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To what extent can big data analytics be utilised to enhance decision-making within management of the supply chain?

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Section 1: Introduction

1.1: Introduction to the author and the company:

To begin this project proposal, an introduction to both myself and the company I am currently working for. My name is Lois Harris, and I am currently working as a technical buyer within the purchasing department at Bisley F C Brown (Steel Equipment) Ltd, based in Newport, South Wales. I have been working at the company for almost eight years since beginning my engineering apprenticeship in 2014. I have recently joined the purchasing department, although prior to this I was working as a product development engineer within the design department. This experience has provided me with a sound understanding, and a well-rounded, unique perspective of the processes currently used within the business.

Bisley is a leading manufacturer of office storage, established in the 1940s. Traditionally specialising in manufacturing steel products, recently (in 2016) the business expanded and invested to manufacture wood products too, moving into sectors including healthcare, residential and hospitality as well as the office. Recent market trends have moved demand towards combining finishes and materials to provide domesticated workspaces, for comfort and adaptability. The business aims to create innovative products that meet the evolving needs of our working world (Bisley, 2021). The manufacturing site uses on average 400 tonnes of steel per week and uses various processes and equipment to produce its final products; some of which include sheet metal laser cutting, WEMO bending lines and electrostatic powder coating plants.

Bisley has just one manufacturing site – although the company sells and distributes products all over the world including the UK, North America, and Dubai, as well as European countries such as France and the Netherlands. There are various sales channels including a dealer and resellers network, sales directly to corporate clients and direct to end users through the Bisley web shop. As customer demands continue to change and evolve, the company has witnessed an increase in the number of projects, whereby non-standard products are supplied to one client across multiple sites. Some examples of these include, JPMC, HMRC, BT and the NHS (Bayliss, R., 2022). Whilst the company is proud to be awarded the supply of these prestigious projects – with them comes increased complexity, with more SKUs within the product sourcing, design, and development. The dilemma is how can the company evolve to sustain its competitive advantage within the industry?

1.2: Research problem – purpose, context, and rationale:

With this being said, the research problem or the purpose of the study is to investigate how big data analytics could be used to enhance the decision-making within management of the supply chain. Decision-making within any business is critical (Sven-Vegard Buer, 2018) and can impact the organisation in various ways including financially, with respect to their position within the industry, environmentally and socially. Combined, these factors determine the overall success of the business. In pursuit of being recognized worldwide as an industry-leader; the company must be focussed on being profitable to ensure longevity, stability, and transparency to customers and employees. The rationale for the proposed study is that the direction of the business is changing. With increasing complexity in product design, manufacturing, sourcing, scheduling, and costing, the study aims to present the cross-departmental opportunities which big data analytics could present. Traditionally, one of the key performance indicators for a manufacturing company would have been its efficiency – the overall equipment effectiveness or the product cycle time or takt time (Abu F., 2019). Whilst these “lean manufacturing” techniques are important and still relevant today – our customers are demanding more in terms of innovation, speed to market and time to delivery (Lean Manufacturing UK Ltd, 2018).

1.3: Major issues addressed by the research:

There are a number of major issues which the research intends to address. Firstly, the forementioned increasing pressure from society to deliver within a shorter lead time at lower cost. As technology has evolved, this has allowed consumer habits and expectations to change (Higgs, 2021). If you look at Amazon for example, thousands of items are available through their platform, many of which can be delivered to the consumers' door the very next day! (Amazon, 2022).

Furthermore, as more of the products/ components need to be sourced externally – the management of the supply chain is even more critical (Boston Consulting Group, 2016). With an increasing number of suppliers comes less control and hence a higher risk of failure. Gone are the days where a customer would order 1,000 of exactly the same filing cabinet, in exactly the same colour. Customer demand is driving the inclusion of diverse materials and finishes, as well as additions such as RFID lock technologies, USB charging and acoustic panels.

