Transportation Research Part A 45 (2011) 667–685

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Seaport research: A structured literature review on methodological issues since the 1980s

Su-Han Woo *, Stephen J. Pettit, Dong-Wook Kwak, Anthony K.C. Beresford

Cardiff Business School, Cardiff University, Aberconway Building, Colum Road, Cardiff CF10 3EU, UK

ARTICLE INFO

Article history:
Received 26 September 2010
Received in revised form 16 April 2011
Accepted 26 April 2011

Keywords:
Seaport research
Structured literature review
Research paradigm
Research method
Interdisciplinarity
Port research
Analysis technique

ABSTRACT

This study aims to investigate how seaport research has been conducted from the methodological perspective. To this end, this study reviews published port literature for the last three decades (1980–2000s). The investigation primarily categorises the literature according to various methodological issues such as research paradigm, research strategy, base-disciplines, research methods and analysis techniques in order to provide meaningful implications on methodological evolution in seaport research for the period. This study suggests methodological bias in port research to a positivistic paradigm, following a quantitative trajectory moving from conceptual to empirical studies. In addition, the increased use of mathematical modelling and advanced statistical analysis methods is clearly observed. The introduction of advanced analytical tools used in other academic disciplines facilitates discussions in particular research area and amplifies the literature in those areas. This paper also suggests research gaps from the methodological perspective and implications for future port research.

1. Introduction

The primary objective of this study is to examine how seaport research has been conducted from the methodological perspective. To achieve this, a structured review of published port[1] literature for the last three decades (1980–2000s) was undertaken. Where review studies for port research have been undertaken in the past, they have generally been in limited situations. Most were conceptual works based on authors' insights and experiences, and they reviewed only a limited number of studies (e.g. Goss, 2002; Heaver 1993; Heaver, 2006; Metaxas, 1983; Suykens and van de Voorde, 1998). Recent review studies adopted a more structured approach, but were limited to specific areas such as terminal operation (e.g. Stahlbock and Vos, 2008; Steenken et al., 2004) and port efficiency (e.g. Gonzalez and Trujillo, 2009; Panayides et al., 2009).

In particular, methodological issues have not been studied in port research, in contrast to other related research fields such as logistics and Supply Chain Management (SCM). The methodological approach in other research fields were relatively widely examined: operations management (Meredith et al., 1989), logistics (Mentzer and Kahn, 1995), and SCM research (Sachan and Datta, 2005; Burgess et al., 2006). A number of studies made efforts to identify the disciplinary characteristics of logistics and SCM research through various approaches such as investigating the theoretical foundation of their research fields (Arlbjorn and Halldorsson, 2002; Stock, 1997; Svensson, 2002) and bibliometric analysis (Harland et al., 2006). Research

* Corresponding author. Tel.: +82 2 2180 2117, fax: +82 2 2180 2123.
E-mail address: shwoo74@paran.com (S.-H. Woo).

[1] The term 'port' in this paper represents seaport hereinafter.

0965-8564/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tra.2011.04.014

approaches used in logistics were extensively examined through content analysis by Spens and Kovacs (2005), and more involvement of qualitative research methods in logistics research was suggested by Mangan et al. (2004) and Naslund (2002).

The backgrounds against which researchers address methodological issues may be: when research fields are relatively new compared to more established academic disciplines such as philosophy, psychology, engineering and economics; when research fields have a multi-disciplinary nature from both theoretical and methodological perspectives; when there is a lack of consensus and awareness on concepts and definitions between the researchers in the field; and when there are debates about whether the research fields are relevant to a specific discipline. It was suggested by Pallis et al. (2010) that port research is an emerging research field, but it is within a pre-paradigmatic phase rather than a mature phase with low coherence and several small communities. They also suggested that the low coherence may be attributed to 'a lack of strong underlying theories or limited consensus', and a comprehensive analysis on methodological perspectives of port research is required for further development.

Woo et al. (2010a) also suggested that not only research demand derived from complex phenomena taking place in port industry, but also the development of theoretical models and the introduction of appropriate methodologies have contributed to the development of port research. Against these suggestions and observations, this study examines the methodological state of port research and the transition of process during the past three decades. This study primarily categorises port research in terms of research paradigm, research strategy, base-theories and disciplines, research methods, and analysis techniques.

2. Review methodology: a classification framework

This study selected port studies published in academic journals were included. The reason is that they have been through peer review procedure and are more appropriate for the investigation of port research from both theoretical and methodological perspectives than other sources. Conference papers, contribution to edited books, dissertations and theses were excluded. While editorials in journals written by journal editors or visited editors were excluded, comments and notes were included if they had either conceptual discussions or empirical analysis. The target period was the last three decades, i.e. from 1980 to 2009. Thus papers which were available as on-line versions on 2009 in advance but of which publishing year was 2010 were not considered for this analysis. All papers relating to port policy, management and operations were searched for, beginning with maritime transport related journals such as *Maritime Policy and Management* (MPM) and *Maritime Economics and Logistics* (MEL) and extending to all journals where such papers were published. The tables of contents of the journals in which port studies are frequently published were reviewed. Then the references of the papers identified were examined to trace the journals and papers which had not been previously identified. In addition, on-line searches were undertaken to identify, using various databases such as Scopus, SciencDirect and Swetswise. Some papers were excluded because their research topics were peripheral to this study, even though they were related to seaports, for example, studies on port history and waterfront redevelopment. 840 papers on ports were identified from 125 journals, and the full list of the journals and the number of papers from the journals are provided in Appendix A.

The identified papers were classified according to various methodological issues, using a classification framework presented in Table 1. Four rounds of review process, including cross-review among the authors of this study, were undertaken to avoid ambiguity in classification and to ensure the categories were exhaustive and mutually exclusive.

For some methodological aspects, categories which have been developed and applied to different research fields could be adopted. Categorisation of research paradigms provides the philosophical approach to port research using the paradigm matrix developed by Burrell and Morgan (1979) for the field of sociology and, also, applied to other fields (Chua, 1986; Goles and Hirschheim, 2000; Burgess et al., 2006). Research strategy is a further categorisation from a philosophical standpoint, focusing more on the epistemological dimension, and the classification scheme of Wacker (1998) is used for this categorisation. Discipline bases were investigated to identify the disciplinary characteristics of port research and academic territory covered by port research. In addition, theories, theoretical models and concepts which have been applied to port research were

Table 1
Classification framework.

Classification	Categories	References
Research paradigm	Functionalist/Interpretivist/ Radical structuralist/Radical humanist	Burrell and Morgan (1979), Chua (1986), Goles and Hirschheim (2000)
Research strategy	Analytical: conceptual/mathematical/statistical Empirical: experimental/statistical/case study	Wacker (1998), Burgess et al. (2006)
Discipline base	Disciplines on which papers are based or to which papers are related	Burgess et al. (2006), Harland et al. (2006)
Theory, model and concept	Theories or theoretical models on which papers are based where discernable	Stock (1997), Amundson (1998), Arlbjorn and Halldorsson (2002), Krugman (1998, 1999), Winston (1985)
Research methods	Survey, Interview, Math modelling, Economic Modelling, Simulation, Case studies, etc.	Mentzer and Kahn (1995), Sachan and Datta (2005), Min and Zhou (2002)
Data analysis techniques	Data analysis techniques used in paper where discernable	Mentzer and Kahn (1995), Sachan and Datta (2005)

examined to show how port research has interacted at a theoretical level with other relevant disciplines. This category includes review studies and literature concerning theory development and academic disciplines in other research fields such as logistics and SCM (e.g. Arlbjorn and Halldorsson, 2002; Stock, 1997), transport economics (e.g. Winston, 1985) and economic geography (e.g. Krugman, 1998, 1999). Research methods and analysis techniques shows how researchers have methodologically addressed problems in port research.

Several questions can be raised about this categorisation. First, are the categorisations appropriate for port research? This question is not easy to answer since particular categorisations have not been used for port research, so it is not possible to argue one is better than the other. However, it should be noted that frameworks and tools more frequently used in research fields close to port research were sought for this study, and multiple aspects of categorisation were applied in order to ensure comprehensiveness and to ensure that they supplement each other. For example, both research paradigm and research strategy were investigated for their philosophical approach and both discipline and theoretical base were examined for disciplinary characteristics. Second, are the results of categorisation reliable? In order to make them more reliable and valid, the authors of this study, who all have academic and practical experience in maritime transport, conducted four rounds of review process including cross review among them as suggested by Cullinane and Toy (2000). Third, is it possible to categorise all the papers exclusively? The classification for some papers was straightforward, but for most it was not. However this study aimed to be mutually exclusive rather than integrative for the categorisation in order to show distinctive trends, although this approach may have disadvantages. Thus the research sought to identify the primary objectives presented in the papers and the methods used to accomplish the objectives. The results are provided in the following sections.

3. Classification results

3.1. Research paradigm

The paradigmatic approach to research has a strong influence on the research process in all areas of study and each research paradigm generally involves a particular research strategy and research method (Naslund, 2002). Paradigm is defined as 'the basic belief system or world-view that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways' (Guba and Lincoln, 1994). Thus in order to understand the nature of research and to discuss the limitations and potential of each research method, the research paradigm should be discussed first (Naslund, 2002). While there are several paradigms identified, broadly speaking there are two opposing philosophical perspectives: the positivist paradigm and the non-positivist paradigm (Mangan et al., 2004). The positivist paradigm generally involves objectivism and ontological consideration believes that an objective world exists, and applies procedures and approaches used in natural science. It follows that quantitative methods are involved with this paradigm to generate 'objective' knowledge. The non-positivist paradigm, ontologically, entails constructivism which believes the world is socially constructed and subjective, and, epistemologically, includes interpretivism where researchers try to understand the world from the inside rather than the outside (Naslund, 2002). Under this paradigm, multiple methods are used to establish different views of phenomena, and which basically include qualitative methods (Mangan et al., 2004).

In line with this discussion, this study uses the framework developed by Burrell and Morgan (1979). The framework is composed of four paradigms: functionalism, interpretivism, radical structuralism and radical humanism. The functionalist paradigm is concerned with 'providing explanations of the status quo, social order, social integration, consensus, and rational choice' (Goles and Hirschheim, 2000), which can be aligned with positivism (Burgess et al., 2006). This paradigm has taken dominance in port research for the three decades as shown in Table 2. Some papers were based on the interpretivist paradigm which seeks 'explanation within realm of individual consciousness and subjectivity (Goles and Hirschheim, 2000)'. The radical structuralist paradigm, 'focusing primarily on the structure and analysis of economic power relationships,' was used in four papers. These papers were primarily studies on industrial relations in port industry (Carter et al., 2003; Herod, 1998; Saundry and Turnbull, 1996; Turnbull, 2006).

