



To determine the effect(s) of Big Data Analytics on Warehousing costs in the FMCGs.

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Abstract

Warehousing forms an integral part of the total supply chain (SC) value network and accounts for approximately 25% of the total SC cost for manufacturers of FMCG. The silo approach throughout the SC nodes is impeding integration. The emergence of IR. 4.0 provides opportunities to adopt and utilise Big Data and Analytics (BDA) to act as a catalyst in improving the flow of information and exchange across the SC value network. This study endeavours to determine the effects of utilising BDA to mitigate warehousing (including 3PLs) costs. That includes the identification of data to be mined, its effect on warehousing cost and factors to consider in the adoption of BDA. The study was conducted utilising experts in either SC and/or in the manufacturing of FMCG and/or the data specialists. A questionnaire with Likert scales and questions requiring more thought in answering them was circulated to the experts for their insight. The findings provide several benefits, including data-driven decision making, improved process efficiency, reduction in warehouse sizes, etc.

Keywords: FMCG, Warehousing costs, Big Data, Big Data Analytics, 3PLs, Information flow, Supply Chain.

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1. Chapter 1: Introduction and Background

1.1. Introduction

This section of Chapter 1, introduces the research. This was exploratory research about the effect(s) of Big Data and Analytics (BDA) on warehousing costs for fast-moving consumer goods (FMCG), and this study was limited to the South African context. The researcher spent some time reading about the costs associated with warehousing incurred by manufacturers of FMCGs, the flow and the exchange of information between the retailers, the warehouses, manufacturers of FMCG and suppliers of raw materials.

1.2. Rationale and Significance of the Study

During the literature review on research topics about BDA, it is evident that BDA has attracted significant attention from both academicians and practitioners alike (Raut *et al.*, 2020) in examining BDA capabilities with the supply chain (SC) (Govindan *et al.*, 2018).

BDA recently focused on identifying trends and patterns in the SC (Raut *et al.*, 2020), (Wang *et al.*, 2020), (Meredith *et al.*, 2012), (Tien 2015), (Tiwari *et al.*, 2018), (Nguyen *et al.*, 2018), smart and lean manufacturing (Lyu *et al.*, 2018), (Ren *et al.*, 2019), (Holweg 2007), (Huson and Nanda, 1995), (Sanchez and Nagi 2001), (Jayal *et al.*, 2010), (Geest *et al.*, 2020) machine learning in predicting demand for FMCG (Tarallo *et al.*, 2019), (Rozados and Tjahjono, 2014), (Koot *et al.*, 2020), enhanced supply chain performance (Bag *et al.*, 2020), (Lun 2011), (Zhou and Zhou, 2015), (Hu *et al.*, 2019), (Mangla *et al.*, 2019), (Taelman *et al.*, 2019) (Jin and Kim, 2018), however, there has been a lack of focus on utilising BDA to optimise warehousing costs.

From research, the researcher identified a gap and decided to pursue research to determine the effects of BDA on warehousing costs.

Figure 1, illustrates the flow and exchange (which is bi-directional) of information amongst the SC value network, using BDA as enablers.

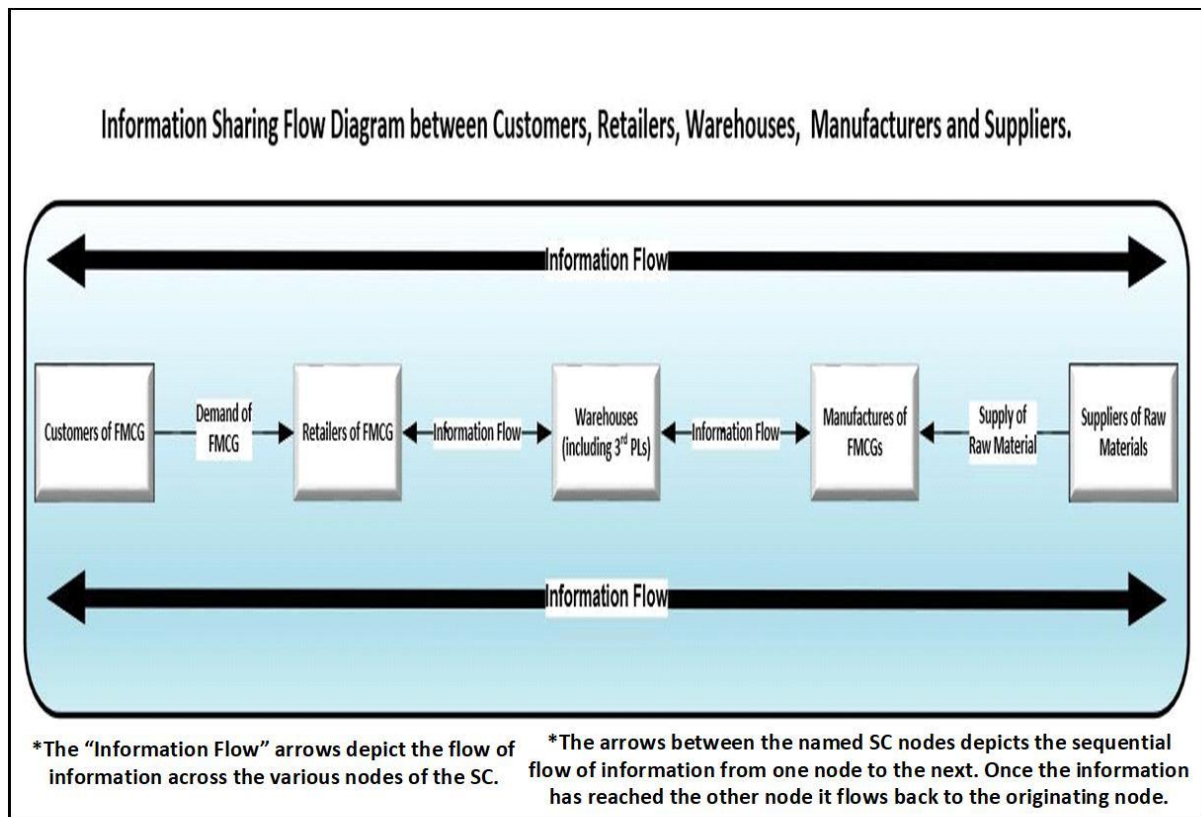


Figure 1: Integrated flow and sharing of information amongst SC nodes

1.3. Background

Products such as food, beverages, personal care products and home care products (Adeoti *et al.*, 2016) are some of the wide categories of FMCGs (KPMG in Africa 2020). The life span of FMCGs is short because they are used for daily (resulting in high demand) consumption (e.g. households utilise milk almost daily for cereal-based breakfasts, etc.), they are perishable (e.g. meat, dairy products, and baked goods) (Why Fast-Moving Consumer Goods Matter, 2020) and low priced. To keep the correct quantities (i.e. supply), there was a need to have a buffer or an inventory between manufacturers of FMCG (e.g. Tiger Brands, Unilever, Pioneer Foods, Premier, etc.) and retailers (i.e. companies who sell FMCG to consumers, such as Woolworths, Shoprite, Checkers, Spar, Pick 'n Pay, etc.). This buffer was achieved through the use of warehouses (to manage the movement and storage of the goods efficiently while also providing flexibility in the resource management (Womack *et al.* 2007) and/or 3rd party logistics (3PL), according to Gilliam (2020), 3PL is a service provided by a company to outsource its operational logistics from warehousing

(Imperial Logistics, Barlow Logistics, Supergroup, etc.), all the way through to delivery.

Warehousing is one of the core functions in the total SC value network, it also acts as a buffer for retailers to have access to goods to replenish their stock levels during the period when they are first produced or purchased by the organisation until they are required for use by the organization.

Although a warehouse plays a pivotal role in the SC network, it accrues costs that include at least the following: operational costs, operation administration costs, insurance costs, shrinkage costs, holding costs, inventory costs (raw material, work-in-progress (WIP)), obsolete costs, general administration costs and finished goods (Vogt, Pienaar and de Wit, 2002). Warehouse operations go beyond the movement of goods, they include the flow of information from the provision of raw material stock, from suppliers and manufacturers to meet market demand requirements from the consumer.

The rise of technology has made collaboration (i.e. the effective flow of information which may lead to better integration (i.e. close alignment and coordination (a joint decision-making process, where separate entities influence each other's decisions more directly (Jiang *et al.*, 2012)) (Simatupang *et al.*, 2002) throughout the SC value network (de Villiers, *et al.*, 2017) possible. These were often achieved with the use of shared management information systems, which referred to systems that were shared by two or more companies to increase efficiency and effectiveness (Mohammed and Hu, 2015).

For the last several decades we have been flooded by newer technologies (Siriram, 2016), which has led to better connectivity across the SC network (Waters, 2010). Radio Frequency Identification Device (RFID) is an Automatic Identification and Data Capture (AIDC) technology, which enables real-time communication with numerous objects simultaneously from a distance without line of sight (García *et al.*, 2007).

Steadily more organizations have embraced the emergence of the Industrial Revolution (IR) 4.0. IR 4.0 can thus be defined as “*the transformation from machine dominant manufacturing to digital manufacturing*” (Oztemel and Gursev, 2018).

In this cyber SCs, physical devices, information and people are electronically connected (Wang *et al.*, 2016). The amount of data generated through connected devices across the SC has grown exponentially in the preceding years, it is a source of untapped information which, if studied may be seen as a potential for BDA (Srinivasa and Bhatnagar, 2012).

The purpose of this research paper was to better understand the impact BDA will have on warehousing costs. Warehousing costs are costs associated with the storage of raw materials, production material, components, semi-finished products, finished products, inventory costs, human resources, rent, shrinkage, obsolete stock and insurance, etc. (Vogt, Pienaar, and Wit, 2005). According to (Bekker 2016), BDA comprises four types of data analytics namely; descriptive, diagnostic, predictive and prescriptive analytics. BDA was used to exploit available data in harnessing the information or the data flows and assist the SC network and impact warehousing costs.

1.4. Problem Statement

The flow and the sharing of information between customers, retailers, warehouses (3PLs) manufacturers and suppliers are fragmented, and not optimally utilized. Figure 2 depicts a lack of flow and the sharing of information amongst the SC nodes.

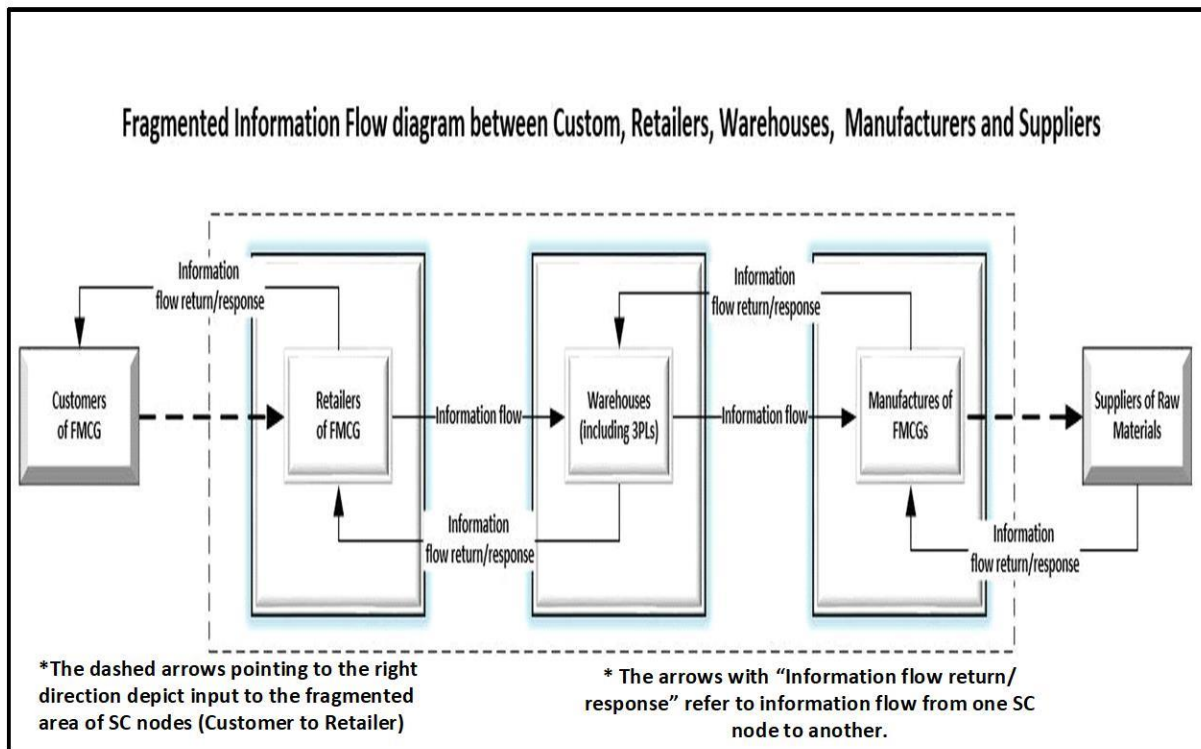


Figure 2: Fragmented Information flow diagram for SC nodes

The availability of big data (BD) across the various nodes of SC and the emergence of BDA technologies provide grounds to explore how BDA may be used to have a positive effect on warehousing costs and to reduce the number of physical warehouses used by manufacturers of FMCG.

1.5. Critical Research Question

What effect will the implementation of BDA have on warehousing costs?

1.6. Research Objectives

- i. To determine what data should be mined for warehousing cost optimization.
- ii. To determine the effect(s) of the mined data on warehousing cost.
- iii. To identify the factors which affect the implementation of BDA.

1.7. Research Limitations

According to (Simon 2011), research limitations refers to “possible weaknesses in a study and are out of the researcher’s control”, this study includes the following limitations;

- i. The sample was small (only 12 “experts”) and individual (i.e. individuals selected based on their involvement in FMCG and warehousing industries),
- ii. Collected data was predominantly non-numerical.
- iii. The study was limited to South Africa.
- iv. The study focused on major manufacturers of FMCG only.

1.8. Research Assumptions

Leedy and Ormrod (2010) suggests that “*assumptions are so basic that, without them, the research’s critical research question could not exist*”, below is the list of assumptions applicable to this study;

- i. Participants answered the questionnaire honestly and candidly,
- ii. The selected participants qualify to be classified as “experts” in the respective domains,
- iii. The findings of this study will contribute to existing knowledge, and
- iv. The selected “experts” wilfully agreed to be part of the study.

