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Determinants of carrier selection: updating the survey methodology into the 21st century

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Abstract

This paper summarizes the key developments of carrier selection literature, especially from the view of survey research. Based on the literature review suggestions on how to make the analysis of carrier selection more rigorous are made. In addition to the most predominant determinants of carrier selection such as cost, reliability and service level, new constructs measuring the role of information sharing capabilities and environmental issues are introduced.

The second objective of the paper is to empirically test the suggested improvements in methodology with survey data. Research constructs measuring the role of both the old and new determinants of carrier selection are formulated and tested. Further, the constructs of carrier selection are tested against set of variables classifying the firms such as firm size, industry and strategic orientation of the firm in order to see if the strategic orientation of the firm is influencing the carrier selection criteria. Methods of content analysis are used to sum up the previous literature in order to identify the key determinants of carrier selection that have previously been used. Based on the literature review, updated research constructs of carrier selection are formulated. Further, these constructs are tested with factor analysis in order to analyze the validity of the constructs.

The empirical data employed in the analysis consists of a self-reported survey data of 483 manufacturing and trading firms operating in Finland. The survey data is analyzed by using descriptive statistics, correlation analysis and ANOVA in order to see whether the carrier selection criteria are dependent on the characteristics of the firm.

The paper is expected to contribute on two separate levels. First, the paper introduces and empirically tests an improved survey methodology of how to analyse the carrier selection. As the survey methodology includes new constructs such as the role of information sharing and environmental questions, the empirical results presents evidence on what is their relative role compared to more traditional determinants of carrier selection. Further, the results provide empirical evidence on the effect of firm characteristics on the importance of carrier selection criteria.

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1. Introduction

For the past 40 years, analyzing the determinants of carrier selection has been one of the veins of transportation and supply chain management research. Historically, carrier selection has been considered as a two-step process, including both the selection of the mode and the selection of carrier within that mode, traditionally in that order (Meixell and Norbis, 2008). Today, this definition as such can be considered out of date, as more and more firms acquire mainly a service of transporting goods to a certain location, leaving the choice of transport mode to the chosen service provider. Even as the definition of carrier selection might be in need of updating, the basic question still remains the same. What are the key motives of selecting the service provider for the needed transport, be it a carrier in a more traditional sense, or a logistics service provider in a wider sense. Past research has addressed the selection of freight carrier from various perspectives. One of the approaches to analyze carrier selection or transport mode choice is the mathematical modelling approach based on inventory-theoretic framework and calculation of total logistics costs as a determinant for optimal mode choice. Already in 1970, Baumol and Vinod modelled the trade-off between transportation costs and inventory carrying costs as part of the model choice decision. Later Sheffi et al. (1988), Tyworth and Zeng (1998) and Blauwens et al. (2006) among others have used a similar approach.

Another, widely used way of analyzing the determinants of carrier selection is the survey methodology, which is in the center of this article. Since the first attempts to identify the determinants of carrier selection by Bardi (1973) over 40 years ago, numerous authors have attempted to capture the essence of carrier selection by using a survey methodology.

During the past 40 years, numerous authors have also summarized the existing body of literature at different time-points. Daley and Lambert compiled the existing literature in 1980, summarizing the findings thus far and suggesting new paths for the carrier selection research, whereas McGinnis (1990) and Liberatore and Miller (1995) did the same in the beginning of the 1990s. In the 21st century, Dobie (2005) and Meixell and Norbis (2008) have brought the carrier selection literature up to date, by introducing the existing body of research from different perspectives.

This article concentrates especially on the carrier selection research performed with survey methodology. Even though the research question is rather specific, many journals in the field of logistics and supply chain management have considered it suitable for discussion in their own forum.

Table 1 presents the articles included in this review. As can be seen from the table, a substantial share of the carrier selection discussion has taken place in *Transportation Journal*, in which 11 of the articles approaching the carrier selection with a survey methodology have been published. The central role of *Transportation Journal* is visible also when the timeline is considered. The first articles by Bardi (1973) and Stock and LaLonde (1977) were published in *Transportation Journal*, as was the last reviewed article by Williams et al. (2013).

Outside the *Transportation Journal*, carrier selection studies have been published also in journals focusing on supply chain management, rather than in transportation research. In the 1990s, 2 carrier selection surveys were published in *Journal of Business Logistics*. In late 90s and early 2000s as many as four articles addressing the question of carrier selection were published in *International Journal of Physical Distribution & Logistics Management*.

Surprisingly, the carrier selection surveys have been outside the scope of *Transportation Research*, with only a single article published. On the other hand, it would seem that the inventory theoretic approach and other modelling approaches have been considered more suitable for the *Transportation Research*.

Table 1. Articles included in the review, sorted by journal of publication

Journal	Articles
Transportation Journal (11)	Bardi (1973), Stock and LaLonde (1977), McGinnis (1978), Bardi et al. (1989), Abshire and Premeaux (1991), Evers et al. (1993), Crum et al. (1997), Kent et al. (2001), Premeaux (2002), Voss et al. (2008), Williams et al. (2013)
International Journal of Physical Distribution & Logistics Management (4)	Pedersen and Gray (1998), Kent and Parker (1999), Pearson and Semeijn (1999), Gibson et al. (2002)
Industrial Marketing Management (2)	Anderson et al. (1978), Krapfel and Mentzer (1982)
Journal of Business Logistics (2)	Lambert et al. (1993), Menon et al. (1998)
Journal of Business Research (1)	Coulter et al. (1989)
International Journal of Logistics Management (1)	Semeijn (1995)
Transportation Research Part E (1)	Murphy et al. (1997)
Maritime Policy and Management (1)	Wong et al. (2008)

The objective of this article is to perform a critical review on the previous survey research on carrier selection. The target groups, response rates and generalizability of the previous studies, as well as the used analyses methods and the key results are summarized in order to come up with recommendations for improvements in both the survey tool and the analysis methods.