3.2. Research strategy

In this study, research strategy discusses both the research approach concerned with the nature of relationships between theory and research which are deductive and inductive, and research design which is a general plan of how to answer

Table 2
Research paradigms in port research.

Paradigm	1980s	1990s	2000s	Total
Functionalist	112	208	510	830
Interpretivist	2	2	2	6
Radical humanist	–	–	–	–
Radical structuralist	–	3	1	4
Total	114	213	513	840

research questions. Specific categorisation for this issue is provided by Wacker (1998) who used a typology of theory-building research comprising broadly analytical research, which applies a deductive approach, and empirical research, which applies an inductive approach. The framework was used to categorise SCM research in terms of research methods by Burgess et al. (2006). As shown in Table 3, analytical research has three sub-categories: conceptual, mathematical and statistical, and empirical research is sub-divided into three: experimental, statistical and case studies. Analytical strategies (58.1%) were used more extensively than empirical strategies (41.9%). Analytical-conceptual research which aims to add new insights into traditional problems by using the researcher's experience, (Wacker, 1998) has been undertaken the most (41.2%), and empirical case studies was the second most (21.4%)used approach. Empirical experimental research strategies, which implements 'field experiments', have not been used.

Decadal trends are provided in Fig. 1. For the 1980s and 1990s, analytical research strategy was dominant (63.1% and 68.1% respectively). In the 2000s, the proportions were more balanced between analytical (52.6%) and empirical strategies (47.4%) with empirical strategies used increasingly. The increasing involvement of research methods, which attempt to gather real world data from for example, surveys and interviews, in this period may have contributed to this change.

3.3. Discipline bases

The term 'discipline' was used by Burgess et al. (2006) as 'a body of practice that is well supported by occupational groupings that identify with or defend a territory of activity'. In addition, Fabian (2000) distinguished 'discipline' from 'paradigm' by proposing that 'a discipline is the common focus of a set of researchers who might perform research in varied paradigms and/or theoretical perspectives'. Seaports are regarded as economic units providing a service or nodes between various transportation modes, or as facilities through which cargoes pass, or as a part of logistics and supply chains (Cullinane and Talley, 2006). Therefore problems in seaports can be viewed and addressed from various perspectives, and researchers who have different disciplinary backgrounds can be involved in port research.

This study, thus, categorised the selected papers into disciplines which appear to form bases for the papers, or to be at least relevant to the papers to a large extent. In this categorisation, the disciplinary backgrounds of the authors of the papers tell much and could not be disregarded. However, theoretical models, analytical approaches and concepts used in the papers were the factors which most clearly influenced the approach taken. When disciplinary characteristics were not discernible from this paper's authors' view, those papers were left as 'Not specific' (17.7%) and the results are presented in Table 4.

Table 4 shows that, from the 1980s onwards, three disciplines dominated port research: economics, geography, and operation research (31.5%, 15.7% and 16.3% respectively). Various disciplines or research fields relating to management studies also contributed considerably to port research, with an aggregated proportion of 13.2%. It is clearly observed that disciplines involved in port research became more diverse in the 2000s than in the 1980s or the 1990s. This trend is distinctive in the 'Management' category. In the 1980s, management-based port studies very rarely seen, whereas, in the 1990s, studies concerned with industrial relations in the port industry were relatively extensive. In the 2000s, strategic management-based, marketing-based and logistics-based research related to ports began to emerge and the number of these studies increased.

Fig. 2 shows decadal analysis in this categorisation. To simplify the diagram, relevant disciplines were integrated: geography and regional planning, and politics and public administration. Economics has been dominant throughout the past three decades, the proportion of papers covered by this discipline has ranged from 22% to 35%. Geography and regional planning also account for a high proportion of papers, but showed a decrease to 11% of papers in the 2000s from 26% in the 1980s. Operations Research and Management disciplines showed a steady increase to 20% of papers in the 2000s from 11% in the 1980s. The proportion of papers in the management discipline was a mere 4% in the 1980s but this has increased to 15% in the 2000s.

3.4. Theories, models and concepts

Theory building and knowledge creation in a research field or discipline is a core part of its development (Arlbjorn and Halldorsson, 2002; Burgess et al., 2006; Wacker, 1998). Researchers have suggested several ways to develop theories and

Table 3
Research strategy in port research.

Strategy	1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	2005–2009	Total
Analytical							
Conceptual	26	30	46	75	79	90	346 (41.2%)
Mathematical	6	10	9	15	48	50	138 (16.4%)
Statistical	0	0	1	0	0	3	4 (0.5%)
Empirical							
Experimental	0	0	0	0	0	0	0 (0%)
Statistical	2	9	6	10	58	87	172 (20.5%)
Case studies	15	16	19	32	30	68	180 (21.4%)
Total	49	65	81	132	215	298	840

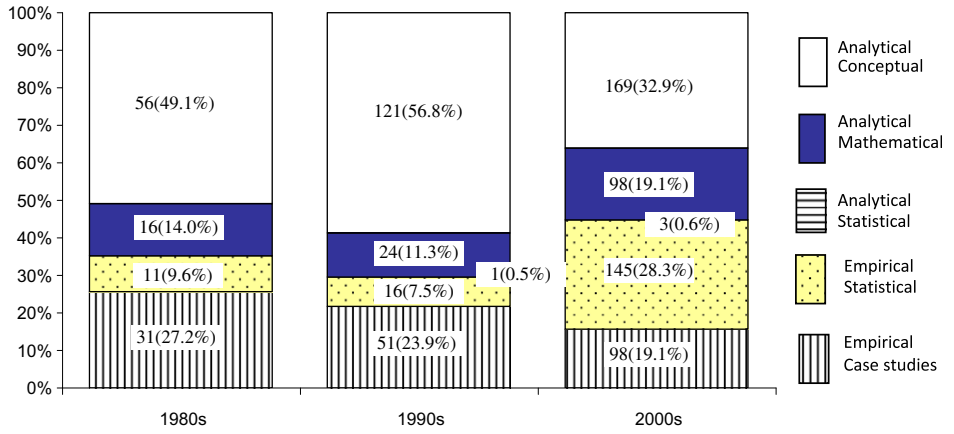


Fig. 1. Proportion of research strategies in port research.

Table 4
Discipline bases in port research.

Strategy	1980–1985	1985–1989	1990–1994	1995–1999	2000–2004	2005–2009	Total
Economics	16	25	15	31	85	93	265 (31.5%)
Geography	8	18	16	35	14	41	132 (15.7%)
Operations research	4	8	9	13	47	56	137 (16.3%)
Management							
Industrial relations	1	–	14	6	8	5	34 (4.0%)
Strategic management	–	–	2	–	12	15	29 (3.5%)
Logistics/SCM	–	–	–	–	2	15	17 (2.0%)
Marketing	–	–	–	1	1	9	11 (1.3%)
Information/communication	–	1	2	2	1	2	8 (1.0%)
HRM	2	–	2	2	–	2	8 (1.0%)
Organisational studies	–	–	–	–	1	2	3 (0.4%)
Regional planning	3	1	–	3	2	1	10 (1.25%)
Environmental studies	–	–	2	10	2	6	20 (2.4%)
Politics	1	–	–	–	–	3	4 (0.5%)
Public administration	2	–	–	1	6	4	13 (1.5%)
Not specific	12	12	19	28	34	44	149 (17.7%)
	49	65	81	132	215	298	840

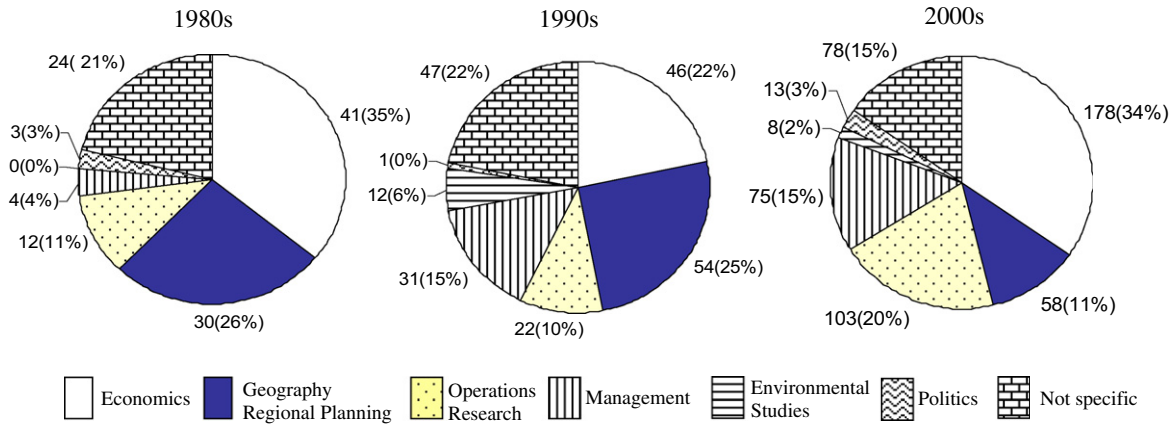


Fig. 2. Proportion of disciplines involved in port research.

create knowledge. It is suggested that researchers have 'borrowed' and 'imported' existing theories from other disciplines, and will or should continue to do so due to the various benefits from these practices (Amundson, 1998; Stock, 1997; Stock, 2002; Svensson, 2003), whereas some researchers have argued that new innovative theories should be developed (Van Maanen, 1995). According to Arlbjorn and Halldorsson (2002), theories can have different levels of abstraction. Grand theory

is concerned with 'lines of thoughts and interpretations representing a science such as classical economics and philosophy of science'. However, this present study is focused on middle-range theories 'reflecting connections between a set of concepts' or small-scale theories reflecting connections between a small number of concepts'. Thus, this study attempts to identify middle or small-range theories, theoretical models based on the theories and concepts used in the models from the selected papers. While this investigation aims to show which theories from which disciplines were applied in port research, it is also an intention to identify theories and models which are specific to port research. The results of this investigation are presented in Table 5.

Compared to the overall number of papers in this study, the number of papers in which theories and models were demonstrably used was not great. Papers of which theories and models were discernable by this paper's authors' knowledge, as listed in Table 5, accounted for only 26% of papers (217 out of 840). Similar is the observation by Burgess et al. (2006) showing existence of a considerable number of the articles with no discernable theory present among the articles included in their study. Even this number may have been exaggerated because some types of papers were counted only because they have applied analysis techniques which were developed based on particular theories. For example, the disaggregate choice model using the multinomial logit model applies the utility function. Papers applying logit models were thus counted under utility theory. The same applied to papers using Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) for production theory. It was also observed that there were few theoretical models which have been applied predominantly or consistently. The highlighted items in Table 5 are theoretical models and concepts applied in a consistent manner: input–output analysis, Production theory, Hayuth model and Port administration model.

