Executive Summary Pampered pets:
Risk assessment and disaster recovery for changes in business operations

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Introduction
This executive summary reveals the probabilities of potential availability and quality issues with regards to the owner's decision of adding an international supply chain and several automated warehouses worldwide to their business operations. There are recommendations to mitigate possible risks, so that the business can keep its world-famous quality products as well as its highly valuable customers. Furthermore, this summary entails a disaster recovery (DR) solution as the business decided to apply an e-commerce strategy and wants to ensure high availability of its web shop.

Quantitative Risk Modelling
As the business decided to add an international supply chain to its business operations, it was confronted by customers who stated concerns regarding the availability and quality of the company's pet food products. To clarify these objections, a Monte Carlo simulation with a high number of iterations will be run, to calculate the potential risks which are related to the changes of the business' operations.

Monte Carlo simulations offer several advantages, particularly in handling uncertainty. They allow the assignment of probabilities to different outcomes, making them highly useful in scenarios where uncertainty plays a central role. The technique is relatively low-cost and enables users to explore how changes in assumptions or the distribution of various parameters affect the overall results. This provides a clear and tangible way to understand how certain factors may influence the likelihood of specific events. However, the method is data-intensive, requiring significant amounts of existing evidence to produce reliable simulations (Biggs & Hamilton, 2023). Since there was no specific data provided by the business, the author must make a few assumptions which will be listed in detail in the further course of this summary.

Risks
The customers are mainly concerned about the quality and availability of the company's pet food products. Hence these two aspects are examined more closely in risk modelling. Various factors must be considered to obtain as accurate a picture as possible, most importantly factors in relation to availability as well as quality. Azizsafaei et al. (2021) mention the following risks in agri-food supply chains:

- Weather related risks (hail, strong winds, excessive humidity)
- Natural disaster risks (typhoons, droughts, floods, earthquakes)
- Biological and environmental risks (bacteria, virus, etc.)
- Market related risks (demand fluctuation, price change)
- Logistical and infrastructure risks (reliability of transport, blockages)
- Political risks (trade disruptions, sanctions)

It can be argued that most of these risks do apply whether the raw material is sourced locally, regionally or globally however, the further away it is sourced, the higher the probability of logistical risks, simply for the reason, that there are more links in the chain that potentially could fail. Hence the author decided to focus on that specific risk for the availability aspect. As for the quality, there is a publicly available FDA database that lists recalls of products with quality issues, in this case pet food products. This shows that there have already been 14 recalls in the current year, 17 in 2023 and 8 in 2022 (Center for Veterinary Medicine, 2024). The most recent case, where the brand ANSWERS had to recall several of its products due to Salmonella, Listeria concerns shows, that they sourced the raw material from the US. Other articles describe dubious practices in which Chinese pet food manufacturers used inferior materials to maximise profits (Shan & Leng, 2024). In contrast to the centralised production and organised distribution systems characteristic of food supply chains in developed countries, China's food industrial structure remains diverse and fragmented, with only approximately 10% of enterprises certified under the Hazard Analysis and Critical Control Points (HACCP) standard (Liu et al., 2019).

Assumptions

As there are parameters needed to run a Monte Carlo simulation, and there was no specific data declared by the company, the author decided to make the assumptions for quality (Q) and availability (A) risk factors listed in the table below.

Risk Factor	Supply Chain		
	Local	Regional	Global
Defect Rate (Q)	2%	3%	4%
Defect Threshold (Q)	3%	3%	3%
Lead Time Minimum (A)	2 days	3 days	5 days
Lead Time Mode (A)	3 days	4 days	6 days
Lead Time Maximum (A)	5 days	6 days	8 days
Supplier Reliability (A)	95%	90%	90%
Transport Delay (A)	2%	5%	8%
Lead Time Threshold (A)	10 days	10 days	10 days

Table 1:Risk Factor Assumptions (Zeier, 2024)

The articles above show, that the quality of raw material for pet food can vary. The risk of food contamination can increase, among other things, because food quality control is sometimes lacking. Lead time is higher for the global supply chain, simply because it takes longer for the products to be shipped. Supplier reliability can be lower due to risks such as political unrest, trade disruptions, sanctions, etc. and the probability of transport delays increases the further away the supplier is located.