First, the generalizability of the previous research is reviewed through the target groups and response rates of the surveys. Second, the various survey instruments are discussed, after which the analysis methods used by the previous authors are reviewed. Finally, suggestions for improving the survey tool and the analysis methods are made, based on the reviewed literature.

2. Generalizability of previous surveys

Table 2. presents the basic details of the reviewed surveys. From the 23 surveys included, 4 were published on the 1970s, 4 on the 1980s, 9 on the 1990s and 6 during the 21st century. Overall, it would seem that the carrier selection theme has remained as a timely topic during the years, even though the frequency of the articles has peaked on the 1990s.

There have been various approaches towards surveying the determinants of carrier selection. The most common way has been to approach the question from the perspective of the shippers. Of all the surveys included, 13 of approached the determinants of carrier selection solely from the perspective of the shippers

Table 2. Basic details of the reviewed articles

Year	Authors	Shippers	Carriers	N	Response rate	Industries
1973	Bardi (1973)	X		186	75%	Multiple
1977	Stock, LaLonde (1977)	X		74	20.7%	Multiple
1978	McGinnis (1978)	X		351	35.1%	Multiple
1978	Anderson et al. (1978)		X	493	Not reported	
1982	Krapfer, Mentzer (1982)	X		230	44.3%	Multiple
1989	Bardi et al. (1989)	X		296	20.4/18.8%	Multiple
1989	Coulter et al. (1989)	X	X	90	24.12%	Multiple
1991	Abshire, Premeaux (1991)	X	X	102/94	29%	Multiple
1993	Lambert et al. (1993)	X		316	28%	Multiple
1993	Evers et al. (1993)	X		128	Not reported	Multiple
1995	Semeijn (1995)	X	X	305/27	23.9%	Multiple
1997	Crum et al. (1997)		X	203	17.4%	Carriers
1997	Murphy et al. (1997)	x	x	325/337	20%/17%	Multiple
1998	Pedersen, Gray (1998)	X		69	23%	Multiple
1998	Menon, McGinnis, Ackerman (1998)	X		41	25.2%	Multiple
1999	Kent, Parker (1999)	X	X	58	46.4%	Multiple
1999	Pearson, Semeijn (1999)	X		301	23.6%	Multiple
2001	Kent et al. (2001)	X	X	753	31%	Multiple
2002	Gibson et al. (2002)	X	X	100	50%	Carriers
2002	Premeaux (2002)	X	X	369/311	36.9%/31.1%	Multiple
2006	Voss et al. (2006)	X		100	Not reported	Multiple
2008	Wong et al. (2008)	X		82	9%	Multiple
2013	Williams et al. (2013)	X		222	Not reported	Multiple

Another option is naturally to survey the determinants from the perspective of the carrier. This kind of approach was used by Anderson et al. (1978) and Crum et al. (1997). As one might assume that the perceptions towards the carrier selection criteria are different between the shippers and carriers, the remaining 8 compared the differences between the shippers and carriers perspectives on the determinants of carrier selection.

The sample sizes of the surveys, as well as the respondent rates vary considerably. Of the 23 articles, the lowest number of respondents (41) was reported by Menon et al. (1998), and the highest number of respondents (753) was reported by Kent et al. (2001). The lowest response rate (9%) was reported by Wong et al. (2008), whereas Bardi (1973) had the highest response rate of 75%. The average number of respondents was 221, and the average response rate was 28.74%. In 4 articles, the response rate was left unreported. Overall the response rates would seem to be in line with surveys of similar scales, as reported by Wagner and Kemmerling (2010).

Even though the response rates of the surveys may be considered adequate, a discussion of generalizability of the results would be needed. In addition, discussion of validity and reliability of the results is considered more or less as a norm, when re-reporting survey results.

Only 2 of the surveys (Coulter et al. 1989 and Premeaux, 2002) have attempted to discuss the used sample further, and compared it with the entire population. Generally, it would seem that the sampling procedures followed by the previous authors have been alternating. For example, some of the authors (Kent and Parker 1999) have used industry listings such as 100 largest firms of the industry as a respondent base, whereas some others have used the subscriber databases of industry magazines (Kent et al. 2001) as sources for contacts.

In relation to the generalizability of the results, one also has to take into account the possibility of the non-response bias, in other words if the respondents of the survey differ significantly from the non-respondents. Bardi et al. (1989) were the first ones to discuss the possible bias of the sample by comparing the sizes of the respondents to the entire population. Since 1990s, discussion of the non-response bias seems to have become a norm in reporting the survey results. Non-response bias was addressed by Abshire and Premeaux (1999), Lambert et al. (1993), Evers et al. (1993), Murphy et al. (1997), Menon et al. (1998), Kent and Parker (1999), Kent et al. (2001) and Premeaux (2002). Surprisingly, four of the surveys (Gibson et al. 2002, Voss et al. 2006, Wong et al. 2008 and Williams et al. 2013) done in the 21st century left the question of possible non-response bias untouched. The most used way of tackling non-response bias was the comparison of the results of different response waves, as suggested by Armstrong and Overton (1977).

Even though the constructs used in the surveys were numerous, and thus were mostly previously untested, the majority of the articles analyzed left the question of validity of the used constructs untouched. Krapfer and Mentzer (1982), Coulter et al. (1989), Lambert et al. (1993) and Kent et al. 2001 used a test group in order to up-grade the wording and increase the content validity of the constructs. Wong et al. 2008 addressed the question of content validity by applying a Delphi –method in order to create valid constructs.

