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DISTRIBUTION STRATEGY PLANNING: A COMPREHENSIVE PROBABILISTIC APPROACH FOR UNPREDICTABLE ENVIRONMENT

Theodor Petřík

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Institute of Economic Studies,
Faculty of Social Sciences,
Charles University in Prague

[UK FSV – IES]

Opletalova 26
CZ-110 00, Prague
E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Institut ekonomických studií
Fakulta sociálních věd
Univerzita Karlova v Praze

Opletalova 26
110 00 Praha 1

E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

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Distribution Strategy Planning: A Comprehensive Probabilistic Approach for Unpredictable Environment

Theodor Petřík

Faculty of Social Sciences, Institute of Economic Studies, Charles University, Prague, Czechia

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Abstract:
Uncertain future development presents a significant challenge during the distribution strategy planning process. Traditional planning approaches, reliant on creating potential scenarios and assigning probabilities, often struggle due to future developments' inherent unpredictability, which can lead to suboptimal strategies if probabilities are inaccurately estimated. This paper introduces a novel method designed to navigate these uncertainties without rigid assumptions about the exact probability of each future scenario. This method aims to identify optimal strategies applicable across a wide range of situations by exploring the entire allowable probability space. The effectiveness of this approach is demonstrated by a case study of a real-world Czech company considering potential expansion. The optimal distribution stratégy is formulated and evaluated in the case study for six years, considering multiple potential development scenarios.

JEL: D81, D22, C44, C61
Keywords: Decision-making under uncertainty, Economic efficiency, Transport Economics, Probabilistic Approach

1 Introduction

This paper presents a robust and reliable approach to the difficult task of distribution strategy decision-making in an environment prone to significant volatility and uncertainty. Distribution strategy planning is a process that each company with a higher transported volume in their network should do. This high volume indirectly affects the company's profit and provides considerable potential for savings while inefficient. Specifically, companies categorized as medium-sized enterprises and larger ones should already start to consider their network on a strategic long-term level. Whether it is a crucial topic for the company depends on its segment and the efficiency of its current logistics solution. For example, based on an analysis performed by Bain and Co. in the segment of consumer-packed goods, the share of distribution cost on the total revenue is 6-10% (Bain, 2018). The higher the ratio is, the larger the space for optimization it provides. These numbers differ in other segments but should always be critically revised and considered.

The task of distribution strategy planning itself is a very complex one. A distribution network design aims to plan the most cost-efficient product movement through the whole supply chain (Ambrosino and Grazia Scutellà, 2005). To stress the importance, Ballou (2001) estimated that through an efficient distribution network and effective facility management, the operation costs can be decreased by up to 15%, making a difference between higher and lower shares in the abovementioned analysis. Mangiaracina et al. (2015) composed a highly comprehensive review of the distribution network optimization methods in the contemporary literature. However, there is a significant gap in the rigid process of handling uncertainties during planning.

We can divide the distribution strategy into two groups from a very high level.

Outsourced to a partner (3PL or 4PL or other) and insourced; for a more detailed description, refer to, for example, (Panicker et al., 2009).In the first case, there is not enough room for significant distribution questions and optimization. This kind of solution better fits smaller companies than those defined above, and the current trend on the market is to take back control of the company's logistics and leave X-PL schemes. Further, in this article, we will consider only in-sourced logistics solutions.

When a distribution strategy is to be designed, it cannot be performed with an outlook of a small period. A distribution network is a structure that requires time to change. It consists of logistics nodes, distribution fleets, and accompanying processes; for details, refer to (Ambrosino and Grazia Scutellà, 2005). Logistics nodes need to be either constructed or rented. Even in the case of renting, it takes at least six months to get a logistics node fully operational. The fleet is usually leased or outsourced without losing control over the operations, and changes can be performed faster. For larger companies, the fleet agreement preparation and the signing process again demand a substantial amount of time.

