

Review

The feasibility of ChatGPT's integration into logistics processes

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CITATION

Wiradisuria AF, Sós E, Földesi P. (2025). The feasibility of ChatGPT's integration into logistics processes. *Journal of Infrastructure, Policy and Development*. 9(1): 9691. <https://doi.org/10.24294/jipd9691>

ARTICLE INFO

Received: 17 October 2024

Accepted: 15 November 2024

Available online: 7 January 2025

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Abstract: Recent times have seen significant advancements in AI and NLP technologies, poised to revolutionize logistical decision-making across industries. This study investigates integrating ChatGPT, an advanced AI language model, into strategic, tactical, and operational logistics. Examining its applicability, benefits, and limitations, the study delves into ChatGPT's capacity for strategic logistics planning, facilitating nuanced decision-making through natural language interactions. At the tactical level, it explores ChatGPT's role in optimizing route planning and enhancing real-time decision support. The operational aspect scrutinizes ChatGPT's capabilities in micro-level logistics and emergency response. Ethical implications, encompassing data security and human-AI trust dynamics, are also analyzed. This report furnishes valuable insights for the logistics sector, emphasizing AI's potential in reshaping decision-making while underscoring the necessity for foresight, evaluation, and ethical considerations in AI integration. In this publication, it is assumed that ChatGPT is not entirely reliable for decision-making in the logistics field: at the strategic level, it can be effectively used for "brainstorming" in preparing decisions, but at the tactical and operational level, the depth of the knowledge is not sufficient to make appropriate decisions. Therefore, the answers provided by ChatGPT to the defined logistic tasks are compared with real logistic solutions. The article highlights ChatGPT's effectiveness at different levels of logistics and clarifies its potential and limitations in the logistics field.

Keywords: logistics; ChatGPT; decision-making; logistics strategy

1. Introduction

Decision-making is a cognitive approach that requires gathering information and analyzing various options to choose between two or more actions in a relevant subject (Suha and Sanam, 2023). It is a highly important asset in Logistics, as day-to-day operations hinge on the ability of the person in charge to assess the situation at hand and deliver the most efficient solution with the information available at hand. This has become increasingly important ever since the shock wave that was generated by the CoVID-19 pandemic and the Ukraine-Russia conflict, forcing the industry to adapt as it faced supply chain disruptions on a scale it has never seen before, the effects of which could still be felt to this day, as an example firms that heavily relies on imported inputs and experience supply chain disruptions chose to hold more inventories after the pandemic despite enormous carrying costs (Zhang and Ha Doan, 2023). Artificial intelligence could help firms deal with supply chain disruptions and build a resilient supply chain, with examples being "Real-time tracking of supply chain activities using the internet of things", "use of cyber-physical systems", and the creation of a "digital supply chain twin", making the uncertainties and risks in the supply chain lower while minimizing human participation by simulating the real supply chain and collecting data (Ahmed et al., 2023). With the rise of Generative AI (Artificial Intelligence) and

machine learning in recent times, the ability of Artificial Intelligence to generate and make decisions, write, and give recommendations based on a given data has become a point of contention in many industries. Generative AI is a technology that leverages deep learning models to generate human-like content in response to complex and varied prompts (Lim et al., 2023). The most discussed generative AI at the time of this writing are ChatGPT. It is an Artificial Intelligence (AI) powered Natural Language Processing (NLP) tool that comprehends and produces text in response to commands (Javaid et al., 2023). ChatGPT has seen explosive growth during its debut, gaining 1 million users in five days with an estimated 100 million active users, intriguing experts and the common folk in its abilities (Brandl and Eilis, 2023).

Artificial intelligence is involved in knowledge synthesis as part of the decision support system. The research question is: at which level of logistics decisions can ChatGPT be used as a decision support tool, and to what extent can it be used? It is assumed that it is more useful at the strategic level, where it is possible to rely on older data. However, at the tactical and operational level, where there are too many parameters that cannot be planned in advance and, therefore, cannot be based on historical data, it is less useful.

The research has applied the following methodological steps: First, the problem was selected, which in the present publication is the problem of decisions in the field of logistics at different levels.

Then, it was translated into a task that ChatGPT could interpret. Then, for each level, an example task could be created for ChatGPT. Multiple generation of answers was also done. Afterwards, the solution to the task was compared with a professionally acceptable solution. Based on this, the conclusion was drawn. Finally, the research question was answered: at what level can these ChatGPT-based decision systems work well?

A graphical representation (flowchart) of the publication presented is provided in Appendix A in order to make this study easy to understand. The answer provided by ChatGPT will also be provided in the appendix.

With this paper, we would like to explore the feasibility of using ChatGPT in a production logistics context and its decision-making capabilities. The analysis will cover three parts of the logistics decision-making framework, including strategic, tactical, and operational, using ChatGPT to make logistics-related decisions and comparing them to what experts would decide to gauge the feasibility of using ChatGPT in logistics. No previous research has specifically focused on decision-making in logistics. Therefore, this research focuses on demonstrating the logistical applicability of ChatGPT at tactical, operational, and strategic levels.

2. Knowledge background analysis

The literature concerning decision-making and artificial language models was examined to explore our research topic and grasp its relevance. ScienceDirect's database was utilized in this research to acquire the background knowledge necessary for investigating this topic. Initially, "decision-making" and "ChatGPT" were searched, followed by the inclusion of "logistics" to refine the search within our

required context. Subsequently, “production” and “management” were added to delve into areas pertinent to decision-making in logistics.

Table 1 shows the results obtained for the keywords in the ScienceDirect database. The results are narrowed down further to show the trend over the last five years (2018–2023), after which the increase will continue until 05/07/2024. The result yielded from the keywords “Decision Making” AND production AND ChatGPT was 158, while adding the keyword “Management” to narrow it further down resulted in 124 publications. It can be observed that due to ChatGPT being released only a year ago at the time of this publication, the trend is recent, resulting in few publications released before 2022.

Table 1. Researched on the 19th of September 2023 and on the 5th of July 2024.

KEYWORDS/RESULT SCIENCEDIRECT	TOTAL		INCREASE
	19/09/2023	05/07/2024	
“Decision Making” Production	280669	310238	11%
Last 5 years (2018–2023/2019–2024)	120743	134753	12%
“Decision Making” Production CHATGPT	158	822	420%
Last 5 years (2018–2023/2019–2024)	158	822	420%
“Decision Making” Production “Industry 4.0” CHATGPT	19	95	400%
Last 5 years (2018–2023/2019–2024)	19	95	400%
“Decision Making” Production Management	215136	238484	11%
Last 5 years (2018–2023/2019–2024)	94790	105994	12%
“Decision Making” Production Management CHATGPT	124	649	423%
Last 5 years (2018–2023/2019–2024)	124	649	423%
“Decision Making” Production Management “Industry 4.0” CHATGPT	19	87	358%
Last 5 years (2018–2023/2019–2024)	19	87	358%
“Decision Making” CHATGPT	483	2458	409%
Last 5 years (2018–2023/2019–2024)	483	2456	408%
“Decision Making” CHATGPT Logistics	36	190	428%
Last 5 years (2018–2023/2019–2024)	36	190	428%
“Decision Making” CHATGPT Logistics Industry 4.0	9	43	378%
Last 5 years (2018–2023/2019–2024)	9	43	378%
“Logistics Strategy” CHATGPT	0	0	0%
Last 5 years (2018–2023/2019–2024)	0	0	0%

Source: Own compilation.

Interest in ChatGPT continued to increase after the original writing date of this paper, which **Table 1** illustrates. The number of publications published with the previous keywords, especially those with ChatGPT as one of its keywords, noticeably increased. The keywords “Decision Making”, Production, and CHATGPT saw a 420% increase in publications in the time period of 290 days, going from 19 publications on the 19th of September 2023 to 822 on the 5th of July 2024. Another notable increase includes the keywords “Decision Making” and CHATGPT, which saw a 409% increase in publications, from 483 publications to 2458 publications. An outlier in the increase of publications includes the keywords “Logistics strategy” and ChatGPT,

which saw no increase in publications, staying at 0. This means that the use of ChatGPT has not yet arisen in the development of logistics strategies, the probable reasons for which will be discussed later.