3. Scales used in the survey questions

In the articles analyzed, various different scales and formulations were used. The most typical way of evaluating the role of the different determinants was by asking the respondents to evaluate the determinants using a Likert–scale. Table 3 presents the scales used in the surveys. The most commonly used scale was a 5-point Likert–scale which was used in 10 surveys (Anderson et al. 1978, Bardi et al. 1989, Abshire and Premeaux 1991, Evers et al. 1993, Murphy et al. 1997, Menon et al. 1998, Kent and Parker 1999, Gibson et al. 2002, Premeaux 2002 and Voss et al. 2006).

In 6 surveys a 7-point scale ranging from 1 to 7 was used (Bardi, 1973, Lambert et al. 1993, Semeijn 1995, Crum et al. 1997, Pearson and Semeijn 1999 and Kent et al. 2001). Coulter et al. 1989 were the only ones to use a 4-point Likert-scale. In addition, other types of scales were also used. Stock and LaLonde (1977) asked the respondents to evaluate the determinants on a scale between 1 and 100. In addition to using a five point scale, Voss et al. (2006) used also another methodology, and requested the respondents to allocate 100 points to the 9 determinants they used.

Williams et al. (2013) asked the respondents to rank the determinants from the most important (1) to least important (17). Four of the articles did not report the used scale.

Table 3. Scales used in the reviewed surveys

Year	Article	Scale	
1973	Bardi (1973)	1-7	Of lesser importance-Of greater importance
1977	Stock, LaLonde (1977)	1-100	
1978	McGinnis (1978)	Not reported	
1978	Anderson et al. (1978)	1-5	Not important-extremely important
1982	Krapfer, Mentzer (1982)	Not reported	
1989	Bardi et al. (1989)	1-5	very high-very low
1989	Coulter et al. (1989)	1-4	Not important- Very important
1991	Abshire, Premeaux (1991)	1-5	Not important-Most important
1993	Lambert et al. (1993)	1-7	Not important- Very important
1993	Evers et al. (1993)	1-5	Poor-Excellent
1995	Semeijn (1995)	1-7	Very unimportant-Very important
1997	Crum et al. (1997)	1-7	Not important-Extremely important
1997	Murphy et al. (1997)	1-5	Highest importance-Lowest importance
1998	Pedersen, Gray (1998)	Not reported	
1998	Menon, McGinnis, Ackerman (1998)	1-5	Strongly agree-Strongly disagree
1999	Kent, Parker (1999)	1-5	Highest importance-Lowest importance
1999	Pearson, Semeijn (1999)	1-7	Not very important-Very important
2001	Kent et al. (2001)	1-7	Not important-Very important
2002	Gibson et al. (2002)	1-5	No importance-Critical importance
2002	Premeaux (2002)	1-5	Not important-Most important
2006	Voss et al. (2006)	1-5	Allocation of 100 points to 9 determinants
2008	Wong et al. (2008)	Not reported	
2013	Williams et al. (2013)		Rankings 1-17

None of the articles further analyzed either the choice of the used scale, or the effects the chosen scale might have on the results. As Finn (1972) and Dawes (2008) have stated, the used scale does in fact have an effect on the observed

results. The coarser the used scale, the more skewed the data would seem to be towards the higher end of the scale. As the skewness in many cases will have an effect on the observed averages, there might be room for some consideration about the used scale.

Also, some of the research methods are sensitive to the assumption of normality of the distributions. As the five-point Likert-scale is causing skewness of the data, one should be careful in both the selection of the scale, and the analysis of the data. For example, regression analysis used by Krapfer and Mentzer (1982) and Evers et al. (1993) may produce biased results with non-normally distributed data (McCulloch et al. 2008).

Similar problem arises with the exploratory factor analysis widely used in the analyzed articles. According to Babakus et al. (1987), the skewness of the variables either increases or decreases the observed correlations between the variables, thus affecting the factor loadings. This would in effect decrease the reliability of the used constructs if not treated properly.

In 13 articles the response scale was set between “not important” and “very important” or some close variant like “extremely”, “highest” or “critical” importance. Bardi et al. (1993) used the scale “very high-very low” and Evers et al. (1993) “Poor-Excellence”. Menon et al. (1998) were the only ones who asked the respondents to take stand on whether they agreed or disagreed with different statements regarding the importance of the determinants of carrier selection. As a summary, it would seem that the established way of studying the determinants of carrier selection is to ask the respondents to rank the importance of the individual determinants in 5-point Likert scale. Considering the concern raised by Finn (1972) and Dawes (2008), the choice of the scale should be done with caution.

4. Determinants of carrier selection during the past 40 years

As the carrier selection has been on the research agenda, and a significant number of researchers have addressed the research question during the past years, the topic has experienced a long development process, which has created a lot of variability.

Already the first glimpse at the articles, and the measures and constructs that have been employed in the surveys reveals that there is hardly any kind of consensus in which determinants to include and which to exclude. Some of the authors have decided to analyze the carrier selection criteria by using a rather limited number of determinants, whereas some others have created an extensive list of determinants, covering a large variety of different themes. McGinnis (1978) and Krapfer and Mentzer (1982) have used a short list of 7 determinants of carrier selection, and Menon et al. (1998) managed with 8. On the other end of the scale, Gibson et al. (2002) included a total of 42 different determinants on their questionnaire, whereas Wong et al. (2008) had the highest number of determinants of all the surveys analyzed with 50. In some cases, the initial number of determinants has been larger than the reported number. For example, Lambert et al. (1993) mention that the original survey contained a total of 199 attributes (determinants), but in their article they report only a small fraction of them. Table 4, summarizes the numbers of determinants reported in the articles.

As the number of determinants in different surveys varies so much, it is quite obvious that there is large variation between the surveys on which areas they cover, and which ones are left out of the analysis. In addition, different authors have used slightly different terminology in their questionnaire, even when referring to the same determinant. For example, the determinant referring to the cost of transportation was phrased in multiple ways. Bardi et al. (1973) used the term “transportation rate”, whereas Stock and LaLonde (1977) used “Freight charges”. Since these first surveys, practically every combination of freight/ transportation and rates/ charges has been used in multiple surveys.