These aspects make it apparent that planning and optimizing the distribution strategy in advance is necessary. At the same time, future effects such as market changes, new customers, drops in demand, external influences such as legislation and petrol costs, and much more play a significant role in the process. Consequently, this article aims to propose and test a way to evaluate distribution strategies without making rigid assumptions regarding future development and provide a tool for management to make informed decisions over multiple years of outlook.

The article is structured as follows. First, the underlining model is introduced in Section 1.1, and the literature is reviewed in Section 2. Next, the approach

to model the optimal distribution strategy and evaluate its share in the space of available strategies is introduced in Section 3. The model is then implemented in Section 4 on a business case of an electronics merchant. It is used to plan an optimum long-term distribution strategy. The last Section 5 provides an overview and a potential for further research.

1.1 Model background

This article builds on the novelty Concurrent Optimization Model (COM) (Petřík and Plajner, 2023), which enables selecting the best long-term distribution strategy based on various development scenarios, their respective likelihoods, and the values of several potential distribution strategies. Using COM, the authors evaluated different potential expansion strategies of a real-world company.

In COM, the effectiveness of each strategy is measured using a key performance indicator (KPI), such as the distribution network operating costs. The COM incorporates the principles of Bayesian Networks (Jensen and Nielsen, 2007; Kjaerulff and Madsen, 2013) to encompass the complete system of values and beliefs. Bayesian Networks are probabilistic graphical models that visually depict knowledge about a system under uncertainty. In these networks, each node represents a random variable, and each connecting arc represents a conditional probability relationship. An example structure of such a network can be seen in Figure 1. The chance nodes represent the model company in a given year. Each chance node has a set of states. In this particular case, traffic restrictions could be adopted by the city that the company operates in. The connecting arcs between the nodes represent the conditional relationships. The variable at the beginning of an arc is called the parent of the variable at its end. A conditional relationship is specified

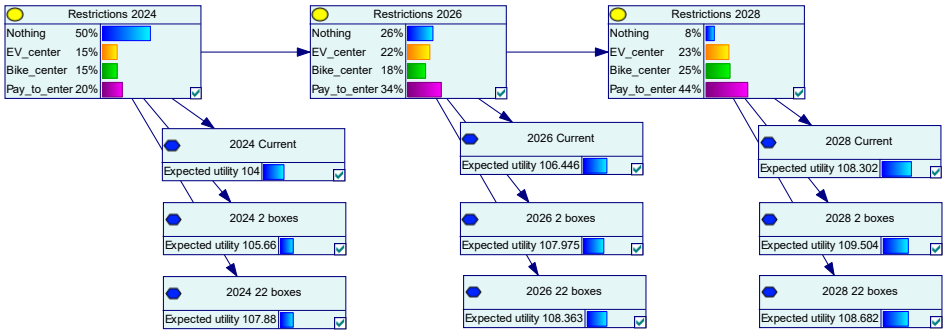

Figure 1: Example of the network structure used

by a conditional probability table (CPT), which defines the probabilities of states of the child, given all states of the parent node. The three nodes dependent on each chance node in Figure 1 are called utility nodes. Their purpose is to measure the expected value of each considered distribution strategy, given the conditional probability of each scenario of the given chance node they depend on.

However, specifying precise conditional relationships in real-world strategic planning is usually very challenging. To address this issue, the approach described in this article assumes only limited or no knowledge of the likelihood of each modeled scenario and no knowledge of the conditional dependencies. Therefore, the model presented in this work assumes no conditional relationships between variables; hence, we do not apply the BN framework as Petřík and Plajner (2023) did.

However, the presented more general approach employs a similar optimization procedure to select the best option for each potential development scenario when searching through the whole probabilistic space. We subsequently measure the share of cases where each distribution strategy is optimal. The significant advantage of the method presented here over Petřík and Plajner (2023) lies in its ability to

provide valuable insights without placing precise, potentially biased assumptions regarding future business scenario development.

