

Artificial Intelligence in Optimizing the Selection of Incoterms Rules in Cross-Border Trade. State of Knowledge and Needs for Further Research

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Abstract

The decision-making areas ideally suited to support AI (Artificial Intelligence) are decisions regarding the choice of Incoterms in cross-border trade. AI makes it possible to analyze huge datasets of historical transactions, considering all relevant decision factors in Incoterm's choice. Based on this data, AI might recommend Incoterms for maximum control and clear landed cost estimation, and real-time landed cost estimation. Consequently, using AI to model Incoterms decisions can streamline buying and selling processes. The article aims to assess the current state of knowledge and identify directions for future research on optimizing decision-making processes related to the choice of Incoterms in cross-border trade based on AI solutions. The study used the Scoping Review method and the VOSviewer IT tool. The keywords co-occurrence analysis showed that there is a lack of in-depth research relating AI issues to choosing Incoterms and modeling and optimizing these decision processes in supply chains.

Keywords: transport management, Incoterms, cross-border trade, decision making, artificial intelligence

1. Introduction

The increasing complexity of dynamic supply chain processes in the cross-border space and the turbulent global environment in which they operate require technological support coping with these challenges. In particular, artificial intelligence-based solutions (AI) such as robotics and machine learning are desirable and can significantly assist the decision-making process of supply chains in overcoming their inefficiencies and ensuring greater responsiveness and facilitating supply chain transformation [1, 2].

Determining the principles of transportation management is among the key areas of strategic logistics decisions made in cross-border supply chains. These decisions relate to the allocation of responsibilities, costs and risks of international delivery between the parties to a trade contract. Indeed, transportation costs are a major category of logistics costs, which are also the most important cost category in global supply chains. Transportation problems have thus gained prominence as strategic problems in the supply chain [3]. The importance of transportation problems in the functioning of supply chains was further underscored by the global economic crisis of the 2020-2021 period caused by the spread of the SARS-CoV-2 coronavirus (COVID-19 pandemic), which resulted in severe disruptions in the functioning of supply chains, forcing the actors involved to drastically reconstruct the architecture of transport chains [4, 5].

The main carrier of information about the results of transportation decisions made in cross-border supply chains are Incoterms (International Commercial Terms) rules. The

selected Incoterms rule clearly defines which steps of the transportation process will be included in the transaction costs of both parties to the contract, and what responsibilities (including customs) they have. Incoterms rules are the main channels linking international trade and logistics, as they apply to all logistics steps and activities involved in international delivery and thus determine various business processes at different levels of supply chain management, from procurement to sales, from legal issues to finance, from business operations to corporate strategy and software algorithms [6, 7]. As a result, the Incoterms rules significantly offset the risk of misunderstandings in cross-border trade relations, the source of which may be differences in interpretation of the detailed terms of contracts (trade terminology) for their transportation and customs handling in different countries. Thus, Incoterms rules significantly reduce the uncertainty arising from the high degree of heterogeneity in international trade practices, creating a common frame of reference for all participants in cross-border supply chains [8].

Thus, the choice of a particular Incoterms rule as a delivery base in trade transactions should be evaluated as a strategic logistics decision made under conditions of uncertainty and risk, which also raises their importance in the context of companies' efforts to gain and maintain a long-term competitive advantage. Knowledge of decision-making factors determines the informed and appropriate choice of Incoterms, which affects the maximization of the benefits of the implementation of an international trade transaction. On the other hand, an inappropriately selected Incoterms rule, which results in different risks, responsibilities and costs for the parties involved in an international trade transaction, may give rise to unintended negative consequences in the area of supply chain management such as delays in customs clearance, additional unplanned transaction costs, and may even result in the need to assume risks that are beyond the control of the cargo gestor. Decisions in this area took on particular importance during the COVID-19 pandemic. Severe disruptions in the operation of transport chains in the cross-border space were associated with significant delays in international deliveries or the inability to deliver at all. These events drew greater attention to the principles of allocating the costs and risks of making international deliveries between the parties to a contract under crisis conditions, as enshrined in the Incoterms.