Table 4. Number(s) of determinants used in the reviewed articles

Year	Article	Number of determinants included in the analysis
1973	Bardi (1973)	16
1977	Stock, LaLonde (1977)	21
1978	McGinnis (1978)	7
1978	Anderson et al. (1978)	14
1982	Krapfer, Mentzer (1982)	7
1989	Bardi et al. (1989)	15
1989	Coulter et al. (1989)	20
1991	Abshire, Premeaux (1991)	33
1993	Lambert et al. (1993)	11
1993	Evers et al. (1993)	18
1995	Semeijn (1995)	28
1997	Crum et al. (1997)	21
1997	Murphy et al. (1997)	17
1998	Pedersen, Gray (1998)	15
1998	Menon, McGinnis, Ackerman (1998)	8
1999	Kent, Parker (1999)	18
1999	Pearson, Semeijn (1999)	26
2001	Kent et al. (2001)	16
2002	Gibson et al. (2002)	42
2002	Premeaux (2002)	33
2006	Voss et al. (2006)	9
2008	Wong et al. (2008)	50
2013	Williams et al. (2013)	16

Altogether, in the 23 surveys covered, there were a total of 87 different determinants. Some of the determinants were used in a single survey, whereas some of the determinants were used widely. In order to identify the most widely used determinants, the frequency of appearance of each determinant was calculated. Table 5 presents the 20 most frequently used determinants in the 23 surveys covered. Of all the determinants, transportation rate or freight charges in some form were the most commonly used determinant. It was included in 21 surveys out of 23. The only surveys that had not rates or charges as one of the determinants were Anderson et al. (1978) and Gibson et al. (2002). In their survey, Anderson et al. (1978) deliberately concentrated on quality-related determinants such as technical ability, service orientation and image, rather than on cost-related issues. Gibson et al. (2002) included a few determinants related to costs, addressing them more from the point of view of being able to affect the cost level, rather than the price level itself.

Table 5. The 20 most commonly used determinants in the reviewed articles

Rank	Determinant	No. of surveys
1	Transportation rate/ Freight charges	21
2	Loss and damage history of the carrier	19
3	Ease of claim settlement	18
3	Transit time	18
5	Reliability of transit time	16
6	Tracking and tracing possibility	15
7	Carrier reputation	12
7	Availability of pickup and delivery service	12
7	Quality of sales personnel/ cooperation skills	12
10	Financial stability of the carrier	11
10	Availability of equipment	11
10	Pricing flexibility	11
10	Quality of carrier personnel (including drivers)	11
14	Ability to handle special requests	10
15	Frequency of service	9
15	Geographic coverage of carrier	9
15	Information provided to shippers by the carrier	9
18	Accuracy of invoicing	8
18	Personal relationship with carrier	8
18	Availability of consolidation services	8

The second most frequently asked determinant was the loss and/ or damage performance of the carrier, which was included in some form or another in 19 surveys. Of the ones that did not include the damage performance, Kent et al. (2001) used a four –factor model in which the customer service factor included other items, whereas in Lambert et al. (1993) the loss/ damage performance was not among the most important or the least important among the exhausting 166 determinants. The other three determinants in the top 5 include (i) the ease of claim settlement, (ii) the length of transit time and (iii) the reliability of the transit time. As one would expect, the most frequently asked determinants mostly address the questions of cost and quality of the service. What is interesting is that the ease of claim settlement is among the most frequently asked questions.

Another interesting finding is that despite the fact that the carrier selection research has been going on for over 40 years, and there are a large number of determinants that have been used during these years, much of the “core” has remained the same. In 1973 Bardi had 16 determinants in his survey. 40 years after that, Williams et al. (2013) had many of the same determinants still remaining in their survey structure. In this sense, there has really been moderate development in the carrier selection literature during the past 40 years.

5. Methods used to analyze survey data

The most common way of reporting and analyzing the survey data, would seem to have been to calculate the mean values of the scores that the respondents have given to individual determinants, and then listing the determinants from the most important one to the least important one. In five articles (Krapfer and Mentzer 1982, Coulter et al. 1989,

Menon et al. 1998, Voss et al. 2006 and Williams et al. 2013) the mean “importances” of the carrier selection determinants were not reported.

The development of the research on the topic is clearly visible in the way the data is analyzed and presented. In the earliest articles like Bardi (1973) and Stock and LaLonde (1977) the results were reported by ranking the determinants according to mean values, without further testing if the differences between the means were statistically significant or not. Since then, statistical testing of the survey results have become a standard.

Also more advanced analysis methods are used. The use of most common analysis methods such as testing the mean scores either with t-test, F-test or ANOVA, or the use of factor analysis are summarized in Table 6. In addition the previously mentioned, some of the more rare methods that have been used in the articles. These included the theory of reasoned action, used by Voss et al. (2006) and Maximum Difference (MD) scaling, used by Williams et al. (2013)

In many of the articles, the individual determinants were grouped into categories by using different methodologies. As a means of categorizing the variables, factor analysis was the most commonly used method, and was used by McGinnis (1978), Bardi et al. (1989), Coulter et al. (1989), Evers et al. (1993), Menon et al. 1998, Kent et al. (2001) and Wong et al. (2008). In addition, Gibson et al. (2002) used principal component analysis, which is closely related to factor analysis, and may thus be considered to be a similar method. In all the previously mentioned articles exploratory factor analysis was used, which indicates that the researchers did not have a priori assumptions about the number and the structure of the constructs, but that the analysis was in a way more “exploratory” in nature rather than confirmatory. In a sense the large number of different determinants in the surveys, together with the absence of established structure of the determinants may at least partly explain the choice of methods.

At the same time, the large number of research on the field would indicate that pre-defined categories of determinants could be identified and tested by the means of confirmatory, rather than exploratory factor analysis.