Table 5
Theories, models and concepts used in port research.

Disciplines	1980s	1990s	2000s
Economics	Benefit-cost analysis (2) Input–output analysis (7) Demand–supply (1) Welfare theory (1) Production theory (4)	Agency theory (1) Economic rents (1) Collective bargaining (1) Game theory (1) Input–output analysis (5) Price differentiation (1) Production theory (6) Demand–supply (1) Externality (1)	Cournot model (2) Contestable markets theory (3) Coase theorem (1) Consumer theory (1) Economic base analysis (2) Game theory (5) Input–output analysis (3) Marginal cost pricing (5) Price differentiation (3) Price-cap regulation (2) Production theory (53) Transaction cost theory (1) Utility theory (12) Value added (1) Worlds of production (1)
Geography	Hayuth model (2) Hinterland concept (2) Port-city model (2) Site and situation (1)	Centrality, intermediacy (1) Hayuth model (4) Site and situation (4)	Hayuth model (1) Port-city model (3) Rimmer model (1) Site and situation (2) TMG (1)
Operations Research	Queuing theory (2)	Queuing theory (1)	Inventory theory (3) Queuing theory (3)
Management		Learning curve (1) Life-cycle theory (1) Strike model (3)	Agility (1) Competitive advantage (3) Co-opetition (1) E-markets model (1) ERP (1) Leanness (2), Marketing channel (2) Portfolio analysis (1) Resource-base theory (2) SERVQUAL (3) SCM (3) Strategic positioning (1) Social responsibility (1) System theory (1) Technology Acceptance model (1)
Computer science		Network analysis (3)	Network analysis (11) Neural network model (1)
Sociology, Psychology, Politics, others			Collective action (2) Institutional theory (2) Structure of provision (2) Power (1), Trust (2)
(Specific to port management)		Port administration model (1)	Port administration model (5)
No. of papers	24	37	156

Note: The numbers in brackets represent the numbers of papers using the corresponding theories, models and concepts.

Table 6
Research methods used in port research.

Methods	1980s		1990s		2000s		Total	
	No. papers	%	No. papers	%	No. papers	%	No. papers	%
Survey	4	3.5	11	5.2	60	11.7	75	8.9
Interview	3	2.6	9	4.2	16	3.1	28	3.3
Economic modelling	15	13.2	17	8.0	106	20.7	138	16.4
Mathematical modelling	9	7.9	18	8.5	68	13.3	95	11.3
Simulation	3	2.6	4	1.9	27	5.3	34	4.0
Case study	38	33.3	74	34.7	105	20.5	217	25.8
Conceptual work	42	36.8	80	37.6	124	24.2	246	29.3
Archival analysis	–	–	–	–	2	0.4	2	0.2
Content analysis	–	–	–	–	5	1.0	5	0.6
	114		213		513		840	

The disciplines from which the theories and models were borrowed were similar to those observed in the discipline bases categorisation. Theories and models from economics were applied the most. The number of theories and models used in geography was not great, but they showed consistency in application. They were introduced in port research in the 1980s (e.g. Hayuth, 1981) and continued to be applied to empirical studies (e.g. Notteboom, 1997; Wang, 1998) and to be extended to further stages of existing models (e.g. Notteboom and Rodrigue, 2005). The clear trend is the increasing involvement of concepts and models from the management disciplines into the 2000s. Although these concepts and models were applied in only a few papers respectively, the variety they exhibit may invite further application in port research.

The models or concepts which have been developed for port research specifically were also examined but only a few were identified. An obvious example was the port administration model (Baird, 1995), sometimes named the port function matrix. Others were theoretical models developed based on geography. One is the Hayuth model (Hayuth, 1981) which can be regarded as a generic model used in transport geography. However, according to his work, it is reasonable to understand that this model was developed to conceptualise the stages of spatial development in seaports based on the Taaffe, Morrill and Gould (TMG) model (1963). A similar model was also developed by Rimmer (1967) but it was not so frequently used. Port-city relationships suggested by Hayuth (1982) and by Hoyle (1989) were also examples of theoretical models developed specifically for seaports.

The low proportion of papers with discernable theories and models and the lack of theories and models specific to port operations and management may have made port research seen as a body of knowledge without firm theoretical bases or without original theories. Given the limitations, however, an increasing diversity in adopting or borrowing theories and models observed in the 2000s is a good sign showing possibilities of not only more involvement of the borrowed theories but also a mixture or combination among them, which is suggested to better address more complicated research problems. This is discussed further in Sections 4.2 and 4.3 examining disciplinary characteristics of port research.

3.5. Research methods

Researchers have various options on how to answer their research questions and the options for this study were chosen based on a review of existing literature (Mentzer and Kahn, 1995; Meredith et al., 1989; Sachan and Datta, 2005). The only key difference identified from the literature is economic modelling which is a modelling of objective reality applying economic theories. Papers using pure mathematical modelling to capture objective reality was categorised under mathematical modelling. The conceptual work category is rather extensive, encompassing conceptual modelling and descriptive studies. The results are presented in Table 6.

Case studies and conceptual works accounted for 55.1% of port research in this study. Economic modelling and Mathematical modelling accounted for 16.4% and 11.3% respectively. Survey and interview methods, which are normally used to capture people's perceptions, have not been extensively used in port research, visible in only 8.9% and 3.3% of papers respectively. Results in other research fields such as logistics and SCM show a much higher proportion of papers in the latter two categories.[2]

3.6. Data analysis techniques

Table 7 shows the results of investigation into data analysis techniques used in port research. Papers included used techniques to deal with either primary data obtained from survey and interview or secondary data in empirical research,[3] and the total number of these papers was 310, which accounted for 37.3% of all the selected papers. The proportions of papers for each

[2] Survey and interview accounted for, respectively, 54.3% and 13.8% of methodologies in Mentzer and Kahn (1995), and 34.6% and 6.8% respectively in Sachan and Datta (2005).

[3] Papers which adopted analysis tools and modelling techniques used in operations research such as Markov modelling, integer modelling and sensitivity analysis were excluded.

Table 7
Data analysis techniques in port research.

	1980s		1990s		2000s		Total	
	No.	%	No.	%	No.	%	No.	%
Descriptive statistics	18	51.4	25	49.0	68	30.0	111	35.5
Descriptive	*12*	*34.3*	*21*	*41.2*	*50*	*22.0*	*83*	*26.5*
Descriptive with index	*6*	*17.1*	*4*	*7.8*	*18*	*7.9*	*28*	*8.9*
Regression	6	17.1	10	19.6	37	16.3	53	16.9
Data Envelopment Analysis	–	–	2	3.9	30	13.2	32	10.2
Logit model	–	–	–	–	16	7.0	16	5.1
Stochastic Frontier Analysis	–	–	1	2.0	14	6.2	15	4.8
Input–output analysis	6	17.1	5	9.8	3	1.3	14	4.5
Multi-Criteria Decision Making	–	–	–	–	14	6.2	14	4.5
Factor analysis	–	–	1	2.0	11	4.8	12	3.8
ANOVA	1	2.9	3	5.9	3	1.3	7	2.2
Shift-share analysis	2	5.7	3	5.9	1	0.4	6	1.9
Error Correction Model	–	–	–	–	5	2.2	5	1.6
Structural Equation Modelling	–	–	–	–	5	2.2	5	1.6
Total Factor Productivity	1	2.9	–	–	2	0.9	3	1.0
Cluster analysis	1	2.9	–	–	2	0.9	3	1.0
t-test	–	–	–	–	3	1.3	3	1.0
Correlation	–	–	1	2.0	1	0.4	2	0.6
Time series analysis	–	–	–	–	1	0.4	1	0.3
Others	–	–	–	–	8	3.5	8	2.6
Sub-total	35	30.7	51	23.9	224	44.2	310	37.3
NA	79		162		289		530	
Total	114		213		513		840	

technique used was calculated against the total number of papers (=310). The main techniques used in port research were descriptive statistics (35.5%), regression (16.9%), DEA (10.2%), Logit model (5.1%) and SFA (4.8%).

As for decadal trends, the first observation of note was that data analysis techniques were used more extensively in the 2000s (=25, the number of data analysis techniques used including techniques recorded under 'others'), compared to the 1980s (=7) and 1990s (=9). It thus follows that the percentage of papers using data analysis techniques was higher in the 2000s (=44.2%) than those of the 1980s (=30.7%) and 1990s (=23.9%). It is also shown that the extent of reliance on descriptive statistics has reduced with the involvement of new techniques in the 2000s. While Mentzer and Kahn (1995) interpreted the high percentage of descriptive statistics usage in logistics research as stemming from the lack of hypothesis-testing oriented research, there could be a variety of explanations and interpretations.

A plausible explanation from these observations is that some particular types of research have gained more attention from port researchers because some techniques such as DEA, SFA, Logit model, Multi-Criteria Decision Making (MCDM), Error Correction Model (ECM) and Structural Equation Modelling (SEM) have more specific purposes and usages than descriptive statistics do. **DEA** and **SFA** are analytical tools for assessing the relative efficiency of port operations, and they were, therefore, applied primarily to port efficiency studies. These techniques were also used to evaluate the consequence of port reform (Cullinane et al., 2002; Cullinane et al., 2005) and the impact of regulation on port efficiency (Barros, 2003; Ferrari and Basta, 2009).

Logit model has been used for various purposes. Logit modelling has traditionally been used to determine or predict demand for freight and passengers in transport economics, using a discrete choice approach (Winston, 1985, p. 72). Therefore this model was frequently used in demand analysis for port services (Anderson et al., 2009; Veldman et al., 2005). However, due to the nature of this model being discrete choice, this model has been used more frequently in port selection studies (Garcia-Alonso and Sanchez-Soriano, 2009; Magala and Sammons, 2008; Malchow and Kanafani, 2001, 2004; Tongzon and Sawant, 2007).

A variety of **MCDM** methods was employed to evaluate competitiveness of particular ports and to develop strategies for competitiveness: Analytical Hierarchical Process (AHP) (Lirn et al., 2003, 2004; Ugboma et al., 2006), PROMETHEE (Castillo-Manzano et al., 2009; Guy and Urli, 2006), Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) (Celik et al., 2009), Gray Relation Analysis (GRA) (Teng et al., 2004; Huang et al., 2003), and Hierarchical Fuzzy Process (HFP) (Yeo and Song, 2006).

ECM is a dynamic model which is concerned with movement of dependent variables in any period, related to the previous period's difference from long-run equilibrium. The strength of ECM is that it allows an analyst to estimate both short term and long run effects of explanatory time series variables (DeBoef, 2001). In this context, ECM is used both for forecasting by predicting short-run adjustments of the dependent variable (Fung, 2001; Hui et al., 2004) and determining relationships between the variables, such as inter-port dynamics (Yap and Lam, 2006).