Nevertheless, research on the decision-making process of choosing Incoterms as strategic logistics decisions is a research area explored to a very limited extent [9]. At the same time, the few studies to date indicate the multiplicity and diversity of decision-making factors that should be included in the selection of Incoterms, in an increasingly dynamic international market environment, which requires expert knowledge and often the support of specialized logistics operators. On the other hand, today's supply chains are at the threshold of a technological revolution led by AI. It is affecting every aspect of the supply chain, from forecasting demand to optimizing operations and supporting sustainability. The tremendous potential from the application of AI in supply chain management should also be tied to the support of decision-making processes, which require the inclusion of a wide variety of factors.

The purpose of the article is to assess the current state of knowledge and identify expected directions for future research on optimizing decision-making processes related to the selection of Incoterms rules in cross-border trade based on the use of AI solutions. The study used elements of the systematic review method (SRL) - the Scoping Review and the VOSviewer IT tool.

2. Methodology

The SRL method [10] employed the Scoping Review (SR) technic for selecting and aggregating knowledge through the process of mapping and structuring information provided by the literature review. In particular in terms of the main concepts, theories, types, and sources of knowledge [11]. This method is useful in the literature review when the research area is not precisely defined and descriptions in scientific publications are dispersed. They are also used to inform about expected directions for future research and to identify implications for practice regarding decision-making [12, 13, 14].

The scoping literature review process used the VOSviewer IT tool (version VOSviewer

1.6.20). The VOSviewer software is based on an algorithm referred to as visualization of similarities and allows to develop maps of interrelationships between concepts (keywords), to indicate the most frequently occurring concepts in the defined bibliographic description of a record, and to highlight clusters of groups of analyzed concepts [15, 16]. Using VOSviewer, keyword co-occurrence analysis was carried out to visualize the main research areas and their interrelationships on Incoterms issues and to support decision-making processes using AI solutions. The usefulness of keywords in literature mapping processes is due to the fact that they are natural language words that express the thematic concepts of the articles. Keywords condense the scientific views of authors, making them an important indicator in bibliometrics [17]. The co-occurrence of keywords can signal the existence of research sub-areas or identify premises that guide the further development of a research area.

The research process was conducted in two stages: literature mapping with VOSviewer tool and analysis of the mapped content of selected articles linking Incoterms and decision-making process using mathematical modeling and AI. The co-occurrence analysis used source data from the WoS (Web of Science) database in RIS (Research Information Systems) format. The keywords came from the bibliographic descriptions of the publications.