2 Literature

The theme of the presented article is distribution strategy planning under uncertainty, which broadly consists of the distribution network design and planning. Distribution network design is not this article's primary focus; the reader is referred to other sources, such as (Chopra, 2003) or Mangiaracina et al. (2015). The branch of literature related to supply chain planning under uncertainty, correspondingly to this article's theme, is discussed in this literature review. There is a wide range of approaches to planning and risk management in unpredictable environments of supply chains. Trend-impact analysis (Gordon and Stover, 1976) and Cross-impact analysis (Gordon and Stover, 2003) comprise a foundational class of scenario planning approaches, which utilize historical data and expert opinion to formulate possible future development scenarios. Both approaches were introduced mainly by the same author and have many applications, for example, developing resilient scenarios for hospital supply chains Nejad et al. (2021). The research in the field is ongoing, and new methods and applications are being developed; for example, the concept of VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) has been explored to identify the challenges and internal barriers in realizing a resilient supply chain Grzybowska and Tubis (2022). Mathematical models have also been developed for recovery planning in three-tier manufacturing supply chains facing sudden disturbances (Paul et al., 2019). A common aspect of these studies is the emphasis on the need for robust planning mechanisms to navigate the

complexities of modern supply chains. Bayesian networks (Jensen and Nielsen, 2007; Kjaerulff and Madsen, 2013), a class of probabilistic graphical models, have been used to deploy a probabilistic approach to risk management. Examples of specific use cases are a risk propagation model Garvey et al. (2015), supply-side risk modeling (Sharma et al., 2022), or a resilience assessment on a deep water port (Hossain et al., 2019). Further studies have explored predictive sales and operations planning based on statistical treatment of demand to increase a manufacturer's efficiency (Gallego-García and García-García, 2021), as well as, for example, sustainable closed-loop supply chain synergy in the forestry industry (Wang and Tian, 2022). Optimal inventory control using stochastic optimization models has also been discussed, focusing on multi-echelon supply chains with uncertain demand (Crevecoeur et al., 2019). These studies indicate the growing interest in employing probabilistic and statistical methods for planning and risk management in domains of a company's operations. Such models considering uncertainty have not been heavily utilized so far. Despite the extensive research in these areas, the specific topic of distribution strategy planning in unpredictable environments still needs to be explored. The main contribution of this article, the method to find an optimal distribution strategy path in an unpredictable environment, is developed in Section 3.

3 Methodology

3.1 Notation

The model searches for the optimum long-term distribution strategy given a set of business scenarios and a set of feasible potential distribution strategies. Business

scenarios can be, for example, different sales growth trajectories, shifts in consumer behavior, or a Black Swan event (Taleb, 2007). Distribution strategies are various configurations of the company distribution network. For the optimization procedure from COM, they must be evaluated across all considered business scenarios. Therefore, if we, for example, consider four business scenarios and two distribution strategy setups, there must be eight estimates in total.

The distribution strategy is designed for n consecutive time periods. Variable A^i, $i \in 1 \dots n$, is the modeled company in the period i, and its states $a^i_j, j \in 1 \dots m^i$ are the possible business scenarios where the company can be in that period. $\mathbf{A} = \{A^1, \dots, A^n\}$ is the set of all company nodes at all time periods. The company must then design a number d of feasible distribution networks $\mathbf{Z}$ which could accommodate the needs of the company $\mathbf{A}$. Symbol $Z^i_f, i \in \{1, \dots, n\}, f \in \{1, \dots, d\}$ then refers to a strategy Z_f implemented during a specific period i.

Next, it is necessary to choose a KPI which will be used to evaluate each business scenario - distribution network combination. From our experience, we define the distribution network operating costs as the one most frequently used in practice. Distribution network operating costs for a company are costs related to network operations. $c^i_{j,f}, i \in \{1, \dots, n\}, j \in \{1, \dots, m^i\}, f \in \{1, \dots, d\}$ stands for distribution network operating costs in a state a^i_j while operating a distribution network Z_f. The tool to obtain all estimates $c^i_{j,f}$ can be chosen freely, but it must be possible to do so for every Z_f at every state a^i_j included in the model.