SEM is a statistical methodology that takes a confirmatory approach to the analysis of a structural theory (Byrne, 2001). Although SEM does not refer to a single statistical technique and has a variety of functions, it primarily enables a researcher to examine a complex model that comprises multiple causal relationships incorporating both unobserved and observed

variables. In addition this analytical tool stemmed from psychometrics and expanded to other disciplines such as marketing or education. In port research, SEM has been employed to examine the channel relationship (Bichou and Bell, 2007; Lai et al., 2008), the impact of people's perception on performance (Shang and Lu, 2009) and the Technology Acceptance Model (TAM) (Norzaidi et al., 2009).

3.7. Analysis in association with research themes

This section discusses the methodological issues in association with research themes of the literature included in this study. Content analysis on research themes in port research was attempted by Pallis et al. (2010) reviewing port literature published in 1997–2008. Woo et al. (2010a) categorised port literature in the same database used in the current study according to the literature's research themes which were devised as eight categories of research themes through a review process in their study. This section formulates a matrix encompassing the eight research themes and the four categories representing methodological alternatives, as shown in Table 8. The four categories are: discipline bases, theories and models, methods, and data analysis techniques. The analysis below therefore discusses variation or consistency in adopting the methodological alternatives in relation to the individual themes.

For 'Discipline Bases', in a similar way to the overall analysis pattern, economics, geography and operations research have generally been the key approaches, but some variation between research themes was found. Some research theme categories clearly had one discipline being the dominant approach: 'Terminal Operations' was almost entirely focused on operations research (99%), 'Spatial Analysis' was dominated by geography (93%), 'Competition and Performance' and 'Planning and

Table 8
Methodological analysis by research themes.

	Disciplines	Theories and models	Methods	Analysis techniques
Port policy	Economics (39%) Geography (12%) Environmental studies (7%) Others (42%)	Price-cap regulation (2) Contestable market (1) Coase theorem (1)	Conceptual (68%) Economic modelling (9%) Case study (9%) Interview (5%) Survey (5%)	Descriptive (3) DEA (2) Analytical (1) MCDM (1) Regression (1)
Governance and reform	Economics (29%) Industrial relations (26%) Geography (5%) Others (39%)	Port administration (6) Strike model (2) Worlds of production (1)	Case study (62%) Conceptual (17%) Survey (10%) Economic modelling (6%) Interview (5%)	Descriptive (11) Regression (4) DEA (1) SFA (1) ANOVA (1)
Management and strategy	Economics (19%) Strategic management (11%) Industrial relations (9%) Others (61%)	Marginal cost pricing (5) Game theory (4) Price differentiation (4)	Conceptual (49%) Case study (15%) Economic modelling (11%) Survey (10%) Others (13%)	Descriptive (10) Regression (7) SEM (3) Logit model (2)
Competition and performance	Economics (60%) Geography (9%) OR (5%) Others (26%)	Production theory (52) Utility theory (8) SERVQAUL (3)	Economic modelling (43%) Survey (20%) Case study (17%) Conceptual (11%) Others (10%)	DEA (29) Descriptive (22) SFA (14) MCDM (12) Logit model (11)
Ports in supply chains	Logistics/SCM (33%) OR (16%) Marketing (7%) Others (44%)	Supply chain strategy (2) Marketing channel (2) Competitive advantage (1)	Conceptual (40%) Survey (28%) Case study (19%) Interview (5%) Others (8%)	Factor analysis (4) Descriptive (4) t-test (2) SEM (2)
Planning and development	Economics (56%) OR (17%) Regional planning (5%) Others (22%)	Input–output analysis (15) Economic base analysis (2) Benefit-cost analysis (2)	Case study (29%) Economic modelling (29%) Conceptual (23%) Math modelling (9%) Others (10%)	Input–output (13) Regression (21) Descriptive (12) ECM (4) Logit model (3)
Terminal operations	OR (99%) Economics (1%)		Math modelling (65%) Simulation (21%) Conceptual (11%) Content analysis (2%) Economic modelling (1%)	-
Spatial analysis	Geography (93%) Economics (3%) OR (2%) Others (2%)	Hayuth model (7) Site and situation (5) Network theory (6) Port-city relationship	Case study (66%) Conceptual (36%) Math modelling (5%) Interview (1%) Others (3%)	Descriptive (20) Descriptive-index (17) Shift-share analysis (3) Factor analysis (2)

Note: The numbers in brackets in columns 'Theories and models' and 'Analysis techniques' represent the numbers of papers using the corresponding theories and models and analysis techniques.

Development' were substantially economics oriented (60% and 56% respectively). There were no dominant 'Theories or Models' apparent across the research themes. However, some research theme categories showed relatively high frequencies for particular theories and models. 'Governance and Reform' studies have employed 'port administration model' as the theoretical basis for their analyses. In 'Management and Strategy', theories related to economic price analysis such as 'marginal cost pricing' and 'price differentiation' strategy have been frequently used. In 'Competition and Performance', production theory and utility theory were well used, associated with particular analysis techniques, such as DEA, SFA and Logit model, resulting in more frequent adoption of economic modelling method (43%). In 'Planning and Development', analysis tools used for economic impact studies such as input–output analysis and economic base analysis were applied to assess the economic impact of port infrastructure and operations. It is worth highlighting that 'Spatial Analysis' has generated relatively stronger theoretic bases than other research theme categories, through the process of model formulation (Hayuth, 1981), application of the model to empirical cases (Notteboom, 1997; Notteboom, 2006; Wang, 1998) and proposals of extended or advanced modelling (Notteboom and Rodrigue, 2005; Van Klink, 1997, 1998). This development may have been attributed to theoretical discussion by transport geographers (e.g. Hayuth, 1981; Zalenski, 1972) arguing that '*the development of concepts, theory, and of analytical framework for specific application to port geography has been very slow and there has been little emphasis on the dynamics of port systems*'.

It is observed that studies in the same categories of research themes have adopted various methodological alternatives to varying degrees, while some groups of studies, such as 'Spatial analysis' of port system and 'Terminal operations', have formulated, to some extent, a typical type of approach addressing their research questions. Thus, it follows, in turn, that papers belonging to the same category in 'Research disciplines', 'Research methods' and 'Data analysis techniques', are not likely to share the same research themes or research objectives or conclusions. In addition, it is not clearly observed whether there are similarities or differences in terms of research objectives and conclusions among papers in the same methodological alternatives at the current state of analysis. However, an investigation into more specific levels of research themes (which were refereed to as 'research topic' in Woo et al., 2010a) may be able to provide some ideas on this issue. For example, when it comes to assessing port labour reform by 'port labour reform' studies, papers categorised into 'Economics' discipline (e.g. McNamara and Tarver, 1999; Saundry and Turnbull, 1997; Stoney, 1999; Trebeck, 1999) showed primarily more positive stances focusing on economic performance improvement, whereas papers in 'Industrial relations' (e.g. Coffey, 2009; Saundry and Turnbull, 1996; Turnbull, 2006) revealed different views demonstrating that port labour reform has weakened 'the totality of social relations between dockers' and 'the sense of workplace norms and obligation'. A philosophical stance of the latter is closer to non-positivistic sides such as 'radical structuralist' whereas that of the former is primarily 'positivistic'. An adoption of particular data analysis techniques may also have impact on the conclusions of studies sharing research objectives and questions as pursued by most researchers. In studies on technical efficiency of port operations, for example, DEA and SFA have primarily been used, and it is shown that the two alternative analysis techniques may result in disparities in research outcomes even with the same set of data (Cullinane et al., 2006). Therefore it can be tentatively stated that, among papers sharing objectives or questions at a specific level of grouping, there is a possibility that particular patterns in usage of the methodological alternatives are found. An examination on this issue requires further investigation than that of this paper, so this is left for future research.

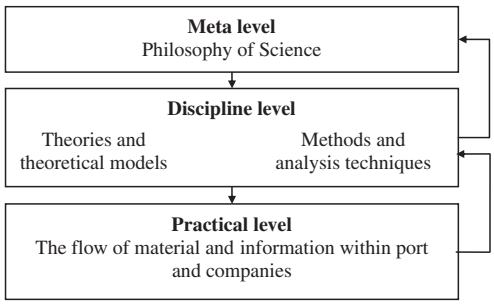
4. Discussion and research findings

Research is a process of creating knowledge and knowledge creation is a dynamic process in which three levels of knowledge creation interplay (Arlbjorn and Halldorsson, 2002) as shown in Fig. 3. The Meta level is concerned with issues related to philosophy of science, the Discipline level is concerned with topics within a research field and how to address those topics, and, thus, disciplinary characteristics and methodological discussion occurs at this level. The Practice level is concerned with phenomena taking place in a business field that the research is relevant to. As this framework fits comfortably with the approach taken in this study, the research findings are presented using this framework.

4.1. Meta level: philosophical stance

The investigation into the paradigmatic stance of port research (Table 2) revealed a strong dependence on the positivistic paradigm. Although Mangan et al. (2004) claimed that social sciences have been migrating from the positivistic paradigm towards the phenomenological paradigm, port research has not shown such trends taking a decadal view. This tendency is similar to that of other disciplines such as management information system (MIS) research (Alavi and Carlson, 1992) and SCM research (e.g. Burgess et al., 2006). Although there have been discipline-debates on the relative merits of paradigmatic unity and plurality (Kuhn, 1970; Poole and Van de Ven, 1989), it is suggested by a number of researchers that greater plurality of the research paradigm may lead to faster and more effective theory development (Mears-Young and Jackson, 1997; Naslund, 2002). This is in line with the lack of theories and theoretical models developed specifically for seaports. A multi-paradigmatic stance is more likely to lead to theoretical and methodological triangulation and may result in better theoretical bases of port research.

When it comes to interpreting the increase of empirical research in the 2000s (see Table 3 and Fig. 1), it is necessary to consider this paradigmatic stance and the lack of theory specific to port operation and management. Empirical research has



Source: Adapted from Arlbjorn and Halldorsson (2002)

Fig. 3. The interplay between the levels of knowledge creation.

more impact on its research field when theories developed specifically for the research field are examined and tested in an empirical situation. However it is reasonable to understand that the increase of empirical research in the last decade was attributed to more both the introduction of advanced analysis techniques and the greater availability of data, making these analyses possible (Heaver, 2006), than the application of 'developed or borrowed theories' to seaports.