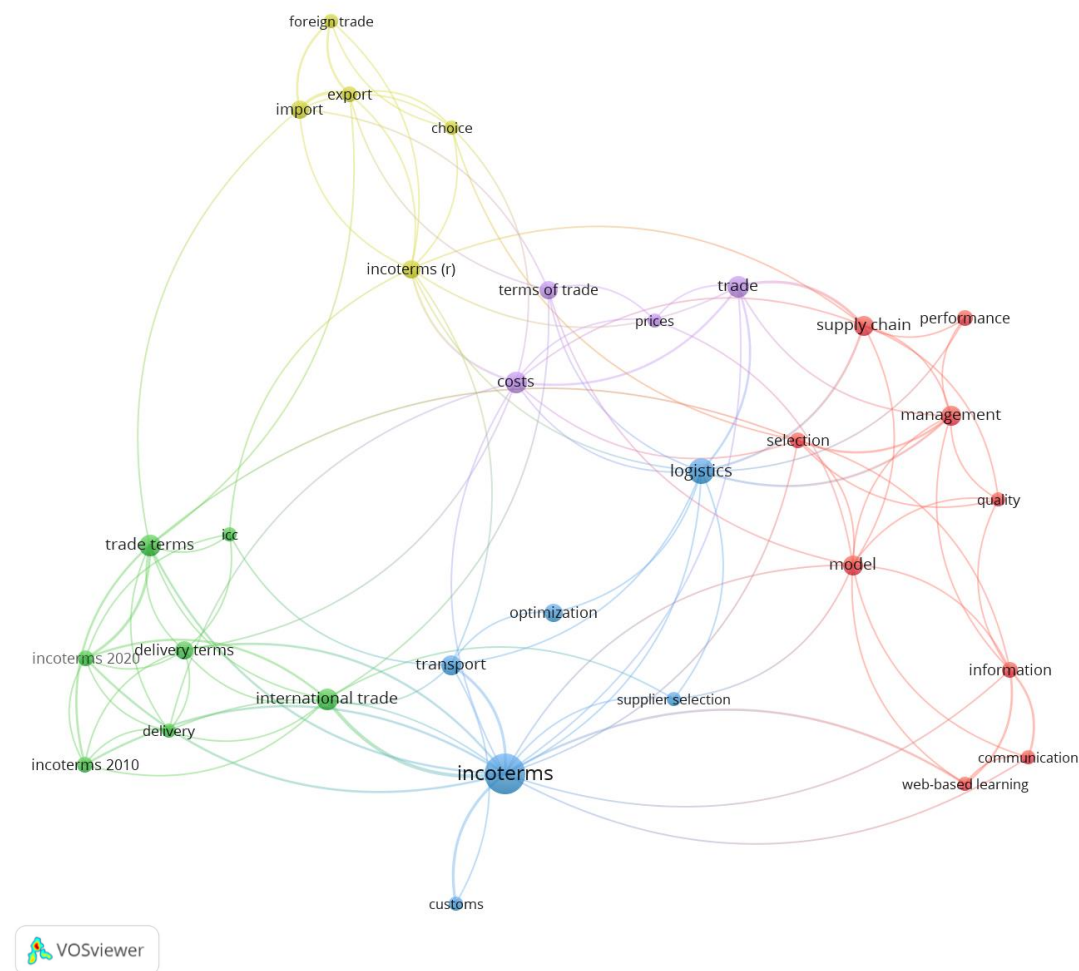


Fig. 1. Keyword: „Incoterms” refined by in the network of connections (minimum threshold of occurrences at the level of 3)

3. Results

Literature mapping using VOSviewer was carried out in two variants. In the first variant, a linkage map was generated for the keyword "Incoterms" and related entries. For the query "Incoterms" in the WoS database, the search selected only 94 items of literature (as of:

15.04.2024). Alternative search terms like: "delivery terms", "trade terms" and "Incoterms" increased the results to 193. Due to the small number of items, the minimal number of occurrences of keyword was set at: 3. Of the 751 identified keywords meeting this criterion, 33 words were listed for which co-occurrences were identified. Unrelated words like "evolutionary psychology" and commonly used "impact" were removed - 31 remained final. For each of the 31 identified keywords, the total strength of co-occurrence of links with other keywords was calculated (Figure 1).