1.9. Summary of the Research Method

A waterfall approach (i.e. a linear approach adhering to the logical progression of steps taken throughout, Royce (1970)) was followed in conducting the research. Each activity adheres to defined goals and deadlines and occurs in a sequential step. As a result, Figure 3 illustrates a sequence of steps that the researcher undertook to complete the research report.

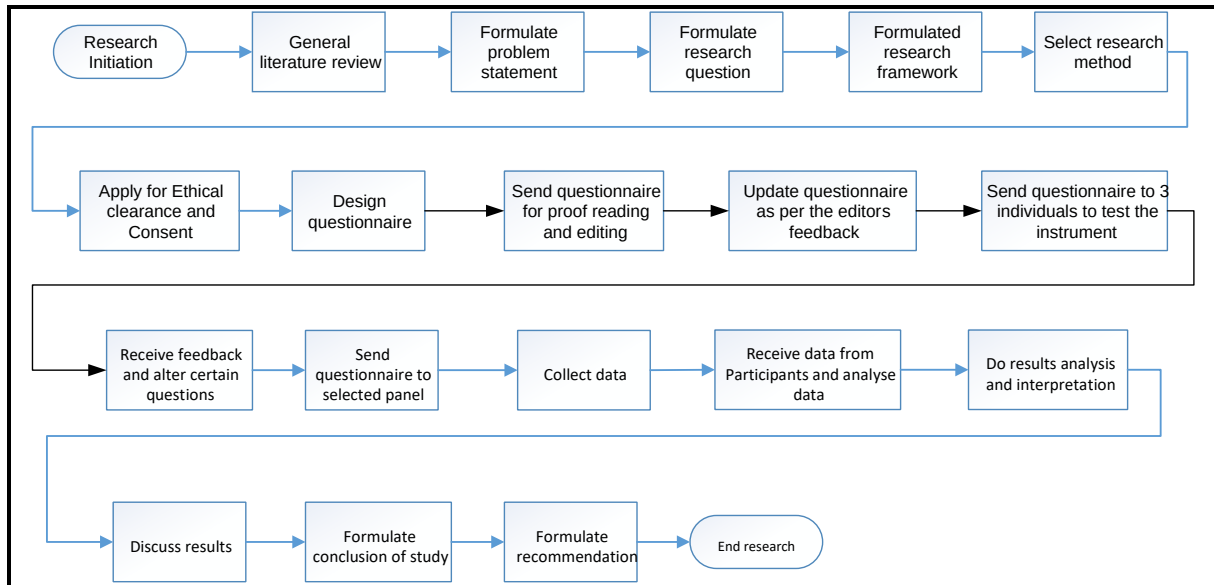


Figure 3: Research Process Flow

1.10. Summary of the Chapters

This section of the study summarises the chapters of the research report.

Chapter 1; Outlined introduction and background, including problem statement, research design objectives, research limitations, research assumptions and research method.

Chapter 2: Provide a detailed review of the existing literature on warehousing costs, information flow, Big Data and Analytics, Industrial Revolution 4.0., etc.

Chapter 3: Outlined the details about the research methodology adhered to in conducting the study. These include the research design and the various available options.

Chapter 4: Outlined the research method followed in conducting the study.

Chapter 5: Outlined the analysis and interpretation of the study's results.

Chapter 6: Outlined the findings of the study.

Chapter 7: Outlined the conclusion and the recommendations that the research offers regarding the study.

2. Chapter 2: The Literature Review

The literature review described the theoretical perspectives and previous research findings (Leedy and Ormrod 2005) on how to mitigate warehousing costs utilising BDA. The purpose of the literature review *“is to “look again” at what others have done in areas similar, though not necessarily identical to, one’s area of investigation”* (Leedy and Ormrod 2005). This chapter provides literature in reasonable detail on the problem being studied.

2.1. Information and Data Flow

The need to manage the complex information flow in the SC value network (Kumar and Pandey, 2018) is dependent on the degree of dependence and interdependence throughout the SC (Donald *et al.*, 2002) and is well documented in the literature. Data continues to become increasingly important for businesses to make decisions. However, that is reliant on its quality, consistency, and integrity of shared information (Lotame, 2021). Over the years, the SCM environment has also become more complex and requiring enhanced synergy throughout the SCM value network and information that is accurate, timely, and affordable (Bowersox and Calantone, 1998).

The lack of information symmetries contributes to greater operational inefficiencies, transaction risks, and coordination costs (Clemons and Row 1992). Through, information exchange of inventory, production, and sales data, planning and forecasting information, reduces the supplier’s demand variance with the potential benefit of reducing costs (Lee, Padmanabhan and Whang 1997).

Normally, companies operating the SCM value network operate in non-sharing of information (Sinclair *et al.*, 1995) or lack of integrated infrastructure to enable communication across the SCM value network (Siemieniuch, Waddell, and Sinclair, 1999). The flow of physical goods and Information historically has been associated with advances in information technology (IT) that have enabled their decoupling (Cachon and Fisher, 2000).

P & G and Wal-Mart found a way to leverage IT by sharing data and knowledge across their mutual SCs (refer to Figure 4 for a graphical view) (Shaw and Grean 2002). Wal-Mart is widely used as a textbook example of an organization that

carefully manages information flows across the retail SC (Shaw and Grean, 2002). The automated collection of data from scanners at points of sale and technologies such as electronic data interchange (EDI) allows data to be shared in real-time among SC participants (Shaw and Grean, 2002).

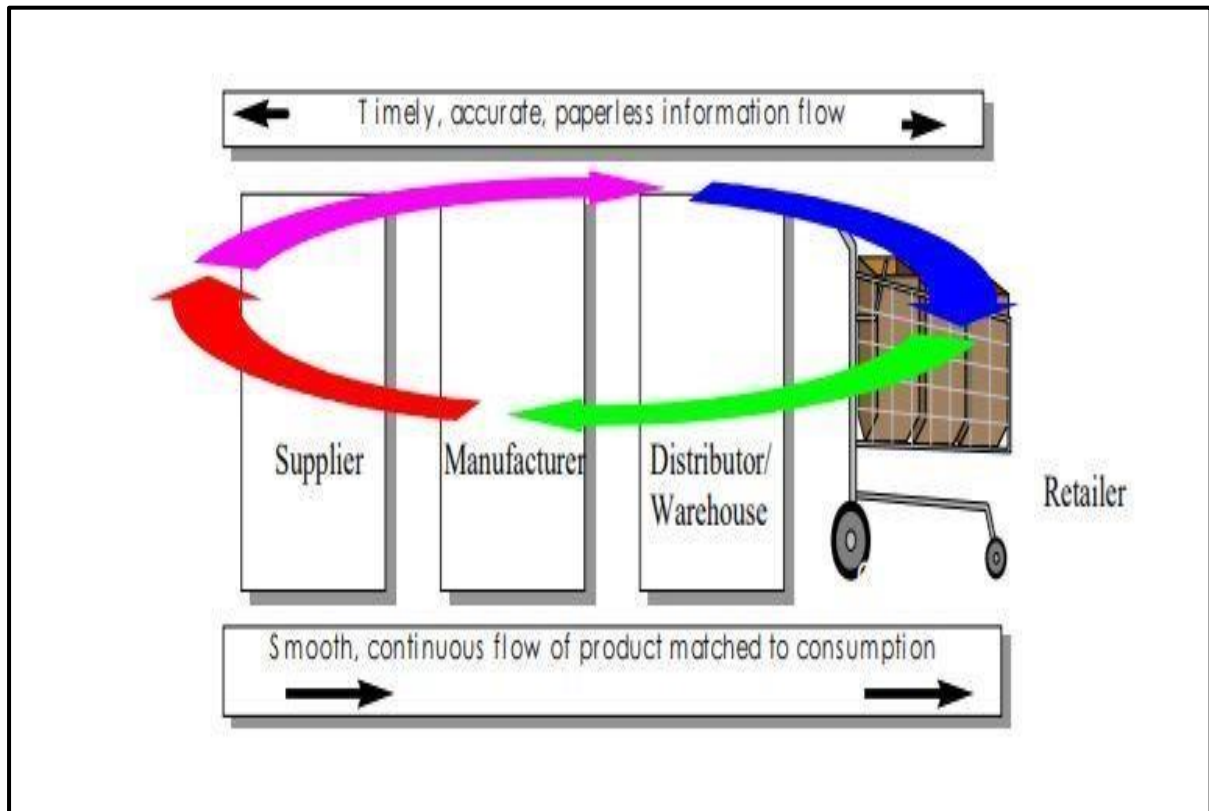


Figure 4: Role of Information Technology in SC Integration Source: Shaw and Grean (2000).

Information about the actual status of items in the SC, at any given instant, is essential to correctly coordinate and collaborate all the combined SC value network.

Companies that work together by sharing information are better positioned to generate relational rents (i.e. *"a Supernormal Profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners"*) (Dyer and Singh 1998).

Integrating information across the SC processes may provide support for collaborated execution including order management, fulfilment, and inventory management, thus positively affecting the stocks and the flow of physical goods (Kaipai 2009). Figure 5, illustrates the effect of not sharing information/data. Such

coordination, waste elimination and efficiency objectives can be identified, measured, and managed across the SC (Kaipia 2009).

“Distorted information from one end of SC network to the other can lead to tremendous inefficiencies, excessive inventory investment, poor customer service, lost revenues, misguided capacity plans, ineffective transportation, and missed production schedules” (Lee, Padmanabhan and Whang 1997).

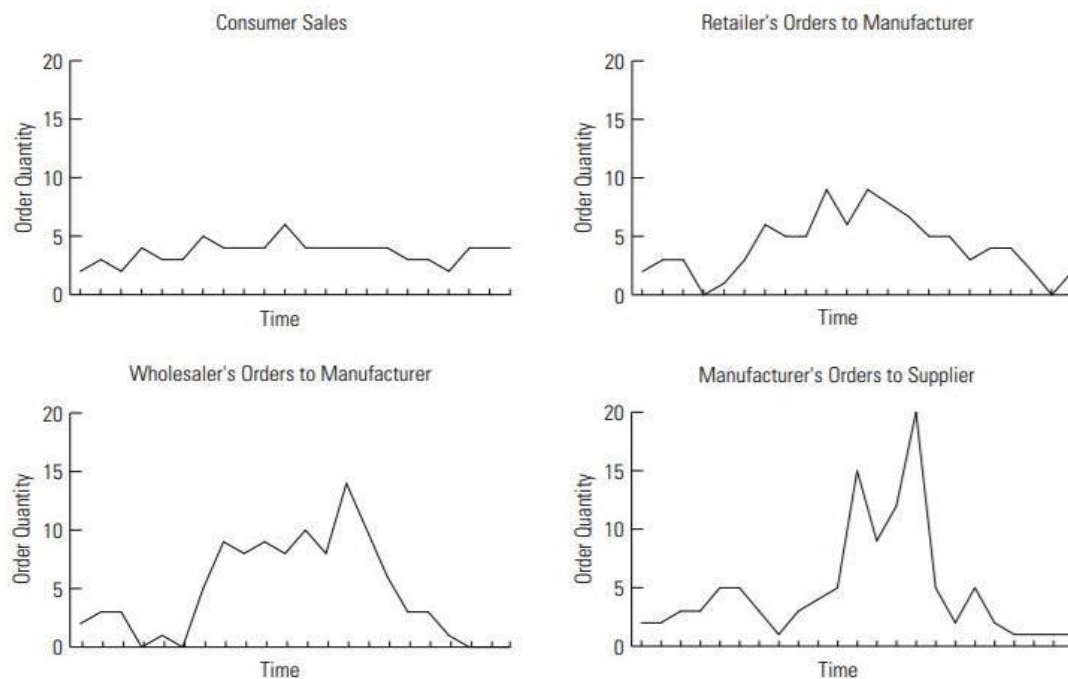


Figure 5: No Information Sharing Effect in SC results in the bullwhip effect. Source (MIT Sloan Management Review (1997))

Chen (1998), found that SC costs could be lowered by as much as nine percent, when a retailer's demand data is available to the supplier. (Lee, Padmanabhan and Whang 1997), attests that information sharing lowered SC costs by about 23%.

Figure 5 depicts the discrepancies in inventory holding. However, through continuous replenishment process (CRP) (i.e. that aims to match product flow with consumer demand, yielding improvements in inventory management and logistics (Kopanaki and Smithson, 2003) manufacturers will reduce the inventory and plan the shipment more efficiently (Lee, Padmanabhan and Whang 1997) throughout the various nodes in the SC value network.

According to (Lee, Padmanabhan and Whang 1997), non-sharing of inventory in the SCM value network leads to redundancy as different stakeholders need to keep

adequate inventory to safeguard against unexpected variances in demand and supply across the SC value network. Regrettably, that has a direct influence on inventory (holding) costs. Figure 5 illustrates the negative effects of non-information exchange, each stakeholder in the SCM keeps inventory in a siloed manner.

Perçin (2008), adopted a “*benefit of information sharing*” approach while (Williams and Moore 2007) used an “*information as power*” framework and analysed the benefits of information sharing (Jraisat and Sawalha 2013).

2.2. Consumers of FMCG

According to (Mohr and Fourie 1995), consumers refer to individuals or to groups who purchase goods for personal use (or households) and/or for consumption, and the end-users to satisfy wants. Since the main focus of the study is primarily on Retailers, Warehouses and Manufacturers of FMCG, the information about consumers will be limited to the one described in this section.

According to (Lautiainen, 2015), consumer needs in general change constantly, as they are influenced by various factors (Hoyer and Macinnis, 2009) including the availability of different brands, substitutes, etc. This results in retailers equip themselves with reliable, almost accurate and timely information to adapt accordingly to meet demand and supply (KPMG, 2016).

Consumers are sensitive to price and/or quality changes. It is important for SC and for manufacturers to be mindful that consumers have greater access to information and that their preference changes due to multiple factors (for example economic factors, the availability of substitutes, etc.) (Mohr and Associates 2015).

To illustrate the importance and the value BDA has on forecasting the Reserve Bank has projected consumer spending to reach R1.9 trillion by the end of this quarter. Figure 6 illustrates the projection (SARB, 2020).