4.2. Disciplinary level: disciplinary characteristics (multi- vs. inter-disciplinarity)

A terminology provided by Morillo et al. (2003) citing the OECD (1998) is adopted to identify the disciplinary characteristics of port research, which are multidisciplinarity, interdisciplinarity and transdisciplinarity. In multi-disciplinary research, 'the subject being studied is approached from different angles, using different disciplinary perspectives and integration is not accomplished'. Interdisciplinary research leads to 'the creation of theoretical, conceptual and methodological identity, so more coherent and integrated results are obtained' (Morillo et al., 2003). Transdisciplinarity 'goes on step further and it refers to a process in which convergence among disciplinesis observed' (Morillo et al., 2003). In other words, given the situation that several different disciplines are often present in a research field, the difference between multidisciplinarity and both interdisciplinarity and transdiscipliarity is whether integration between involved disciplines is attained or not.

It was clear from the investigation into the discipline bases and theoretical bases of port research that it has developed multidisciplinary characteristics and the intensity of the research has increased as shown in Fig. 4. In the 1980s, three primary disciplines, economics, geography and operation research were involved. In that decade, seaports were studied as a part of transport economics and transport geography, and this approach is still generally accepted. Therefore it is not surprising that theories and analytical tools used in transport economics and transport geography were applied to seaports by transport economists and transport geographers. This implies that economic and geographical theories were applied to seaports through sub-disciplines such as transport economics and transport geography rather than directly from the core disciplines of economics and geography.

In the 1990s, industrial relations and environmental studies began to be involved in port research due largely to the process of port reform undertaken throughout the world and to the increase in environmental concerns. In the 2000s, as shown, substantially more disciplines have been involved in port research. Management discipline areas such as strategic management, HRM, and information/communication appeared in the picture of port research. The involvement of these new disciplines had an important influence on theory transfer and application. Researchers, in this decade, tended to 'borrow' theories, models and knowledge and apply them to seaports directly from other disciplines, and independently of traditional primary disciplines such as transport economics and transport geography. This may have resulted in a blurring of territorial boundaries of the traditional disciplines, and led to interaction between them and with the newly-involved disciplines.

Then, the question which arises is: is port research moving towards becoming an interdisciplinary research field in its own right? Researchers suggest that interdisciplinary research is increasing since greater specialisation in science and complicated phenomena result in a greater necessity of combining knowledge from different fields (Lariviere and Gingras, 2010; Morillo et al., 2003). It is generally accepted that seaports, transport and services have become complicated and sophisticated and a more integrated research approach is necessary (Heaver, 2006). Panayides (2006) suggested a variety of research agenda and directions to reflect the convergence of maritime transport and logistics including the integration of ports in the concept of logistics and supply chains. Olivier and Slack (2006) argued that the emergence of trans-national terminal operating companies may be able to facilitate dialogue between economic geography and port geography which had traditionally exhibited a tendency to maintain ties with urban geography.

The investigation in this study has also revealed, to some extent, the possible existence of interplay among researchers from different disciplines at the level of theoretical models, research methods and analysis techniques. One possible combination is the association of geographical concepts and economic analysis. Accessibility and connectivity are traditional

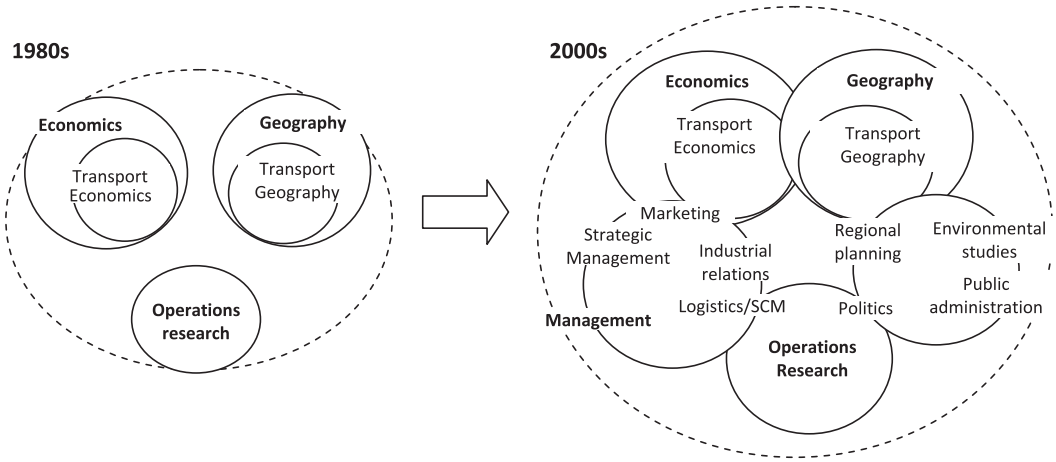


Fig. 4. Disciplinary evolution of port research.

concepts used in transport geography and they have been analysed recently using econometric analysis (Cullinane and Wang, 2009; Low et al., 2009; Wang and Cullinane, 2008). Another is the combination of economic concepts with a geographical context. Complements and substitutes which are basic concepts used in consumer theory in micro economics were applied to investigate relationships between load centres located in a single gateway region (Notteboom, 2009). Geography and public administration/politics is a further possibility (Hall, 2003), showing a spatial variation of institutional changes derived from common technological impacts such as containerisation. Interplay between economics and management disciplines is clearly very likely given their real-world association.

4.3. Tentative evidence of the disciplinary characteristics of port research

It can be concluded that port research is a multidisciplinary field and its multidisciplinarity has become greater during the past three decades, as shown previously in Table 4, since multidisciplinarity of a field is generally measured by the number of disciplines involved (Schummer, 2004). As for interdisciplinarity, port research appears to have had interdisciplinary characteristics for the past three decades based on the discussion above. However, to make this argument more convincing, this study attempted to measure the interdisciplinarity of port research. While there are various ways to measure interdisciplinarity of a research field, most use the ratio of the number of references made to papers assigned to a discipline which is different from that of the citing paper to the total number of references (Lariviere and Gingras, 2010). The data for this measurement are provided in *Journal Citation Reports of ISI Web of Knowledge*. However, leading journals which publish port research, such as *Maritime Policy and Management* and *Maritime Economics and Logistics*, are not registered in the database, so this study selected sample papers and calculated the ratio of each paper manually.

The sample was selected in a very conservative way, which is to choose a group of papers most unlikely to be interdisciplinary but which have the possibility of interacting with other disciplines. A group of port studies were selected, which analyse spatial development of port system and are suggested to be purely geography-based (see Section 3.7) ($n = 47$). Interdisciplinarity for each paper was measured by calculating the ratio of references published in journals of different disciplines such as economics and management. References in the papers included journal papers, books, government and institute reports, and internet articles. All the references in the papers were included in the total number of references, but references from sources other than journal articles were not included in the number of references from other disciplines, in order to maintain conservatism within the analysis.

This conservative approach resulted in a very low interdisciplinarity level, as shown in Table 8. The average ratio of references published in journals from different disciplines was 3.5% in the 1980s, increasing to 10.1% in the 2000s. The distribution of interdisciplinarity of each paper is shown in Fig. 5. The distribution in the 1980s and the 1990s showed a marked concentration within the range between 0% and 5%, while in the 2000s the levels were broadly equally distributed between 0% and 30%. Given the limitations of representativeness of the sample and the low level of interdisciplinarity measured, it was found that the interdisciplinarity level of the sample group of papers has increased significantly during the full period from the ANOVA results, as shown in Table 9. Based on this examination, a significant increase in interdisciplinarity level of port research for the last three decades is tentatively assumed.

4.4. Disciplinary level: Research methods and data analysis techniques

According to the investigation into research methods used in port research (see Table 6), port research shows a distribution skewed to 'artificial' types of research in the 1980s, but towards 'people's perceptions' types of research in the 2000s as shown in Fig. 6.

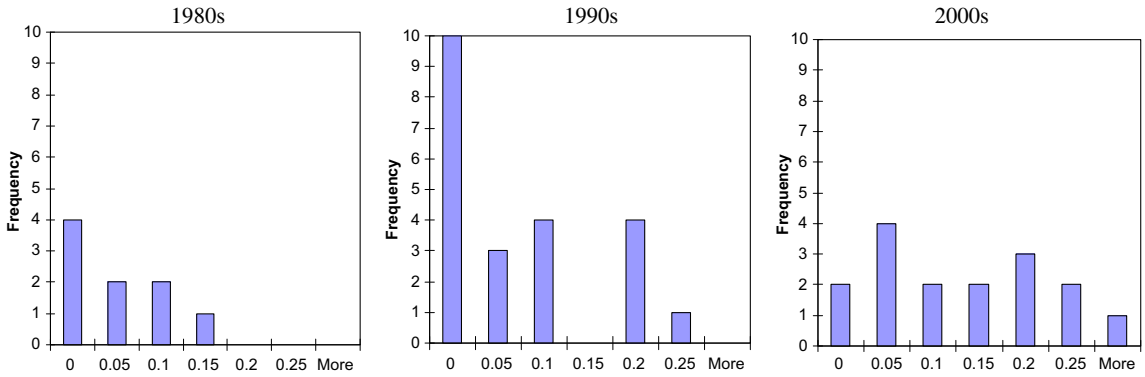


Fig. 5. Interdisciplinarity of port research.

Table 9
Interdisciplinarity of port research.

	1980s	1990s	2000s	ANOVA
Mean	3.5%	6.4%	10.1%	$F = 3.113*$
SD	0.04	0.08	0.08	$P = 0.05$

Given that conceptual work in the categorisation includes both conceptual modelling and descriptive studies, and case studies in port research rely on descriptive statistics rather than action research or field experiments, a considerable number of papers (typically economic and mathematical modelling) fall within the area of 'artificial-axiomatic' and 'artificial-positivist'. Methods employed to reflect peoples' perceptions, such as survey and interview, have been increasingly used, the proportion increasing from 6.1% of papers in the 1980s to 14.8% in the 2000s with a high proportion of 'artificial' type of research persisting through the past three decades.

Port research has exhibited dramatic advancements in terms of data analysis techniques in the 2000s (see Table 7). However, the techniques which were used more extensively, such as DEA, SFA, Logit model and ECM, are more suitable to deal with secondary data in association with economic or mathematical modelling than primary data obtained from survey or interview. For example, analytical tools which have strengths in testing hypotheses and, which, accordingly, in turn lead to theory development, such as SEM, have rarely been used in port studies compared to their popularity in other disciplines such as marketing.

5. Conclusion

This study addressed extensive methodological issues in port research including research paradigms, research strategies, discipline and theoretical bases, and research methods and analysis techniques during the past three decades. For the period under consideration, port research has shown healthy growth in terms of the number of research areas, and the number of theories and analysis techniques which have been 'borrowed' from other disciplines to meet the research demand. This has been the complexity of the relationships observed in the port industry. In addition, as for the disciplinary characteristics of port research, multidisciplinarity has become stronger and interdisciplinarity level is also assumed to have increased for the three decades. However, this study also revealed a methodological bias of port research towards the positivistic paradigm and economic and mathematical modelling approaches.