In addition to this, another issue which needs to be addressed by the study is the requirement of greater emphasis on the commercial viability of a project. This can help to prioritise areas of business growth and ensure adequate resources are in place to facilitate those developments. There are various potential benefits to this which could include more transparent trading with key suppliers, to accommodate spikes in demand more efficiently and help to maintain high quality with top tier customers (Weskamp C., 2019).

Finally, much of the previous research conducted regarding how industry 4.0 technology can enhance decision-making has focussed on efforts to improve and optimize only the production processes (Cagnetti C., 2021). This is a similar trend with research relating to implementation of traditional lean manufacturing techniques and continuous improvement philosophies. However, these approaches are reactive rather than proactive. The study aims to identify ways in which processes can be more efficient prior to production - at the very beginning of the supply chain.

1.4: Phenomenon and hypothesis:

The phenomenon at the focus of this study is that without the implementation of big data analytics fundamental mistakes will be made concerning the decision-making within the management of the supply chain. The company will lose their grasp on understanding the wants and needs of the customer, and waste valuable resources developing over-complicated solutions which are difficult and expensive to source and manufacture (Nicholas, 2018). This could result in the potential loss of competitive advantage over competitors within the industry, as they struggle to catch up to other aspiration suppliers. As well as unclear business strategy, limited innovation, and poor product development, this could also bring negative connotations socially and environmentally.

The hypothesis for investigation is that implementation of big data analytics can be utilised to enhance and improve decision-making within management of the supply chain, to allow the organisation to benefit financially, industrially, socially, and environmentally.

1.5: Boundaries of the research:

The boundaries of the proposed research are that whilst big data analytics is a core element of the wider industry 4.0 framework (i-SCOOP, 2020), this study is limited to only this aspect. As a result, the study will not consider the impact of other industry 4.0 technologies such as AI, additive manufacturing, simulation, or augmented reality. In addition to this, the benefits and risks will be explored within the context of the four sub-categories financial, industrial, environmental, and social. Those outside of these areas will not be critical evaluated to form conclusions. Finally, the study will

explore the potential of adoption of big data analytics specifically at Bisley F C Brown (Steel Equipment) Ltd – no other manufacturers within the industry will be considered within the study.

1.6: Key Concepts:

Within the following research proposal, the meaning of the following key concepts are as follows. These may need to be scrutinised and/or adapted following the completion of the literature review to ensure understanding is consistent with other academic literature.

Big data analytics describes the process of uncovering trends, patterns, and correlations in large amounts of raw data to help make data-informed decisions. These processes use familiar statistical analysis techniques—like clustering and regression—and apply them to more extensive datasets with the help of newer tools (Beier G, 2019).

Decision-making encompasses key questions which the business needs to address:

- What is commercially viable?
- What new products can we make part of the standard offering?
- How are customer demands/the market changing?
- Why do we have competitive advantage over competitor?
- Where should we focus innovation/improvement efforts?
- Who are the key suppliers and key customers?

Within the context of the study, the **supply chain** may be considered as internal (within the business) and external (inclusion of suppliers and customers). The fundamentals of the process remain the same for both – as the project flows from sales to design, to purchasing to production, and then to distribution. However, the external supply chain must also consider the supplier as antecedent and the customer as the denouement (Lee, 2003).

Section 2: Literature Review

2.1: Financial implications

Over the past 18 months, the world has been through unprecedented times. This has impacted the availability of raw materials, increased lead times and resulted in astronomical price increases (Market line, 2022). There have been various factors which have caused this including the COVID-19 pandemic, Brexit and the Ukrainian conflict. During these times, like many industries, the company has needed to react to these external factors. Not only the changing consumer habits and customer needs. For example, the way of working for many customers changed from working in large corporate buildings to working from home. The company also needed to make important, strategic decisions to ensure the stability of the business, such as the forecasting of supply to ensure availability of raw material from suppliers.

