As part of this executive summary, we will be presenting an overview of different quantitative modelling techniques and their usability in the case of Pampered Pets’ digitalisation efforts, where additional warehouses are introduced, and the supply chain allows the business to rapidly scale up globally. First, a quantitative method is presented with the reasoning behind choosing a specific one. After building a case with different probabilities, a summary of different results is composed. Lastly, a correct disaster recovery approach is paramount to the availability and integrity of the data, and therefore an overview and recommendations are discussed.

**Quantitative Modelling**

While both qualitative and quantitative risk approaches can be used, qualitative risk assessment is generally not sufficient for risk events where effects are interdependent, meaning that an impact in a particular risk dimension will affect another risk in the same, or even different category. Therefore, a quantitative approach should be used. I chose to use Bayesian Belief Networks, based on the Bayesian Theorem. While other quantitative approaches such as AHP and TOPSIS exist, these methods generally fail to consider the risk interdependencies, and cannot be used to conduct a temporal risk analysis (Samvedi et al. 2012). The main principles of the Bayes Theorem can also be applied here, including subjective probabilities as well as a prior selection of different hypotheses. This modelling approach uses manually created networks with probability nodes that subsequently affect the probability in other nodes. This approach is especially useful when analysing supplier failures and risks (Lockamy, 2011).

As previously mentioned, the core foundation of this modelling approach consists of networks consisting of nodes. Before this can be accomplished, risks need to be categorized into three primary categories: Organizational, Industrial and Environmental (Rao & Goldsby, 2009). After a thorough investigation of available documentation, there were as many as 105 different risks associated with the aerospace industry (Badurdeen et al., 2013). For the purposes of this executive report, I am reducing the targeted risks to focus on the quality of the food and the security of the supply chain.

For the probability exercise, I use Netica software (Norsys, 2022), which allows the user to build nodes, and networks as well as the associated probability tables. The following categories are used for influencing the potential success of each new branch that can be opened:

* Location Performance, a composite of both Product and Platform Satisfaction
  + Product Satisfaction, a composite of both the product cost and product quality
    - Product Cost, a composite of Inflation and Transport Costs
    - Product Quality, a composite of Quality Certification and Inspection Quality
  + Platform Satisfaction, a composite of Infrastructure and Service Quality
    - Infrastructure, which directly relies on IT Maturity
    - Service Quality, a composite of Language Proficiency and Turnover Rates

Under normal circumstances, the data would be obtained by surveying supply chain industry stakeholders, followed up by the results being fed into the platform. However, in our case, the results and calculations are based on the best guess and in some cases, common sense with explanations provided. A detailed list of assumptions for individual metrics can be found below this text:

![Table

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Figure : Variable Matrix with Definitions

Based on these metrics, calculations were carried out to determine a probability for each node state, based on the states of its parent nodes. The results of the parent nodes were considered based on the importance of a given metric as follows:

* Inflation would have a higher impact on a product cost, as impacts all costs associated with the final product, while transport costs would only affect the shipping costs
* Inspection Quality would have a higher impact on the final quality of the product since you can achieve a high level of quality even with no quality certifications
* Product Quality would have a higher impact on overall product satisfaction, as customers would be willing to buy a high-quality product at all price ranges, while not willing to compromise on the quality while paying the same amount
* Language Proficiency and Turnover Rate are considered equally, as the high turnover rate means a decrease in senior skilled workers present at the business, as the time to become familiar with the software and the tools become an obstacle
* Service Quality has a much higher impact on customer satisfaction as opposed to infrastructure availability. Even with a high level of IT Maturity, businesses with poor customer support report poor results
* Product Satisfaction has a higher priority as opposed to platform/service satisfaction, as customers can be still willing to purchase the product with a lower level of customer support, but not buy a poor-quality product with great customer support

Because of the use of Bayesian Belief Networks, the final results of this approach are presented in a graphical representation, where the user can manually change certain probability, add additional nodes as well as immediately see the effect a small change can have on the overall performance, cost, or quality of the product and the service.

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Figure : Completed Bayes Belief Network for Pampered Pets

This approach also allows us to create country-specific predictions, where a location would greatly impact the potential success. Let’s have a look at three potential locations, the UK, USA and India. An example would be:

* India having a lower language proficiency than the US and the UK but also having lower inflation
* UK having high language proficiency and IT maturity but also having high inflation and transport costs
* US having high language proficiency, IT maturity as well as an average level of inflation, but also having a higher labour cost if compared to India

As can be seen before, additional nodes can be dynamically added to the network as new evidence and facts emerge. Businesses can start small with guaranteed assumptions while experimenting with additional nodes as information becomes available, thus increasing the size, but also precision of the assumption network.

**Result Summary and Recommendations**

‌For the purposes of this exercise, there are three different examples chosen to correctly show the potential of this quantitative tool and the results.

**Scenario 1:**

* Inputs:
  + Low Inflation, High Transport Cost, Low-Quality Certificate, Medium Inspection Quality, Medium IT Maturity, Medium Language Proficiency and High Turnover Rate
* Results:
  + Product Cost (H:25%,M:50%,L:25%), Product Quality(H:20%,M:45%,L:35%), Infrastructure(H:45%,M:40%,L:15%), Service Quality(H:15%,M:55%,L:30%)
    - Product Satisfaction(H:24.3%,M:42.4%,L:33.4%)
    - Platform Satisfaction(H:32.8%,M:31%,L:36.2%)
      * Location Performance = H: 24.3%, M: 32.9%, L: 42.8%

Based on the above calculation, a specific location with the pre-defined inputs from scenario 1 would most likely be a low-performing branch (<5% net profit). The main indicators being the lack of quality, high transport costs and high turnover rates.