VOSviewer was used to analyze the publications database. Using different statistical approaches, this visualization visualisation text mining program creates multiple graphs and bibliometric maps of terms in the corpus (Jan van Eck and Waltman, 2023). VOSviewer shows the association between terms in the corpus, highlighting publications on specific topics over time. Keywords used were “Decision Making” AND Production AND ChatGPT for **Figure 1**, and “Decision Making” AND Production AND ChatGPT AND Management for **Figure 2**. Both figures required a minimum of three occurrences. The analysis reveals the correlation between these keywords, with colors indicating recency: yellow for the most recent and blue for the oldest.

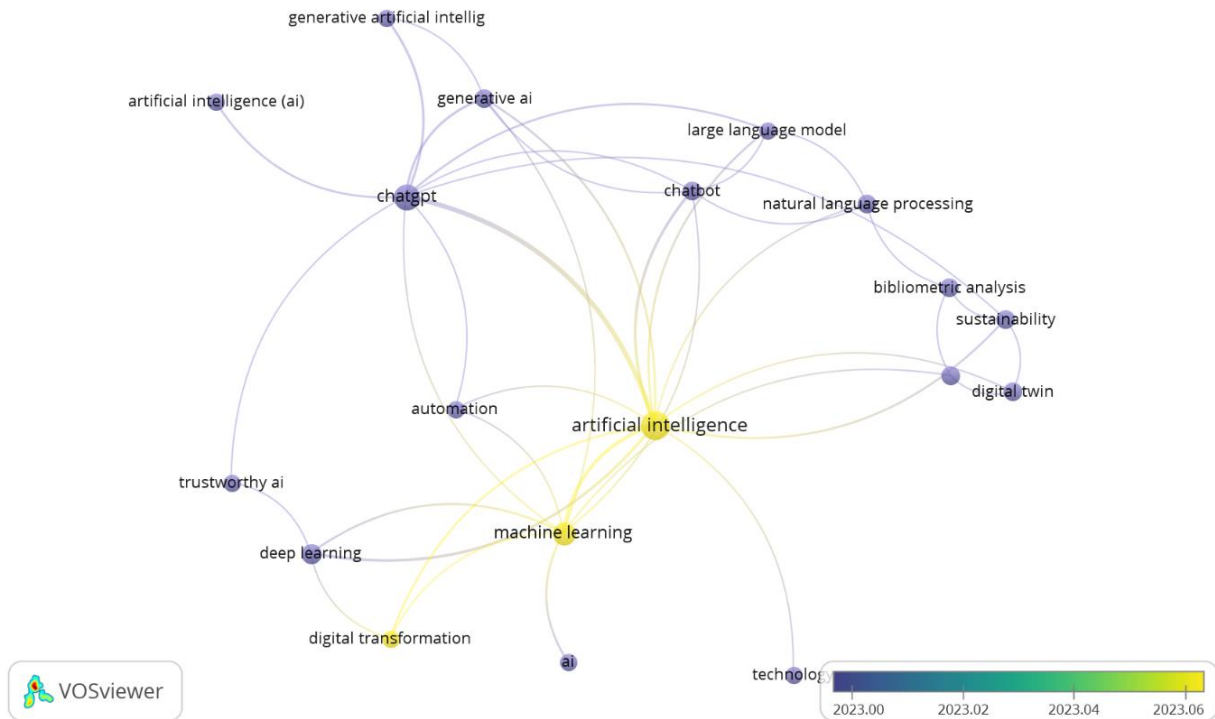


Figure 1. Overlay visualization by VOSviewer from the ScienceDirect research results of keywords: “Decision making” and production and ChatGPT-Last 5 years (2018–2023).

Source: Own compilation.

Figure 1 illustrates correlations between keywords, highlighting artificial intelligence as central and closely linked with machine learning and ChatGPT. The presence of terms like deep learning and digital twins underscores the recognition of artificial intelligence’s relevance in decision-making and management practices. Moreover, the emphasis on “sustainable” suggests a growing belief in AI and chatbots fostering sustainable management and data-driven decision support for businesses. In this search, several relevant articles have been found, such as Fosso Wamba et al. (2023), which explore the problems and benefits of generative AI and ChatGPT in operations and supply chain, with improvement in efficiency being the main benefit.

Javaid et al. (2023) explore the challenges and potentials of ChatGPT for Industry 4.0. Discussing its potential uses from analyzing industrial data to handling customer service issues, and discussed its limitations, such as data and intellectual security concerns, and even its moral and ethical dilemma of replacing human labor. It was discussed (Ghobakhloo et al., 2023) AI implementation in a corporate setting, and finds that the firm’s environment mainly determines AI implementation.

Regarding **Figure 2**, it was observed that it is similar to **Figure 1**, albeit with a notable absence of the keyword “trustworthy AI.” It is believed that this absence may be attributed to the addition of the “management” keyword. Trustworthy artificial intelligence itself could be defined as a holistic and systemic approach that people and societies must have to design, implement, and employ AI systems. It is made up of three pillars and seven requirements: human agency and oversight; technical robustness and safety; privacy and data governance; transparency; diversity, non-discrimination, and fairness; societal and environmental wellbeing; and accountability (Smuha, 2019).

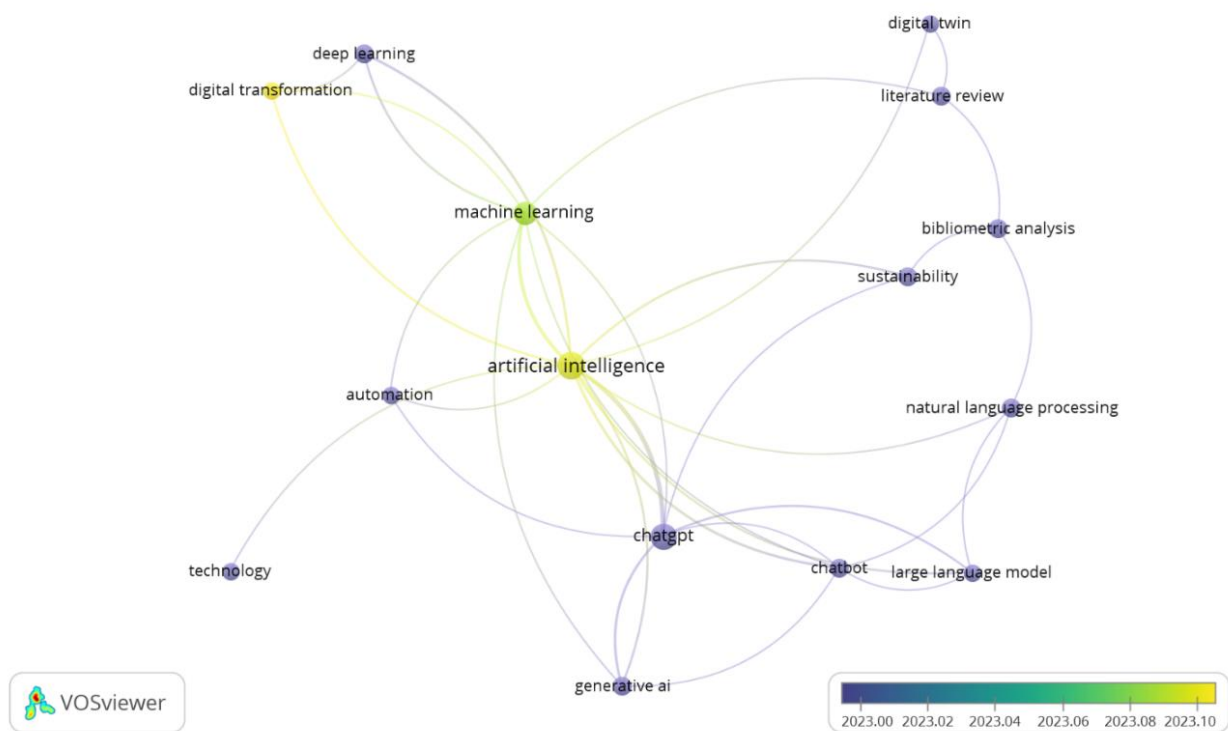


Figure 2. Overlay visualization by VOSviewer from the research results of keywords: “Decision making” and production and ChatGPT and management-Last 5 years (2018–2023).

Source: Own compilation.