As some of the authors were categorizing the determinants without a priori assumptions, some others made the choice of categorizing them without testing statistically, if the categories they had decided really existed or not.

Bardi (1973) divided the determinants into 9 areas, reliability, security, user satisfaction, availability, capability, transit time, business practices, carrier information and transport costs, but presented no statistical method which would confirm that these areas existed, or that the determinants really distributed into these areas as assumed.

Semeijn (1995) referred to the previous work of McGinnis (1989, 1990) in categorizing the determinants, but failed to present any statistical evidence that the categories existed in the data. Further, Semeijn (1995) proceeded with the analysis by calculating composite measures based on the untested categories and by comparing the mean values of the composite measures against each other. Pedersen and Gray (1998) refer among others to D’Este and Meyring (1989) and end up with four factors, timing, price, security/ control and service, without providing any evidence that these factors are present in their data.

Table 6. The most commonly used methods of analysis in the reviewed articles

Year	Article	Means		Cluster analysis	Factor analysis	Regression analysis
		Means	tested			
1973	Bardi (1973)	X				
1977	Stock, LaLonde (1977)	X				
1978	McGinnis (1978)	X	X		X	
1978	Anderson et al. (1978)	X				
1982	Krapfer, Mentzer (1982)					X
1989	Bardi et al. (1989)	X	X		X	
1989	Coulter et al. (1989)			X	X	
1991	Abshire, Premeaux (1991)	X	X			
1993	Lambert et al. (1993)	X	X			
1993	Evers et al. (1993)	X			X	X
1995	Semeijn (1995)	X	X			
1997	Crum et al. (1997)	X	X			
1997	Murphy et al. (1997)	X	X			
1998	Pedersen, Gray (1998)	X				
1998	Menon, McGinnis, Ackerman (1998)				X	
1999	Kent, Parker (1999)	X	X			
1999	Pearson, Semeijn (1999)	X	X			
2001	Kent et al. (2001)	X	X		X	
2002	Gibson et al. (2002)	X	X		X	
2002	Premeaux (2002)	X	X			
2006	Voss et al. (2006)					
2008	Wong et al. (2008)	X			X	
2013	Williams et al. (2013)			X		

A number of problems arise from this approach. The first problem is that even though the abovementioned authors refer to previous research as a source for their measures, they do not in fact use the exactly same measures as has previously been used. Instead, they combine the approaches of multiple separate studies, and refine them further into a measure of their own. As such, the combination of previous research is acceptable. At the same time, a critical reader would expect the validity and reliability of these constructs to be tested, before using them as composite measures in the analysis.

6. Key findings of the previous research

The key determinants for carrier selection are presented in various ways in the articles. The majority (16) of the articles present the ranking of individual determinants as such, whereas some others either report them by using different categorizations or leave them completely unreported. Evers et al. (1993) compared the carrier selection determinants of different transport modes (intermodal, rail and road), concluding that the selection criteria differ from one mode to another. Kent et al. (2001) found similar trends among the different segments of road transport. McGinnis (1978), Anderson et al. (1978), Krapfer and Mentzer (1982), Coulter et al. (1989) and Wong et al. (2008), have left the ranking of individual determinants entirely unreported, proceeding directly to a more sophisticated analysis.

Of all the surveys that have reported the ranking of the carrier selection criteria, one determinant arises. Reliability of the service, in one way or another is considered as a top priority in 11 of the 15 studies that rank the determinants. On-time pickup and/ or delivery is found to be the top determinant by Bardi (1973), Stock and LaLonde (1977), Abshire and Premeaux (1991), Semeijn (1995), Crum et al. (1997), Premeaux (2002) and Williams et al. (2013). Overall reliability is identified as the top determinant by Murphy et al. (1997), Kent and Parker (1999) and Pearson and Semeijn (1999), whereas Bardi et al. (1989) report transit time reliability as the top determinant for carrier selection.

Freight rates and the cost of transport have been included in the surveys since the very beginning, and it has been the most widely included determinant. Surprisingly, previous research strongly indicates that freight rate is not as widely considered a top determinant for carrier selection as one would expect. Only three previous authors (Pedersen and Gray 1998, Gibson et al. 2002 and Voss et al. 2006) identify the low freight rate as the most important determinant for carrier selection.

Other reported top determinants include quality of dispatch personnel (Lambert et al. 1993) and responsiveness to unforeseen problems (Menon et al. 1998).

If the scope of the determinants is expanded to cover also others, say the top 3 determinants in different surveys, the list of determinants naturally grows longer. The length of transit time is listed among the top three determinants by Stock and LaLonde (1977), Bardi et al. (1989), Abshire and Premeaux, (Semeijn (1995), Murphy et al. (1997) and Pearson and Semeijn (1999).

Even though the loss and damage performance is included in 19 of the surveys, it is listed as one of the top three determinants in only three (Bardi et al. 1973, Pedersen and Gray 1998 and Menon et al. 1998). Equipment availability is mentioned by Murphy et al. (1997) and Kent and Parker (1999).

Another finding is that while the determinants included in different surveys during the past decades are many, there have been minor changes in the top determinants. The study by Premeaux (2002) was able to reflect the development in the information technology, listing web-enhanced EDI (Electronic Data Interchange) as one of the top determinants, but otherwise one is drawn towards a perspective, that there really has not been much development in how the buyers and sellers in the transport market see the world.

As summarized before, many of the previous authors made an attempt to categorize the numerous determinants they and the authors before had used to survey the carrier selection. Table 7 summarizes the categories from the 11 articles. Just like different authors have used varying number of determinants, they have ended up with different number and structure of the constructs. The smallest number of constructs (2, performance and capability) were identified by Menon et al. (1998), whereas Gibson et al. (2002) were able to identify as many as 12 different constructs.

