

Big Data in Supply Chain Management

Abstract - The recent shift from high street to online shopping has reduced a physical aspect in the retail chain, going from a single retail store covering part of a city to a distribution warehouse covering multiple cities. This has put an emphasis on the supply chain management that goes behind the scenes of the likes of online retailers like Amazon and ASOS, with competition being between two supply chains rather than just brands [1]. A large amount of data is collected by these companies as they are entirely based online and it can be used for optimising and improving their supply chains and their operations by identifying trends and predicting future trends to ensure they are efficient and save costs. This dissertation will look at how big data can be used to achieve this.

I. SUPPLY CHAIN MANAGEMENT

A supply chain is the network of entities that are directly involved in the supply and distribution from source to the final consumer [2]. Supply Chain Management (SCM) ‘requires overt management efforts by the organisations within the supply chain’ [2]. Within the retail industry, the relationship between the retailer and the final consumer essentially defines the retailer’s supplier network [3]. The article in [2] published in 2001, states that providing a faultless product to a customer quicker than the competition is a basic requirement to stay in the market rather than a competitive advantage. In 2020 with services such as Amazon Prime Now, delivery times are as low as 2 hours for some products.

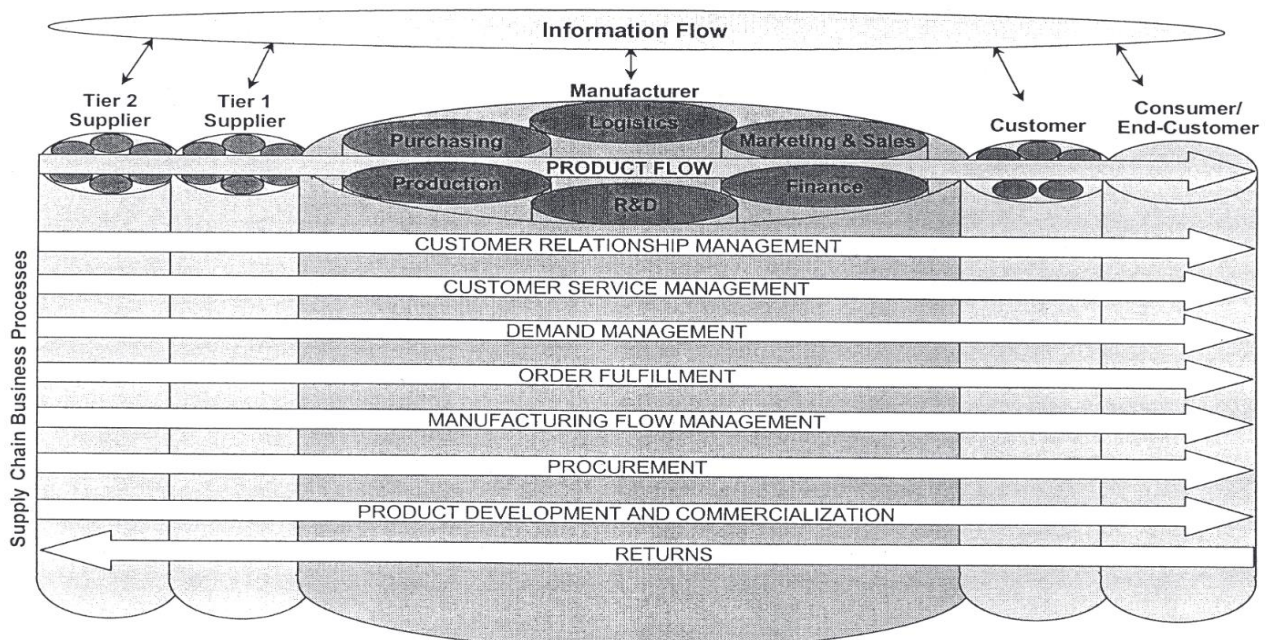


Figure 1: An overview of the processes in a supply chain, sourced from [1]

Figure 1 from [1], ‘Issues in Supply Chain Management’, places Information Flow at the top of the diagram connected to everything. The article, published in 2000, affirms that information flow is crucial to the efficiency of a supply chain and this reiterates the importance of data in SCM.

II. DATA

The term Big Data includes its three properties [4]:

- 1) **Volume** – The ‘amount of data available to an organisation’ or the capability of an organisation to process large amounts of data [4]

- 2) **Velocity** – The speed of data creation or the capability of an organisation to process the data at a high speed.
- 3) **Variety** – A measure of the ‘richness of data representation’ or the capability of an organisation to ‘integrate various sources of data’ [4].

Table 1 below gives a brief overview of SCM data within the properties of Big Data defined above.

Table 1: Examples of Big Data for SCM, sourced from [5]

DATA TYPE	VOLUME	VELOCITY	VARIETY
SALES	Details of each sale; price, quantity, date, time, season, customer data and variables around the sale e.g. weather	Data created at each sale. For a big company like Amazon this will be very large.	Direct sales, international sales, competitor sales, supplier’s other sales
CONSUMER	Behaviour details; products browsed/purchased, frequency, wish list, timing e.g. close to salary dates.	Data created at each click through to card usage	Eye-tracking data, social media activity, product reviews
INVENTORY	Movement of each product at each location, also includes variations of products, e.g. size	Each time a product has moved locations	Inventory at warehouses, distribution centres
LOCATION AND TIME	Sensor data to detect location of product in warehouse, e.g. racks, picking, sorting. Transportation data	Each time a product moves from its current position, e.g. from distribution centre to transport carrier	Where the product is, what is close to it, who moved it, its path, timestamps of each movement.