The question therefore arises as to how port research will and should be conducted in new environments: physical transport modes are becoming more closely integrated, strong inter-port competition exists, and increasingly ports have some form of private sector involvement in operations due to port privatisation. Thus port management is becoming market-oriented and, therefore, actor-, terminal-, firm-centred rather than policy-oriented and port-centred (Olivier and Slack, 2006; Panayides, 2006). Fig. 7 suggests a framework for knowledge creation in port research through interaction between the practitioners within the industry, and discipline dimensions and meta levels of port research.

The changes taking place at the practical/industry level have had a significant impact on research practices. Market-oriented and actor-centred port management is leading researchers to focus on analysis at a firm level involving Terminal Operating Companies (TOCs) rather than on analysis at a port level. This trend is already being realised through the increased number of market and industry analyses (Pallis et al., 2010; Parola and Musso, 2007; Soppe et al., 2009; Woo et al., 2010a,b). In addition, researchers are becoming more interested in the behaviour of TOCs in areas such as decision-making, choice and ownership.

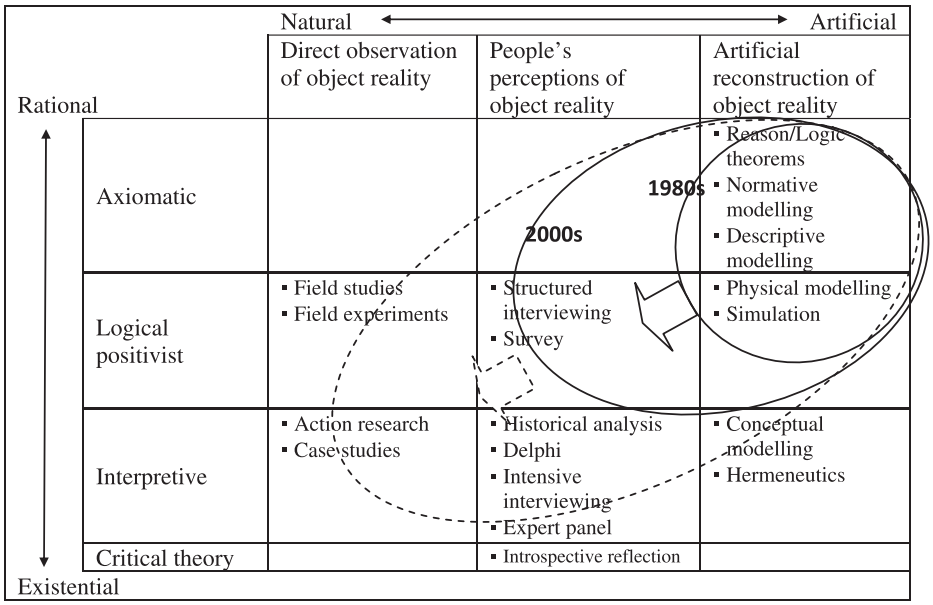


Fig. 6. A framework for research methods.

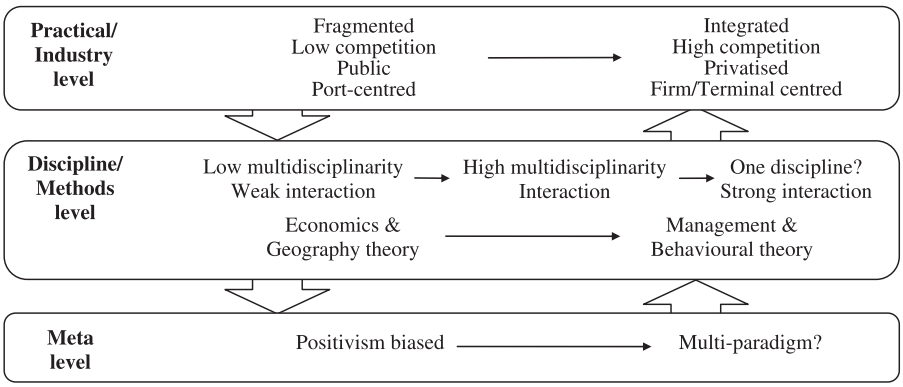


Fig. 7. Knowledge creation in port research in new environments.

Looking forward at the discipline level, both multidisciplinarity and interdisciplinarity will increase. In particular, behavioural approaches within economics and management studies are increasingly being used in port research. Theories used in marketing and strategic management, and behavioural approaches to theory of the firm, are also being applied. The geographical expansion of TOCs through horizontal integration will encourage interaction between economics and geography as suggested by Olivier and Slack (2006). Due to integration of TOCs along supply chains, researchers will pay more attention to strategic management theories such as competitive advantage and resource-based theory. It goes without saying that transaction cost theory will also provide a powerful theoretical base for this issue. Further, the application of psychological theories is inevitable in research associated with strategic management and SCM research.

Regarding the scope for extending investigation into the disciplinary characteristics of port research, two questions need to be addressed in future studies. The first, given the interdisciplinarity of port research which highlighted in this study, is whether the trend towards interdisciplinarity can be found across the full spectrum of port research. The second is whether the expected involvement of more disciplines and stronger interaction between them will result in the development of port research as a separate discipline. This discussion relates to several points such as whether such development is necessary or not, and, more subtly, how to evaluate a discipline. It is open to discussion as to whether the diverse group of theories and disciplines involved in port research, or alternatively the development of port research as a distinctive discipline, will make the greater contribution to port research (Harland et al., 2006).

As for methods and analysis techniques, the tendency to move towards the central concept of 'people's perception-positivist' approaches as shown in Fig. 6 will likely continue because human factors are necessarily involved in these types of research. Therefore, particular methods, such as surveys and interviews, will be required in order to incorporate companies' behaviour and people's perceptions into port research. However, more abstract and complicated concepts are expected to be used in the future, such as integration, cooperation, trust, power, relationships, and leadership, etc. Thus methods and analytical tools which can manage these concepts and multiple relationships among them will be required. Therefore Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) should be capable of contributing to the management of these methodological problems. In addition, qualitative research methods such as grounded theory and action research must also be used to develop theories from the empirical phenomena taking place in port industry. This will encourage the movement of more diverse paradigms in port research at the meta level. Thus it is possible that there will be further movement in the type of research conducted towards the 'direct observation' approaches as suggested.

It is worth discussing the findings and contribution of this study in the context of other transport research fields and logistics and SCM literature. A reliance on positivist research paradigm in port research is in line with the findings in review studies of logistics and SCM literature such as Burgess et al. (2006) and Sachan and Datta (2005), and maritime transport (e.g. Mangan et al., 2004). Increasing involvement of multi- or interdisciplinary approaches, which has been observed and is expected to take place in the future in port research, is also suggested in SCM research (Burgess et al., 2006) and intermodal transport research (Bontekoning et al., 2004) to address problems that are becoming more complicated. Contribution made by adopting advanced research methods and analytical tools to port research has been consistently observed in various research fields such as airport research (Tosic, 1992), vehicle-crash study (Lord and Mannering, 2010), and public transport research (Graham-Rowe et al., 2011; Guihaire and Hao, 2008), and, accordingly, further development and application of sophisticated methods and data analysis techniques are suggested in the research fields including port research.

Appendix A

Journals	1980–1989	1990–1999	2000-2009	Total
Maritime Policy and Management	55	82	96	233
Maritime Economics and Logistics	0	2	99	101
Journal of Transport Geography	0	11	18	29
International Journal of Transport Economics	1	8	17	26
Transportation Research Part A: Policy and practices	5	1	15	21
Geojournal	4	9	7	20
Transportation Research Part B: Methodological	3	5	12	20
Tijdschirft voor Economische en Sociale Geografie	4	9	5	18
Transportation Research Part E: Logistics and transportation review	0	2	15	17
Transport Reviews	1	1	13	15
European Journal of Operation Research	0	0	14	14
Transportation Journal	3	3	8	14
Coastal Management	3	7	3	13
Geoforum	5	4	3	12
Marine Policy	0	4	8	12
Environment and Planning A	2	3	6	11
Journal of Transport Economics and Policy	4	3	4	11
Applied Economics	1	0	9	10
Transport Policy	0	4	6	10
International Journal of Logistics: Research and Applications	0	0	9	9
International Journal of Physical Distribution and Logistics Management	3	1	5	9
International Journal of Production Economics	1	2	5	8
Journal of Waterway, Port, Coastal and Ocean Engineering	4	2	2	8
Growth and Change	2	1	4	7
European Journal of Transport and Infrastructure Research	0	0	6	6
Review of Network Economics	0	0	6	6
Industrial Relations Journal	0	3	2	5
Journal of Marine Science and Technology	0	0	5	5
Journal of Urban Technology	0	4	1	5
OR Spectrum	0	0	5	5
British Journal of Industrial Relations	0	3	1	4

(*continued on next page*)

Appendix A (*continued*)

Journals	1980–1989	1990–1999	2000-2009	Total
Computers and Industrial Engineering	0	3	1	4
Economic Affairs	0	4	0	4
Economic Geography	1	1	2	4
Journal of Transport Security	0	0	4	4
Simulation	1	2	1	4
Transportation Quarterly	0	2	2	4
Transportation	0	0	4	4
Transport Science	0	2	2	4
International Association of Traffic and Safety Sciences	0	0	3	3
Journal of Industrial Relations	0	2	1	3
Journal of Urban Planning and Development	0	0	3	3
Marine Pollution Bulletin	0	0	3	3
Ocean and Coastal Management	0	2	1	3
Professional Geographers	3	0	0	3
Transportation Research Part D: Transport and environment	0	0	3	3
Australian Geographers	2	0	0	2
Asian Pacific Viewpoint	0	0	2	2
Capital and Class	0	2	0	2
Economic Development Quarterly	0	0	2	2
Expert Systems with Applications	0	0	2	2
Human Geography	1	1	0	2
International Journal of Logistics Management	0	0	2	2
International Journal of Transport Management	0	0	2	2
Industrial Relations	0	0	2	2
Journal of Development Economics	0	1	1	2
Journal of Industrial Economics	1	0	1	2
Journal of International Logistics and Transport	0	0	2	2
Journal of Productivity Analysis	0	0	2	2
Journal of Strategic Information Systems	0	0	2	2
Journal of Transportation Law, Logistics and Policy	0	0	2	2
Logistics Information Management	0	1	1	2
Networks and Spatial Economics	0	0	2	2
Public Administration	1	1	0	2
Review of Urban and Regional Development	0	0	2	2
Sociological Review	0	2	0	2
Transportation Research Part C: Emerging Technologies	0	0	2	2
Transport	0	0	2	2
World Development	0	1	1	2
Work, Employment and Society	0	2	0	2
Asian Economic Journal	0	1	0	1
Applied Mathematics and Computation	0	0	1	1
Annals of Operation Research	0	0	1	1
Asian Pacific Education Review	0	0	1	1
Asian Pacific Journal of Marketing and Logistics	0	0	1	1
Area	1	0	0	1
Benchmarking: an International Journal	0	0	1	1
Cities	0	0	1	1
Cambridge Journal of Economics	0	1	0	1
European Journal of Industrial Relations	0	0	1	1
European Journal of Scientific Research	0	0	1	1
European Management Journal	0	0	1	1
Environment and Planning C	1	0	0	1
International Journal of Computer Applications in Technology	0	0	1	1
International Journal of Critical infrastructures	0	0	1	1
International Journal of Decision Sciences, Risk and Management	0	0	1	1