Table 7. Categories of determinants discovered in the carrier selection survey literature

Article	Categories
Bardi (1973)	Reliability, security, user satisfaction, availability, capability, transit time, business practice, carrier information, transport costs
McGinnis (1978)	Speed and reliability, loss and damage, inventories, freight rates, market competitiveness, company policy and customer influence, external market influences
Bardi et al. (1989)	Rate related, customer service, claims handling and follow-up, special equipment availability
Coulter et al. (1989)	Reliability of performance, Insurance of service provision, Quality of services, Personalizing factor, Handling services
Evers et al. (1993)	Timeliness, availability, suitability, firm contact, restitution, costs
Semeijn (1995)	Cost, transit time, reliability, OSD, carrier considerations, shipper considerations, electronic data interchange, forwarding services, distribution services, warehousing facilities
Pedersen, Gray (1998)	Timing factors, price factors, security/ control factors, service factors
Menon et al. (1998)	Performance, capability
Kent et al. (2001)	Service offering, customer service, 3PL, economics
Gibson et al. (2002)	Cost effectiveness, trust, flexibility, channel perspective, information sharing, time horizon, performance management, planning, strategic fit, rules of engagement, control power, shared risk/reward
Wong et al. (2008)	Internal factors: shippers reputation, cargo location, shippers own capabilities, External factors, customer service, cargo handling capabilities, relationship with customs office, comprehensive global service

As much as the number of identified constructs in different articles varies, so does their content. Despite the differences, also some common themes could be identified. Two of the most commonly used themes were the reliability of the service, sometimes referred as timeliness, which was used as a construct by Bardi (1973), McGinnis (1978), Coulter et al. (1989), Evers et al. (1993), Semeijn (1995), Pedersen and Gray (1998), Menon et al. (1998) and Gibson et al. (2002).

Costs or freight rates were identified as separate constructs by Bardi (1973), McGinnis (1978), Bardi et al. (1989), Evers et al. (1993), Semeijn (1995), Pedersen and Gray (1998), Kent et al. (2001) and Gibson et al. (2002). As an additional remark on the role of costs in defining the structure of the determinants is an article by Men-on et al. (1998), in which the cost –related items were included in the survey, but did not load consistently into a factor and were thus left outside of the analysis. As suggested before, also in this situation applying confirmatory factor analysis instead of

an exploratory alternative might have provided sufficient tools to form a valid construct for the cost-related items as well.

In addition to reliability and cost-related factors, previous authors have addressed the service dimension of the carrier selection in different ways. Bardi (1973) distinguishes availability and capability, whereas Bardi et al. (1989) name customer service and special equipment availability as individual constructs. Coulter et al. (1989) identify personalizing factors and handling services, whereas for example Pedersen and Gray (1988) bundle them as service factors.

The two latest surveys that make an attempt to categorize the determinants of carrier selection, take a somewhat different approach. Unlike in the earlier surveys, in the article by Gibson et al. (2002) the supply chain approach is clearly visible in constructs such as channel perspective, control power and shared risk and reward. Wong et al. (2008) on the other hand make a distinction between internal and external factors of carrier selection by naming the shippers reputation, cargo location and shippers own capabilities as internal factors, and customer service, cargo handling capabilities, relationship with customs office and comprehensive global service as external factors for carrier selection.

As with the individual determinants of carrier selection, a more thorough analysis on the used constructs during the past 40 years reveals that outside just a handful of more widely used constructs, the literature is mostly rather inconsistent in what to include and what to exclude in the surveys. At the same time, it is easy to identify the few constructs that have in one form or another been in the core of the carrier selection survey research for the whole time.

One of the themes one would assume have emerged is the rapid development in information systems and real time tracking and tracing capabilities. Excluding the single finding of Premeaux (2002) highlighting the web-enhanced EDI as one of the top 3 determinants of carrier selection, it seems that the development of IT has not been a major issue in the transport sector. Either because the development has gone so far that the information systems enabling real time tracking and tracing are a basic requirement, or that the transport sector is still comfortable with the old ways of doing business.

Another interesting finding, highlighted also by Meixell and Norbis (2008) is the practical nonexistence of environmental themes. Even though the transport sector may be considered conservative and not as responsive to new ideas as other sectors, one would have assumed that the environmental questions would have reached the carrier selection literature. Especially considering the large environmental impact of the transport sector combined with the growing stakeholder pressure towards the buyers of the transport services. Surprisingly, though, environmental questions are not entirely new for the carrier selection literature, they have just been forgotten for 40 years. In one of the earlier surveys done on carrier selection Stock and LaLonde (1977) had a series of questions measuring the importance of environmental questions on carrier selection. A few years after the first oil crisis the effect of rising fuel prices on freight rates caught minor attention among the buyers of transport services, whereas determinants like vulnerability of mode to current or future energy/ ecology problems, energy efficiency of mode and environmental impact of mode were considered even less significant. As a new, or perhaps more as a revived theme, these questions might be useful when surveying the determinants of carrier selection in the new millennium.

7. Improved methodology for surveying carrier selection

The findings of the existing literature provide basis for improvement of the survey methodology in carrier selection research. To take the initiative further, a suggestion for improved survey methodology was created and tested. Based on previous surveys, three commonly used factors of carrier selection, the cost and pricing of transport (Cost), the quality of the service (Quality) and the adjustability of the service (Service) were included. In addition, factors measuring the Information technology and communication capabilities (IT), and environmental aspects (Environment) were included. The factors of Cost, Quality, Service and IT were designed to consist of five individual items, whereas the factor measuring the environmental issues consisted of four items. All the items were measured by using a five point Likert scale, ranging from “not significant” (1) to “decisively significant” (5). The individual items are presented in Table 8.