It was inquired (Puri and Keymolen, 2023) ChatGPT itself about its trustworthiness by its analysis. They found that the willingness of ChatGPT to offer accurate information and the acknowledgement that it cannot be trusted in the same way that a person can are both factors that foster trust. They also remarked that although it increases reliability to state where your skill begins and ends, ChatGPT’s demarcation is quite ambiguous and rough; it is unclear which areas ChatGPT excels in and which areas it is less confident in its recommendations. Therefore, it is

necessary to ascertain the company’s trustworthiness in handling ChatGPT. OpenAI itself has stated on its website that they’re committed to keeping its AI safe and broadly beneficial, which includes building safe AI systems, real-world learning to improve safeguards, protecting children, and respecting privacy (OpenAI, 2023).

Comparison with current data

This change can also be seen in the data pulled from Vosviewer, which can be observed in **Figures 3** and **4**. Both used the same keywords from the previous figures, however, the number of occurrences has significantly increased, despite still using the minimum occurrences of three. In **Figure 3**, new keywords have appeared in the visualization, including AI regulation, governance, carbon emission, and algorithm aversion.

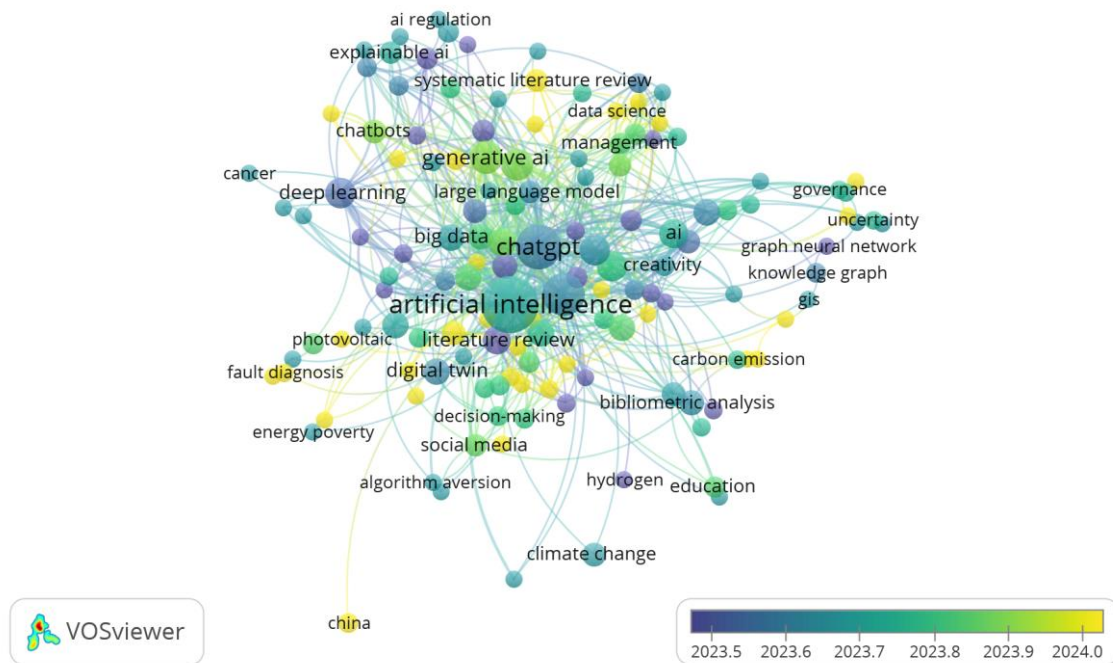


Figure 3. Overlay visualization by VOSviewer from the research results of keywords: “Decision making” and production and ChatGPT (2019–2024).

Source: Own compilation.

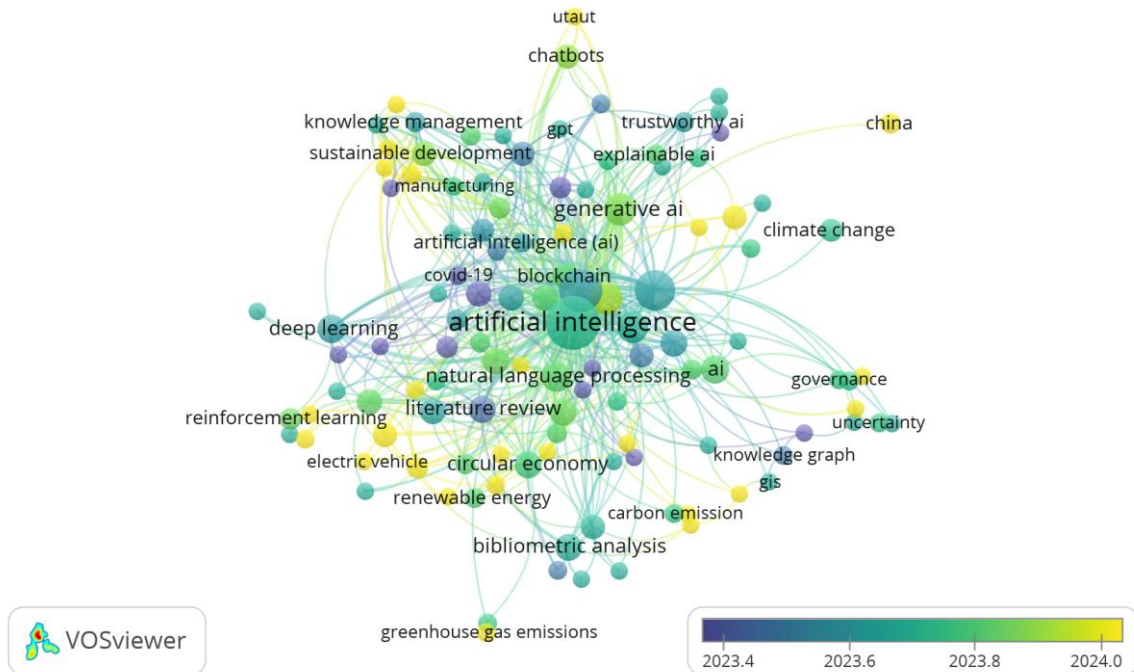


Figure 4. Overlay visualization by VOSviewer from the research results of keywords: “Decision making” and production and ChatGPT and management (2019–2024).

Source: Own compilation.

Algorithm aversion refers to the tendency to undervalue the decisions made by algorithms compared to one’s own decisions or those of others, whether consciously recognizing the historically high performance of algorithms or unconsciously due to a fundamental mistrust of them (Mahmud et al., 2022). This is especially important as an aversion to algorithms may hinder the use of ChatGPT as a decision-making tool. The previously mentioned sustainability has additional co-occurrences in the Vosviewer graph, such as sustainable development, industry 4.0, and energy efficiency. Trustworthy AI has also grown, with co-occurrences mentioning AI regulation, AI ethics, and privacy.

Figure 2, which includes keyword management, also shows a noticeable growth in the co-occurrences of keywords. An example is digital transformation occurring with management, circular economy, and policy. One notable addition is trustworthy AI which was missing in the previous graph, along with its co-occurrences, such as AI regulation, explainable AI, AI ethics, and privacy.

3. Decision-making in a logistics context

Based on the book (Kahneman, 2011) titled “Thinking, Fast and Slow”, decision-making and thinking could be separated into two categories. Slow thinking is the deliberate, diligent production of ideas in a structured flow. When thinking slowly, intentional decisions are made using attention and memory, overriding the guiding impulses and connections of fast thinking. The defining characteristics include rational thought, a conscious effort, a regulated mental process, purposeful action with self-awareness or control, logical and sceptical, and role is seeking new/missing

information and making decisions. Slow thinking regulates 2% of thinking, while fast thinking regulates the remaining 98%. Fast thinking itself could be defined as a primitive survival strategy that employs heuristics, or cognitive shortcuts, to respond to dangers quickly with defining characteristics such as unconscious, automatic, and effortless without self-awareness or control, with its role being assessing a situation and delivering updates. Slow thinking and decision-making in logistics are applied in fields such as purchasing (procurement), logistics strategy, and warehouse planning and design. Fast thinking and decision, on the other hand, apply themselves more to the operational and day-to-day side of logistics, examples being day-to-day production operations, just-in-time deliveries, and day-to-day controlling and management in general. Based on the theory of fast and slow thinking (Kahneman, 2011) and the knowledge of the strategic, tactical and operational levels of logistics (Awudu and Zhang, 2012; Kunaka, 2021; Kress, 2016), **Figure 5** was developed and improved as an approach to the different levels of logistics decisions.