3.2 Modeling the share of cases when a distribution strategy is optimal

While facing the long-term planning task and creating a robust strategy, expectations about future development are required. The expectations can be obtained using data and mathematical forecasting methods (such as regressions, neural networks, and such) or experts' opinions and educated guesses. Having worked on various distribution strategy design projects, we discovered that acquiring conditional probability tables, as described in Subsection 1.1, is challenging using either data or expert knowledge, especially with a long horizon of more years. Underlying data are usually too sparse for robust predictions, prone to unforeseen events, and expert knowledge is hard to obtain in a precise form. The causal transitions among states between company nodes are difficult to capture and notoriously prone to misspecification. To address this difficulty, we design a process that helps experts fill their expectations into the model and calculation even though they are very imprecise. We propose to limit the possible future scenarios to a smaller area (viable options). In this area of potential future development, we estimate the percentage share when a distribution strategy is optimal. This answers strategists and planners on the chance that the selected path will be correct, which is significant information in the planning process. The advantage of this approach is its robustness to the user's misperception of the likelihood of future development scenarios. On the other hand, even with this approach, evaluating the future distribution network scenario is necessary as it is an essential input for calculations. We use a proprietary software, Distribution Wizard, which allows us to do such calculations.

The computations in the presented model are conducted separately for each company node A^i, $i \in 1 \dots n$ from the network. Accordingly, we assume the inde-

pendence of different company nodes. However, the users have demonstrated a far better ability to accurately describe the probability of a_j^i by an interval than by an exact CPT. Therefore, we allow the user to restrict the probability of each state a_j^i in the network, to model their assumptions about the state's a_j^i probability. The user-restricted probability space $\mathbf{P}$ can be defined as.

$$\mathbf{P} = P(A^i = a_j^i) \in [\overline{w_j^i}, \hat{w_j^i}], i \in \{1, 2, \ldots, n\}, j \in \{1, 2, \ldots, m^i\},$$

$$\overline{w_j^i} \in [0, 1], \hat{w_j^i} \in [0, 1],$$

where the $\overline{w_j^i}$ and $\hat{w_j^i}$ are the lower and upper limit for the probability that the state a_j^i can have. In the application presented in this article, we model business scenarios in which the modeled company is assumed to shift a part of its wholesale from Czechia to Poland. The user-restricted probability space $\mathbf{P}$ allows us to model the situation when, for example, the scenario in mind has a probability of at least 10% and a maximum of 60% to happen in the future.

Now let us define a subspace $\mathbf{W}_f \subseteq \mathbf{P}$, which represents all probability combinations for which a strategy $f \in \{1, \ldots, d\}$ is optimal. Probabilities $p_j^i, i \in \{1, \ldots, n\}, j \in \{1, \ldots, m^i\}$ create the subspace $\mathbf{W}_f$, where the following condition is satisfied for a given f:

$$f = \arg\min_d \left\{ \sum_{j=1}^{m^i} p_j^i c_{j,d}^i \right\} \tag{1}$$

The condition depicted by the Equation 1 is based on the COM (Petřík and Plajner, 2023). It states that a distribution strategy Z_f yields the lowest expected distribution network operating costs at the company node A^i given the probability

combination p_j^i and the costs $c_{j,d}^i$ associated to each business scenario a_j^i and each distribution strategy Z_d.