Although Figure 6 does not exactly relate to FMCG, it is used to illustrate and emphasise the importance of data about forecasting. Figure 6 acts as information input to retailers, warehouses, manufacturers of FMCG, and suppliers, to enable them to project and forecast, based on consumer spending.

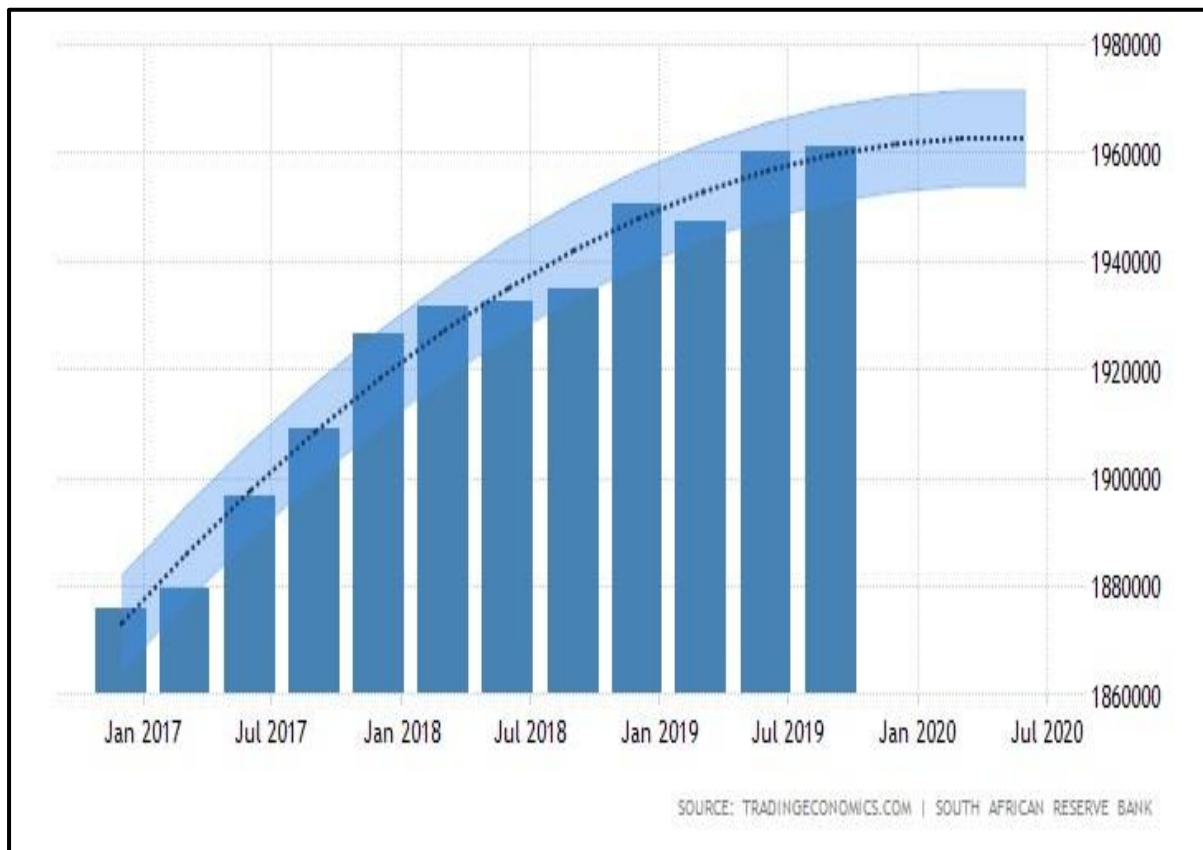


Figure 6: South Africa Consumer Spending Source: South African Reserve Bank (2020)

2.3. Retailers

At its essential core, success in retailing (i.e. all activities involved in the sale of goods and those who produce or provide these goods and services (Richert *et al.* 1974)) depends upon customer satisfaction and repeat purchases at the same retailer, as a result, all the functions of retailing must be targeted to satisfying customers. Retailers must be prime providers of information (Pintel and Diamond 1983) in the SC value network, the gathered demand and supply patterns assist in the decision-making process on the quantities required at any given time.

In the information era, retailers need to obtain sound, reliable and timely information to adapt their operations according to the information collected and collated over some time.

Collaboration is usually retailer led and it is based upon their determination to reduce costs and focus more closely on their customers (Walters and Hanrahan 2000), while (Evans and Wurster 1997), state that *“Information is the glue that holds together the structure of all companies”*.

The role of the retailers is to provide manufacturers of FMCG with consumer consumption patterns of the various FMCGs in a manageable easily accessible through agreed information sharing and exchange protocols in the SC value network. Retailers purchase the goods from the manufactures at cost and they market them to consumers at retail price (i.e. the price paid by a customer at the retailers).

2.4. Warehousing (including third Party Logistics)

3PLs provide transportation, warehousing, inventory management, material handling (Mothilal *et al.* 2012), cross-docking, reverse logistics, freight forwarding (Park and Jeong 2016); (Shaharudin *et al.* 2017), customer service and information related services (Payaro and Papa 2017).

Several manufacturers of goods utilise warehouses (defined as, *“that part of a company’s logistics system that stores products (raw materials, parts, goods-in-process, finished goods) at and between point-of-origin and point-of-consumption, and provides information to management on the status, condition, and disposition of items being stored”*) (Stock and Lambert, 2001), and provides information to management on the status and the condition of the items being stored. Figure 7, provides a graphical view of the 3PLs role and association, specifically aligned to warehouses.

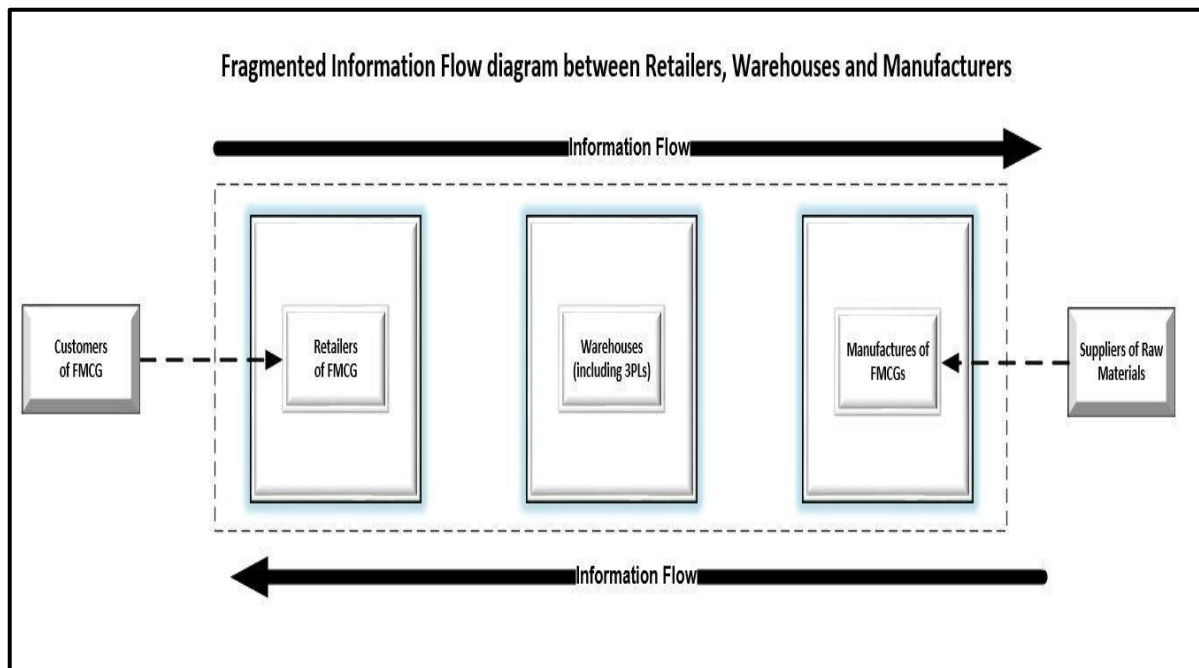


Figure 7: Graphical view of 3PL in the SC Integration Source: Self-constructed

In the last 30 years (Lieb and Kendrick 2002), states that companies in the production sector have increased the use of a 3PL service provider that manages all or part of the logistics operations.

For example:

- a) *“3PL users report an average of 44% of their total logistics expenditures is related to outsourcing. 72% of firms are increasing their use of outsourced logistics services in 2015”* (Payaro and Papa 2017).
- b) According to (Li et al., 2012), 70% (Japan), 42% (United States) of companies outsource their main logistics to 3PL's and Italy is estimated at 70% (Payaro and Papal 2017).

Although this study is limited to South Africa, globally, approximately 40% of the global logistics services will be outsourced (Jiang, Frazier and Prater 2006).

3PL has become a topic of studies and research in the scientific literature (Tate 1996), because of its value add in the provision of logistics and strategic alliances formed to manage inventory and logistics costs.

The use of 3PLs by manufacturers of FMCG is indicative of the trend to outsource (i.e. *“the sourcing of goods and the services previously produced internally within a*

company from external suppliers..." (Ronan 2005) logistics related functions. "Logistic providers are experienced and competent enough to satisfy clients by providing them with expert services" (Kotzab, Seuring and Muller 2005). 3PL's offer a range of service (e.g. logistics services, etc.) which manufacturers of FMCGs may choose from to in line with their inventory/logistics needs.

3PLs *"invest in resources as well as IT systems so that they will be able to provide integrated solutions to their customers"* (Stefansson 2006; Cui and Hertz 2011) at a lower overall cost for warehousing and logistics. 3PLs utilises various IT systems that improve the flow of information management, *"inventory synchronization mechanisms and scaling of resources"* (Ross and Droge 2004).

Hughes (2020), provided an overview of the functions and the services provided by 3PLs, as listed in Table 1.

Table 1: Common functions of 3PLs

Functions/Services provided by 3PLs	Description
Shipping and Receiving	Shipping and receiving are normally provided by 3PL service providers. The focus is on real-time whilst increases transportation throughout the SCM network. 3PL's to a large extent use technology as an enabler (Hughes 2020).
Transportation	3PL's provide and facilitate the logistics service of transporting goods between places of consumption (Hughes 2020).
Warehousing	Warehousing (including 3PLs) is integrated into a company's warehousing and transportation procedures and specializes in the storing and the distribution of goods and/or services. Many warehouse 3PL providers offer customizable ways to handle storage, distribution, and product transportation (Hughes 2020).
Distribution	The outsourcing of distribution function to 3PLs enables the manufacturers of FMCGs to concentrate on their main business (Hughes 2020).
Inventory Management	The objective of inventory management involves: i. reduce inventory operating costs to a minimum. ii. provide the desired level of service to customers; and iii. carrying stock to cover delays, etc. (Attwood and Attwood 1992).
Cross-docking	<i>"The enable consolidation of differently sized shipments with the same destination to full truckloads so that economies in transportation costs can be realized"</i> (Apte and Viswanathan 2000).

An increase in the digitalisation of most operational processes has contributed to the increase in the number of companies adopting e-commerce, including 3PLs through offering efficient, tailor-made to customer needs.

According to Mbaje and Lunga (2015), below are some of the advantages of 3PL:

- a) Efficient transport and other logistics services hence improved customer relations and services.
- b) Reduces capital investment due to 3PL's provision of trucks and warehouses.

- c) SC costs are reduced due to a faster flow of materials and information at a lower cost.

Mbaje and Lunga (2015), cautioned buyers of 3PL services to note that 3PL services are not a complete integrated SC service in the logistics process. According to Hughes, (2020), although 3PLs provide advantages, there are disadvantages associated with them and they include;

- a) Loss of control, when a company chooses a 3PL provider, it must be aware that sharing certain proprietary information with a third party (sourcing, order information, etc.) could leave companies vulnerable in the event of a data breach.
- b) Cost reduction: while a 3PL can save a business significant time and money, external factors (tariffs, over-regulation, weather, etc.) can lead to escalating costs. A 3PL company might make financial sense initially, but the company is at the mercy of this external trading partner and its business strategy.
- c) Special treatment, 3PLs offer this service to multiple companies, which might compromise the attention required and run the risk of not meeting delivery requirements.

According to Nieman and Bennett (2014), a substantial number of companies are focusing on their core competencies (2020), and outsource functions that are not their core competencies. Thus, provide opportunities to reduce their costs and improve flexibility. Companies, need to be certain of the business and financial value to be provided by 3PLs, before opting for their services?

“3PLs service providers started offering integrated logistics services, which filled the need for managing complex, global supply chains. In the 2000s, the massive expansion of the internet opened the door for 3PLs to offer “connected” SC solutions to global companies. Transportation, logistics, and stock management were all integrated into impressive technology platforms which allowed for true SC visibility”. Today, 3PLs continue to expand and adapt their services to meet the demands of an ever-changing global marketplace (General Archives | Distribution | Logistics, 2020).

According to (Lambe and Stock 1993), manufacturers of FMCG may optimise their warehousing operations by outsourcing warehousing for the consolidation of products from multiple production facilities for shipment to a single customer.

According to Nieman and Bennett (2014), warehousing can be for several functions, including inbound and inbound consolidation. For clarity, a definition for each function of warehousing is provided;

- a) **Inbound consolidation:** the consolidation of received goods from different manufacturers for consolidation in one centralised warehouse and to be transported to different destinations (Smith *et al.* 2019).
- b) **Outbound consolidation:** the consolidation of goods from different manufacturing institutions, destined single customer or within the nearby geographic areas, combined for a single shipment to mitigate transportation costs (Smith *et al.*, 2019).
- c) **Break-bulk:** it is the receiving of a larger cargo of goods from the manufacturer, then consolidate the cargo according to received orders and delivered to different customers (2014).