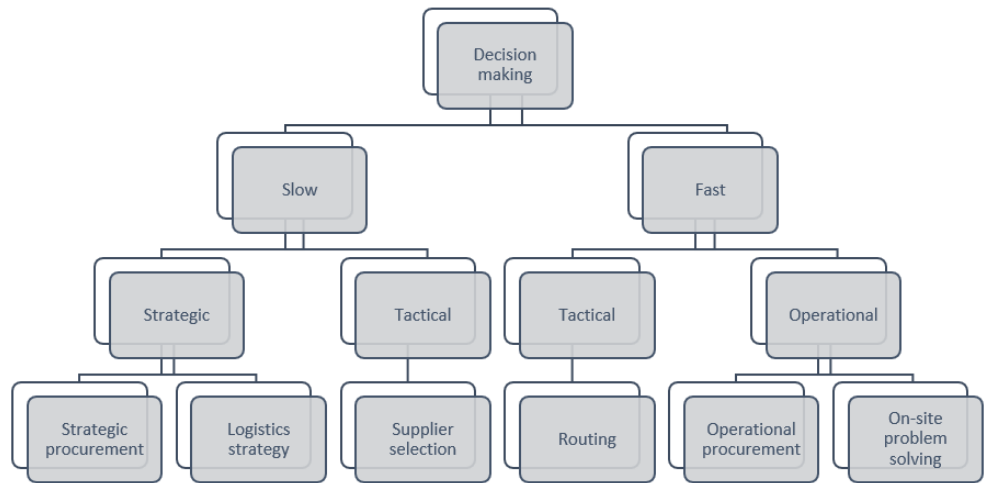


Figure 5. Hierarchy chart of decision-making in logistics.

Source: Own compilation.

The logistics decision-making levels can be further categorized into three categories: strategic, tactical, and operational. To strengthen, coordinate, and manage the relationship between corporate strategy and logistics, as well as to align business strategy with other functional areas of the organization to ensure the company's effectiveness and serve customers well, is what is meant by strategy-level decision-making in logistics (Kunaka, 2021). Various logistics methods can be according to their disciplines, such as Push or Pull, centralized or decentralized, single-stage or multi-stage distribution, and single-channel or multi-channel (Stank and Traichal, 1998). Tactical decisions are medium-term decisions that include sourcing, production, scheduling, transportation and logistics contracts, and the defining of the planning process (Awudu and Zhang, 2012). Product pricing modifications, work schedule changes, departmental rearrangement, and other comparable actions are examples of tactical decisions and have a medium impact on the organization's risk and profitability (Süle and Schunder, 2024). Operational logistics and decision-making are the most complex and typical of the two (Kress, 2016); in the context of managerial actions, operational decisions are the daily choices made by organizational

leaders-These decisions are the practical expression of strategic directives and objectives created at higher levels of the organizational hierarchy, in which strategic-level requirements are converted into concrete and pragmatic courses of action (Aurum and Wohlin, 2005). Operational decision-making involves a wide range of operations related to the manufacturing process, such as planning, technical preparations, and skilled supplier relationship management (Hald and Mouritsen, 2013). With these categories in mind, each category can be categorized into the slow and fast thinking framework, with strategic categorized into slow thinking and decision-making, and operational categorized into fast thinking and decision-making, while tactical falls into both. The feasibility of using ChatGPT in logistics will be explored with this framework.

4. ChatGPT and decision-making

ChatGPT provides insights and decisions by processing and analyzing data (Thiago, 2023). Range and Mayer-Schönberger (2023) wrote that three phases characterize well-informed decisions. The first phase is defining the goal and the context itself, the second is developing choices, and the last is evaluating those options and making a well-informed decision.

In **Table 2**, we have compiled a set of questions for each level of logistical decision-making, representing real-world logistical issues. The answers provided by ChatGPT will be reviewed, and their suitability and coherence will be assessed. The strategic level will encompass a strategic procurement decision, while the tactical level will cover routing, and problem-solving will be addressed at the operational level. Four answers will be regenerated from ChatGPT to determine its consistency.

Table 2. Prompt questions for ChatGPT based on the three levels of logistics decision-making.

STRATEGIC

A large-scale automotive manufacturing company is deciding which supplier to supply its transmission from for its newly designed ICE vehicle. "Supplier A" has a reputation for its innovative transmission technology and quality. "Supplier A" can focus on reducing production costs and offering competitive prices for the company by optimizing its supply chain, improving manufacturing efficiency, and negotiating favorable terms with its suppliers. "Supplier A" also offers innovative technologies and customization options for the company, which include research and development. "Supplier A" also offers resilient supply chains, ensuring a constant supply of components. "Supplier B" is renowned for its engineering expertise and precision in manufacturing. "Supplier B" can leverage its expertise to collaborate with the company to develop solutions that align with the specifications needed. "Supplier B" uses a strict quality control system that ensures a high-quality standard that could lead to long-term trust and collaboration. "Supplier B" also adopts sustainable manufacturing practices that could reduce carbon emissions and footprints in manufacturing; they are also highly popular with the public and could help boost the company's image of sustainability. With these options in mind, which one of the suppliers would be more strategically beneficial for the company if it focused on sustainability and innovation? Please also elaborate on your supplier selection method.

TACTICAL

A truck carrying fresh and frozen goods is ordered to deliver from GYŐR to three cities before returning. Here are the delivery details: GYŐR, EINDHOVEN (each pallet 800 KG, 10 frozen pallets to deliver), FRANKFURT (each pallet 300 KG fresh on 10 pallets and 500 KG on 6 frozen pallets to deliver), LODZ (each pallet 400 KG on 6 fresh pallets to deliver, then taking 20 fresh pallets from LODZ), GYŐR (last location). These locations are not in order. If the efficiency of the route is the main consideration, what is the optimal route for shipping?

OPERATIONAL

My supplier, who usually delivers on time, suddenly could not deliver a part to my automotive manufacturing plant because of a natural disaster. The supplier told me that it would be resolved in one week. The manufacturing uses a just-in-time system, and the part in question is a "jobstopper", meaning that when the emergency stock depletes, production will be halted, which would be tomorrow. What can I do to keep the production going, and what decision could I make?

Source: Own compilation.

5. ChatGPT's answers

In this chapter, ChatGPT and its answers to logistics questions were prepared for examination. During the analysis, the answers are compared with real logistics solution options defined by professionals.

5.1. Strategic

Selecting the best supplier is a well-researched goal in decision-making, production management, and supply chain literature. Researchers employ various instruments and methods to address supplier selection challenges (Mahmoudi and Javed, 2022). Selecting a supplier involves defining the problem, developing criteria, analyzing potential suppliers' qualifications, and making a selection. However, qualifying suppliers alone doesn't ensure the framework's validity in real-world group decision-making scenarios. A decision made by unqualified or untrustworthy evaluators may be contested subsequently, leading to disputes amongst the parties concerned (Abdel-Basset et al., 2022). It was noted (Goh, 2018) that five approaches are being used to assist with supplier performance evaluation: the categorical method, weighted-point method, cost ratio method, dimensional analysis method, and analytical hierarchy method (APM).

In the initial query, which could be observed in Appendix B, ChatGPT was asked to decide strategically between two suppliers, "Supplier A" and "Supplier B," focusing on the company's priorities of sustainability and innovation. ChatGPT gave a detailed response to the prompt, outlining steps without claiming to provide a definitive answer, emphasizing its role in assisting decision-making. The initial answer included 15 steps, concluding with ChatGPT's suggestion. It began by emphasizing the importance of defining objectives. An objective is a justification for choosing one course of action over another. Without values, there is no decision, and all options are equal. The long-term objectives of a decision-maker's organizational context are reflected in a strategic objective, and numerous organizational actions can impact performance on a strategic objective (Merrick, 2011). ChatGPT correctly took the manufacturer's focus in the prompt, which was sustainability and innovation, and it also determined the goals of the two main objective focuses. The next step ChatGPT provided is an evaluation criterion. It did not elaborate on its method of assessment, but ChatGPT probably uses a weighted-point method with the step it provided in "Decision-making" (12th step) and "Selection" (14th step). The next step it chooses for the user to consider is the Request for Information and Request for Proposal (RFI and RFP, respectively).

With ChatGPT's tendency and ability to hallucinate, it is important to check sources whenever a term is presented. ChatGPT works on the concept of reinforcement learning (Lin, 2023), so the default system receives feedback and learns. Thus, the more "prompts" are used to narrow a topic, the more accurate the ChatGPT will be. However, there is a risk that when asked a question on a given topic, the "prompts" will refine the answer until the ChatGPT gives precisely the answer the user "wants to hear". This is not always the correct answer (Li et al., 2023; Maican et al., 2023), but because it gives a very definite answer and it is genetically encoded in humans, we are

more inclined to “accept” a confident answer as “true” and, therefore, often accept the answer without verification. This causes hallucinations.