Finally, we want to estimate the size of the subspace $\mathbf{W}_f$. Let us first denote the size as $S \in [0,1]$, $S(\mathbf{W}_f) = 0$ implies that the strategy is never optimal in the subspace. The size S of the strategy f is then the integral of the $(r-1)$th order over this subspace. r is the number of states a_j^i which a company node A^i can have. One integral dimension is subtracted due to the logical restriction $\sum_j p(a_j^i) = 1$.

$$S(\mathbf{W}_f) = \int_{W_f}^{(r-1)} 1 \, dW_f \tag{2}$$

In case there are any user-defined restrictions placed on the probability space $\mathbf{P}$, the $\sum_{f=1}^{d} S(\mathbf{W}_f) \neq 1$. Therefore, the values $S(\mathbf{W}_f)$ are normalized to

$$S'(\mathbf{W}_f) = 1 \tag{3}$$

for better interpretation. The resulting $S'(\mathbf{W}_f)$ then represents the percentage share of the cases when the strategy f is optimal in the user-restricted probability space $\mathbf{P}$.

4 Case study: Choosing the optimal distribution strategy in an unpredictable environment

In a case study involving a consumer electronics wholesale company [1] operating primarily in Czechia, we applied the methodology presented in Section 3 to explore the probability of three distinct distribution networks being optimal under the impact of four considered scenarios of future business development. The prospective analysis extended to a six-year period, divided into three distinct time frames: 2024, 2026, and 2028. As distribution network changes take time to implement, it is reasonable to use two-year intervals. These intervals can be modified to any necessary length if needed. For this analysis, we project a steady wholesale volume over the whole outlook. The case study is structured as follows: initially, we present the logistics operations and an overview of the modeled traffic restrictions. Subsequently, we implement our method and examine the findings.

4.1 Logistics operations description

The company's operations comprise two major parts. First is a chain of retail electronics stores with branches in most Czech cities. The second is wholesale to a vast network of other customers. The company also operates an e-commerce platform, representing only a minor portion of sales. Currently, wholesale deliveries and deliveries to the retail chain are conducted from one distribution center situated on the outskirts of Prague. Two main channels facilitate the distribution. A network of privately operated trucks is used to deliver bulk amounts to the own

[1] As per the company's request, the name will remain undisclosed, and any other facts according to which it could be decisively identified. Consequently, all prices are always listed in units corresponding to CZK*coefficient, and the conclusions are expressed in relative terms that remain accurate.

retail chain and to those customers whose orders are large enough. Outsourced logistics service providers are then used to deliver goods to the remaining clients where operating their own 22-ton trucks is not economically viable. However, the currently used distribution centers' storage and throughput capacity is constantly under strain, and a portion of the portfolio, consisting of large consumer electronics, is to be moved to a new distribution center.

4.2 Business development scenarios

We modeled several different business development scenarios that could significantly influence the choice of optimal distribution strategy. In addition to the current status quo, which assumes no changes in the current state, we present three distinct scenarios.

- **Sales shift:** In this scenario, we assume that 30% of the sales conducted in retail stores would shift to e-commerce. Such a shift would reduce the overall amount transported by the own fleet to the retail branches. The goods would be shipped directly to the consumers via outsourced services.

- **Wholesale shift small:** We model a wholesale shift to Poland (+15,000 m^3) from Czechia (-90%). In this scenario, the major wholesale customers in the Czech market signal the option of diverting and purchasing the goods directly from overseas manufacturers. At the same time, there are advanced negotiations with a major online e-commerce company from the fast-emerging Polish market, which could soon become a major customer. In this scenario, most shipments to the Czech wholesale customers, whose warehouses are primarily located in the Central-bohemian region, would stop. However, a

significant amount of goods would be newly delivered to the distribution center of the Polish company located on the outskirts of the capital, Warsaw.

- **Wholesale shift large:** We model a wholesale shift to Poland (+25,000 m^3) from Czechia (-90%). This scenario is identical to the previous one, except for the amount newly delivered to the Polish company.

4.3 Distribution strategies

We propose three alternative strategies with different network topologies. The network topology is defined by the distribution nodes (warehouses, cross-docks) and the vehicles operating them. Each strategy corresponds to a different location choice for the new distribution center.