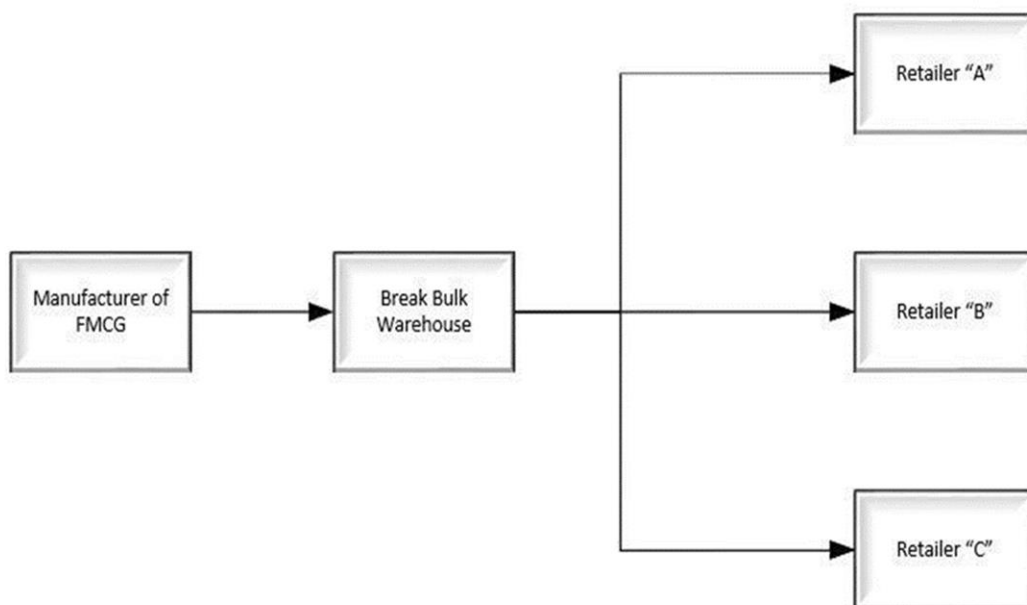


Figure 8: Break Bulk. (Source: Self-constructed).

- d) **Mixing (consolidation):** refers to a consolidation of products, packaging them into smaller quantities and consolidating them before transporting them to respective consumers (Niemand and Bennett 2014).
- e) **Storage:** The storage of goods for a defined period.

Notwithstanding the improvement of efficiency and effectiveness by the utilisation of 3PLs, the sharing and exchange of information must be utilised by manufacturers, warehouses and retailers, to achieve maximum efficiency in the SC value network.

Seamless movement of goods, products and information in the SC value network is a key determinant for business performance.

2.5. Suppliers of Raw Material to FMCG Manufacturers

Suppliers (individuals or companies who cultivate and distribute what has been grown to the manufactures of FMCGs (KPMG Sector Report (2014)) include (e.g. wheat farmers) who supply the manufacturers of flour, sunflower seed farmers who supply the manufactures of sunflower oil, etc.

Suppliers to be able to cultivate adequate quantities of raw materials require information (e.g. quantities of sugar cane, etc.), this information is required for suppliers to cultivate crops according to the available demand patterns (Kopanaki and Smithson, 2003) to capacitate their production operations (e.g. trucks, seeds, human resources, etc.). The absence of information exchange between the SC nodes leads to either the supplier producing too much or too little (Kopanaki and Smithson, 2003).

Information sharing contributes to a higher level of optimization of any SC (Moore, 2008), project and execute with the highest level of accuracy to meet the demand from the manufacturers and to supply the correct amount of raw material to the manufacturers at the requested time, correct quantities and at the agreed price.

Suppliers of raw materials and manufacturers of FMCG may realise these major benefits if they share information amongst themselves (Lofti *et al.* 2013);

- a) Improved planning by the respective organisations.
- b) Reducing unnecessary operational costs.
- c) Improving production efficiency.
- d) Improving production projections, the ability to project production based on available information across the SC value network.
- e) Meeting demand and supply needs.

- f) Proactively mitigating unforeseen circumstances (i.e. seeking alternative suppliers in situations of drought, etc.).

2.6. Manufacturers of Fast-Moving Consumer Goods (FMCG)

The FMCG industry is rapid and agile (Kärkkäinen 2003) and comprises several product variants (KPMG in Africa 2020). According to Kenton, (2018), FMCGs have a short shelf life because of high consumer demand (for example soft drinks, confections, etc.) or because they are perishable (for example meat, dairy products, and baked goods) and requires a continuous balancing act between demand and supply, to not lose a sale.

“There is a rise in the sales of packaged food, this is mainly due to the busy lifestyles which leave people with no time to cook at home, thus bringing about a change in consumer lifestyle, coupled with the easy availability of packaged food” (Infiniti Research Limited, 2017).

Predicting an accurate demand and supply is a common challenge, as manufacturers try to reduce the manufacturing lead-time (Jovane *et al.*, 2008). According to (KPMG Africa 2020), the most well-known FMCG companies in the world include:

- i. Unilever,
- ii. The Coca-Cola Company; and
- iii. Johnson & Johnson.

2.6.1. Categories of FMCG

“The range of FMCG products are classified into three broad categories: household care, food and beverages, and personal care products” (Mohan and Sequeira 2016). Table 2 lists categories and products of FMCG and the products for the functioning of modern society, and people must have constant access to them.

Table 2: FMCG Category and Products. Source: IBEF 2006.

Category	Products
Household care	Fabric wash (laundry soaps, and synthetic detergents), house cleaners (dish/utensil cleaners, floor cleaners, toilet cleaners, air fresheners, insecticides and mosquito repellents, metal polish and furniture polish).
Food and beverages	Health beverages, soft drinks; staples/cereals, bakery products (biscuits, bread, cakes), snack food, chocolates, ice creams, tea, coffee, processed fruits, vegetables, dairy products, bottled water, branded flour, branded rice; branded sugar and juices.
Personal care	Oral care, hair care, skincare, personal wash (soaps), cosmetics and toiletries, deodorants, perfumes, feminine hygiene, paper products.

2.7. Warehousing Costs (Inventory Handling Costs)

Warehousing costs (i.e. costs associated with the storage of raw materials, production material, components, semi-finished products, and finished products (Rosing, 2020), inventory costs, human resources, rent, shrinkage, obsolete stock and insurance, etc. (Vogt, Pienaar and Wit 2002) is the opportunity cost in making sure that demand and supply are continuously met the impact and the influence warehousing costs have on the retail price is not always to the benefit of the consumer as these costs get factored in the retail price.

Inventory holding is one of the most expensive assets of any company, in certain areas being more than 10 to 15% of the total assets for some companies (Zhang *et al.* 2019). Keeping adequate inventories is necessary to ensure that no shortage occurs (Vogt, Pienaar and de Wit, 2002).

Providing an accurate cost of warehousing activities is not simple and identifiable, warehousing cost reduction has received wide coverage in the literature (Lyu *et al.* 2020). Inventory holding attempts to minimize manufacturers of FMCGs operating costs.

Inventory management traditionally includes inventory and warehousing challenges (Robert and Copacino 1994), these are closely connected. Inventory management determines the type, size and geographical location of the warehouse (Ackerman 1993).

According to (de Villiers, Nieman, and Niemann 2017), warehousing cost generally amounts to 25% of manufactures of FMCGs in the SC value network turnover annually, also known as the holding cost (e.g. insurance, depreciation, etc.) rate.

For many years, logistics (i.e. Total Supply Chain Costs) literature has quoted a figure of twenty-five percent (25%) as the annual inventory holding cost rate for the FMCG industry (Vogt, Pienaar, de Wit, 2014). Figure 9 depicts the total SC costs breakdown.

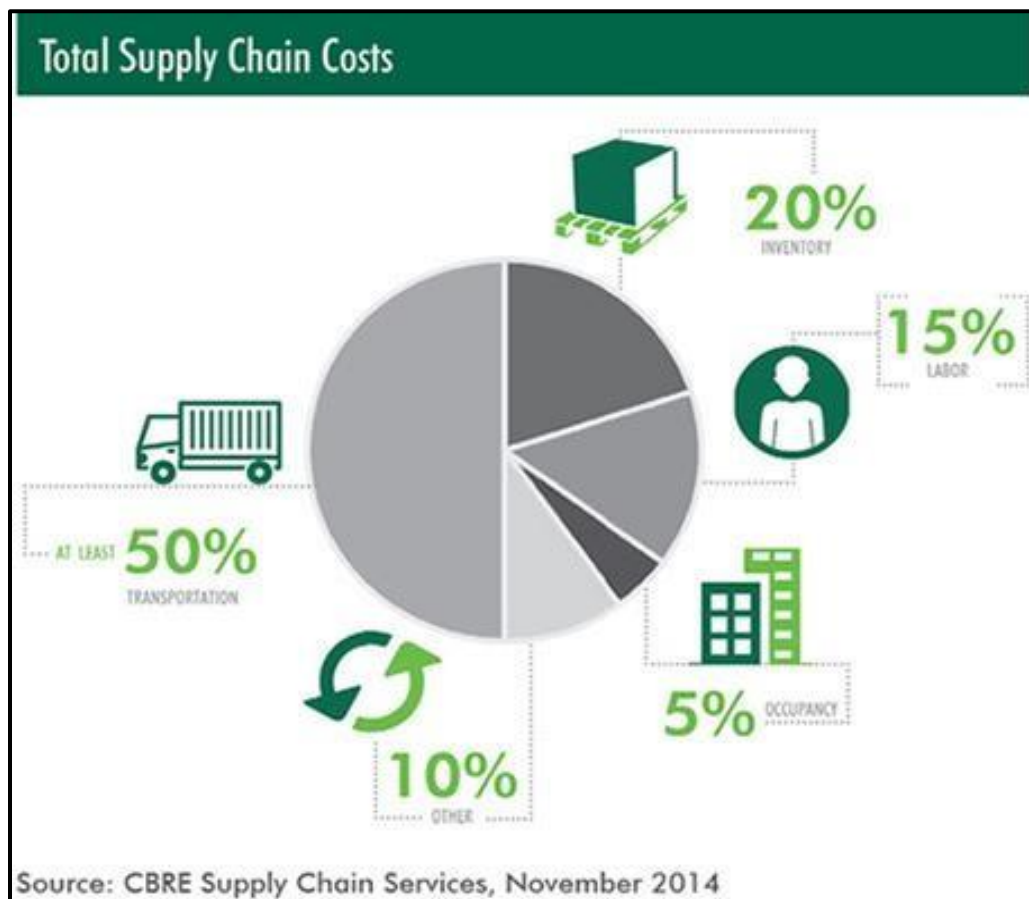


Figure 9: Total Supply Chain Costs Source: CBRE Supply Chain Services, (2014).

Warehousing costs comprise the total of warehousing cost-plus inventory carrying costs (e.g. for the year 2014, that comes to 25.8% or R121bn of total supply chain costs).

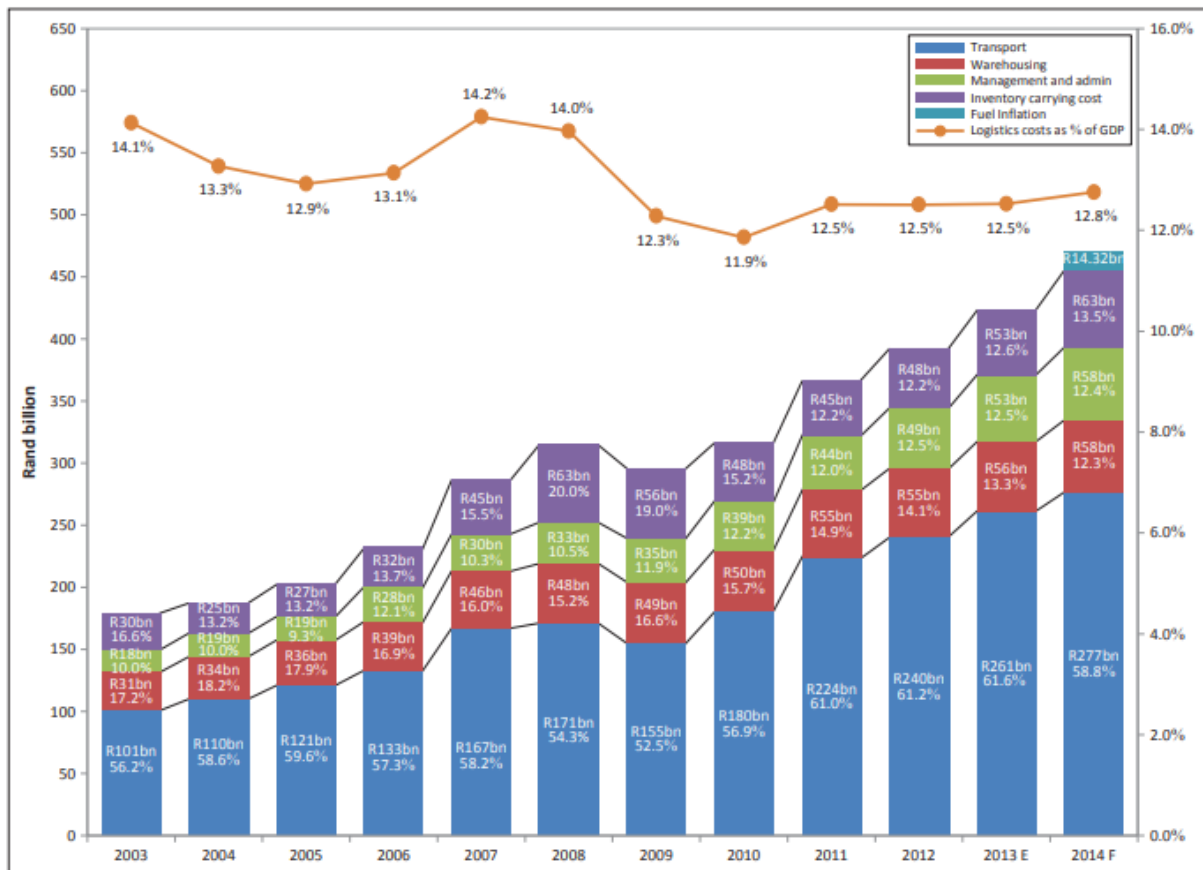


Figure 10: Total South African national logistics costs and the components, 2003-2014. Source: (Havenga, Simpson, Bod and Viljoen, 2020).

According to Chopra (2019), warehouses add value and they act as a conduit between the manufacturers of goods and the retailers, maintain stock levels, and they act as a buffer, etc. By keeping sufficient inventory, a company inevitably incurs costs, as shown in Figure 9, showing the total SC costs.