In this case, both are real and see use in selecting a supplier. A request for information (RFI) helps organizations gather details about potential suppliers and their offerings to support business expansion. It's used during the planning stage of sourcing and procurement. On the other hand, a request for proposal (RFP) asks suppliers to submit comprehensive proposals, including company information, delivery plans, client lists, and financial details. When an organization wants to select the best vendor for a project by evaluating the bidders on criteria other than price, it issues a request for proposals or RFP. ChatGPT, however, did not include RFQ (Request for Quotation), which is also used to evaluate a potential supplier. A request for quotation is a written document that lists all the products and services that an organization intends to purchase. Potential suppliers are required to provide a price quote in response to proposal request. A request for proposals (RFP) is usually sent out when a business wishes to get standard goods or services at the lowest possible cost while still meeting its needs. It is possible that ChatGPT chose not to include RFQ based on its purpose of reducing costs, as it is not stated in the main objective that cost would be a focus of the company.

While cost analysis is the next step, the omission of RFQ is notable. If ChatGPT aims to present various decision-making approaches, it should include all types of requests. This is especially crucial for inexperienced users who are unaware of their options. However, ChatGPT did list RFI followed by RFP in the commonly used order. In the next step, ChatGPT proposes to analyze the cost structure of each supplier; it is defined as the types and relative amounts of fixed and variable expenditures incurred by a business. Smaller definitions of the notion might be provided by division, client, product, service, product line, product, or geographic area. It is feasible to separate the material portion of the whole price by comprehending a supplier's cost structure. Therefore, to better negotiate this cost rise, only consider the supplier's demand for the material portion of the acquired product, all the while trying to maximize the supplier's added value. In the context of manufacturing, quality assurance, or QA, refers to the procedures that producers use as a component of a quality management system to ensure that the products they make meet consistent, expected quality standards (Fogg, 2021). ChatGPT proposes to examine both suppliers' quality assessment, choosing to review “Supplier A” track record as it is stated in the prompt that “Supplier A” has a great reputation and assessing the quality control of “Supplier B” as the prompt did not state their track record.

From the 7th to the 10th step, ChatGPT proposed reviewing each supplier's advantage from the prompt: innovation capabilities and supply chain resilience for A and sustainability practices and public perception for B. In some cases, it even proposes how each supplier could compete with another in a specific area in the other supplier has an advantage; for example, in “Supplier B” public perception and brand image perception, ChatGPT added “Supplier A” innovative technology could also improve brand image and is worthy of consideration. While ChatGPT did exclude RFQ from the previous steps, it is apparent that ChatGPT is trying to provide the user with different approaches, offering alternate solutions with the other supplier to inform the user of an alternate solution. In a decision-making context, this is believed to be

ChatGPT's main strength. It can "brainstorm" possible alternate solutions from a limited prompt and offer other angles that the user could consider. It may not be able to give the user all the possible options for a given problem, but when it does, it does it quite well, making a "brainstorming" session for the user easier and more productive.

What follows in the next step is risk assessment, identification of possible risks, evaluation of their seriousness, allocation of appropriate mitigating measures, and designation of risk "owners" accountable for each recorded risk are all part of the risk assessment process (Clyne, 2022), ChatGPT includes examples for this step as well. The next steps suggested by ChatGPT involve decision-making and negotiation, although the actual selection of the supplier was not carried out in this part, considering its definition. ChatGPT wrote, "Weigh the pros and cons of each supplier's offerings in the context of your defined objectives and evaluation criteria", this is more akin to a weighted-point method of selection earlier, while not mentioning choosing one supplier over the other before the negotiation process. This could be a way for ChatGPT to inform the user of using all the weighted options before the negotiation while making a mistake on the title/definition. The next step provided is a negotiation between the company and the suppliers and, at last, selection; it recommends the user choose the option that outweighs the other one based on the user themselves and the objectives it had helped to set. The last step is monitoring and collaboration between the company and the supplier. ChatGPT determined that "Supplier B" is strategically preferable over "Supplier A," highlighting its strong reputation for sustainability and quality control, which could enhance long-term collaboration and trust. It advises continued monitoring of "Supplier B" regarding sustainability goals. Over subsequent prompt regenerations, ChatGPT consistently reaffirmed "Supplier B" as the optimal choice strategically. It did not, however, reach that conclusion in the same step as the first generated answer.

While consisting of mainly the same idea as the first answer to the prompt, the second answer, which could be observed in Appendix C, completely excludes RFI and RFP from the decision-making process. Instead, it chose to answer with total cost of ownership (TCO). Total Cost of Ownership is a procurement process that computes all the costs related to a certain purchase throughout its whole lifecycle. Together with the original purchase price, further expenses related to upkeep, repairs, renovations, and disposal are also included in the expenditures. This illustrates ChatGPT's inability to consistently generate detailed, step-by-step answers, particularly with this prompt. Instead, ChatGPT relies on a generalized decision-making framework derived from the prompt, generating steps accordingly. While its ability to brainstorm ideas based on the prompt is a strength, it becomes a weakness because it doesn't adhere to consistent, concrete steps, varying its responses while maintaining thematic consistency. This variability is evident in the third answer provided, which could be observed in Appendix D, where ChatGPT independently established evaluation criteria and notably altered its approach to answering the prompt.

5.2. Tactical

Next, the tactical prompt is based on a routing problem, which will be presented in Appendix E. Route planning is the process of figuring out which route is best for delivery drivers. This incorporates several variables, such as the distance, the volume of traffic, the weather, the availability of drivers, etc. Route planning is essential for companies looking to expedite and optimize delivery times (Woods, 2023). ChatGPT was provided with the amount of cargo that needed to be delivered and the cities the transport needed to travel.

ChatGPT provided a satisfactory answer to the prompt, clearly explaining its reasoning and offering recommendations with its signature “humbleness”. It advised considering traffic jams and road conditions and consulting specialized software or a logistics expert. However, the second generation of the prompt differed significantly. The second generation of the answer, which could be observed in Appendix F, showed that ChatGPT did not answer the prompt, opting instead to give the user a guide to use a travelling salesman problem for the solution.

ChatGPT elaborated that it cannot access real-time maps or data to calculate distances and vehicle capacity. The former is arguable since the first answer to the prompt included, “It also allows you to consolidate fresh goods at Lodz, which is closer to your final destination in Győr.” A quick Google search also proved that Lodz is closer to Győr than any other city in the list, with 646.1 km and the second closest being Frankfurt with 844.4 km. So why did ChatGPT refuse to answer the prompt and redirect it to the user instead? It could be because it thinks the answer to the prompt being asked could be dangerous if not provided by an expert, like how (Caruccio et al., 2024) encountered a problem when they asked for a diagnosis of an illness with ChatGPT answering “I am not a doctor. I cannot answer this question.” It is strange that ChatGPT successfully answered the prompt in both its first and third attempts.

It was found (Schwab, 2023) that ChatGPT produced a significantly more similar answer (77.91%) to a minimal prompt compared to a more detailed prompt (73.17%). It shows an ability to produce similar answers when asked to regenerate its answer (between 76.02% and 80.04%, depending on the question). The user is encouraged to be very detailed in their prompt, and the more detailed it is, the more unique the answer given by ChatGPT will be, which is believed to be happening here as a completely different answer was yielded again in the next regeneration of the same prompt in Appendix F. ChatGPT instead chose to go to Lodz first compared to when it chose to go to Eindhoven in the first generation of the prompt. Both cited that the route and minimizes backtracking, although in this case, the first answer was much more detailed than the third, explaining exactly where and why it reduces backtracking. The third answer, which could be observed in Appendix G, also did not make a humble gesture by requesting the user to ask an expert for further clarification; instead, it ended its answer with a definitive statement saying, “This route minimizes unnecessary stops and backtracking, making it the most effective route for shipping.” Thus, in this context, ChatGPT is shown to be unreliable in its answer and may not be suitable for accurate and efficient route planning. The first answer ChatGPT provided was insightful and useful. Still, if regeneration means generating an answer to the prompt by the user, then it could be a gamble whether the user might get a good answer like

the first one or ChatGPT refusing to answer and instead redirecting or guiding the user to what it deemed suitable for the prompt. It is believed that this problem could be alleviated by regenerating as needed by the user and choosing the best possible answer or creating an average of all the answers. However, it would not eliminate the problem; instead, it would merely work around it.