- **Praha:** New distribution center near Prague
- **Brno:** New distribution center near Brno
- **Ostrava:** New distribution center near Ostrava

4.4 Modeling

We model one year of operations of each network as described in Subsection 4.3 under each considered scenario from Subsection 4.2 using real data of historical orders provided by the company. The data includes details about precise delivery time and date, order size, delivery channel used, and customer location addresses. To model each scenario as realistically as possible, we deployed a proprietary simulation software Distribution Wizard from the company Logio, a Czech consultancy and technological company that has been providing supply chain management services to major retailers and manufacturers worldwide since 2004. Distribution

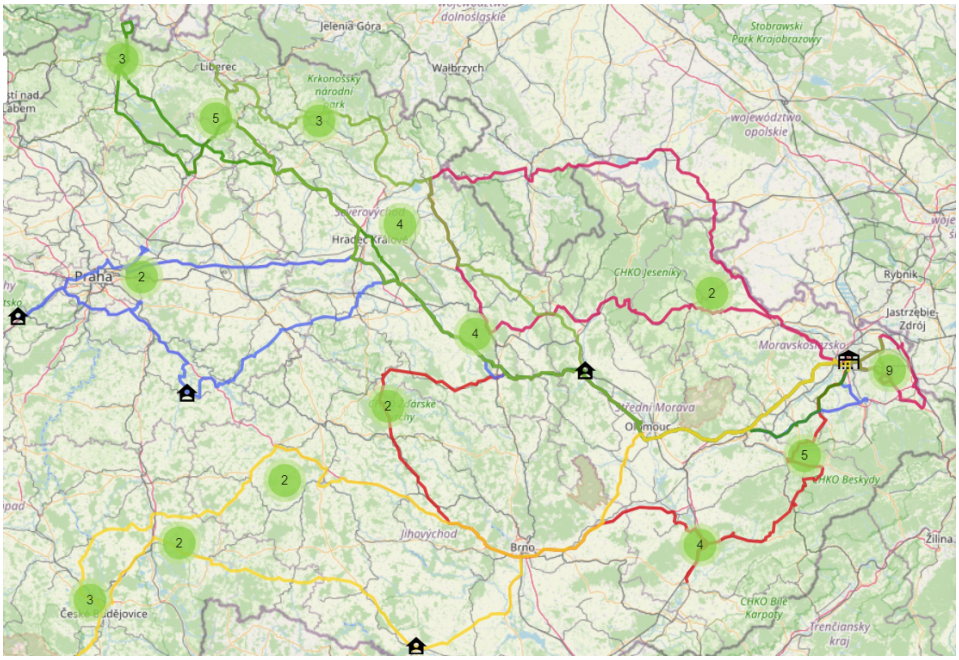

Figure 2: Distribution routes from the Ostrava warehouse

wizard's engine GraphHopper (2024) can solve large vehicle routing problems and integrates a wide range of parameters, which enables us to model a wide range of network configurations accurately. Next, we simulated the modeled scenarios and fine-tuned the model parameters where necessary. The example of graphical output provided by DW can be seen in Figure 2. Each colored line represents a route designed by DW to deliver a given set of orders to customers on a given day. The Figure shows explicitly one of the simulations for the distribution scenario when the new distribution center is located near Ostrava.

The Table 1 provides the overview of the calculated costs of each distribution strategy under each business scenario. Each figure is a combination of the costs for the own fleet of trucks, as estimated by DW, and the costs of outsourced

Table 1: Comparison of the operating cost of each scenario and each strategy

	Scenario			
Strategy	Current	Sales shift	Wholesale shift small	Wholesale shift large
Praha	1 000 000	1 136 622	1 196 659	1 335 397
Brno	1 048 860	1 163 901	1 165 068	1 279 688
Ostrava	1 114 696	1 184 497	1 159 403	1 239 946

providers. The costs for pallet deliveries were calculated using our knowledge of the industry standard delivery prices for a given distance from the origin and the pallet weight. Since we focus on the relative rather than absolute differences between the results, the absolute estimates were scaled for the distribution strategy **Praha** in the current state business scenario to equal 1,000,000 units. Scaling preserves the relative ratios and enhances the readability of the results for the reader.