The opportunity that big data analytics presents is to ensure that these are data-driven decisions. This can allow for opportunities and risks to be assessed in more detail. This can be financially beneficial, ensuring the best price possible from suppliers – hence also ensuring a greater accuracy of demand forecasting to manage stock control and accommodate for spikes and falls in demand. The fundamental opportunity that this presents is a more proactive approach to the management of the business as a whole, rather than being reactive to changing external factors outside of the company's control.

The risk with the implementation of big data analytics, as with much of the industry 4.0 framework as a collective, is that companies do not have the resources, both time and personnel, to successfully adopt such technologies into their existing processes (Deloitte, 2022). Before implementing such technologies, fundamental prerequisite work needs to occur, including the identification of wasteful, non-value adding activities and bottlenecks (Powell, 2021). As previously mentioned, there is a lack of research within the current available literature with regards to the opportunities of industry 4.0 technologies and lean manufacturing principles to processes outside of the production department (B. Tjahjono, 2017). If big data analytics could be introduced prior to production, at the beginning of the process, more efficient and effective decision-making could be made in terms of managing the supply chain. In turn, this would make the company approach to problem-solving more proactive as opposed to reactive (Huthwaite, 2007).

2.2: Opportunities within the industry

In every industry, companies are faced with competition. What differentiates them is the way that products are designed and built. Listening to the wants and needs of the customer is fundamental, however given that all competing companies have the ability to do this to some extent; production capability becomes key to competitiveness. Companies with a competitive advantage are able to consistently provide products that are competitive with regard to quality (better), price (cheaper), time (faster), and response to change (agile) (Nicholas, 2018).

Much of the current available literature would suggest that industry 4.0 technologies are enablers of lean manufacturing principles and can be used to enhance competitive advantage by helping to identify waste within a process from a customer's perspective and adding value. As customer demands change and evolve, mass customization is a technique used to incorporate the flexibility and personalization of custom-made products with low unit costs associated with mass production (Yi Wang, 2017). There are various product development strategies such as the kano model. This is an approach which prioritises features based on the degree to which they are likely to satisfy the customer. As the industry becomes closer to the wants and the needs of the customer, delighter requirements soon become "industry-standard" and consumer needs progress even further (Ping Ji, 2014).

There are various benefits to being close to the end user, brand equity, reputation, loyalty (Mahr, 2014). However, historically these insights have been focussed on improvement unidirectionally towards the customer (Bilgrim, 2011). The purpose of big data analytics is to use these trends and pattern to enhance decision-making bi-directionally to ensure that the front end of the process, for example sales forecasting and inventory control can better support the customer and the production function of the business. In addition to this, there is an opportunity to ensure a clear vision and direction for the business and to allow all departments to work together to realise this goal.

Enhanced decision-making through big data analytics can steer decisions in terms of innovation. (Satell G. , 2021) refers to four different types of innovation, sustaining, breakthrough, disruptive and basic research. An innovation can be categorized depending on how well defined the problem is and how well the skills domain is defined. Of course, the more well defined – the less risk associated with the innovation. For this reason, most companies chose not to invest the capital and resources into breakthrough or disruptive innovation. Although, as previously mentioned, if done successfully this can change the basis of competition within the industry, so the higher price may be more rewarding. (Satell G. , 2017) suggests implementation of the 70/20/10% rule whereby the majority of the focus is on investment into the core business. The remaining innovation capacity involves exploration into adjacent markets and capabilities and finally "long term bets" where basic research is required to

identify new technologies and new business outside of the current venture of the company. With greater data analytics to support these decisions – the risk of investment could be reduced with greater confidence of return on investment.

2.3: Environmental factors

The opportunities which big data analytics present with respect to the environment is again revolved around the idea of the approach being proactive rather than reactive. Often environmental sustainability of new product is only considered in the context of recycling once the product reaches the end of its service. Big data analytics can help to ensure that decision making regarding the eco-design of the product are built in from the outset. For example, the specification or product brief refers to the importance of considering the life cycle of the product, rather than finding solutions to reduce, reuse and recycle parts once production has already begun (Dahmani N, 2021).