5.3. Operational

The last part of the analysis is ChatGPT's answer to an operational-level prompt where a problem with supply in the production line will be presented in Appendix H. It was noted (Simmons, 2023) that 38.8% of US small businesses faced supply chain delays due to the pandemic, manufacturing faced the highest impact at 64.6%, followed by retail at 59.8% and construction at 58.5%. The main issues that caused supply chain disruptions in 2022 were loss of talent/skills, illness, and transport network issues.

An immediate threat to a society's core interests with potentially disastrous physical, economic, and/or social repercussions is considered a crisis (Uriel et al., 2001). Crises are hard to plan for because they happen seldom and frequently without warning. In a crisis, decision-makers frequently lack relevant prior experience and trustworthy information. The accessible information is frequently obscured by a constant stream of subjective and biased input (Dekker and Hansén, 2004). ChatGPT first suggests assessing the impact of the delay on production and confirming the new delivery date with the supplier. Next, it recommends using any emergency stock available. Third, communicate with the supplier; fourth, reach out to alternative suppliers if possible. Effective communication is crucial for all key procurement and supply chain players.

The supply chain and procurement team should have a clear decision-maker hierarchy and operational structure. IT solutions like delivery tracking systems and e-procurement platforms can aid communication. ChatGPT's suggestion to use inventory buffers did not apply since the manufacturer uses a Just In Time (JIT) system. It also recommends real-time production scheduling to quickly adapt to disruptions and temporary workarounds as a last resort to maintain product quality. Prioritizing critical orders and maintaining communication with consumers is crucial. Lastly, the situation must be monitored, and a comprehensive emergency plan developed.

6. Discussion

ChatGPT's answer was decent but general and lacked depth. While its outline could help those new to the field, experienced managers may not gain much. It didn't provide a detailed step-by-step guide, but with enough user information, the generalized response could help re-orient them in a crisis. ChatGPT is consistent, reshuffling the order or phrasing but keeping the same ideas. It may be useful in some scenarios, like for a disoriented manager needing ideas, but its generalized answers might not be very helpful for urgent decision-making. Coupled with ChatGPT's ability to suffer a significant outage (Griffin, 2023) and full servers (Somoye, 2023), it could make ChatGPT a hindrance in the field when fast decisions are needed.

The question may arise as to why empirical studies have not validated the research. The reason why empirical validation has not been done for publication is that it would require a logistic strategy to be set up with ChatGPT and then operated, which could lead to significant cost losses. This is because a logistics strategy is implemented for the long term, and if it is not workable, it will impact costs and processes that will only become apparent months/years later. Accuracy Rates cannot be precisely defined in a clear-cut way, as each logistical problem is specific and was examined at different levels (tactical, operational, and strategic). Unfortunately, it was impossible to provide a quantitative analysis of ChatGPT performance. However, it can be concluded that ChatGPT is consistent for different but related issues or situations.

Another possibility for validation would be to create a complete logistics strategy using ChatGPT and compare it with a logistics strategy created by an expert. Since ChatGPT generically creates the logistics strategy without using the conditions and parameters, based on an older database, it will probably only be suitable for “brainstorming”, as it cannot take into account the company’s specificities. A logistics strategy prepared by an expert takes a significant amount of time and costs.

One promising approach to making chatbots more specialized is the development of task-oriented chatbots (Hsu et al., 2023). This involves maintaining the general capabilities of ChatGPT or similar technologies while teaching them to handle domain-specific queries more efficiently. Other applications of this concept have already been successfully implemented in several fields (Vahidnia, 2024), and it is, therefore, worthwhile to focus future research on developing a task-oriented chatbot that could provide adequate technical support for logistic processes.

7. Conclusion

This study has explored the feasibility of using ChatGPT in logistics decision-making at three levels: strategic, tactical, and operational. Decision-making in a logistics context has also been explained and explored, along with ChatGPT and its relevant decision-making processes. The findings suggest while ChatGPT is great at “brainstorming” and coming up with a generalized idea for a solution, it is not 100% reliable when it comes to decision-making in logistics. At the strategic level, while coming up with great ideas, it lacks consistent structure to make a truly informed decision. At the tactical level, while it did great on its first generation of the answer, it lost momentum when the prompt was regenerated, producing one refusal/redirection of the answer and switching to a different one in the other. At the operational level, it lacks the depth to help manage and guide the user in a specific way; it also comes with technical problems that may hinder the user from deciding if they rely on it solely and excessively. From this finding, we concluded that ChatGPT is mostly not suitable for decision-making in a logistics context as a final decision maker. Despite this, ChatGPT excels at brainstorming and suggesting different approaches, enhancing decision-makers’ quality of life. It supports the decision-making process with additional information but shouldn’t be used alone for decisions. The examples demonstrated indicate that ChatGPT can be mainly used for brainstorming in the logistics decision-making process, as each logistics problem is specific and requires decisions at different levels (tactical, operational and strategic). Furthermore, the supply chain is

significantly affected by any unforeseen events (e.g. COVID, war, other unforeseen situations, etc.), so ad hoc decision-making along these events is necessary during the logistics processes. Thus, when making decisions in the logistics field, logistics managers always need critical thinking, as ChatGPT cannot take into account the impact of specific circumstances on the supply chain. Since logistics decisions depend heavily on specific parameters and circumstances, ChatGPT should be avoided for logistics decision-making, as it serves best as a general tool, while human critical thinking is essential.

Acknowledgments: The APC was funded by Széchenyi István University.

Conflict of interest: The authors declare no conflict of interest.