**Scenario 2:**

* Inputs:
  + High Inflation, High Transport Cost, High-Quality Certificate, High Inspection Quality, Low IT Maturity, Low Language Proficiency and Medium Turnover Rate
* Results:
  + Product Cost (H:80%,M:15%,L:5%), Product Quality(H:85%,M:10%,L:5%), Infrastructure(H:30%,M:50%,L:20%), Service Quality(H:10%,M:25%,L:65%)
    - Product Satisfaction(H:34%,M:41.4%,L:24.6%)
    - Platform Satisfaction(H:18.2%,M:19.9%,L:61.8%)
      * Location Performance = H: 24.9%, M: 37.1%, L: 38%

Based on the above calculation, a specific location with the pre-defined inputs from scenario 2 would most likely be either a low or medium-performing branch (0-15% net profit). The main indicators being the high production cost and low service quality, even with high product quality.

**Scenario 3:**

* Inputs:
  + Low Inflation, Low Transport Cost, High-Quality Certificate, High Inspection Quality, Low IT Maturity, Low Language Proficiency and Low Turnover Rate
* Results:
  + Product Cost (H:5%,M:15%,L:80%), Product Quality(H:85%,M:10%,L:5%), Infrastructure(H:30%,M:50%,L:20%), Service Quality(H:15%,M:30%,L:55%)
    - Product Satisfaction(H:69.4%,M:20.6%,L:10%)
    - Platform Satisfaction(H:23.6%,M:22.1%,L:54.4%)
      * Location Performance = H: 39%, M: 37.5%, L: 23.4%

This location has the highest probability of succeeding, based on the low cost and high product quality, even though the IT maturity and language proficiency might be quite low.

While not all the risks can be predicted, information on some of these risks is widely available such as the inflation and language proficiency in a given country, for example:

* India
  + Inflation: 6.77% as of October 2022 (Ferreira, 2022)
  + Language Proficiency: Only 10.62% of the population can speak English (Hindustan Times, 2018)
* The USA
  + Inflation: 7.7% as of October 2022(Statista, 2022)
  + Language Proficiency: 91% of the population being proficient in English (Zong, 2016)
* The UK
  + Inflation: 9.6% as of October 2022 (ONS, 2022)
  + Language Proficiency: 91.1% of the population being proficient in English (ONS, 2021)

Based on the above information, the variable matrix in figure 1 could actually be refined to something close to real-time values in 2022 (L:6-7%,M:7-8%,H:8%+).

The businesses could then consult the most probable information available to them to modify or compose a brand-new network to calculate the probability. As of 2022, the major differentiators when determining the performance become inflation and the availability of raw materials (not covered in the existing network.

Below is the summary of the results for the intermediary nodes, based on the inputs provided. These inputs can be based on a specific year, based on a specific country or verticals such as food, manufacturing, pharmaceuticals or technology.

![Table

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Figure : Probabilities and Results for IN, SQ, PS

Figure : Probabilities and Results for PC, PQ, PS

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Figure : Probabilities and Results for Location Performance

**Disaster Recovery**

In this age and time with the increased dependency on technology, business activities are in jeopardy of disturbance to those services (Cerullo & Cerullo, 2006). Which makes Business Continuity and Disaster Recovery Development a must for all organisations regardless of their size; big or small. The BC and RC strategy is set to ensure business activities stay intact. As the shop needs to be available 24/7/365 and can only afford less than a one-minute changeover window, in addition to that no more than one minute of data loss is affordable.

In case of a disaster that could affect the shop premises, the digitalised system has to be online at all times with no downtime. In order to achieve the required recovery time objective RTO and recovery point objective RPO, a Hot Standby database mode is chosen, where another data centre has to be running at the same time as the main data centre to ensure that in case of a disaster the system starts running instantly (Alhazmi & Malaiya, 2013). Since cold standby mode or warm standby mode would take hours if not days before starting which does not match the business’s continuity requirements. Moreover, a disaster recovery plan consists of different phases for full business infrastructure recovery including critical Application Assessment, Backup, recovery, implementation and test procedures and lastly maintenance planning to get the system back to its original state before the disaster (Mohamed, 2014).

However, according to Lumpp et. al (2008), the importance of customers in the case of disaster weighs more than the importance of the business infrastructure, which means that in order to keep the business running customers’ regular activities should not be affected at any cost. Consequently, although this type of backup is costly, the requirement of being only able to afford the loss of one minute of data and less than one minute of downtime makes the Active–Active mode the best option for disaster recovery. To ensure service availability in case of a disaster a public cloud will be used with DRaaS (Saquib et al, 2013).

There are several cloud providers that can offer great options including Microsoft and AWS, both have similarities in the services provided, however, Microsoft Azure is favourable due to the fact that it would be less costly (Al-Sayyed et al, 2019). Moreover, Azure has data centres around the world to ensure the backup data centre is distanced from the primary one in case of a disaster and it would only need one minute for changeover as required. Furthermore, according to Al-Sayyed et al (2019), Microsoft Azure guarantees high availability, confidentiality, and secrecy at the level of 99.99%, without any SLA violations.

Regarding vendor lock-in, the existing systems will be moved to Microsoft Azure without any change to them. Consequently, third-party firewalls, databases, and application servers can still be retained, while running on top of Microsoft’s infrastructure, thus minimizing the vendor lock-in risk.

Based on the above information, we were able to choose suitable quantitative modelling for this use case, present our findings and results, as well as propose a disaster recovery solution that could increase the success of a newly established warehouse or a complete digitalisation of the supply chain.

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