Table 8. Test statistics of exploratory and confirmatory factor analysis together with the final survey instrument

	Cost	Quality	Service	IT	Environment
Price of service	0.639 (-)				
Flexibility of pricing	0.837 (10.88)				
Terms of payment	0.578 (9.81)				
Predictability of price level	O				
Price of additional services	O				
Ability to follow the agreed pickup and delivery times		0.594 (-)			
High frequency of (transport) service		0.725 (10.92)			
Short transport time		0.794 (11.25)			
Loss and damage performance of the carrier		O			
Carriers' ability to accept transports on short notice		O			
Availability of door to door service			O		
Ability to handle special requests			O		
Availability of transport equipment			0.654 (-)		
Availability of additional services			0.821 (14.12)		
Technical quality of transport equipment			0.853 (14.36)		
Possibility to real time tracking and tracing				0.775 (-)	
Carriers' ability to communicate disturbances				0.753 (15.30)	
Carriers' ability to communicate on costs				0.698 (14.18)	
Carriers' ability to share information on different levels of organization				O	
Entrance to carriers' transport information system				0.645 (13.08)	
Energy efficiency of transport services					0.921 (-)
Environmental impact of (transport) service					0.941 (35.68)
Environmental certificate of carrier					0.875 (29.19)
The effect of tightening environmental regulation on transport service					0.852 (27.37)
CR	0.731	0.749	0.821	0.811	0.943
AVE	0.482	0.503	0.608	0.518	0.806
Cronbach's α	0.707	0.74	0.821	0.811	0.945

Chi-square = 450.19 ; df = 109; NNFI = 0.953 ; CFI = 0.963 ; RMSEA = 0.083

O: Excluded during the Confirmatory Factor Analysis

In order to analyze the reliability of the variables and the pre-determined constructs (factors) a survey data was collected. The data was collected as part of a national Finland State of Logistics 2014 survey in May-June 2014. The sample frame comprised all non-student members of the Finnish Association of Purchasing and Logistics (LOGY), members of the Finnish Transport and Logistics association (SKAL), and members of the Federation of Finnish Enterprises (SY) that were active in the industries covered in the survey. In order to ensure the coverage of the sample, 100 largest manufacturing firms in Finland were identified and contacted by telephone.

A total of 1,731 responses were received from manufacturing and construction, trading, logistics service providers, and consulting and educational services, the overall response rate being 5.9 per cent. Wagner and Kemmerling (2010) give a detailed summary of 229 survey studies in the field of logistics, including the respective response rates. Compared to their findings, the response rate of the Finland State of Logistics 2014 survey is well in line with other

surveys on a similar scale. For the purpose of this research, all the manufacturing and trading firms with complete responses in all the questions related to carrier selection were included, resulting in a final sample of 483 firms.

In order to address potential non-response bias, it was decided to compare the early and late respondents (Armstrong & Overton, 1977). The questionnaire was sent in three waves. Responses collected in the last wave were compared to 78 responses collected in the first and second wave by carrying out an independent samples t-test on the two groups' perceptions of the research variables. The tests showed no significant differences at the 0.01 level. Although the results do not reject the possibility of non-response bias, they suggest that non-response may not be a problem to the extent that the late respondents are similar to non-respondents (Armstrong & Overton, 1977).

A set of procedural remedies suggested by Podsakoff et al. (2003) were applied in order to address potential common method bias caused by collecting the data through the same survey. In order to avert the possible consistency motive, the dependent and independent variables were separated and placed in different phases of the survey. Furthermore, to avoid the social desirability bias, respondents could choose to give their email address and the name of the company or remain anonymous. Following Podsakoff et al. (2003), the presence of common method bias was tested with Harman's single factor test (Harman, 1967), with the first factor accounting for 38.6 per cent of the total variance. Given that one factor does not account for the majority of the variance among the measures, common method bias does not seem to be a problem (Podsakoff et al., 2003).

To test the pre-determined constructs, the items were first subjected to exploratory factor analysis with Varimax rotation and using eigenvalue over unity as a criterion. The exploratory factor analysis divided the items into five factors according to the pre-determined constructs, indicating construct validity. However, some of the loadings of individual items were either relatively low (under 0.6), or the items were loading on two factors.

For this purpose, and for further analysis, the items were subjected to confirmatory factor analysis. Based on the results of both the exploratory factor analysis and the initial CFA, some items were omitted from the model. The composite reliabilities and average variances extracted of the constructs in the final CFA are presented in Table 8. The CR's are all over .7 and the AVE's over .5 with one exception, which indicates the reliability of the constructs (see for example Fornell and Larcker 1981, Hair et al. 1998). The AVE of the Cost construct was found to be 0.48, which is below the 0.5 limit. However, as Fornell and Larcker (1981) point out, the AVE is a more conservative measure than CR, and as the CR of the Cost construct was over 0.7, the construct could also be considered reliable. Also, the Cronbach's alphas (Cronbach 1951) of all the constructs were found to be acceptable.

Discriminant validity of the constructs was tested with the nested model test by first constraining the correlation parameter between the two constructs into 1 and then performing a chi-square difference test on the values obtained from the constrained and unconstrained models, as suggested by Jöreskog (1971). Further the test was performed for each pair of factors individually, as suggested by Anderson and Gerbing (1988).

To test the improved methodology in practice, new variables were formed by calculating the averages of individual items included in the research constructs. Further, these composite measures were tested together with two single item questions measuring the importance of 1) lower business costs and 2) lower environmental impacts as a competitive advantage for the firm. These questions were also on a five point Likert-scale ranging from 1 (totally disagree) and 5 (totally agree). For the analysis, the companies were divided into three categories, in which the firms responding "totally disagree" formed one group, the firms responding "totally agree" another group, and the firms in the middle forming the third group.