Monte Carlo simulation

Based on the risk factors explained in the previous section, the author explains his calculations below using the Monte Carlo simulation, which is carried out with the help of the YASAI Excel add-in.

To simulate the probability of loss of quality, the Binominal formula is used with the defect rate from the table above. A quality control is then simulated, which is 90%

effective in finding errors. If the threshold value of 3% is then exceeded, this is recognised as a loss of quality.

To simulate the probability of availability issues, a random integer is created by using the GENTRIANGULAR functionality with a minimum, mode and maximum value for the days needed for delivery. The author decided to use this functionality over the GENNORMAL functionality because when working with low means and standard deviations, the simulation can generate negative numbers which does not make sense in this case since lead time can never be negative. The supplier reliability is simulated by generating a random number using the GENUNIFORM which is compared to the defined reliability from the table above. If the random number is higher, a penalty is being applied with a factor of 0,5 days. The same is done with transport delays, if the random number exceeds the defined transport delay, a penalty of 1 day is added. The simulation is being run with a sample size of 10,000 and the spreadsheet with the calculations can be found in the appendix.

Results

The results show a gradual increase in availability and quality disruption the longer the supply chain is. This is partly due to non-existent quality controls in countries like China but also because the probability of delayed transportation increases the further away the supplier is. The reasons for that are multiple, e.g. political, logistical and infrastructural risks.

Supply Chain	Probability of quality issue	Probability of availability issue
Local	2.01 %	0.00 %
Regional	3.18 %	5.26 %
Global	3.95 %	15.78 %

Table 2:Monte Carlo simulation results (Zeier, 2024)

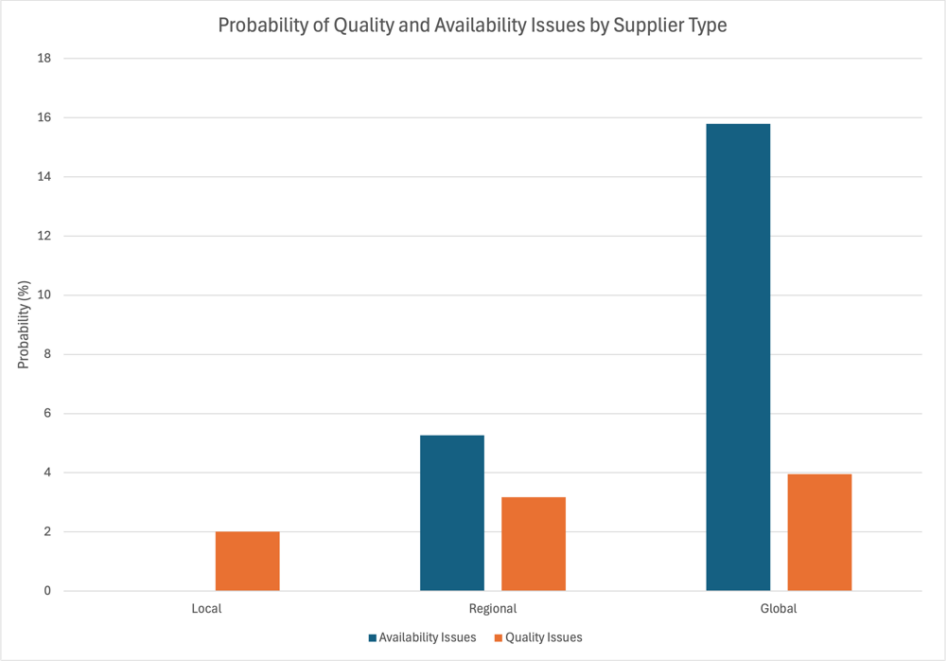

Figure 1: Monte Carlo simulation graph (Zeier, 2024)

As laid out in the first assignment which was a group project, there are financial benefits to using a global supply chain. To make use of these but keep the world-famous quality and prevent lack of availability, the author will list specific recommendations in the next part and discuss the mitigation of those risks.