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Appendix A

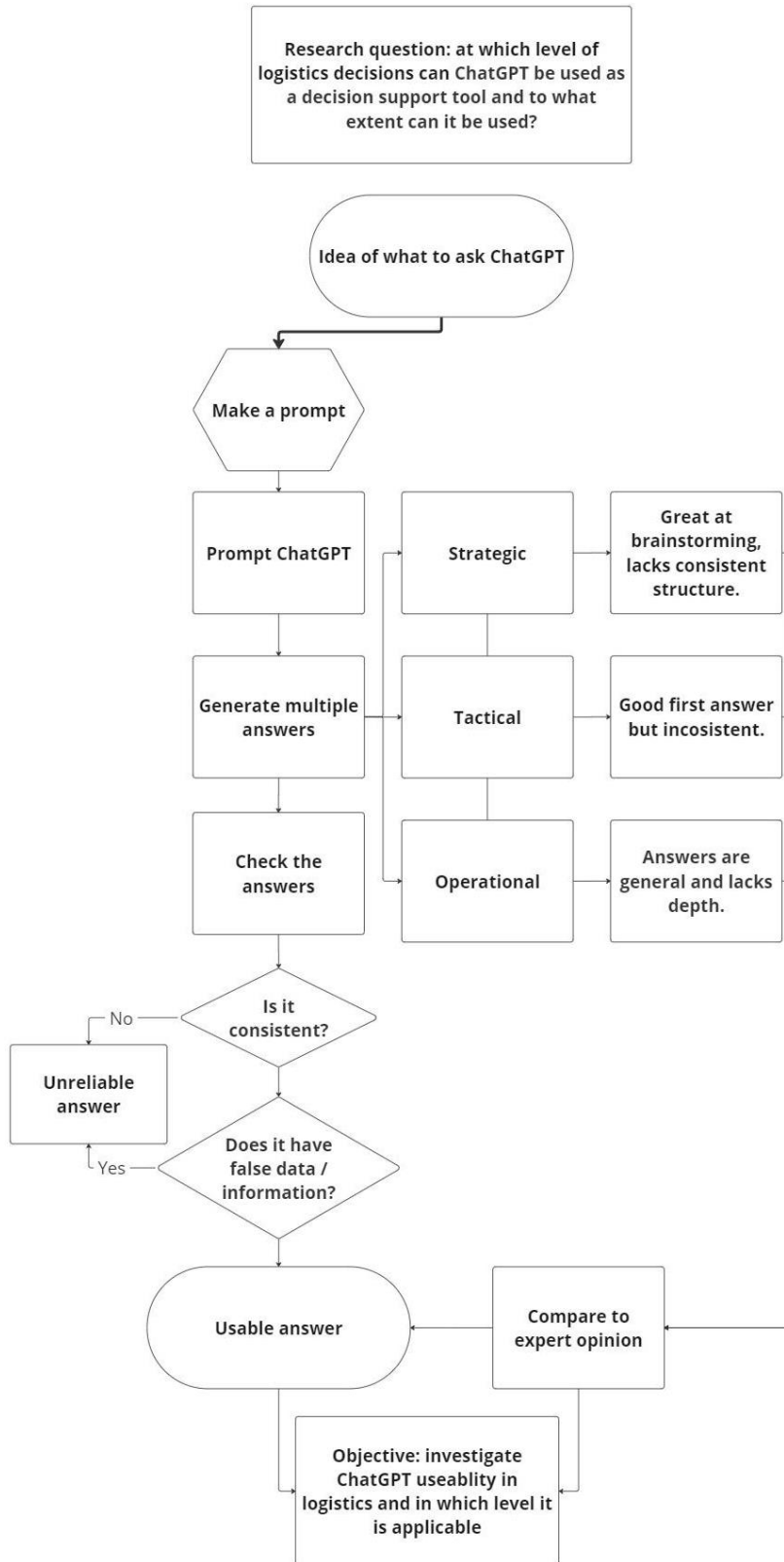


Figure A1. Flowchart of the application of ChatGPT in the logistics field.

Appendix B

Selecting the right supplier for a large-scale automotive manufacturing company, especially when focusing on sustainability and innovation, is a critical decision. The choice depends on various factors and requires a structured supplier selection process. Here's a step-by-step approach to help you make an informed decision:

- 1) Define Your Objectives:
 - Start by clearly defining your company's objectives. In this case, it's sustainability and innovation. Determine the specific sustainability and innovation goals you want to achieve, such as reducing carbon emissions, improving product quality, and staying ahead in technology.
- 2) Supplier Evaluation Criteria:
 - Create a set of evaluation criteria that align with your objectives. Consider criteria like cost-effectiveness, product quality, innovation capabilities, sustainability practices, reliability, and public perception.
- 3) Request for Information (RFI):
 - Send out RFIs to both Supplier A and Supplier B. This initial step helps gather essential information about their capabilities and offerings in line with your criteria.
- 4) Request for Proposal (RFP):
 - After the RFI stage, send out RFPs to both suppliers. In the RFP, ask for detailed proposals that outline how they plan to meet your sustainability and innovation objectives. This should include cost structures, quality control measures, innovative technologies, and sustainability initiatives.
- 5) Cost Analysis:
 - Analyze the cost structures provided by both suppliers. Consider not only the initial product cost but also the long-term costs related to quality control, supply chain optimization, and sustainability practices.
- 6) Quality Assessment:
 - Assess the quality control measures of Supplier B and how they can contribute to long-term trust and collaboration. Review Supplier A's track record in quality and any innovative technologies they offer for enhancing quality.
- 7) Innovation Capabilities:
 - Evaluate Supplier A's capabilities in terms of research and development and their potential to offer customization options. Examine how these innovations align with your company's goals and customer demands.
- 8) Sustainability Practices:
 - Review Supplier B's sustainability practices and their potential to reduce carbon emissions and environmental footprint in manufacturing. Consider how Supplier A can contribute to sustainability through supply chain optimization and innovative technologies.
- 9) Supply Chain Resilience:
 - Consider the supply chain resilience offered by Supplier A. Evaluate their ability to provide a consistent supply of components, which is crucial for automotive manufacturing.
- 10) Public Perception and Brand Image:
 - Assess the public perception of Supplier B, as their popularity and sustainability practices can positively impact your company's image. Consider how Supplier A's innovative technologies can improve your company's image as well.
- 11) Risk Assessment:
 - Evaluate the risks associated with each supplier. This includes risks related to quality control, supply chain disruptions, and the potential for innovation not meeting expectations.
- 12) Decision Making:

- Weigh the pros and cons of each supplier's offerings in the context of your defined objectives and evaluation criteria. Consider the short-term and long-term impact on sustainability, innovation, and overall business success.
- 13) Negotiation:
- Engage in negotiations with both suppliers to see if they are willing to make any adjustments to their proposals, such as pricing, sustainability commitments, or innovation initiatives.
- 14) Selection:
- Based on the comprehensive evaluation, select the supplier that aligns most closely with your sustainability and innovation objectives. Ensure that the selected supplier's strengths in these areas outweigh any potential weaknesses or risks.
- 15) Monitoring and Collaboration:
- After selecting a supplier, establish a monitoring and collaboration framework to ensure that they deliver on their promises in terms of sustainability and innovation. Regularly assess their performance against your objectives.

In this specific case, Supplier B seems to be the more strategically beneficial choice for the company if the focus is on sustainability and innovation. They have a strong reputation for sustainability practices and are popular with the public, which can enhance your company's image. Their quality control system can lead to long-term trust and collaboration. However, it's essential to continue monitoring their sustainability efforts and ensure they align with your specific sustainability goals.

Appendix C

Selecting the right supplier for an automotive manufacturing company, especially when considering sustainability and innovation, is a critical decision. Here's a step-by-step analysis and recommendation for the company:

- 1) **Identify Key Objectives:** First, the company needs to clearly define its objectives. In this case, the key objectives are sustainability and innovation. The company wants to not only produce high-quality transmissions but also focus on reducing its environmental impact and staying at the forefront of technology.
- 2) **Assess Supplier A:**
 - **Innovation:** Supplier A is known for its innovative transmission technology and offers customization options. This aligns with the company's innovation objective, as it can help the company stay competitive and technologically advanced.
 - **Cost Optimization:** Supplier A can help reduce production costs, which can indirectly contribute to sustainability by potentially reducing resource usage.
 - **Resilient Supply Chain:** A resilient supply chain is crucial to avoid disruptions. This is especially important for maintaining production and ensuring the sustainability objective is met.
- 3) **Assess Supplier B:**
 - **Quality Control and Engineering Expertise:** Supplier B's strict quality control system and engineering expertise can contribute to producing high-quality transmissions, aligning with the company's sustainability objective by reducing defects and waste.
 - **Sustainable Manufacturing Practices:** Supplier B's sustainable practices can directly contribute to the company's sustainability goals by reducing carbon emissions and enhancing the company's image as an environmentally responsible organization.
- 4) **Consider Long-term Collaboration:**
 - Long-term trust and collaboration are essential for sustainability initiatives. Supplier B's emphasis on quality and sustainable manufacturing practices can build trust and contribute to long-term partnership.
- 5) **Consider Public Perception:**
 - The public's positive perception of Supplier B for its sustainability practices can enhance the company's image and potentially lead to increased sales and customer loyalty.
- 6) **Supply Chain Resilience:**
 - Evaluate how resilient each supplier's supply chain is. Sustainability and innovation goals could be compromised if there are frequent disruptions due to supply chain issues.
- 7) **Negotiation and Alignment:**
 - Engage in discussions with both suppliers to understand their commitment to your sustainability and innovation objectives. Seek alignment in terms of customization, innovation projects, and sustainability initiatives.
- 8) **Total Cost of Ownership (TCO):**
 - Consider the TCO for each supplier, which includes not only the initial purchase price but also factors like operational costs, quality control, warranty, and potential costs related to sustainability efforts.
- 9) **Risk Assessment:**
 - Assess the risks associated with each supplier, including the risk of not meeting sustainability goals, disruptions, or quality issues. Mitigate these risks where possible.
- 10) **Decision:**
 - Based on the assessment, it appears that Supplier B is strategically more beneficial for the company if it focuses on sustainability and innovation. Supplier B's commitment to quality control, sustainable practices, and its positive public perception can contribute significantly to the company's sustainability goals while

maintaining a high-quality standard. Furthermore, the long-term trust and collaboration potential with Supplier B can support the company's innovation objectives.

Ultimately, the choice may depend on the specific priorities of the automotive manufacturing company, but given the emphasis on sustainability and innovation, Supplier B seems to be the more strategically advantageous option.