According to (Harper, 2020), warehousing involves mainly transfer, inventory-holding, and exchange of information and consists of four separate roles, namely;

- Consolidation of inbound goods from logistics service providers (as well as verifying their quality and quantity),
- Movement of consolidated goods from where logistics service provides keep them to assigned allocations in the warehouse,
- Identifying and packing ordered goods in the warehouse to fulfil customer orders, and
- Consolidation of goods from different manufacturers utilising applicable logistic services.

Information is needed to evaluate the optimum usage of equipment, labour productivity, and floor area optimisation (Bloomberg, 2002). Human resources are needed to manage the warehouse, and computers are needed to improve oversight in data handling (Vogt, *et al.*, 2004).

Over the past decades, SC networks have undergone tremendous changes. Various models were developed to mitigate warehousing costs, namely;

- The application and the implementation of Just-In-Time (JIT), which refers to the elimination of surplus inventory (Vogt, Pienaar and de Wit, 2002). JIT is very data-intense and requires a clear and complete understanding of factors such as seasonal demand, geographic and political events that might affect logistics, and customer buying patterns, both in the short and long term (DeVecchio, 2021).
- Efficient Consumer Response (ECR), *"a comprehensive management concept based on vertical collaboration in manufacturing and retailing with the objective of an efficient satisfaction of consumer needs"* (Saosaovaphak, 2020).
- The economic order quantity (EOQ) is a model which considers the trade-off between ordering costs and storage costs, in choosing the quantity to stock in replenishing item inventories (Schwarz, 2008).
- Lean manufacturing, *"a philosophy (Bhasin and Burcher, 2006) that enables industries to do better by employing the principles of continuous improvement and changing the organizational culture"* and
- Material requirements planning (MRP); the well-known and widely adopted push-based fulfilment technique, theoretically guarantees no storage quantities when a 'lot for lot' reorder policy is adopted (Pacheco et al., 2017). Companies use material requirements-planning systems to estimate quantities of raw materials and schedule their deliveries (Kenton, 2020).

These are some of the many available methodologies/models used to reduce both inventory and warehousing costs. However, these approaches have not yielded the desired effect of reducing warehouse costs (Hedley, 2019). Further evidence of this is the shift towards utilizing 3PLs as an alternative to conventional warehousing methods, (viz. the number of sophisticated warehouses which are being developed,

(for example Imperial Logistics has built a state-of-the-art warehouse in Centurion), showing that conventional warehousing costs remain too high.

An extract from Gartner (2016), provides the following to SC;

- Gartner (2018), projects that through 2018, 75% of companies will struggle to invigorate their complete SC cycle.
- The lack of complete SC cycle knowledge slows innovation.
- IR 4.0 technologies and data collection are not being leveraged to the fullest extent possible (Gartner, 2016).
- More than 75% of SC executives claim that they have limited (Gartner, 2016), selective or even no information regarding their SC.

Inventory holding costs will be part of FMCGs manufacturers, however, it is in their interest to continuously strive to mitigate inventory holding costs.

2.8. The Emergence of Industrial Revolution (IR) 4.0

According to Tang *et al.*, (2019), Information and Communications Technology (ICT) facilitates progression in digitization, automation, including increased use of the main concepts of IR 4.0. *“IR 4.0 is also referred to as the “Fourth Industrial Revolution” is the progressive phase in the advancement of technology following the IR that took place in the 18th century”* (Tang *et al.*, 2019). Advancement through production and automation was brought on by steam and waterpower (IR 1.0), subsequently by electrification (IR 2.0), and more recently by the digital computer (IR 3.0). Figure 11 represents the history of IRs over the centuries. Tang *et al.*, (2019), stated that IR 4.0 builds on IR 3.0, leveraging emerging technologies such as:

- a) **Additive Manufacturing (also known as 3D Printing).** *“.... an approach to the production of various objects from a three-dimensional model by adding layer-by-layer material. With the development of 3D printing technology, this approach has ceased to be used only for prototyping. Now it can be used directly even in serial production of parts from various materials”* (Chaika 2020).
- b) **Advanced Robotics.** *“The advancements of the communication technologies, sensor capabilities, and artificial intelligence are making robots*

smarter so that they can work safely alongside human workers” (Tang and Veelenturf 2019).

- c) **Artificial Intelligence (AI).** the mimicking of human cognition by computers, machines, etc. (Suman 2021).
- d) **Blockchain.** An innovative application model of distributed data storage, point-to-point transmission, consensus mechanism, encryption algorithm and other computer technologies in the Internet era (Zhihan *et al.*, 2019).
Blockchain technology contains six core technologies, which are intelligent contract, consensus mechanism, privacy protection, encryption algorithm, network protocol and data storage. Blockchain is a huge transaction network that can realize transactions, value and asset transfer between individuals without an intermediary (Zhang 2020).
- e) **Cybersecurity.** The exercise of defending computers, servers, mobile devices, electronic systems, networks, and data from malicious attacks. It is also known as information technology security or electronic information security Kaspersky (2020). The term applies in a variety of contexts, from business to mobile computing, and can be divided into several common categories.
- f) **The Internet of Things (IoT).** *“a network where several and various interconnected, smart objects continuously generate a large amount of data transmitted over the Internet” (Diallo, Dhaussy and Teodorov 2019).* Devices and sensors combined in one network and interacting with each other or, if necessary, with higher-level controllers allow for a more flexible production process (Jazdi 2014). It enables objects and machines such as mobile phones and sensors to “communicate” with each other as well as human beings to work out solutions (Industry 4.0: Definition, Design Principles, Challenges, and the Future of Employment, 2020).

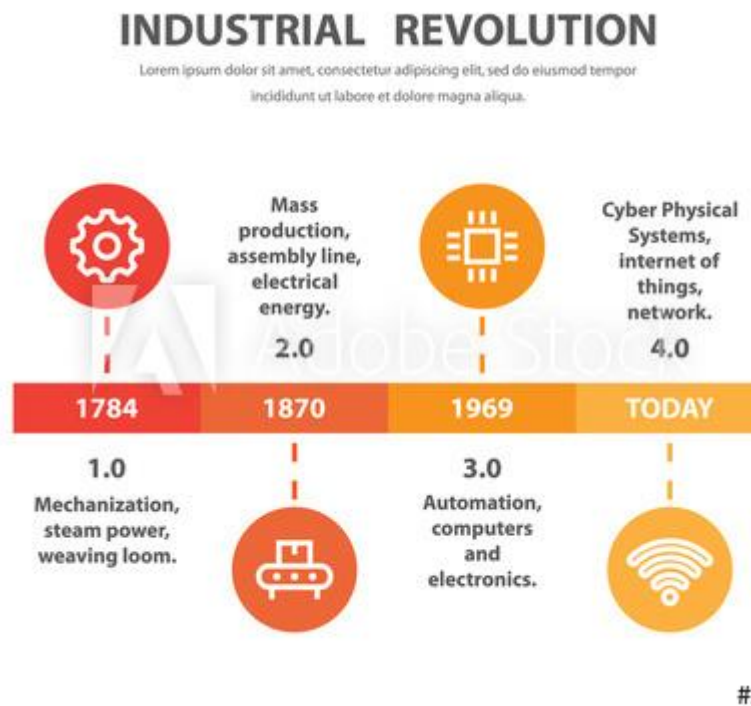


Figure 11: The road to Industrial Revolution 4.0. Source: Adobe Stock (2016)

“IR 4.0 is fundamentally different because it leverages connectivity and communication among billions of devices. People, devices, infrastructures, and sensors can constantly communicate by exchanging data and generating new data that traces many of these exchanges” (Schwab 2016). During such communication exchanges, data accumulates and requires new ways of collecting, collating and storing for further processing.

The SC value network is a series of largely discrete, siloed linear events (i.e. each does according to its environment). IR 4.0 brings together digitization, brings down the siloed steps (Schrauf and Bertram, 2016), and the eco-system becomes integrated and transparent.

Schrauf and Bertram (2016), state that a critical element will be the evolution of traditional SCs toward a connected, smart, and highly efficient SC ecosystem. IR 4.0 provides many opportunities to fully digitalise SC. According to Tao *et al.*, (2011), the emerging IR 4.0 concept is an umbrella term for a new industrial paradigm that embraces a set of future industrial developments including Cyber-Physical Systems (CPS) the Internet of Things (IoT), the Internet of Services (IoS), Robotics, Big Data, Cloud Manufacturing (it is *“a new model of network manufacturing-oriented to*

service, based on manufacturing resources and with the platform as the core” (Li et al., 2010)(Zhang et al., 2010)(Ren et al., 2017) and Augmented Reality (Pereira and Romero 2017), refer to Figure 12 for a graphical view of the concepts and their links.

It is essential to adopt these technologies to the development of intelligent manufacturing processes (Weyer et al. 2015), they can independently exchange information across the SC value network. According to Küpper (2020), IR 4.0 enables the capability to gather and analyse data across the SC value network to enable cost reduction.

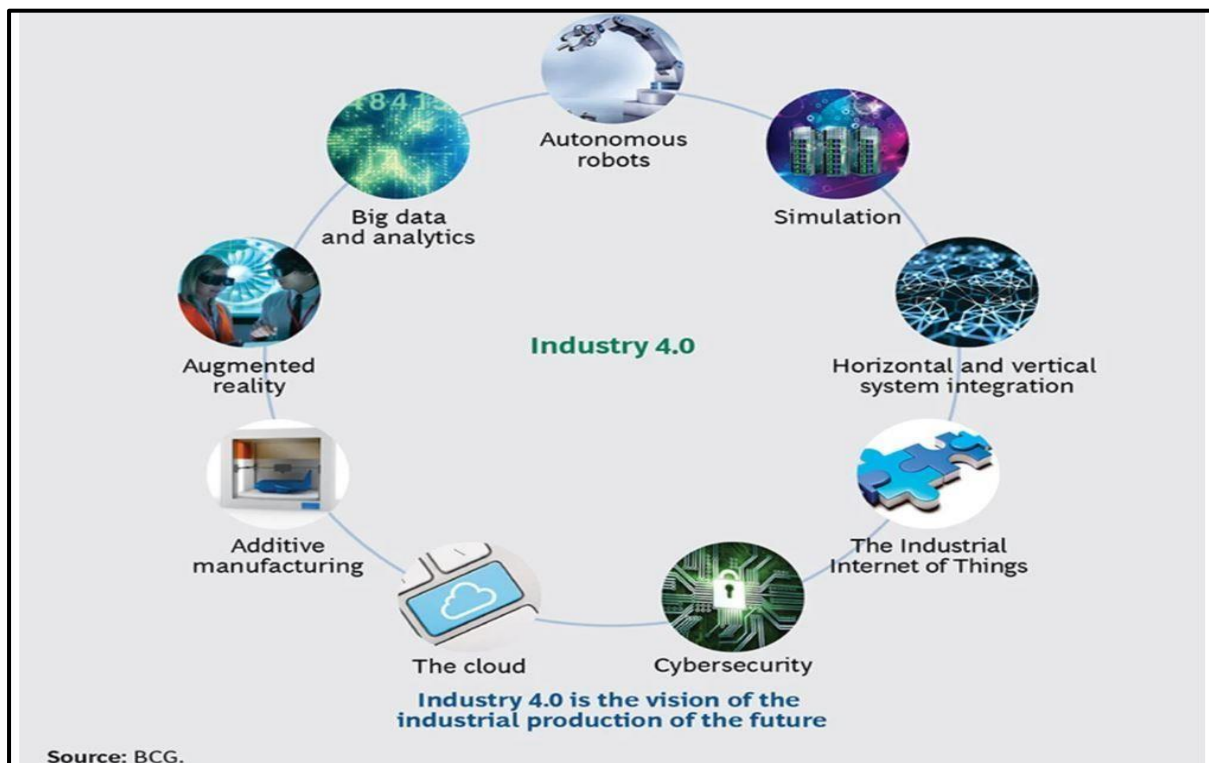


Figure 12: Nine technologies that are transforming industrial production Source Küpper (2020).

IR 4.0 is based on a framework of “connection and collaboration” utilising BDA as core capabilities.

2.8.1. Application of IR 4.0 to the Research Framework

The researcher constructed a research framework as indicated in Figure 13 to illustrate the flow and link of information through IR 4.0, Big Data and Big Data Analytics and their relationship to the SC value network.

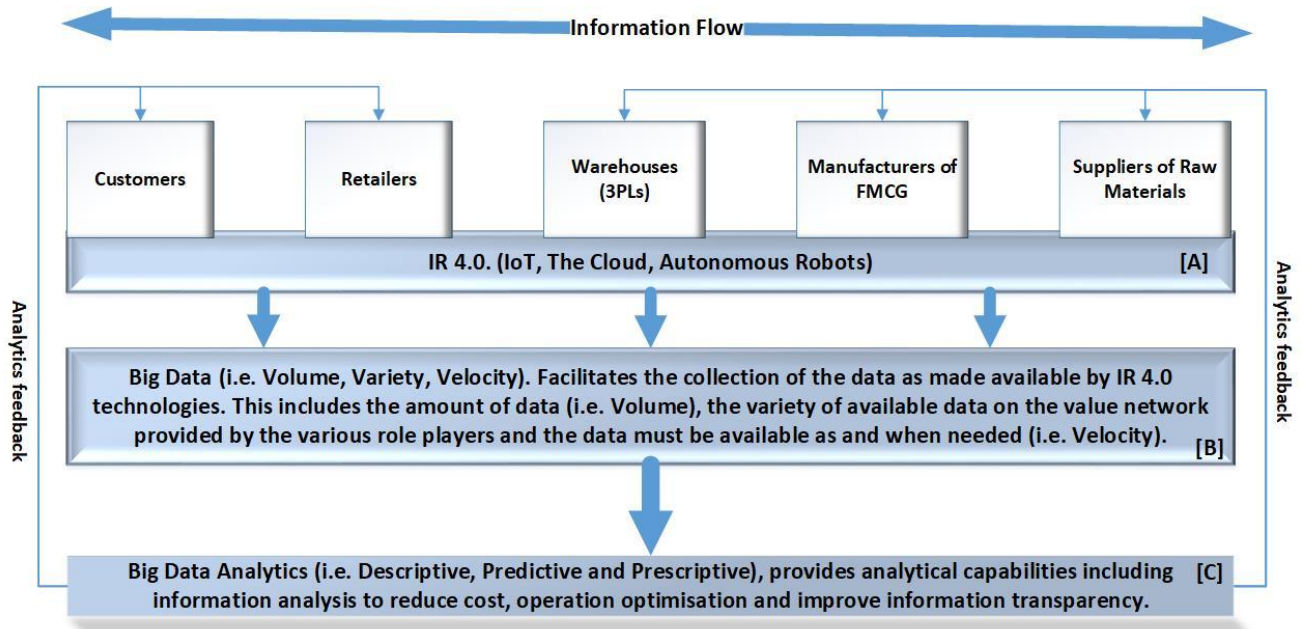


Figure 13: Research Framework, Source (Self-constructed)

IR 4.0 offers opportunities with the mass of collected data from the various source systems to support real-time decision making (Srinivasa and Bhatnagar, 2012).