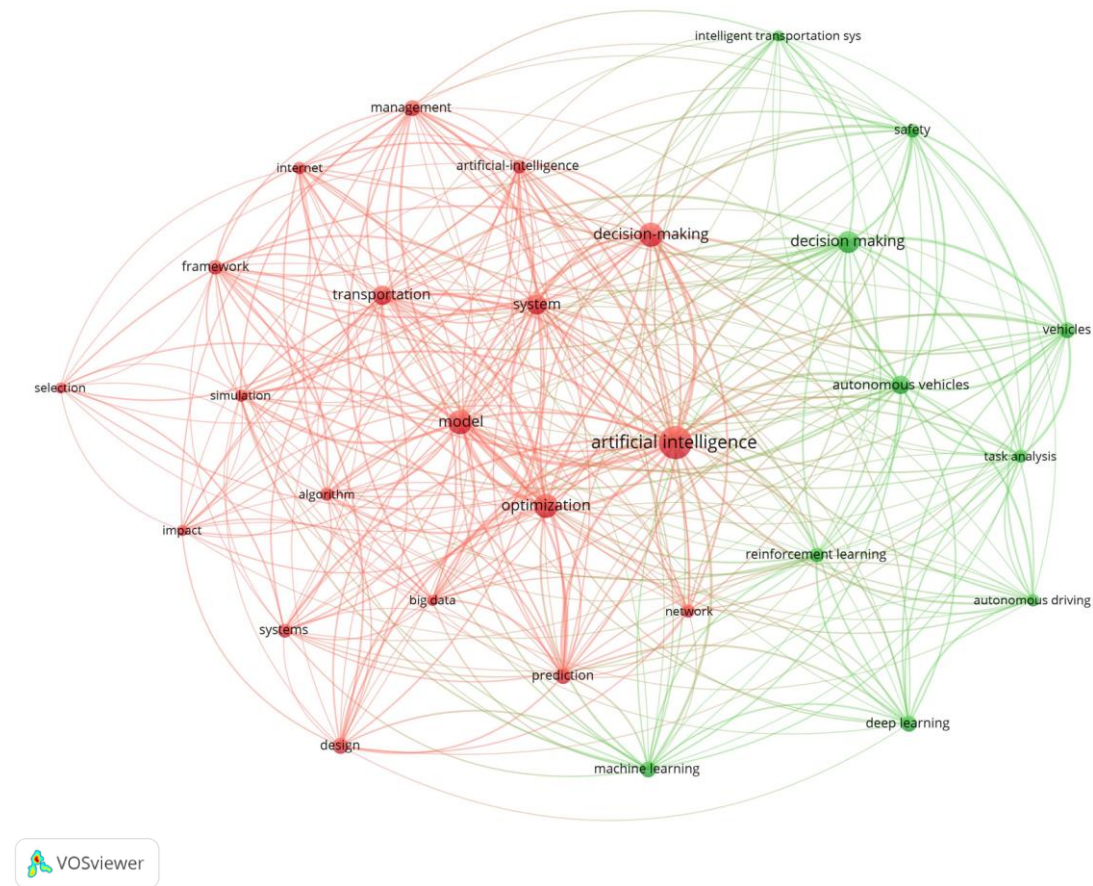


Fig. 2. Keyword “artificial intelligence” refined by "transportation" and "decision-making" in the network of connections (minimum threshold of occurrences at the level of 5)

The analysis showed that there are 5 main clusters of keyword associations: cluster 1 (9 items, red colour), cluster 2 (7 items, green colour), cluster 3 (6 items, blue colour), cluster 4 (5 items, yellow colour), cluster 5 (4 items, purple colour). The most studies on Incoterms are focused on the perspective of international logistics and supply chain management (cluster 1) in conjunction with the issues of cost, supplier selection and customs handling of transactions (cluster 3), as well as international economics and foreign trade (cluster 4 and 5). An important stream of research (cluster 2) also focuses on interpreting, explaining and comparing changes in successive interpretations of Incoterms (Incoterms 2000, 2010, 2020). Only a small part of analyzed studies deal with the issue of Incoterms selection decision-making. Only 23 literature items out of 193 filtering the results by the keyword “Decision”, and they deal with decision-making issues related to supplier selection. On the other hand, there is no research at all directly linking the problem of applying AI in modeling the decision-making processes under study (a search in the WoS database for the keywords “Incoterms” and “artificial intelligence” yielded 0 results).

Therefore, in the second stage of literature mapping, the problem of AI was related to the issues of transportation and decision-making to see what are the dominant areas of research. For the keyword “artificial intelligence”, refined by “transportation” and

“decision making”, yielded 547 results from WoS database. Minimal number of occurrences of keyword was set at: 15. Of the 2788 identified keywords, 28 meet the threshold (suggested threshold of 5, increased for better readability of the map and to indicate the most common research links in this area), Figure 2.

The analysis showed that there are two main clusters of relationships of the keywords studied. The first cluster contains 19 items (red) and indicates directions for earlier research (until 2021). Research in this area combines AI issues with issues of optimization and modeling of processes and transportation systems to improve their efficiency, and only indirectly addresses issues of transportation decision-making. The second cluster contains 10 items (green color) and indicates the directions of the latest research (from 2022). Issues related to intelligent transportation system the autonomization of transportation modes are becoming an important area of research. Decision-making issues in this area of research are linked to issues of transportation safety.

At the same time, the analysis carried out indicated that there is a lack of in-depth research linking AI issues with the process of making transportation decisions in supply chains, including those related to the selection of Incoterms rules and the modeling and optimization of these processes.