Appendix D

Selecting the right supplier for a large-scale automotive manufacturing company, especially when considering sustainability and innovation, is a critical decision. To make an informed choice, you can follow a structured supplier selection process that takes into account various factors. Let's evaluate both Supplier A and Supplier B in the context of sustainability and innovation, using a step-by-step approach:

- 1) Define Your Requirements:
 - Clearly outline your company's objectives and priorities regarding sustainability and innovation in the transmission supply chain. Consider factors such as cost reduction, product quality, sustainability, innovation, and customizability.
- 2) Supplier Evaluation Criteria:
 - Develop a set of criteria specific to your company's needs. In your case, criteria may include:
 - Cost competitiveness.
 - Product quality and reliability.
 - Sustainable manufacturing practices.
 - Innovation capabilities.
 - Customization options.
 - Supply chain resilience.
 - Reputation and public perception.
- 3) Supplier Assessment:
 - Evaluate each supplier based on the criteria established in step 2. Here's an assessment of both suppliers:
Supplier A:
 - Cost Competitiveness: Yes, they can reduce production costs and offer competitive prices.
 - Product Quality: Reputation for quality.
 - Sustainability: No specific information provided about sustainability practices.
 - Innovation: Offers innovative technology and customization options.
 - Customization: Offers customization through research and development.
 - Supply Chain Resilience: Ensures a constant supply of components.
Supplier B:
 - Cost Competitiveness: No specific information provided about cost reduction.
 - Product Quality: Strict quality control system for high-quality products.
 - Sustainability: Adopts sustainable manufacturing practices.
 - Innovation: No specific information provided about innovation capabilities.
 - Customization: No information about customization options.
 - Supply Chain Resilience: Not specified.
- 4) Weighted Scoring:
 - Assign weights to each criterion based on your company's priorities. For example, if sustainability and innovation are highly valued, you might assign higher weights to those criteria.
- 5) Scoring and Ranking:
 - Score each supplier based on the criteria and weights assigned. Calculate a total score for each supplier.
- 6) Risk Assessment:
 - Consider potential risks associated with each supplier. For instance, Supplier A may not have demonstrated sustainable practices, while Supplier B's sustainability could enhance your company's public image.
- 7) Consult Stakeholders:
 - Involve relevant stakeholders in the decision-making process, as their input can provide valuable insights.

8) Decision:

- Based on the scores, risk assessment, and stakeholder input, make an informed decision. In your case, if sustainability and innovation are top priorities, you may lean towards Supplier B due to their sustainable manufacturing practices.

9) Negotiate and Establish a Partnership:

- Once a supplier is chosen, negotiate terms and establish a partnership agreement that clearly outlines expectations, performance metrics, and sustainability commitments.

10) Monitor and Review:

- Continuously monitor the supplier's performance, including their sustainability and innovation efforts, and periodically review the partnership to ensure it aligns with your company's evolving goals.

In summary, Supplier B seems to align better with your focus on sustainability, given their sustainable manufacturing practices. However, it's essential to ensure that their manufacturing processes are genuinely sustainable and not just based on reputation. You may also want to discuss with Supplier B about their capabilities in terms of innovation and customization to make an informed decision.

Appendix E

To determine the optimal route for shipping while considering efficiency, you can use a combination of factors, including minimizing distance, time, and fuel costs. Given the locations and the goods to be delivered, here's a potential optimal route:

- 1) Start in GYŐR.
- 2) Deliver the 10 frozen pallets to EINDHOVEN. This minimizes the weight of frozen goods to be carried over long distances.
- 3) Go to FRANKFURT to deliver the fresh and frozen goods. This ensures that you don't have to backtrack to FRANKFURT later.
- 4) Head to LODZ to deliver the 6 fresh pallets. After delivering, load the 20 fresh pallets from LODZ.
- 5) Return to GYŐR, the starting point.

This route minimizes backtracking and the need to carry heavy frozen goods for extended periods. It also allows you to consolidate fresh goods at LODZ, which is closer to your final destination in GYŐR.

However, you should also consider factors such as road conditions, traffic, and time constraints when planning the route, as they can affect the overall efficiency of the delivery. It's advisable to use a routing and logistics software or consult with a professional logistics expert to further optimize the route based on real-time information and specific constraints.

Appendix F

To determine the optimal route for shipping while considering efficiency, you can use a variation of the Traveling Salesman Problem (TSP), which is a classic optimization problem. In your case, the TSP involves delivering goods to multiple cities and returning to the starting point (GYŐR) while minimizing the total distance traveled.

Let's analyze the problem step by step to find the most efficient route:

- 1) Calculate the distances between each pair of cities. You would need access to a transportation network or mapping software to do this accurately. The distances should be in kilometers or another suitable unit.
- 2) Calculate the total weight of goods that need to be delivered to each city. This includes both fresh and frozen goods.
- 3) Determine the truck's capacity and any weight restrictions or constraints. Make sure you account for the weight of goods taken from LODZ.
- 4) Use a TSP solver or algorithm (such as the nearest neighbor algorithm, the Christofides algorithm, or a branch-and-bound method) to find the optimal route that minimizes the total distance traveled.

Since I don't have access to real-time maps or data to calculate distances and vehicle capacity, you would need to perform these calculations and use a TSP solver to find the optimal route based on your specific requirements and constraints. There are also various software tools and libraries available that can help you solve TSP problems efficiently.

After running the TSP solver with your specific data, you'll have the optimal route that minimizes the distance traveled while delivering goods to GYŐR, EINDHOVEN, FRANKFURT, LODZ, and back to GYŐR.

Appendix G

To determine the optimal route for shipping while considering efficiency, we should minimize the overall distance traveled and the number of unnecessary stops. Here's the optimal route for the truck carrying fresh and frozen goods:

- 1) Start in GYŐR.
- 2) Deliver 6 fresh pallets to LODZ.
- 3) Take 20 fresh pallets from LODZ.
- 4) Head to EINDHOVEN.
- 5) Deliver 10 frozen pallets in EINDHOVEN.
- 6) Head to FRANKFURT.
- 7) Deliver 10 fresh pallets and 6 frozen pallets in FRANKFURT.
- 8) Return to GYŐR.

This route minimizes the distance traveled by first delivering and picking up goods in LODZ, then delivering frozen goods in EINDHOVEN, followed by fresh and frozen goods in FRANKFURT, and finally returning to GYŐR. This route minimizes unnecessary stops and backtracking, making it the most efficient route for shipping.

Appendix H

Facing a situation where your automotive manufacturing plant's production is about to be halted due to a delayed part delivery caused by a natural disaster can be challenging. To keep the production going and make the best decision, consider the following steps:

- 1) **Assess the situation:** Start by understanding the full extent of the delay and the impact on your production. Verify the expected delivery date from your supplier and their commitment to resolving the issue in a week.
- 2) **Emergency stock:** If you have any emergency stock or backup parts available, use them to prevent immediate production halts. Ensure that you only use these resources to cover the most critical needs.
- 3) **Communicate with your supplier:** Maintain open and transparent communication with your supplier. Confirm their timeline for resolving the issue and ask if there are any alternative sources they can recommend. Request regular updates on the situation.
- 4) **Alternative suppliers:** In parallel with working with your current supplier, start researching and contacting alternative suppliers who can provide the needed part. You may need to expedite the procurement process or pay for faster shipping to get the part as quickly as possible.
- 5) **Inventory buffer:** In the long term, consider building a buffer inventory for critical parts to mitigate the risk of future supply disruptions. However, this may not help you in the short term.
- 6) **Shift production focus:** If possible, reassign your workforce to work on other tasks or production areas that don't rely on the missing part. This can help maintain some level of production and avoid idling workers.
- 7) **Adjust production schedules:** If you have the flexibility, reschedule production to focus on products that do not depend on the missing part or are less impacted by its absence.
- 8) **Temporary workarounds:** Explore whether it's possible to adapt or modify your manufacturing process temporarily to use an alternative part or work around the missing component. This should be a last resort as it may affect product quality or efficiency.
- 9) **Prioritize orders:** If you have multiple orders or customers, prioritize those that are most critical or have contractual obligations. Communicate with other customers about the delay and work on solutions to meet their needs.
- 10) **Emergency response plan:** Develop a comprehensive emergency response plan to deal with future disruptions, including identifying alternative suppliers, building stockpiles of critical components, and creating contingency production plans.
- 11) **Continuous monitoring:** Keep a close eye on the situation and adjust your plans as needed. If there are any changes in your supplier's status or new developments in the natural disaster's aftermath, respond accordingly.

Ultimately, your decision will depend on the specific circumstances and the resources at your disposal. The key is to act swiftly, communicate effectively, and prioritize maintaining critical operations while seeking alternative solutions to keep your automotive manufacturing plant running smoothly.