The results suggest that building the new distribution center in Praha under the current scenario yields the lowest operating costs. Moreover, the same distribution strategy is also the most cost-efficient under the **Sales shift** scenario, when we modeled a sales shift from the retail store shelves to e-commerce. Under both of these business scenarios, the distribution strategy **Ostrava** is the most expensive. On the other hand, in the case of a wholesale shift to Poland as modeled in the third and the fourth scenarios, **Ostrava** corresponds to the lowest estimated costs, and **Praha** to the highest. That is an expected outcome because the wholesale shift is much more favorable to **Ostrava** than **Praha**, as it lies much closer to the Polish capital, Warsaw. The operating cost of the **Brno** strategy lies always between **Praha** and **Ostrava**.

4.5 Finding the probabilistically optimal strategy for each year

Having obtained the expected costs of each strategy under each scenario, we approached the application of the methodology presented in this work in Section 3. In line with the presented method, we first restrict the probability space. We limit the **Wholesale shift small** and the **Wholesale shift large**. The first restriction assumes that the probability of the **Wholesale shift small** scenario in 2026 is at least 10% and in 2026 at least 20%. The second assumes that the probability of **Wholesale shift large** is at least 5% and in 2026 at least 10%.

According to Condition 1, we identified the subspace for each of the three considered distribution strategies, where each strategy yields the lowest expected operating costs. The respective subspaces were approximated by discretization of the full probability space. Tests have shown that the granularity of multiples smaller or equal to 10% for each $P(a_j^i)$ quickly converges to a stable result. We have chosen a sufficient granularity of 5% to proceed with the method. Consequently, we obtained the percentage share of the number of cases when each given strategy is optimal. This calculation[2] was done in line with Equation 2. Finally, the shares were normalized according to Equation 3 to make the total sum equal to one.

Figure 3 depicts the results of our model application. The stacked bars represent shares of cases when each considered strategy is optimal in each modeled year, given the user-placed assumptions referenced in the figure caption. In 2024, the distribution strategy in Prague holds the majority share. Yet, as we explore scenarios where there's a higher probability of shifting wholesale operations to Poland,

[2]Since we discretized the probability space, the percentage share was not obtained by integration, but summation.

we observe a transition of shares from **Praha** to the strategies in **Ostrava** and **Brno**. **Ostrava** emerges as a practical alternative due to its proximity to Warsaw, making it an attractive location for a new distribution center.

However, an interesting movement is seen in the shares towards the **Brno** strategy. Although the data in Table 1 suggests that placing a new warehouse in Brno isn't optimal in any given scenario, this strategy still boasts the highest expected value for a considerable range of probability distributions across various scenarios. This might have been overlooked if we relied only on traditional scenario analysis methods. The appeal of the **Brno** strategy lies in its resilience to changes across different scenarios. It might not be the best choice under any circumstance, but it's never the worst-performing one, either. Hence, it embodies a safe choice. Furthermore, even when we impose user-defined probability limits on specific scenarios as illustrated in Figure 3, the share of **Brno** changes minimally compared to **Praha** and **Ostrava** strategies. This highlights **Brno's** strategy as a steady and reliable choice. From a planning and risk management standpoint, a strategy offering the most consistent outcome can be more valuable than riskier ones, promising higher rewards. Thus, **Brno's** strategy may be a compelling choice due to its predictability and stability.

The method to find the optimal distribution strategy path, as introduced in Section 3, was successfully deployed on an actual company case study in Section 4. The application enabled us to identify the most fitting distribution strategy under the modeled development scenarios in three time periods. As the modeled shift to Poland becomes increasingly probable, the Ostrava strategy is likely optimal. However, Brno was discovered to be the most stable strategy under different development scenarios.