As well as this, mentioned several times throughout the research proposal, product complexity and number of SKUs is increasing. As customer demands become more advanced, there is a risk that product designs become over complex and hence waste is produced in the guise of features that customers are not willing to pay for (Oliver K., 2007). Through big data analytics, and a better understanding of the end user – products can be developed through frugal engineering or innovation. This method is commonly referred to as “good enough” innovation, low-cost innovation or maximising the value to resource ratio – “doing more with less” (Albert, 2019). This philosophy is supported by the scrum product development process (Petra Coach, 2020). Products are developed starting with the absolute minimum functionality, i.e the must haves and not the nice to haves. First prototypes are built quickly, and work is carried out in short bursts; updates are based on feedback directly from customers.

Finally, the study has demonstrated how big data analytics can promote more open and transparent trading with key suppliers- and more accurately forecast to prepare for spikes and falls in demand. Similarly, promotion of working together as an industry rather than in silo can enable the transfer to a circular economy rather than a linear economy. An example of this in practice is Celsa UK’s circular steel scheme (Bailey, 2022) whereby:

- 86% less emissions are produced compared to order processed steel making
- 98% recycled content in their finished product
- 100% of their scrap comes from the UK

2.4: Societal impact

Big data analytics provides the opportunity to increase collaborative working across multiple departments within the organisation. This can help develop multi-skilling but also give an appreciation of the work of others, and their perspective on key business decisions (Powell D.J, May 2020). This can be advantageous as employees are more likely to draw on the expertise of others when required and be more effective at problem solving. The major challenges faced particularly by SMEs is the difficulty of implementing change and engaging stakeholders throughout the hierarchical structure of the organisation. It can be difficult to engage employees with change and innovation due to their own reservations, and natural tendency to become defensive of the importance of their role. Improvements should be small and incremental to focus on a collective, long-term goal (Nicholas, 2018).

Section 3: Methods

3.1: Utilisation of case studies

In order to address the research question, to what extent can big data analytics be utilised to enhance decision-making within management of the supply chain; a case study will need to be identified. As previously mentioned within the project proposal, the company has witnessed an increase in the number of projects, whereby non-standard products are supplied to one client across multiple sites. One of the projects supplied within the last year, should be selected as a case study to explore the potential benefits using big analytics could have provided. Using a case study will allow “real” data to be collected and reviewed rather than information being fictitious and possibly inaccurate or non-transferable to “real-world application”.

3.2: Identification of non-standard product types

Once a case study has been selected, all corresponding customer orders will need to be reviewed relating to the project to determine what percentage of the product came from outside of the company’s standard offering. This information can be used to identify the non-standard product types which were common for this project, for example, this could be locks, electrics, fabric, box section or complete bought-out products from suppliers such as Moving Walls, Vetrospace, or Deadgood for example. Based on this information, the number of suppliers from the external supply chain can be calculated – demonstrating the complexity of the project. At this stage, it may also be beneficial to identify how inventory control is currently optimised to accommodate this type of project – and how this agrees or contradicts with traditional lean methodology? – i.e the perceived waste – inventory.

3.3: Examination of current state

A critical review should be undertaken to examine the current state of the process starting from the customer enquiry to the salesperson through to delivery of the end product to the customer. This should identify who are the key stakeholders within the process, where the critical sign-off gates are within the process and also how the project information is communicated through the various departments and at what stage. One of the key outcomes from the literature review was ensuring that the correct information was available at the right time within the process, to ensure its efficiency and optimisation.

3.4: Opportunities and risks

Qualitative and quantitative data should then be collected to critically evaluate the management of decision-making and its effect on the management of the supply-chain within the company. The use of both types of data will allow stakeholders to voice their opinions based on their perspective, whilst also reviewing the quantitative data will address any disparities between the information. Based on the data collected, process improvements should be identified. Methods for implementing the changes should be developed before discussing the proposed improved process with the key stakeholders. The literature review proved that “buy-in” from stakeholders from the offset can help maximise the chances of successful implementation.