Figure 13 illustrates the collection of data from various nodes of the SC and being able to connect and collaborate with the various nodes.

This has a direct effect on SC processes as they will be dependent on the available data as one of its decision-making sources as SC is becoming increasingly more automated (i.e. TIA) and the traditional tasks of SCM will be partially substituted as a result (Choobineh, 2007).

According to Küpper (2020), the pillars of IR 4.0 are based on information integration through IoT, Big Data, Big Data Analytics, etc. to provide opportunities to mine accurate, reliable and shared information throughout the SC value network. IR 4.0 facilitates the collection and the comprehensive evaluation of the data sourced and mined (Ciccone, 2020)

2.9. Big Data

Strom (2012) defined BD as: *“the computational difficulties of processing and analysing it, or in storing it on a single machine”*. According to (Wired 2020), data in the twenty-first century is like oil was in the eighteenth century; an immensely, untapped extremely valuable asset. As with oil, for those who see data’s fundamental value and learn to extract and use it, there will be huge rewards. BD is not a luxury but a necessity that is required to make valuable predictions (Alaoui and Yousef, 2019). The etymology of ‘Big Data’ has been traced to the mid-1990s, first used by John Mashey; former Chief Scientist at Silicon Graphics (Kitchin and McArdle, 2020), that was used for the handling and the analysis of massive data sets (McArdle and Kitchin, 2015). In 2001, Doug Laney explained that BD was characterised by three traits:

- a) Volume (consisting of enormous quantities of data).
- b) Velocity (created in real-time), velocity refers to the speed of processing data (Ghasemaghahi 2018).
- c) Variety, being structured, semi-structured and unstructured Gerwitz, (2018).

Figure 14 provides a graphical view of the 3Vs of BD.

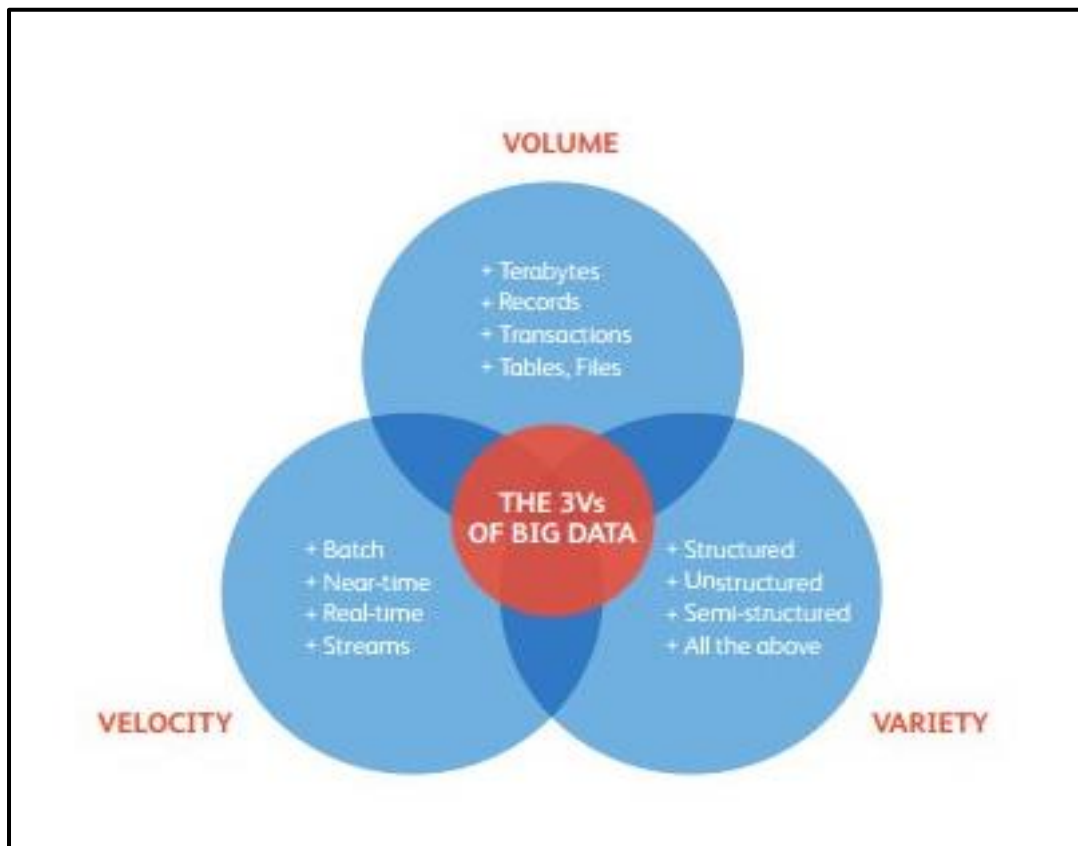


Figure 14: The three Vs of big data. (Source: Psannis et al., 2018).

Since then, others have attributed other qualities to BD, including:

- a) Exhaustive (an entire system is captured, $n = \text{all}$, rather than being sampled) (Cukier and Mayer-Schönberger, 2013).
- b) Relationally (i.e. containing common fields that enable the conjoining of different datasets) (Boyd & Crawford, 2012).
- c) Extensionality (can add/change new fields easily) and scalability (can expand in size rapidly) (Marz and Warren, 2012).
- d) Value (many insights can be extracted, and the data repurposed) (Marr, 2014).
- e) Variability (data the meaning of which can be constantly shifting according to the context in which they are generated) (McNulty, 2014).

The fruits of the information society are easy to see, with a cell phone in every pocket, a computer in every backpack, and big information technology systems in back offices everywhere. The challenge currently is the datasets being produced merely in the latest form (McArdle and Kitchin, 2015) (for example video, pictures,

audio, etc.), which require a new technique to process, store and make sense of them (Kitchin and McArdle 2020).

	Small data	Big Data
Volume	Limited to large	Very large
Velocity	Slow, freeze-framed/ bundled	Fast, continuous
Variety	Limited to wide	Wide
Exhaustivity	Samples	Entire populations
Resolution and indexicality	Course and weak to tight and strong	Tight and strong
Relationality	Weak to strong	Strong
Extensionality and scalability	Low to middling	High

Figure 15: Qualitatively differences between Small and Big data. Source: *Big Data & Society* (2014).

According to Maxwell, Steiner and Stein (2013), BD is high volume, high velocity and a high variety of information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making. This view is also reinforced by Kshetri (2014).

These additional V-words are often descriptive of a broad set of issues associated with BD, rather than characterising the ontological traits of the data itself (Paganoni 2019). BD sets are generated continuously and are more flexible and scalable in their production. For example, in 2014, Facebook was processing ten (10) billion messages, four and a half (4.5) billion 'Like' actions, and three hundred and fifty (350) million photo uploads per day (Marr, 2014), and they were constantly refining and tweaking their underlying algorithms and terms and conditions by changing what and how data was generated (Bucher, 2012).

According to Ghasemaghaei (2018), the main four (4) V's that characterize BD, are volume, velocity, variety and veracity, refer to Table 3 for details.

- a) Volume refers to the size of the data, which is increasingly growing.
- b) Velocity refers to the speed of processing the data.

- c) Variety refers to types of data, which ranges from unstructured to structured data.
- d) Veracity refers to how accurate or truthful a data set may be (Gutcheck, 2019).

Though volume, velocity and variety are continuously used to refer and describe BD, the additional dimension of *Veracity* has been added to describe data integrity and quality (Li *et al.*, 2016). Table 3 shows a detailed description and examples of BD.

Table 3: The details of the 4 V's of Big Data

Big Data V	Definition of Terminology	Explanation and Application
Velocity	Data velocity is the speed of generating and analysing data (Ghasemaghahi & Calic, 2019a).	The availability of digital devices (for example smartphones, etc.) has increased the amount of data generated and this has led to a (Ling Lui and Ozsu, 2018) need for better-capacitated computation tools to analyse the data in real-time (Technopedia, 2018).
		<i>“For example, the real-time analysis of data about customers, such as their buying patterns and their geospatial location, could create real customer value for firms”</i> (Ghasemaghahi, 2018).
Volume	Refers to the size of the data, which is increasingly growing (Ghasemaghahi, 2018).	A huge amount of data created from a wide range of resources, such as transactions, unstructured streaming from the text, images, voice, audio, VoIP, TV, videos and other media, sensors, historical weather data, satellite imagery, and machine-to-machine data (Kshetri, 2014).
		American Apparel collects large sizes of data from different social networks to understand consumers' emotions about its products. Processing large amounts of data enabled this company to enhance its insight into its consumers' behaviour which consequently improved its financial performance compared to its competitors (Brynjolfsson <i>et al.</i> , 2013; Sun <i>et al.</i> , 2018).

Variety	Data variety refers to the diversity of data types, which include both structured (for example numbers) and unstructured data (for example pictures, customer reviews, audio, sensor data) (Lam, Sleep, HenningThurau, Sridhar & Saboo 2017) and semi-structured data, which refers to information that does not reside in a relational database but that has some organizational properties that make it easier to analyse (Taylor 2018).	Usage of structured and unstructured data for various purposes (for example mapping of weather patterns in a certain geographical area). Email is a very common example of a semi-structured data type.
	Data originates in multiple formats such as structured and unstructured, numeric data in traditional databases and unstructured text documents, emails, video, audio, financial transactions (Kshreti, 2014).	
Veracity	Data veracity relates to the accuracy or truthfulness in dataset (Gutcheck, 2019).	When it comes to the accuracy of big data, it is not just the quality of the data itself that counts, but how trustworthy the data source is its type, and how trustworthy the processing of it is. Removing things like bias, abnormalities or inconsistencies, duplication, and volatility are just a few aspects that factor into improving the accuracy of Big Data (Gutcheck, 2019).

It would take a library of books to describe all the various methods that BD practitioners use to process the three Vs. The big takeaway should be this: “once you start talking about data in terms that go beyond basic buckets, once you start talking about epic quantities, insane flow, and wide assortment, you're talking about Big Data” (Gewertz, 2018).

2.10. The Application of Big Data to the Research Framework

Ghasemaghaei (2019b) argues *“that data that is high in terms of volume, velocity, and variety helps companies to enhance value generation by enabling them to automate decisions that were previously dependent on human judgment and*

intuition". The processing of the various types of data enhances decisions that are evidence-based and reduce (or eliminate) intuition and unreliable decision making. In a BD world, data changes at a rapid rate in certain areas, while in others at a slow pace. Cukier and Mayer-Schönberger (2013), states that data's value shifts from its primary use to its potential future use once the future need is identified. In the context of the SC value network, BD can provide unique insights into, *inter alia*, frequently bought goods, periods at which goods are bought, etc., as well as into ways of lowering costs and enabling more targeted business decisions (Wang *et al.*, 2016).

Figure 13, section [B] (refer to page 30 of this document), illustrates the role of BD in the SC value network, by collecting data from the various nodes of the SC value network (i.e. customers, retailers, warehouses, etc.). As the data is collected, it is stored in a manner that can technically be called extract, transform and load (ETL). The ETL'ed data is then "ready" as input onto BDA. The various nodes of SC need to be integrated and to share information as discussed in section 2.1. BD carries with it the opportunity to change the business model's design and day-to-day decision making that accompany emerging data analysis. The growth in the quantity and diversity of data has led to data sets that are larger than is manageable by the conventional, hands-on management tools. To manage these new and potentially invaluable data sets, new methods of data science and new applications in the form of predictive analytics (predictive analytics is discussed in detail in section 2.10.1), have been developed (Matthew *et al.*, 2013). BD can help companies to address a myriad of business challenges, (refer to Table 4 for some examples).

Table 4: Benefits of BD in SC

Benefits	Detailed Description of the Benefits
Product Development	Companies like Netflix and Procter & Gamble use Big Data to anticipate customer demand. They build predictive models for new products and services by classifying the key attributes of past and current products or services and modelling the relationship between those attributes and the commercial success of the offerings. Also, Procter & Gamble uses data and analytics from focus groups, social media, test markets, and early store rollouts to plan, produce, and launch new products (Davenport & Spanyi, 2016).

Predictive Maintenance	Factors that can predict mechanical failures may be deeply buried in structured data, such as the year, make, and model of equipment, as well as in unstructured data that covers millions of log entries, sensor data, error messages, and engine temperature. By analysing these indications of potential issues before the problems happen, organizations can deploy maintenance more cost-effectively and maximize parts and equipment uptime (Oracle, 2020).
Customer Experience	The rapid pace of changing customer mindset is at an alarming rate and therefore requires a new and informed response. Big Data enables companies to gather data from social media, web visits, call logs, and other sources, to improve their interaction experience and to maximize the value delivered. Companies must start delivering personalized offers, reduce customer churn, and handle customer issues proactively (Oracle, 2020).
Operational Efficiency	Through the use of BD, companies can utilise collected data to derive informed operational efficiencies, also BD can be utilised to identify areas requiring attention. BD can assist companies to improve their efficiency by identifying and reducing outages and thus improve production through the utilisation of collected data to anticipate future demands and by taking necessary measures to match demand (Self-constructed).
Drive Innovation	BD can help companies innovate by studying interdependencies among humans, institutions, entities, and process and it can then determine new ways to use those insights. A user can use data insights to improve decisions about financial and planning considerations can examine trends and detect what customers want to deliver new products and services and implement dynamic pricing. There are endless possibilities (Oracle, 2020).
Fraud and Compliance	When it comes to security; it is not just a few rogue hackers—you are up against entire expert teams. Security landscapes and compliance requirements are constantly evolving. Big Data helps you identify patterns in data that indicate fraud and can aggregate large volumes of information to make regulatory reporting much faster (Oracle, 2020).