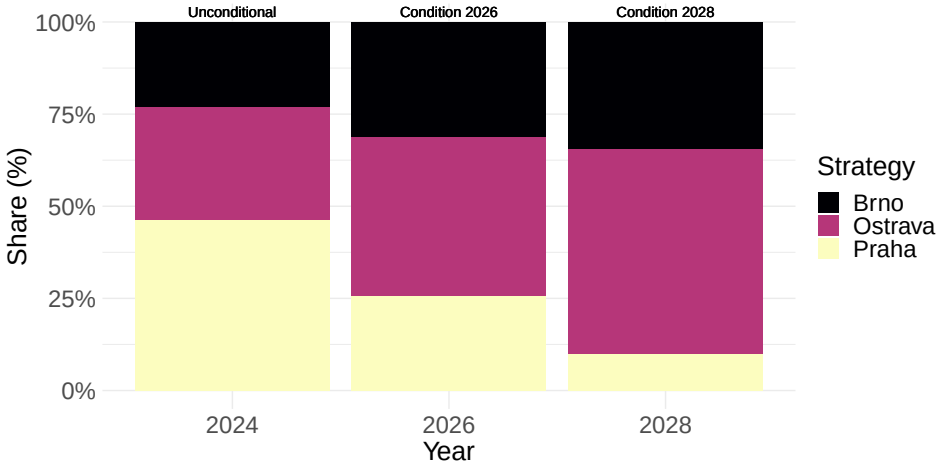

Figure 3: Shares of optimal distribution strategies each year,
Condition 2026: P(Wholesale shift small), P(Wholesale shift large) > 0.05,
Condition 2028: P(Wholesale shift small), P(Wholesale shift large) > 0.10

5 Conclusion

This article was centered on the complex topic of distribution strategy planning. First, we describe the problem and explain our motivation and connection with previous research. There are some blank spots for practical decision-making in strategic distribution network planning and current best practices. We proposed a methodology for how to overcome one of these problems. The key is to circumvent the problem of defining expectations about the future or potential situations in the future. We replaced such expectations with probability intervals, which are much easier for users to provide. From the users' perspective, this represents a significant reduction in complexity. Furthermore, despite the simplification, our method maintains a high level of information value, ensuring no loss in the quality of insights obtained. However, the presented method still assumes accurately de-

fined and estimated development scenarios. Therefore, the proposed method is not applicable when planners cannot determine the development scenarios and assess the distribution network costs under these scenarios.

In this article, we presented a business case of a Czech-based company looking for a potential storage location and working with many uncertainties during its decision-making process. It is a real-world example where we empirically present the usefulness and usage of the proposed method. In our example, the company can take three different potential directions. One is currently the best, and the other is the best in specific future scenarios. The last scenario is never the best-performing one when evaluating things in this straightforward way. While utilizing our method, it becomes clear that the third network is the best for over 30% of cases. It is still not the best result compared to other networks, but it shows that a methodic approach such as the proposed one helps to identify real potential. Using different probability intervals or introducing the KPI volatility in the evaluation could provide even more strictly positive results for the middle variant.

We have created an approach to utilize uncertain future expectations for model-backed informed management decisions. The approach is a crucial takeaway for distribution network planners to work with their long-term plans and uncertain events to achieve robust and reliable network designs. The work presented in this article exhibits significant potential, and we intend to explore this field further. One of the main topics is how to introduce causal relationships between individual company states. This article removed these relationships, and we want to introduce them back. Causal relationships add a new layer of complexity but also provide considerable potential for more complex model design, which covers more potential situations.

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Univerzita Karlova v Praze, Fakulta sociálních věd
Institut ekonomických studií [UK FSV – IES] Praha 1, Opletalova 26
E-mail : ies@fsv.cuni.cz http://ies.fsv.cuni.cz