4. Discussion

A review of the literature indicated that research on Incoterms to date consists mainly of case study analyses and is based mostly on a small amount of qualitative data (information obtained through surveys and expert interviews). The dominant research technique is the analysis of the structure of the Incoterms rules used in different countries and industries [18]–[22], only a few studies use mathematical modeling techniques in support of these processes. Suraraksa et al. [23] used the AHP method to assess the importance of decision-making factors in choosing Incoterms. Unal and Metin [24] evaluated the importance of factors influencing the selection of Incoterms rules using the FAHP methodology. A study (Nechaev et al. [25] proposed a toolkit for selecting the optimal means of transportation and Incoterms delivery terms, taking into account time and cost factors. Pozzo et. al. [26] developed a model for estimating costs and risks and supporting formal decision-making processes with contextual variables. Baena-Rojas & Cano [27] developed a model to estimate costs and prices based on Incoterms, depending on the agreed responsibility and risk that stakeholders are willing to assume. In a recent study Kumar Detwal et al. [1] directly tying Incoterms and AI in the context of decision-making, the authors proposed a model for Incoterms-based supplier selection based on machine learning using a multi-channel pharmaceutical supply chain as an example. Taking into account the most important factors affecting the supplier selection decision under Incoterms rules for pharmaceutical goods, the proposed model can accurately predict the right Incoterms of a supplier for given values of input parameters.

In summary, there are few studies to date that consider mathematical modeling on representative quantitative data, particularly based on the AI paradigm, which can assist supply chain managers in the decision-making process of selecting Incoterms rules for specific transactional conditions. The main limitations of existing studies are the sources of data used in the research (mainly information from surveys and expert interviews with small numbers). At the same time, previous research also points to the enormous potential for studying the mechanisms of Incoterms rule selection has information extracted from customs and statistical declarations [28]. There is also tremendous potential for modeling these decisions using AI, as well as companies' historical data on executed transactions.

5. Conclusions

Traditionally, selecting the optimal Incoterm requires expertise and detailed analysis and understanding of the impact of various decision factors in conjunction with specific transactional considerations. It is increasingly common for mature supply chains to use mathematical modeling to support decision-making processes related to the selection of Incoterms supply terms in cross-border trade transactions, but it is still not the norm. IT support is particularly important and desirable at the operational level of supply chain management. Their use makes decision-making processes more transparent by modeling

them in software, and the software helps automate these processes. Incoterms decisions are increasingly implemented in supply chain management support systems like ERP, CRM, TMS, WMS or in dedicated in tax software. Importers are using Incoterms decision checklists for procurement teams that specify options and caveats for selecting Incoterms rules or even excluding them. Mature sales organizations use pricing schemes that incorporate a given Incoterms rule along with other transaction terms, such as payment terms, if applicable, in pricing and profitability analyses. Nevertheless, past research underscores that managers often follow routines and established practices in decisions about Incoterms, which do not always work in the new turbulent environment in which global supply chains operate today. A strongly accentuated problem in the research to date is the general lack of knowledge and awareness of the effects of specific Incoterms rules, particularly among companies less experienced in international trade [18], [19], [29], [30].

In this context, the development of tools based on the AI paradigm can further optimize the decision-making processes under study. AI makes it possible to analyze huge datasets of historical transactions (purchase and sales transactions), meticulously taking into account all relevant decision factors, such as the origin/destination of the shipment, historical transportation costs, type of goods, customs regulations. Based on this data, AI might recommend Incoterms for maximum control and clear landed cost estimation and real-time landed cost estimation. Consequently, the use of AI in modeling Incoterms decisions can streamline buying and selling processes and reduce human error.

Nevertheless, although AI-based technologies avoid errors and operational costs as a result of the decision-making processes studied, these solutions are still rare in practice [31]. Analytical tools to support these decision-making processes are desired. An interesting recommended direction for further research, already initiated by other researchers [32], is the use of Incoterms rules in the context of modeling sustainable transportation processes, taking into account the aspect of environmental costs in the decision-making process.

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