Risk Mitigation Recommendations

The availability risk can be reduced by calculating the ideal reorder point (ROP). In practice, this means the company would reorder raw material, which is used to manufacture their pet food products, once a certain threshold value would be exceeded. The ideal ROP as well as the order quantity could be again simulated with the Monte Carlo method. This mitigates the risk of running out of raw material and hence reduce the availability risk drastically. It could be argued that the supplier could run out of raw material however, this could also be the case when using a local supply chain and therefore it does not add a new risk.

The second concern, which addresses quality issues, needs to be examined in more detail. There are several aspects to this point, starting with the raw material which is sourced from a certain supplier.

DeBeer et al. (2024) highlight the need to develop safe, nutritious pet food and maintain strict manufacturing standards. They recommend regular employee training, adherence to Sanitation Standard Operating Procedures (SSOPs), and continuous vigilance to prevent human errors and contamination, ensuring both pet and human safety. It is strongly advised that the business collaborates with certified suppliers. The European Pet Food Industry Federation (FEDIAF, 2019) states, that a responsible pet food manufacturer should also undertake external audits and pursue voluntary certifications, such as ISO 9001:2015 and ISO 14000, through an accredited external certification body.

Quality assurance is not only in the hands of supplier and manufacturer, the customer itself also plays an important role. Morelli et al. (2021) recommend educating pet owners about proper storage to ensure that the nutritional and sensory properties of the feed are preserved. They emphasise that veterinarians should provide clear guidance on the storage of perishable ingredients such as fish oils, especially during the warmer months of the year when the risk of spoilage is greater. The importance of dispelling scepticism about preservatives in commercial pet food is also highlighted and it is suggested that manufacturers should adopt clearer labelling and communication strategies to inform the public about the necessity and safety of these additives. Hence it is recommended for Pampered Pets to label its food according to the guidelines.

If the business fails to mitigate the risks mentioned with the recommendations made, quality and availability issues could occur which could result not only in disgruntled customers but also in financial loss if the customers decide to avoid their products in the future.

Disaster Recovery
In this part, the author will draw a solution for Ms. O'dour's requirement, to have its shop available 24/7/365 with a less than 1 minute changeover window should disaster recovery (DR) need to be invoked. She also mentioned that the business cannot afford to lose more than 1 minute of data. In technical terms, this means the recovery time objective (RTO) is >1 minute and the recovery point objective (RPO) is >=1 minute.

A low RTO means that there is no time for a backup service to be setup in the case of a disaster. Hence an exact replica of the primary service which can take over in such an event is needed. In addition, the very low RPO means that there is no time to restore a backup of the data. Therefore, a mirroring of the data is needed which means it must always be stored on two sites simultaneously. An active-active solution, where two identical setups are configured in different regions e.g. Amazon Web Service' (AWS) multi-site service could be used. These services are relatively expensive and are typically used for mission critical services (Baginda et al., 2018).

Another eminent aspect is to prevent the use of proprietary services of a cloud service providers (CSP), which could lead to a vendor lock-in. The use of such services could lead to substantial migration costs if the business decides to use the service of a different CSP. Pellegrini et al. (2017) recommend focussing on portability and interoperability by using modern technologies such as microservices and container solutions (e.g. Kubernetes). These technologies help abstract the underlying infrastructure, enabling applications and services to operate across different cloud providers seamlessly. Furthermore, they recommend avoiding vendor-specific solutions and proprietary technologies but instead using standardised application programming interfaces (API's).

All major CSP's such as AWS, Microsoft Azure and Google Cloud Platform (GCP) offer solutions for the given scenario however, it seems that AWS and Azure offer more options for mission critical services with low RPO and RTO times. The competition between AWS and Azure is immense and therefore it is difficult to name specific advantages. Nevertheless, the author recommends using AWS's multi-site service which uses multiple highly available multi-Availability Zones (AZ) in different regions. Each AZ contains Front end- and Application-Server. Databases are shared between AZ's and replicated between regions (Eliot, 2021). Proprietary services from AWS should be avoided and containerised software, e.g. based on Docker, should be used instead. Furthermore, the author recommends reconsidering the recommendations due to the extremely high costs that could occur.

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Appendix
The Monte Carlo simulation with all its calculations can be found in the spreadsheet which is uploaded as a separate file. Please note that this spreadsheet relies on the YASAI Excel add-in, which can be downloaded here: https://sites.rutgers.edu/yasai/downloads/

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