The composite measures of Cost and Environment were tested with ANOVA to see whether the firms with different levels of cost and environmental strategy were different considering the determinants of carrier selection; in other words to see whether the firms with a high focus on lower business costs considered cost criteria more important than others, and whether the firms with a high environmental focus considered the environment criteria more important than other firms. The results are presented in Table 9.

Table 9. ANOVA test results of Cost and Environment composite measures and cost and environment strategies

Cost determinants for carrier selection				
Lower business costs strategy	n	Mean	Std. Dev.	Skewness
Totally disagree	24	3.94	0.719	0.088
Partially disagree-partially agree	371	3.59**	0.737	-0.403
Totally agree	88	3.81	0.785	-0.783
Environmental determinants for carrier selection				
Lower environmental impact strategy	n	Mean	Std. Dev.	Skewness
Totally disagree	13	2.42**	1.32	0.045
Partially disagree-partially agree	403	2.73**	0.936	0.052
Totally agree	67	3.28	1.09	-0.307

** difference to "totally agree" significant on 0.05 level

Not surprisingly, the firms with high emphasis on business costs in their strategy seem to value the cost determinants of carrier selection higher (mean value 3.81) than the firms with less emphasis (mean value 3.59). Also, firms with higher emphasis for environmental impact in strategy value the environmental determinants of carrier selection higher (mean 3.28) higher than firms with less emphasis on environment. For the methodology of carrier selection research, however, the more interesting result is in the skewness of the composite measures of cost and environmental determinants. As suggested before, the use of a 5-point Likert-scale has been considered too coarse, resulting in a skewed distribution of the variable. At least on a level of composite measures, the skewness of the variables seems to be well within acceptable range.

8. Discussion and conclusions

This article draws up the carrier selection literature from past 40 years, illustrating how the key determinants of carrier selection have evolved during the years. More than just summarizing the previous literature, this article takes a critical view on how the carrier selection is studied by using survey methodology, suggesting improvements for the future carrier selection research. Further, in this article, the suggestions are taken into practice by constructing and testing a new, improved survey tool.

The first finding is the lack of consistency in the data collection and sampling procedures. In some of the articles, the sampling procedure has been presented thoroughly, and the sampling criteria have been consistent. For example, some of surveys (Kent and Parker, 1999) have been using the top 50 firms of the industry as a sample. At the same time, some of the other authors (Kent et al. 2001) have used the subscriber databases of industry magazines as the sampling procedure.

The generalizability of the results has been discussed in different ways. In most of the articles, the authors leave the generalizability of the results undiscussed, leaving the critical reader to wonder if 20% of subscribers of a magazines is a sample from which conclusions can be drawn towards the behavior of the entire population.

The same inconsistency continues with the determinants included in the surveys. McGinnis (1978) surveyed the carrier selection by using a short list of 7 determinants, whereas Lambert et al. (1993) had included an exhausting list of 199 attributes for carrier selection in their survey, while reporting only a small fraction of them in their article.

As the determinants used in different surveys are many, so are the different categories those determinants have been divided in the articles. Menon et al. (1998) were able to identify two different categories of determinants, whereas Gibson et al. (2002) found 12.

Moreover, the previous authors have also used different approaches to identify these categories. Some of them have just relied on previous literature and divided the individual determinants into categories based on a priori assumptions,

whereas some others have relied on exploratory factor analysis or principal component analysis in defining how the determinants they have used should be categorized.

The large variance in the used terminology and the determinants as well as the used analysis methods has led into a situation where the discipline lacks consistency. Even though it is acceptable that the survey tool and the methods depend on the research setup, one would expect a bit of consistency for the results to be comparable.

For improving the survey methodology and the analysis of carrier selection, a few suggestions could be made. If the purpose of the analysis is to analyze wider categories or constructs of determinants, an a priori structure of the constructs should be formulated, based on previous research and theory.

As a possible structure of a more pre-defined survey, the most predominant themes of the previous research should be included. These themes would include constructs such as costs of transport, reliability of the transport service, and service level of the service provider. In addition, some timely themes could be included. As the modern supply chain management relies heavily on seamless flow of material and information, one of the themes that could be included and has so far had a minor role in carrier selection literature is the information sharing capabilities or information systems support of the service provider.

Another current theme which was already explored by Stock and LaLonde in 1977 in the aftermaths of the first oil crisis, but since then forgotten for almost forty years is the role of environmental issues in the carrier selection. After all, one would expect that the rising value of environmental considerations would also be visible in the determinants the firms use to decide their transportation choices.

In this article, three constructs, costs, quality and service were created based on previous literature, whereas two additional ones, IT and Environment were created to reflect the increasing role of ICT and environmental questions.

To test the constructs, confirmatory factor analysis testing the a priori model should be applied, instead of letting the data define the structure through exploratory factor analysis. In this article, the designed survey tool was tested with means of both exploratory and confirmatory factor analysis. Based on these tests, some of the individual items were excluded, and the process ended with an improved and consistent survey tool for the carrier selection research.

Furthermore, the scale(s) used in the survey is important. As a conclusion, the most common way of surveying the determinants of carrier selection is by using a five-point Likert-scale. As suggested Finn (1972) and Dawes (2008), the coarser the scale, the more positively the data tend to be. As the common research methods such as regression analysis and factor analysis are sensitive to the normality of the data (McCulloch et al. 2008 and Babakus et al. 1987), the use of five-point scale could lead to either less reliable constructs or biased results, or even both, the future conductors of carrier selection surveys are recommended to consider the use of less coarse scales. In this article a five-point scale was used. However, the skewness of the composite measures remained well within the range of acceptable, indicating that a five-point scale may in fact be sufficient.

The empirical contribution of this article remains limited, as the empirical results are mainly examples of the designed survey tool. The main contribution of this article is in the systematic analysis of previous research, which is then refined into an improved and tested survey tool for further use.

As the use of this improved survey tool is limited in this article, future research should take the initiative and use it for a more meaningful empirical analysis.

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