Although BD provides immense benefits, it does, however, have its challenges. According to Agrawal *et al.*, (2012), these include:

- a) An enormous amount of unprocessed data may be generated by various data sources, However, that data may not be valuable without a proper definition of filters required to not discard useful information from the gathered one.
- b) To automatically generate the correct metadata to describe what data is recorded and how it is recorded and measured. This metadata is likely to be crucial to downstream analysis.
- c) The information collected may not be in a format ready for analysis, which requires an information extraction process that pulls out the required information from underlying sources and expresses it in a structured form that is suitable for analysis which will be beneficial for stakeholders in the SC value network.
- d) Mining requires integrated, cleaned, trustworthy, and efficiently accessible data, declarative query and mining interfaces, scalable mining algorithms, and Big Data computing environments.

The worth of data is its unlimited potential for reuse. The collection of information is important; however, its value is realised in its utilisation and not only its attainment (Cukier and Mayer-Schönberger, 2013).

2.10.1. Big Data Analytics (BDA)

(Akter *et al.*, 2019), defined BDA as a holistic process that involves the collection, the analysis, the use, and the interpretation of data, for various functional divisions, to gain actionable insights, create business value, and for establishing a competitive advantage. According to Chen, Preston and Swink, (2016), there are several examples of applications of BDA in distinct contexts, such as value creation in SCM (Dubey *et al.*, 2018). BDA makes it possible to analyse the collected data at a more advanced level than traditional tools, through the use of advanced computation power to give a clear picture (Perera *et al.*, 2015).

BD can help to address the critical challenges of predictive analytics (Chen, Chiang and Storey, 2012) that refer to data capture, storage, transfer and sharing and searching, analysis, and visualization (i.e. data analytics) (Erevelles, Fukawa and Swayne, 2016).

BD and predictive analytics (BDPA) are all-encompassing terms for techniques destined to handle big data characterized in terms of high volume, velocity and variety (Wang *et al.*, 2016).

Srinivasa and Bhatnagar (2012) provide evidence of BDA on warehousing costs. Companies expect to capitalize greatly on BDBA in logistics and SC operations, to improve the visibility, flexibility, and integration of global SCs and logistics processes; and to effectively manage demand volatility and to handle cost fluctuations (Genpact, 2014).

It is becoming evident that BDA is a fast-growing and influential practice. It should be noted that two technical entities have come together. First, there's BD for massive amounts of detailed information. Secondly, there is advanced analytics, which is a collection of different tool types, including those based on predictive analytics, data mining, statistics, artificial intelligence, natural language processing, etc. BDA explores granular details of business operations and customer interactions that seldom find their way into a data warehouse or a standard report (Russom, 2011).

To retrieve knowledge from BD, (Sun *et al.*, 2015) and (Huisman, 2015) agreed that BDA comprises three main components: Descriptive, Predictive, and Prescriptive Analytics which is often described as a summarization of historic data into knowledge and meaningful information, through the discovery of existing relationships within the BD (Sun *et al.*, 2015; Huisman, 2015).

According to Russom (2011), BDA is where advanced analytic techniques operate on big data sets. BDA is really about two things:

- a) Big Data and Analytics; and
- b) Creation of synergy between Big Data and Analytics to derive business intelligence (BI).

BDA consist of three major analytics; namely, descriptive, predictive and prescriptive analytics, as per Figure 16.



Figure 16: Major types of Analytics. (Source: InfoGov World Media, 2019)

A definition and a description for each is necessary for clarification and understanding regarding the capabilities of BDA.

- a) **Descriptive Analytics:** This is used to categorize, characterize, consolidate and classify data to generate valuable information to identify and to understand problems in the company's performance. Descriptive analytics is the most frequently used and easily perceived type of analytics (Evans and Lindner, 2012). Most companies make use of descriptive analytics for a better understanding of what happened, and a few data-driven organizations go as far as predictive analytics to make insightful forecasts.
- b) **Predictive Analytics:** Wessler (2013) defines predictive capability as the process of using a set of sophisticated statistical tools to develop models and estimations of what the environment will do in the future. By definition, predictive capability emphasizes the prediction of future trends and the exploration of new insights, through the extraction of information from large data sets. To create predictive capability, organizations have to rely on a predictive analytics platform that incorporates data warehouses, predictive analytics algorithms (for example regression analysis, machine learning, and neural networks), and reporting dashboards that provide optimal decisions to users. This platform makes it possible to cross-reference current and historical

data, to generate context-aware recommendations that enable managers to make predictions about future events and trends (Wang *et al.*, 2015).

- c) **Prescriptive Analytics:** This applies algorithms on datasets to explore and examine potential decisions that involve high-volume and complex objectives and requirements to optimize organizational performance (Wang *et al.*, 2015). It is the most sophisticated type of business analytics and it can bring the greatest intelligence and value to businesses. It aims at suggesting (prescribing) the best decision options to take advantage of the predicted future, utilizing large amounts of data (Šikšnys *et al.*, 2016). It incorporates the predictive analytics (Basu, 2013) output and utilizes artificial intelligence, optimization algorithms and expert systems in a probabilistic context (Engel, Etzion and Feldman, 2012) to provide adaptive, automated, constrained, time-dependent and optimal decisions (Gartner, 2017).

According to (Muhtaroglu *et al.*, 2013), BDBA has attracted significant attention from researchers and decision-makers in organizations. It has been used in research to verify existing models or theories, and in the industry to enable business organizations to make better decisions; particularly in logistics and supply chain management (LSCM) (Fosso *et al.*, 2015). Furthermore, there is also an increasing trend to arrive at data-driven decisions. According to Hiller and Lieberman (2015), heuristics (i.e. a procedure that is likely to discover a very good feasible solution, but not necessarily an optimal solution for the specific problem being considered) and meta-heuristics (i.e. a general solution method that provides both a general structure and strategy guidelines for developing a specific heuristic method to fit a particular problem) both decision making are inherently data-driven and predictive approaches (Fosso *et al.*, 2015). BDA has emerged as a means of arriving at more precise predictions (Awwad *et al.*, 2018).

Despite the many benefits of BDA, it has its disadvantages and its barriers. To obtain a sense of which barriers are more likely to occur than others, according to Russom (2011) - Table 5 lists some of the barriers and the advantages of BDA.

Table 5: Advantages, Disadvantages and Barriers to BDA

Barriers to BDA Adoption	Advantages of BDA
i. Technology related barriers (for example a lack of an infrastructural the facility, lack of interest in implementing new technology, etc.) (Abdul Moktadir <i>et al.</i> , 2019).	According to TDWI Research Russom (2011), BDA has a few advantages, namely; Business intelligence, in general, can benefit from BDA thus: - i Result in more numerous and accurate business insights. - ii An understanding of business change. - iii Better planning and forecasting; and - iv Identification of the root causes of cost. According to Russom (2011), BDA can help with: i. Developing definitions of churn and other customer behaviours; and ii. Understanding consumer behaviour from clickstream.
ii. Expertise and investment-related barriers (for example the lack of skilled personnel, Information Technology (IT), high cost of investment, lack of funding etc.); (Malaka and Brown, 2015), (Alharthi, Krotov, and Bowman, 2017).	
iii. Organizational barriers (for example time constraints, the mindset in terms of big data, etc.), (Zhong, Newman, Huang and Lan 2016; Abdul Moktadir <i>et al.</i> , 2019	
iv. Data-related barriers (for example complexity of data integration, performance and scalability, data security and privacy, etc.) (Alharthi, Krotov, and Bowman, 2017; Malaka and Brown, 2015; Fallik, 2014).	
v. The difficulty of architecting a BDA system and problems with making big data usable for end-users.	

2.11. The Application of BDA to a Research Framework

The collection, integration, storage, processing, and analysis of data is a key challenge. BD systems need to integrate all the entities and the data needs of a company. BDA makes it possible to analyse the collected data at a more advanced level than traditional tools, through the use of advanced computation power to give a clear picture (Perera, *et al.*, 2015). Figure 13 (Page 30) illustrates how BDA will provide analytical capabilities to select the optimal supplier, according to their historical performance, as well as market information, etc. Secondly, product segmentation and allocation related to order patterns will be easily extrapolated from the collected data. BDA will facilitate the right product, the right amount at the right location at the right time through advanced analyses. Also, transparency will be made possible through technology in managing supplier orders, real-time decision support related to shipments, etc.

LaLalle *et al.*, (2011) looked at analytics adoption categories of BDA capability in three levels: aspirational, experienced, and transformed. The former two levels of analytics capabilities focus on using business analytics technologies to achieve cost reduction and operation optimization. The third level of capability is aimed at driving customer profitability and making targeted investments in niche analytics. For this study, the three categories of BDA will not be pursued, but they will be used to emphasise the available and the partially exploited benefits of BDA.

BDA systems provided the opportunity for better data-driven decisions on predictive approaches (Srinivasa and Bhatnagar, 2012). To elaborate on the benefits of BDA, a survey conducted by (Russom, 2011) has been used to show the impact of BDA in general and its applicability in this research study. Table 6 shows a few of the benefits of the BDA application. Russom, (2011) states that BDA can help develop definitions of churn and other customer behaviours, as well as provide an understanding of consumer behaviour from clickstreams and Business intelligence, in general.

Table 6: Benefits of BDA on Customers and for Business

Benefits on Customer	Business Benefits
Better-targeted social-influencer marketing	This could result in more numerous and accurate business insights
Customer-base segmentation	Understanding of business change
Recognition of sales and market opportunities	Better planning and forecasting
	Identification of root causes of cost

2.12. Literature Key Takeout

The literature review provided theoretical perspectives and previous research findings on BDA. It is evident that the flow of information was crucial and extensively emphasized to enhance synergy throughout the SC value network (Siemieniuch, Waddell, and Sinclair, 1999), (Cachon and Fisher, 2000), (Shaw and Grean 2002), (Donald *et al.*, 2002), (Bowersox and Calantone, 1998). The lack of information symmetries contributes to greater operational inefficiencies, transaction risks, and coordination costs (Clemons and Row 1992), (Ross and Droge 2004), (Lee, Padmanabhan and Whang 1997), (Kumar and Pandey, 2018), (Bloomenthal, 2021).

Companies that work together by sharing information are better positioned to generate relational rents, improve order management, fulfilment, inventory management, and the flow of physical goods (Perçin, 2008) (Kaipai 2009), (Dyer and Singh 1998), (Kopanaki and Smithson, 2003) reduce the supplier's demand variance with the potential benefit of reducing costs (Lee, Padmanabhan and Whang 1997) (Donald *et al.*, 2002), (Chen, 1998), (Jraisat and Sawalha 2013), (Kopanaki and Smithson 2003) and allow for data to be shared in real-time among SC stakeholders (Shaw and Grean, 2002), (Waters, 2010).

Inventory holding is one of the most expensive assets of any company, in certain areas being more than 10% to 15% of the total assets for some companies (Zhang *et al.*, 2019), (Robert and Copacino, 1994), (CBRE Supply Chain Services, 2014), (Park and Jeong 2016). Warehousing costs (i.e. storage of raw materials, production material, components, semi-finished products, and finished products, inventory costs, human resources, rent, shrinkage, obsolete stock and insurance, etc. (Gudehus and Kotzab, 2012), (Vogt, Pienaar and Wit 2002), (Mothilal *et al.* 2012), (Gartner, 2020)

generally amounts to 25% of manufactures of FMCGs annual turnover (de Villiers, Nieman, and Niemann, 2017), (CBRE Supply Chain Services, 2014), (Hughes, 2020), (Lyu *et al.* 2020). Various models were developed to mitigate warehousing costs (Vogt, Pienaar and de Wit, 2002), (Saosaovaphak, 2020), (Schwarz, 2008), (Bhasin and Burcher, 2006), (Pacheco *et al.*, 2017), (Kenton, 2020), (Hedley, 2019).

BDA is a fast-growing and influential practice that has advanced analytics (i.e. Predictive, Descriptive and Prescriptive analytics) which facilitates analysis of massive data sets needed to arrive at valuable predictions, enhanced insight and decision making, evaluating the optimum usage of equipment, labour productivity, warehouse floor area optimisation, to predict an accurate demand and supply, and try to reduce the manufacturing lead-time (Bloomberg, 2002), (Jovane *et al.*, 2008), (Genpact, 2014), (Alaoui and Yousef, 2019), (Kitchin and McArdle 2020), (Maxwell, Steiner and Stein, 2013), (Russom, 2011), (Chen, Chiang and Storey, 2012), (Alaoui and Yousef, 2019). BDA makes it possible to analyse the collected data at a more advanced level than traditional tools (Perera *et al.*, 2015), (McArdle and Kitchin, 2015), (Ghasemaghahi 2018), (Ghasemaghahi 2019b) (Chen, Chiang and Storey, 2012), (Muhtaroglu *et al.*, 2013), (Erevelles, Fukawa and Swayne, 2016).

3. Chapter 3: The Research Methodology

3.1. Research Methodology

A research methodology is a general approach that the researcher takes in carrying out the research, this approach dictates the tools that the researcher selected (Leedy and Ormrod, 2013).

The research methodology followed in this research included the following;

- Literature survey,
- Development of qualitative research instrument, and
- Interpretation of survey results.

This research utilised a questionnaire as a primary research method to selected individuals who are considered as “experts” in the SC environment.

3.2. The Research Design

A research design is a logic that links the research purpose and questions (Bloomberg and Volpe, 2008) to the processes for empirical data collection, data analysis (Rowley, 2002), to make conclusions drawn from the data (Yin, 2009).

In this study, the researcher studied the three common approaches to conducting research, namely; quantitative (i.e. research yielding information that is inherently numerical or can be easily reduced to numbers (Leedy, Ormrod and Johnson, 2019), a qualitative approach (i.e. one in which the inquirer often makes knowledge claims based primarily on a constructivist perspective (Creswell, 2002) and a mixed-methods approach (i.e. the branch of multiple methods research that combines the use of quantitative and qualitative data collection techniques and analytical procedures (Saunders *et al.*, 2016)).

Upon evaluating the three approaches, the researcher opted for a qualitative approach, because the research being conducted required the researcher to gain new insights, new ideas, and knowledge in a field that has still not reached maturity.

The researcher has studied the nature of the available qualitative design approaches as illustrated in Table 7.