Appendix A (*continued*)

Journals	1980–1989	1990–1999	2000-2009	Total
International Journal of Environmental Technology and Management	0	0	1	1
International Journal of Integrated Supply Management	0	0	1	1
International Journal of Ocean Systems Management	0	0	1	1
International Journal of Public Sector Management	0	0	1	1
International Journal of Technology Management	0	1	0	1
International Labour and Working-Class History	0	0	1	1
Information and Management	0	0	1	1
Industrial Marketing Management	0	0	1	1
International Review of Business Research Papers	0	0	1	1
International Regional Science Review	0	0	1	1
Journal of Applied Transport	0	1	0	1
Journal of Business Logistics	0	0	1	1
Journal of Economics and Business	0	0	1	1
Journal of Forecasting	0	0	1	1
Journal of Hazardous Materials	0	0	1	1
Journal of Infrastructure Systems	0	0	1	1
Journal of Loss Prevention in the process industries	0	0	1	1
Journal of Labour Research	0	0	1	1
Journal of Management Development	0	1	0	1
Journal of Management Science	0	1	0	1
Management Decision	0	0	1	1
Oxford Bulletin of Economics and Statistics	0	1	0	1
Public Administration Review	1	0	0	1
Public Management Review	0	0	1	1
Political Geography	0	0	1	1
Planning Perspectives	0	0	1	1
Politics and Society	0	0	1	1
Queuing Systems	0	0	1	1
	0	1	0	1
Review of International Economics	0	0	1	1
Research of Policy Research	0	0	1	1
Regional Studies	0	0	1	1
Supply Chain Management: an international journal	0	1	0	1
System Practice and Action Research	0	0	1	1
Safety Science	0	0	1	1
Transaction of the Institute of the British Geographers	0	1	0	1
Transportation Planning and Technology	0	1	0	1
Urban Geography	0	0	1	1
Utilities Policy	0	0	1	1
World Review of Intermodal Transportation Research	0	0	1	1
	114	213	513	840

References

Alavi, M., Carlson, P., 1992. A review of MIS research and disciplinary development. Journal of Management Information Systems 8 (4), 45–62.

Amundson, S.D., 1998. Relationships between theory-driven empirical research in operations management and other disciplines. Journal of Operations Management 16, 341–359.

Anderson, C.M., Opaluch, J.J., Grigalunas, T.A., 2009. The demand for import services at US container ports. Maritime Economics and Logistics 11 (2), 156–185.

Arlbjorn, J.S., Halldorsson, A., 2002. Logistics knowledge creation: reflections on content, context and processes. International Journal of Physical Distribution and Logistics Management 32 (1), 22–40.

Baird, A.J., 1995. Privatisation of trust ports in the United Kingdom: review and analysis of the first sales. Transport Policy 2 (2), 135–143.

Barros, C.P., 2003. Incentive regulation and efficiency of Portuguese port authorities. Maritime Economics and Logistics 5 (1), 55–69.

Bichou, K., Bell, M.G.H., 2007. Internationalisation and consolidation of the container port industry: assessment of channel structure and relationships. Maritime Economics and Logistics 9 (1), 35–51.

Bontekoning, Y.M., Macharis, C., Trip, J.J., 2004. Is a new applied transportation field emerging? A review of intermodal rail-truck freight transport literature. Transportation Research Part A 38 (1), 1–34.

Burgess, K., Singh, P.J., Koroglu, R., 2006. Supply chain management: a structured literature review and implications for future research. International Journal of Operation & Production Management 26 (7), 703–729.

Burrell, G., Morgan, G., 1979. Sociological Paradigms and Organizational Analysis. Heinemann Books, London.
Byrne, B.M., 2001. Structural Equation Modeling with AMOS Basic Concepts, Applications, and Programming. Lawrence Erlbaum Associates, Mahwah, NJ.
Carter, C., Clegg, S., Hogan, J., Kornberger, M., 2003. The polyphonic spree: the case of the Liverpool Dockers. Industrial Relations Journal 34 (4), 290–304.
Castillo-Manzano, J.I., Castro-Nuno, M., Laxe, F.G., Lopez-Valpuesta, L., Arevalo-Quijada, M.T., 2009. Low-cost port competitiveness index: implementation in the Spanish port system. Marine Policy 33 (4), 591–598.
Celik, M., Cebi, S., Kahraman, C., Er, I.D., 2009. Application of axiomatic design and TOPSIS methodologies under fuzzy environment for proposing competitive strategies on Turkish container ports in maritime transportation network. Expert Systems Applications 36 (3), 4541–4557.
Chua, W., 1986. Radical developments in accounting thought. The Accounting Review 61 (4), 601–633.
Coffey, D., 2009. Old-time militancy and the economic realities: towards a reassessment of the dockers' experience. Industrial Relations Journal 40 (4), 292–308.
Cullinane, K., Talley, W.K., 2006. Introduction. In: Cullinane, K., Talley, W.K. (Eds.), Port Economics. Elsevier, London.
Cullinane, K., Toy, N., 2000. Identifying influential attributes in freight route/mode choice decisions: a content analysis. Transportation Research Part E 36, 41–53.
Cullinane, K., Wang, Y., 2009. A capacity-based measure of container port accessibility. International Journal of Logistics: Research and Applications 12 (2), 103–117.
Cullinane, K., Song, D.-W., Gray, R., 2002. A Stochastic frontier model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures. Transportation Research Part A 36, 743–762.
Cullinane, K., Ji, P., Wang, T.-F., 2005. The relationship between privatization and DEA estimates of efficiency in the container port industry. Journal of Economics and Business 57, 433–462.
Cullinane, K., Wang, T.-F., Song, D.-W., Ji, P., 2006. The technical efficiency of container ports: comparing data envelopment analysis and stochastic frontier analysis. Transportation Research Part A 40, 354–374.
DeBoef, S., 2001. Testing for cointegrating relationships with near-integrated data. Political Analysis 9, 78–94.
Fabian, F.H., 2000. Keeping the tension: pressures to keep the controversy in the management discipline'. Academy of Management Review 25 (2), 350–372.
Ferrari, C., Basta, M., 2009. Port concession fees based on the price-cap regulation: a DEA approach. Maritime Economics and Logistics 11 (1), 121–135.
Fung, K.-F., 2001. Competition between the ports of Hong Kong and Singapore: a structural vector error correction model to forecast the demand for container handling services. Maritime Policy and Management 28 (1), 3–22.
Garcia-Alonso, L., Sanchez-Soriano, J., 2009. Port selection from a hinterland perspective. Maritime Economics and Logistics 11 (3), 260–269.
Goles, T., Hirschheim, R., 2000. The paradigm is dead, the paradigm is dead. . .long live the paradigm: the legacy of Burrell and Morgan. Omega 28, 249–268.
Gonzalez, M.M., Trujillo, L., 2009. Efficiency measurement in the port industry: a survey of the empirical evidence. Journal of Transport Economics and Policy 43 (2), 157–192.
Goss, R.O., 2002. An early history of maritime economics. International Journal of Maritime Economics 4 (4), 390–404.
Graham-Rowe, E., Skippon, S., Gardener, B., Abraham, C., 2011. Can we reduce car use and, if so, how? A review of available evidence. Transportation Research Part A 45, 401–418.
Guba, E.G., Lincoln, Y.S., 1994. Competing paradigms in qualitative research. In: Denzin, N.K., Lincoln, Y.S. (Eds.), Handbook of Qualitative Research. Sage publication, Thousand Oaks.
Guihaire, V., Hao, J.-K., 2008. Transit network design and scheduling: a global review. Transportation Research Part A 42, 1251–1273.
Guy, E., Urli, B., 2006. Port selection and multicriteria analysis: an application to the Montreal–New York alternative. Maritime Economics and Logistics 8 (2), 186–196.
Hall, P.V., 2003. Regional institutional convergence? Reflections from the Baltimore waterfront. Economic Geography 79 (4), 347–363.
Harland, C.M., Lamming, R.C., Walker, H., Phillips, W.E., Caldwell, N.D., Johnson, T.E., Knight, L.A., Zheng, J., 2006. Supply management: is it a discipline? International Journal of Operation and Production Management 26 (7), 730–753.
Hayuth, Y., 1981. Containerization and the load center concept. Economic Geography 57 (2), 160–176.
Hayuth, Y., 1982. The port-urban interface. An area in transition. Area 14 (3), 219–224.
Heaver, T.D., 1993. The many facets of maritime economics, in association. Maritime policy and Management 20 (2), 122–132.
Heaver, T.D., 2006. The evolution and challenges of port economics. In: Cullinane, K., Talley, W., (Eds.), Port Economics. Elsevier, London, pp. 11–41.
Herod, A., 1998. Discourse on the docks: containerization and inter-union work disputes in US ports, 1995–1985. Transactions of the Institute of British Geographers 23, 177–191.
Hoyle, B.S., 1989. The port-city interface. Trends, problems and examples. Geoforum 20 (4), 429–435.
Huang, W.-C., Teng, J.-Y., Huang, M.-J., Kou, M.-S., 2003. Port competitiveness evaluation by fuzzy multicriteria grade classification model. Journal of Marine Science and Technology 11 (1), 53–60.
Hui, E.C.M., Seabrooke, W., Wong, G.K.C., 2004. Forecasting cargo throughput for the Port of Hong Kong: error correction model approach. Journal of Urban Planning 130 (4), 195–203.
Krugman, P., 1998. What's new about the new economic geography? Oxford Review of Economic Policy 14 (2), 7–17.
Krugman, P., 1999. The role of geography in development. International Regional Science Review 22 (2), 142–161.
Kuhn, T., 1970. The structure of Scientific Revolutions. University of Chicago Press, Chicago, IL.
Lai, K.-H., Bao, Y., Li, X., 2008. Channel relationship and business uncertainty: evidence from the Hong Kong market. Industrial Marketing Management 37 (6), 713–724.
Lariviere, V., Gingras, Y., 2010. On the relationship between interdisciplinary and scientific impact. Journal of the American Society for Information Science and Technology 61 (1), 126–131.
Lirn, T.-C., Thanopoulou, H.A., Beresford, A.K.C., 2003. Transhipment port selection and decision-making behaviour: analysing the Taiwanese case. International Journal of Logistics: Research and Applications 6 (4), 229–244.
Lirn, T.-C., Thanopoulou, H.A., Beynon, M.J., Beresford, A.K.C., 2004. An application of AHP on transhipment port selection: a global perspective. Maritime Economics and Logistics 6 (1), 70–91.
Lord, D., Mannering, F., 2010. The statistical analysis of crash-frequency data: a review and assessment of methodological alternatives. Transportation Research Part A 44 (5), 291–305.
Low, J.M.W., Lam, S.W., Tang, L.C., 2009. Assessment of hub status among Asian ports from a network perspective. Transportation Research Part A 43 (6), 593–606.
Magala, M., Sammons, A., 2008. A new approach to port choice modelling. Maritime Economics and Logistics 10 (1), 9–34.
Malchow, M., Kanafani, A., 2001. A disaggregate analysis of factors influencing port selection. Maritime Policy and Management 28 (3), 265–277.
Malchow, M., Kanafani, A., 2004. A disaggregate analysis of port selection. Transportation Research Part E 40 (5), 317–337.
Mangan, J., Lalwani, C., Gardner, B., 2004. Combining quantitative and qualitative methodologies in logistics research. International Journal of Physical Distribution and Logistics Management 34 (7), 565–578.
McNamara, T.M.J., Tarver, S., 1999. The strengths and weaknesses of dock labour reform – ten years on. Economic Affairs 19 (2), 12–17.
Mears-Young, B., Jackson, M.C., 1997. Integrated logistics-call in the revolutionaries. Omega 25 (6), 605–618.
Mentzer, J.T., Kahn, K.B., 1995. A framework of logistics research. Journal of Business Logistics 16 (1), 231–250.
Meredith, J.R., Raturi, A., Amoako-Gyampah, K., Kaplan, B., 1989. Alternative research paradigms in operations. Journal of Operation Management 8 (4), 297–326.
Metaxas, B.N., 1983. Maritime economics: problems and challenges. Maritime Policy and Management 10 (3), 145–164.
Min, H., Zhou, G., 2002. Supply chain modelling: past, present and future. Computers & Industrial Engineering 43, 231–249.