Consumer data is essential in order to study consumer trends and analyse the relationship between them and the retailer. Sales data from Walmart showed before a hurricane, people bought Pop-Tarts and water in high volumes [6], allowing Walmart to stock up on these items in areas where a hurricane is forecasted.

A similar recent unusual trend is the stockpiling of toilet paper caused by the current pandemic [7]. These trends can be very useful in avoiding lost sales by effective forecasting and inventory management [6]. BBC article, [7], also implies the photos on social media of empty shelves has contributed to the stockpiling, this is supported by the research in [8] which developed a framework for improving demand forecasting using data from social media.

III. FUTURE CASE – ANTICIPATORY SHIPPING

A future use of big data and predictive technology is Amazon’s plan to introduce ‘anticipatory shipping’, which means delivering a product to a hub near the consumer before they have made the purchase, with the aim of even faster delivery times. An article in [9] develops a Genetic Algorithm to predict consumer behaviour and manage this shipping method, consisting of 3 modules;

- 1) **Big Data Management Module** - the importance of information sharing is recognised and the data in the Big Data Management Module is stored in the cloud, available to share with all entities involved in the supply chain.

- 2) **Predictive Consumer Analytics Module** – Implements data mining to extract data and make predictions.
- 3) **Anticipatory Shipping Optimisation Module** – Generates the optimal delivery solution.

This has the potential for further enhancing Amazon's service by offering an order-less delivery for certain Fast-Moving Consumer Goods (FMCG) by studying individual customers' buying patterns over time and delivering just before the consumer has run out. This would give Amazon a significant competitive advantage by effectively eliminating a repetitive task for a customer [10].

IV. PRIVACY CONCERNS

There are of course, privacy concerns regarding data in general. With SCM's focal point being the consumer, storage of personal data is unavoidable. The anticipatory shipping method is specifically designed to analyse personal shopping data. Consent and awareness of data collection are the main ways to regulate this. De-identification algorithms in relation to big data are also being developed to anonymise personal data [11].

References

- [1] D. M. Lambert and M. C. Cooper, "Issues in supply chain management," *Ind. Mark. Manag.*, vol. 29, no. 1, pp. 65–83, 2000.
- [2] J. T. Mentzer *et al.*, "DEFINING SUPPLY CHAIN MANAGEMENT," *J. Bus. Logist.*, vol. 22, no. 2, pp. 1–25, Sep. 2001.
- [3] C. R. Chiles and M. T. Dau, "An Analysis of Current Supply Chain Best Practices in the Retail Industry with Case Studies of Wal-Mart and Amazon.com," Massachusetts Institute of Technology, 2005.
- [4] E. Hofmann, "Big data and supply chain decisions: the impact of volume, variety and velocity properties on the bullwhip effect," *Int. J. Prod. Res.*, vol. 55, no. 17, pp. 5108–5126, Sep. 2017.
- [5] M. A. Waller and S. E. Fawcett, "Data Science, Predictive Analytics, and Big Data: A Revolution That Will Transform Supply Chain Design and Management," *J. Bus. Logist.*, vol. 34, no. 2, pp. 77–84, Jun. 2013.
- [6] "(PDF) Click Here for a Data Scientist: Big Data, Predictive Analytics, and Theory Development in the Era of a Maker Movement Supply Chain." [Online]. Available: https://www.researchgate.net/publication/259552550_Click_Here_for_a_Data_Scientist_Big_Data_Predictive_Analytics_and_Theory_Development_in_the_Era_of_a_Maker_Movement_Supply_Chain. [Accessed: 30-Mar-2020].
- [7] "Coronavirus panic: Why are people stockpiling toilet paper? - BBC News." [Online]. Available: <https://www.bbc.co.uk/news/world-australia-51731422>. [Accessed: 02-Apr-2020].
- [8] R. Iftikhar and M. S. Khan, "Social media big data analytics for demand forecasting: Development and case implementation of an innovative framework," *J. Glob. Inf. Manag.*, vol. 28, no. 1, pp. 103–120, Jan. 2020.
- [9] C. K. H. Lee, "A GA-based optimisation model for big data analytics supporting anticipatory shipping in Retail 4.0," *Int. J. Prod. Res.*, vol. 55, no. 2, pp. 593–605, Jan. 2017.
- [10] "Why Amazon's Anticipatory Shipping Is Pure Genius." [Online]. Available: <https://www.forbes.com/sites/onmarketing/2014/01/28/why-amazons-anticipatory-shipping-is-pure-genius/#3d30f8284605>. [Accessed: 02-Apr-2020].
- [11] "(PDF) Big Data and Consumer Privacy." [Online]. Available: https://www.researchgate.net/publication/275036101_Big_Data_and_Consumer_Privacy. [Accessed: 02-Apr-2020].