteboom and Rodrigue, 2009), (Cronje et al., 2009), (AdolfK. Y. Ng and Gujar, 2009), (Caballini and Gattorna, 2009), (Rodrigue et al., 2010), (Bentaleb et al., 2015a), (Roso and Lumsden, 2010), (Ng and Tongzon, 2010), (Hanaoka and Regmi, 2011), (Monios, 2011), (Dadvar et al., 2011), (Cullinane and Wilmsmeier, 2011), (Do et al., 2011), (Korovyakovsky and Panova, 2011), (Cullinane et al., 2012), (Beresford et al., 2012), (Monios and Wilmsmeier, 2012b), (Veenstra et al., 2012), (Chen and Wang, 2012), (Ng and Cetin, 2012), (Ng et al., 2013), (Lättilä et al., 2013), (Zeng et al., 2013), (Rožić et al., 2014), (Bask et al., 2014), (Witte et al., 2014), (Wang, 2014), (Crainic et al., 2015), (Li et al., 2015), (Panova and Hilmola, 2015), (Wiegmans et al., 2015a), (Jeevan et al., 2015), (Berg and Langen, 2015), (Rožić et al., 2016), (Nguyen and Notteboom, 2016), (Witte et al., 2016), (Wang et al., 2018), (Witte et al., 2017), (Wei et al., 2018), (Nguyen and Notteboom, 2019), (Tsao and Linh, 2018), (González-Sánchez et al., 2015), (Witte et al., 2019), (Caris et al., 2014), (Santos and Guedes Soares, 2017), (Pham and Lee, 2019),(Roso et al., 2019),(Tsao and Thanh, 2019)(Montwiłł, 2019), (Khaslavskaya and Roso, 2019), (Bentaleb et al., 2016b), (Protic et al., 2019), (Zhang et al., 2006), (Wiegmans et al., 2019), (Black et al., 2018), (Qiu and Lam, 2018).

Performance	66	(Kondratowicz, 1992), (WALTER and POIST, 2003), (Wood, 2004), (Walter and Poist, 2004), (Cortés et al., 2007), (Cronje et al., 2009), (Garnwa et al., 2009), (AdolfK. Y. Ng and Gujar, 2009), (Hanaoka and Regmi, 2011), (Monios, 2011), (Schindlbacher et al., 2011), (Arango et al., 2011), (Garnwa et al., 2009), (Carrese and Tatarelli, 2011), (Van den Berg and De Langen, 2011), (Liedtke and Carrillo Murillo, 2012), (Padilha and Ng, 2012), (Monios and Wilmsmeier, 2012b), (Rodrigue and Notteboom, 2012), (Chen and Wang, 2012), (Ng and Cetin, 2012), (Mundutéguy, 2012), (Dooms et al., 2013), (Monios and Wang, 2013), (Wen and Chen, 2013), (Wang et al., 2014), (Li and Jiang, 2014), (Witte et al., 2014), (Martínez-Pardo and Garcia-Alonso, 2014), (Wilmsmeier et al., 2015), (Qiu et al., 2015), (Clausen and Kaffka, 2016), (Roso et al., 2015b), (Bentaleb et al., 2015b), (Wiegmans et al., 2015b), (Andersson and Roso, 2016), (Li et al., 2017), (Seguí et al., 2016), (Witte et al., 2016), (Witte et al., 2017), (Wei and Sheng, 2018), (Jeevan et al., 2017), (Jeevan et al., 2018), (Lizbetin and Bartuska, 2019), (Wei et al., 2018), (Carboni and Deflorio, 2018), (Kramberger et al., 2018), (Chang et al., 2019b), (Fazi and Roodbergen, 2018), (Tan et al., 2018), (Oláh et al., 2018), (Wan et al., 2018), (Smid et al., 2016), (Tadić et al., 2019), (Lizbetin and Bartuska, 2019), (Jeevan et al., 2019), (Hossain et al., 2019), (Whitman et al., 2019), (Iannone, 2012), (Khaslavskaya and Roso, 2019), (Gonzalez-Aregall and Bergqvist, 2019), (Protic et al., 2019), (Abdoulkarim et al., 2019a), (Chen et al., 2017), (Hui et al., 2019), (Chen et al., 2018), (Musso and Sciomachen, 2019).
Optimization	23	(K. Y. A. Ng and Gujar, 2009), (Arango et al., 2011), (Carrese and Tatarelli, 2011), (Henttu et al., 2011), (Chang et al., 2011), (Mundutéguy, 2012), (Lam and Gu, 2013), (Crainic et al., 2015), (Qiu et al., 2015), (Rathnayake et al., 2015), (Andersson and Roso, 2016), (Debrie and Raimbault, 2016), (Jeevan et al., 2017), (Nguyen and Notteboom, 2017), (Fazi and Roodbergen, 2018), (Tsao and Linh, 2018), (Wei and Dong, 2019), (Van Nguyen et al., 2019), (Qiu and Xu, 2019), (Chang et al., 2019a), (Zhang et al., 2006), (Wei and Sheng, 2017), (Ji et al., 2019).

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