To answer the research question, both the opportunities and the risks of implementing big data analytics will need to be addressed. Once the risks are identified, methods can be established to mitigate or reduce the risk as much as possible. The final aspect of the study will be to determine the impact this could have on various parts of the supply chain.

Section 4: Results

4.1: Types of data

Quantitative data is numerical information – usually regarding quantities or values. Whereas qualitative data is more descriptive and can be used to interpret phenomenon which can be observed but not measured, such as language.

Quantitative research involves the process of objectively collecting and analysing numerical data to describe, predict, or control variables of interest. The goals of quantitative research are to test causal relationships between variables, make predictions, and generalize results to wider populations. Use of this type of data can be beneficial as it is not open to interpretation. Results are often considered to be more “matter of fact” – the disadvantage to this type of data is that it can be hard to identify the root cause of an effect or result you have concluded.

Qualitative data, on the other hand, is defined as non-numerical data, such as text, video, photographs, or audio recordings. This type of data can be collected using diary accounts or in-depth interviews and analysed using grounded theory or thematic analysis. Whilst collection and analysis of this type of data can be more time-consuming, it can often provide a more in depth understanding of not only the result, but what has caused it. Nevertheless, it can be difficult to manage the collect of qualitative data as you must consider the ethics of the data collection – ie, is the data being sourced in a fair and transparent way? Do the participants understand the use for the data they are providing? (McLeod, 2019).

4.2: Quantitative data collection

Examples of the types of quantitative data that are likely to be required to address the research problem are:

- Number of projects
- Profit analysis of projects
- Time spent on projects
- Number of suppliers
- Product SKUs

4.3: Qualitative data collection

Examples of the types of qualitative data that are likely to be required to address the research problem are:

- Informal interviews with stakeholders
- Questionnaires to customers
- Industry expert opinions
- Market trends forecasts

Section 5: Evaluation

5.1: Potential impact of proposed research

The potential impact of the proposed research surrounding the use of big data analytics is great - particularly within the management of the supply chain, due to the fact that this has an impact organisation wide – across a multitude of departments. There are not only financial opportunities for the business to profit from but also opportunities to ensure and maintain their position within the industry. Big data analytics can also ensure environmental sustainability and build social advantages through a more engaged, problem-solving, and knowledge workforce.

The proposed research can help ensure that Bisley are ahead of the curve within the industry and make them more prepared to adopt industry 4.0 strategies as a whole. Traditionally-thinking companies will be left behind as more proactive companies advance further by utilising industry 4.0 technology to enhance key manufacturing principals such as lean manufacturing and continuous improvement. They will be more agile and increase their ability to react to changing customer demands. Their products more innovative, produced in shorter lead times, at a lower cost, with more consistently achievable high-quality – making them true industry leaders that customers are loyal to.

5.2: Limitations and weaknesses

As discussed within section 1 of the research proposal, one of the limitations of this study is that it does not consider the implementation of any other types of industry 4.0 technologies such as simulation or additive manufacturing. Due to the time constraints of this research study, it would not be possible to provide a detailed analysis of each technology, therefore big data analytics will remain the focus of the study.

In addition to this, the proposal does not include reference to the method in which the new product development team within the company currently prioritise or address new projects. Likewise, during the composition of the research proposal the Bisley strategy documentation for 2022-23 was not available, therefore it would be appropriate to incorporate this information whilst undertaking the project, subject to its availability. The documentation of 2020-21 has been reviewed as part of the literature review however (Costin, 2020).

To conclude, the final weaknesses within the current research proposal are the lack of detail with regards to the cost of implementation and the risk that too much data analytics could in fact be wasteful if not utilised correctly. As data can only become information through contextualisation, information can only be knowledge if it is meaningful, and when knowledge is transformed to an insight, then you have wisdom (i-scoop, 2022). This risk will need to be addressed and mitigated with the methodology used for implementation of the research study.

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