Morillo, F., Bordons, M., Gomez, I., 2003. Interdisciplinarity in science. A tentative typology of disciplines and research areas. Journal of the American Society for Information Science and Technology 54 (13), 1237–1249.
Naslund, D., 2002. Logistics needs qualitative research – especially action research. International Journal of Physical Distribution and Logistics Management 32 (5), 321–338.
Norzaidi, M.D., Chong, S.C., Murali, R., Salwani, M.I., 2009. Towards a holistic model in investigating the effects of intranet usage on managerial performance. A study on Malaysian port industry. Maritime Policy and Management 36 (3), 269–289.
Notteboom, T.E., 1997. Concentration and load centre development in the European container port system. Journal of Transport Geography 5 (2), 99–115.
Notteboom, T.E., 2006. Traffic inequality in seaport system revisited. Journal of Transport Geography 14 (2), 95–108.
Notteboom, T.E., 2009. Complementarity and substitutability among adjacent gateway ports. Environment and Planning A 41 (1), 743–762.
Notteboom, T.E., Rodrigue, J.P., 2005. Port regionalization: towards a new phase in port development. Maritime Policy and Management 32 (3), 297–313.
OECD, 1998. Interdisciplinary in Science and Technology. OECD, Paris.
Olivier, D., Slack, B., 2006. Rethinking the port. Environmental Planning A 38 (8), 1409–1427.
Pallis, A.A., Vitsounis, T.K., De Langen, P.W., 2010. Port economics, policy and management: review of an emerging research field. Transport Reviews 39 (1), 115–161.
Panayides, P.M., 2006. Maritime logistics and global supply chains: towards a research agenda. Maritime Economics and Logistics 8 (1), 3–18.
Panayides, P.M., Maxoulis, C., Wang, T.-F., Ng, K.Y.A., 2009. A critical analysis of DEA applications to seaport economic efficiency measurement. Transport Reviews 29 (2), 183–206.
Parola, F., Musso, E., 2007. Market structures and competitive strategies: the carrier-stevedore arm-wrestling in northern European ports. Maritime Policy and Management 34 (3), 259–278.
Poole, M., Van de Ven, A., 1989. Towards a general theory of innovation processes. in: Van de Ven, A., Angel, H., Poole, M., (Eds.), Research on the Management of Innovation, Harper & Row, New York, NY.
Rimmer, P.J., 1967. The search for spatial regularities in the development of Australian seaports, 1861–1961/2. Geografiska Annaler. Series B. Human Geography 49 (1), 42–54.
Sachan, A., Datta, S., 2005. Review of supply chain management and logistics research. International Journal of Physical Distribution and Logistics Management 35 (9), 664–705.
Saundry, R., Turnbull, P., 1996. Melee on the Mersey: contracts, competition and labour relations on the docks. Industrial Relations Journal 27 (4), 275–288.
Saundry, R., Turnbull, P., 1997. Private profit, public loss: the financial and economic performance of UK ports. Maritime Policy and Management 24 (4), 319–334.
Schummer, J., 2004. Multidisciplinarity, interdisciplinarity, and patterns of research collaboration in nanoscience and nanotechnology. Scientometrics 59 (3), 425–465.
Shang, K.-C., Lu, C.-S., 2009. Effects of safety climate on perceptions of safety performance in container terminal operations. Transport Reviews 29 (1), 1–19.
Soppe, M., Parola, F., Fremont, A., 2009. Emerging inter-industry partnerships between shipping lines and stevedores: from rivalry to cooperation? Journal of Transport Geography 17 (1), 10–20.
Spens, K.M., Kovacs, G., 2005. A content analysis of research approaches in logistics research. International Journal of Physical Distribution and Logistics Management 36 (5), 374–390.
Stahlbock, R., Vos, S., 2008. Operations research at container terminals: a literature update. OR Spectrum 30 (1), 1–52.
Steenken, D., Vos, S., Stahlbock, R., 2004. Container terminal operation and operations research – a classification and literature review. OR Spectrum 26 (1), 3–49.
Stock, J.R., 1997. Applying theories from other disciplines to logistics. International Journal of Physical Distribution and Logistics Management 27 (9/10), 515–539.
Stock, J.R., 2002. Marketing myopia revisited: lessons for logistics. International Journal of Physical Distribution and Logistics Management 32 (1), 12–21.
Stoney, P., 1999. The abolition of the National Dock Labour Scheme and the revival of the port of Liverpool. Economic Affairs 19 (2), 18–22.
Suykens, F., Van De Voorde, E., 1998. A quarter of a century of port management in Europe: objectives and tools. Maritime Policy and Management 25 (3), 251–261.
Svensson, G., 2002. The theoretical foundation of supply chain management: a functionalist theory of marketing. International Journal of Physical Distribution and Logistics Management 32 (9), 734–754.
Svensson, G., 2003. Holistic and cross-disciplinary deficiencies in the theory generation of supply chain management. Supply Chain Management: An International Journal 8 (4), 303–316.
Taaffe, E.J., Morril, R.L., Gould, P.R., 1963. Transport expansion in underdeveloped countries: a comparative analysis. The Geographical Review 53, 503–529.
Teng, J.-Y., Huang, W.-C., Huang, M.-J., 2004. Multicriteria evaluation for port competitiveness of eight East Asian container ports. Journal of Marine Science and Technology 12 (4), 264–265.
Tongzon, J.L., Sawant, L., 2007. Port choice in a competitive environment: from the shipping lines' perspective. Applied Economics 39 (4), 477–492.
Tosic, V., 1992. A review of airport passenger terminal operations analysis and modelling. Transportation Research Part A 26A (1), 3–26.
Trebeck, D., 1999. Port reform without tears – the New Zealand experience. Economic Affairs 19 (2), 23–30.
Turnbull, P.J., 2006. The war on Europe's waterfront: repertoires of power in the port transport industry. British Journal of Industrial Relations 44 (2), 305–326.
Ugboma, C., Ugboma, O., Ocwude, I.C., 2006. An Analytic Hierarchy Process (AHP) approach to port selection decisions: empirical evidence from Nigerian ports. Journal of Maritime Economics and Logistics 8 (3), 251–266.
Van Maanen, J., 1995. Fear and loathing in organization studies. Organization studies 6 (6), 687–692.
Van Klink, H.A., 1997. Creating port networks: the case of Rotterdam and the Baltic region. International Journal of Transport Economics 14 (3), 393–409.
Van Klink, H.A., 1998. The port network as a new stage in port development: the case of Reotterdam. Environment Planning A 30 (1), 143–160.
Veldman, S.J., Buckmann, E.H., Saitua, R.N., 2005. River depth and container port market shares: the impact of deepening the Scheldt River on the West European container hub-port market shares. Maritime Economics and Logistics 7 (4), 336–355.
Wacker, J.G., 1998. A definition of theory: research guidelines for different theory-building research methods in operations management. Journal of Operations Management 16, 361–385.
Wang, J.J., 1998. A container load center with a developing hinterland: a case study of Hong Kong. Journal of Transport Geography 6 (3), 187–201.
Wang, Y., Cullinane, K., 2008. Measuring container port accessibility: an application of the Principal Eigenvector Method (PEM). Maritime Economics and Logistics 10 (1), 75–89.
Winston, C., 1985. Conceptual developments in the economics of transportation: an interpretive survey. Journal of Economic Literature 23 (1), 57–94.
Woo, S.-H., Pettit, S.J., Kwak, D.-K., 2010a. Trends and themes in port research since 1980-a decadal approach. In: Proceedings of the IAME Annual Conference, Lisbon, Portugal.
Woo, S.-H., Pettit, S.J., Kwak, D.-K., 2010b. Methodological issues pertaining to port research since 1980. In: Proceedings of the IAME Annual Conference, Lisbon, Portugal.
Yap, W.Y., Lam, J.L., 2006. Competition dynamics between container ports in East Asia. Transportation Research Part A 40 (1), 35–51.
Yeo, G.-T., Song, D.-W., 2006. An application of the hierarchical fuzzy process to container port competition: policy and strategic implications. Transportation 33 (4), 409–422.
Zalenski, J., 1972. Remarks on the range of methods of research of geography of sea transport. Geographia Polonica 21, 79–89.