Table 7: Distinguishing characteristics of different qualitative designs. Source: Leedy, Ormrod, and Johnson (2005).

Design	Purpose	Focus	Methods of Data Collection	Methods of Data Analysis
Case study	To understand one person or a situation (or perhaps a very small number) in great depth	One case or a few cases within its/their natural setting	Observation Interviews Appropriate written documents and/or audio-visual materials	Categorisation and the interpretation of data in terms of common themes Synthesis into an overall portrait of the case(s)
Ethnography	To understand how behaviours, reflect the culture of a group	A specific field site in which a group of people share a common culture	Participants' observation Structured or unstructured interviews with 'informants' Artefacts/document collection	Identification of significant phenomena and underlying structures and beliefs Organisation of data into a logical whole (e.g. chronology, typical day)
Phenomenological study	To understand an experience from the participants', point of view	A particular phenomenon as it is typically lived and perceived by human beings	In-depth, unstructured interviews Purposeful sampling of five to twenty-five (5 to 25) individuals	Search for 'meaning units' that reflect various aspects of the experience Integration of the meaning units into a 'typical' experience

Grounded theory study	To derive a theory from data collected in a natural setting	A process, including human actions and interactions and how they result from and influence one another	Interviews Any other relevant data source	Prescribed and systematic method of coding the data into categories and identifying interrelationships
				Continual interweaving of data collection and data analysis Construction of a theory from the categories and the relationships
Content analysis	To identify the specific characteristics of a body of material	Any verbal, visual, or behavioural form of communication	Identification and possible sampling of the specific material to be analysed Coding of the material in terms of predetermined and precisely defined characteristics	Tabulation of the frequency of each characteristic Descriptive or inferential statistical analyses, as needed to answer the research question
Narrative inquiry	To explore rich experiences and the stories of the individuals (Leedy, Ormrod, and Johnson (2005)	A set of experiences shared by a few or more individuals across periods and contexts	In-depth unstructured and semi-structured interviews Autobiographical writings, poetry, and other narrative documents Leedy, Ormrod, and Johnson (2005) Photographs and other visual materials (Leedy, Ormrod, and Johnson (2005)	Identification of narrative themes, threads, and tensions Reordering of narratives into a coherent chronological or thematic story

Exploratory research	To gain new insights, discover new ideas, and for increasing knowledge of the phenomenon	Focuses on a problem which is not clearly defined (Leedy, Ormrod, and Johnson (2005). It often occurs before much is known about a phenomenon	Often relies on available secondary research, such as reviewing available research and/or data	Often assists in deciding the appropriate research design and data collection method.
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Exploratory research is flexible and does not depart from a fixed theoretical framework, often works towards building a new understanding (Maree, 2016) and has the advantage of adapting to change (Saunders *et al.*, 2016) as the study progresses it allows for adaption accordingly.

3.3. Reasons for selecting Exploratory Research

Having evaluated the various research methods, exploratory research method was selected for the following reasons:

- I. The researcher had limited knowledge of the phenomena of BDA and needed to explore the phenomena broadly.
- II. To establish an understanding and theme(s) to be provided by participants, which will be grouped accordingly to arrive at various themed.
- III. To delimitate the research scope and objectives.
- IV. Exploratory research utilises words in explaining collect data and the processing of collected data.
- V. It is inexpensive, a quick approximation of the truth.
- VI. Discovery of a new approach in executing the “major study” which will emanate from this exploratory research.

4. Chapter 4: Research Method

4.1. Sampling

Qualitative samples tend to be purposive rather than random because the studies are usually not prescribed as they can evolve once fieldwork has begun (Miles *et al.*, 2020). According to Baruch and Holtom, (2008), the level of the response rate is an important, sometimes crucial factor in assessing the value of research findings. For most of the academic studies involving individuals or a company's representative, a response rate of approximately 50% or 35 to 40% are reasonable (Baruch and Holtom, 2008).

The sample comprised of 12 “experts” from FMCG and warehousing industries. According to Williams and Webb (1994), an accurate mechanism does not exist for identifying the number of individuals or the number of panels for inclusion in any individual study. This study utilised non-probability sampling, for all non-probability sampling techniques, the issue of size is ambiguous, and, unlike probability sampling, there are no rules (Saunders *et al.*, 2016).

To maximise the knowledge and experience from the selected participants, purposive sampling was utilized. Purposive sampling is the process in which participants or other units of study are selected based on how much and what type of information they can yield about the topic under investigation (Leedy, Ormrod, and Johnson, 2019). Patton (2002), states the purposive sampling is typically used in qualitative research to identify and select the information-rich cases for the most proper utilization of available resources.

Based on purposive sampling, the selection of participants was based on the following criteria;

- i. The participants were from FMCG and Warehousing sectors, which each participant provides knowledge of holistic FMCG and warehousing, each participant also has unique skills from their respective functional areas (e.g. inventory management, data analysis, warehouse operations, IT, Human Resources, etc.).
- ii. Each of the selected participants provided their unique and ‘expert’ knowledge in addressing sections 1.4 and 1.5 of the study.

- iii. To obtain an inexpensive, quick approximation of the truth about BDA's effects on warehousing costs.
- iv. Participants were chosen to provide diverse views based on their experiences.

In terms of this research 'experts' (i.e. expert sampling is a positive tool to use when investigating new areas of research, to garner whether or not further study would be worth the effort) (Etikan, Musa and Alkassim, 2016) comprising specialists and/or academics as listed:

- i. Data Scientists and/or Specialists.
- ii. Supply chain operations specialists (e.g. Process Engineers, and Supply Chain Specialists); and
- iii. Researchers (Warehousing and Big Data Analytics)

The participants were selected from the professional network of the researcher, as well as through referrals, totalling 12 the number of participants.

4.2. Instrumentation

A self-completed questionnaire (a collection of questions administered to the respondents (Bryman, 2016)) was utilised to collect data from participants. The questionnaire was inspired by the literature review, the research question and the research objectives. The questionnaire consisted of four sections, refer to Appendix "A", for details Section A to C for a detailed questionnaire.

Appendix "B" provides a list of questions and source(s) used to arrive at the questions. An overview of each of the sections is provided next.

- 1) Questionnaire Topic Section. This section consists of a questionnaire topic, an introduction of the researcher and the purpose of the questionnaire and the questionnaire completion instruction
- 2) Section A is for the participants to capture their limited demographic information (for example age group, academic qualification, work experience, etc.), not all questions in this section are mandatory.

- 3) Section B consists of closed Likert scale questions and motivation for the selected Likert scale, testing the participants' justification for their selected Likert scale selection, the alignment between the Likert scale selection and motivation.
- 4) Section C consists of open-ended questions, testing participants' in-depth understanding of the various aspects associated with BDA, warehousing costs to data to be mined.

4.3. The Data Collection Method

To ensure that participants could freely share their opinions, a self-completed questionnaire was designed, utilising Google Forms Design comprising of (Section A): Participants Demographic Information, (Section B): Likert Scale Questions and (Section C): Open-ended questions) and sent to participants via their respective email addresses. Participants were informed via WhatsApp that an online questionnaire had been sent to their email addresses. Courtesy reminders were sent to participants requesting them to submit the questionnaire.

4.4. Data Handling

Data handling is the process of ensuring that research data is stored, archived or disposed of safely and securely during and after the conclusion of a research project (Data Handling, 2020) The data will be kept on Google drive for two years and it will be responsibly discarded after two years. Discarding would include deleting the questionnaire from Google drive. A password (only known by the researcher) is utilised to access Google Forms to safeguard the content of the collected data.

4.5. Validity

To validate the instrument the researcher upon completion of designing the questionnaire, performed a pre-test validation. The pre-test validation included sending the questionnaire to a language editor from the company the researcher works for (through email). The editor has more than nine years of experience in the editing field. The editor edited the questionnaire and provided feedback and the researcher updated the questionnaire accordingly.

The pre-test validation of the instrument was checked by sending the questionnaire to three individuals with the following credentials:

- i. A risk manageress from a reputable financial sector, with more than 20 years of experience.
- ii. A system analyst from a reputable information technology company, with more than 14 years of experience.
- iii. A team leader in the solution architecture field from a reputable company, with more than 18 years of experience

The questionnaire was also pre-tested. The pre-test validation included sending the questionnaire to three individuals to review. Based on the feedback from the reviewers, the questionnaire was amended in line with the comments from the reviewers. The questionnaire was, thereafter, sent to four individuals as the 2nd round of pre-test. The individuals accepted the questionnaire. The questionnaire was then used in the research.

The researcher strived to produce a credible study. A credible study refers to “a characteristic of a research study, the study’s overall quality as judged by other scholars; includes the use of appropriate designs and methods, believable findings, and plausible interpretation (Leedy, Ormrod, and Johnson, 2019)”.

The researcher undertook the following steps to comply with the validity criteria.

- 1) The researcher selected participants, to be inclusive of ‘experts’ and who are either working or have worked in SC nodes (i.e. Manufactures of FMCG, Warehouses, etc.) and are ‘experts’ or have adequate knowledge in BDA.
- 2) The questionnaire questions were constructed according to the literature review, the researcher’s curiosity (i.e. observation), the research question and the objectives, etc.
- 3) The researcher has a purely professional relationship with the participants, and they have no personal interest in the study, it was voluntarily to the study.
- 4) The researcher did not promise or offer the participants financial or any other sort of reward for their participation in the study

- 5) The participants did not know each other and they have no relationship with one another.

4.6. Reliability

According to (Saunders 2019) reliability refers to replication and consistency. If the researcher can replicate an earlier research design and achieve the same findings, then the research can be seen as reliable. It is, however, difficult to replicate some qualitative research.

The researcher maintained the following to ensure the study is reliable;

- i. The feedback from the participants must never be altered.
- ii. All the participants were given the same set of questions.
- iii. Questionnaires were sent to all participants on the same day at the same time.
- iv. All the participants had an equal response time frame.
- v. All the participants used Google Forms; the standard form of research tool used. Google Forms are supplied by a trusted company and it is a reliable tool as it has been used previously.
- vi. The responses from the participants were directed by the Google Form to reflect patterns and were not directed by the researcher in any way.
- vii. Out of the 12 participants requested to respond, only nine participants responded. That was a reasonable number (Baruch and Holtom 2008).
- viii. The researchers' knowledge and experience, and the supervisor's input combined, were utilised to derive the themes and other objectives of the study.

Replicating qualitative research is challenging and not easy (Leedy, Ormrod, and Johnson, 2019), as a result, the conclusions of the study were solely based on the actual data collected.

The researcher relied on the participants' feedback and did not impose his views on the participants. The researcher is happy to subject the questions on the questionnaire to scrutiny at any given time.

4.7. The Limitations of the Study

The research identified the following limitations:

- a) The study was time-constrained and as a result, the participants were given approximately two weeks to complete and return the questionnaires.
- b) The participants could have been biased in their responses. Bias is an influential factor that could distort the data obtained or the conclusions drawn (Leedy, Ormrod, and Johnson, 2019).
- c) A small sample was used in the study that may not adequately represent the target population (Dudovskiy, 2019), which its results cannot be generalized to a wider population.
- d) Some questions may be ambiguous, which is inherent in human language and can be recognized in the analysis (Atieno, 2009).
- e) The findings cannot be extended to a wider population with the same degree of certainty that quantitative analyses can. This is because the findings of the research are not tested to discover whether they are statistically significant or due to chance (Atieno, 2009).
- f) The findings of such type of studies are not usually useful in decision making at a practical level (Research-Methodology, 2012).

4.8. Ethical Issues

The ethical requirements for conducting the study ethics application for the MSc Eng. (50/50) research report has been successful and ratified by the HREC Non-medical. The clearance number is MIAEC 107/20.

5. Chapter 5: Data Analysis and Interpretation

This chapter analysed and interpreted how the collected data was presented, described and interpreted methodologically, as the subsequent step to the research process.

5.1. Data Analysis

According to Gibbs (2007), qualitative data analysis is a process of the transformation of the collected qualitative data, utilising analytic procedures, into a clear, understandable and insightful, trustworthy and even original analysis. A lot of qualitative research is specifically trying to generate new theories and new explanations. In that sense, the underlying logic was inductive (i.e. a process in which a researcher begins with multiple specific observations about a particular phenomenon and then makes a broader generalisation about the phenomenon (Leedy, Ormrod, and Johnson, 2019). There are two contrasting logics of explanation, induction and deduction and qualitative research uses both (Gibbs, 2007).

Qualitative data analysis is less standardised with a wide variety of approaches to qualitative research, matched by the many approaches to data (Kreuger & Neuman, 2006).

The researcher opted for qualitative data analysis involving the deconstruction of the qualitative data into manageable categories (which had already been done by Google Forms), the patterns (already developed by Google Forms, specifically Section 1 and 2 of the questionnaire), the themes (this was done by the researcher by comparing the feedback from the participants and the literature review, the research question and the objectives of the study).

Qualitative samples tend to be purposive rather than random. Samples in qualitative studies are usually not prescribed but can evolve once fieldwork begins (Miles et al., 2020).

5.2. The Participants Response Rate

Twelve “experts” participants were identified for the study, a questionnaire was sent to them electronically, using their email addresses. A 2-week response period was assigned to all participants. Upon expiry of the 2 weeks, only nine responded, and three did not respond at all. For most of the academic studies involving individuals or a company’s representative, a response rate of approximately fifty percent (50%) or thirty-five to forty percent (35 to 40%) is reasonable (Baruch and Holtom, 2008).

According to (Baruch and Holtom, 20018), the level of the response rate is an important, sometimes crucial, factor in assessing the value of research findings, the response was 75% that was reasonable.

5.2.1. Participants personal information

The questionnaire was sent to a diverse group of participants. Name and surname and company name were not mandatory, and the rest of the questions were mandatory. Out of the nine participants who responded, seven completed either their name and/or their surname. The researcher compiled a series of questions requesting the participant’s personal information. In the interest of anonymity, the names of the participants were not published.

5.2.2. Industry sector

The selected participants were from various FMCGs and warehousing industries. Figure 17 provides a graphical view of the industries in which participants work for. It was noted with concern that 55% of the participants selected ‘other’ and they did not provide details or the name of the industry that they work in. The spread of industries was a bit worrisome because the total sum of ‘other’ was greater than the total sum of the rest.

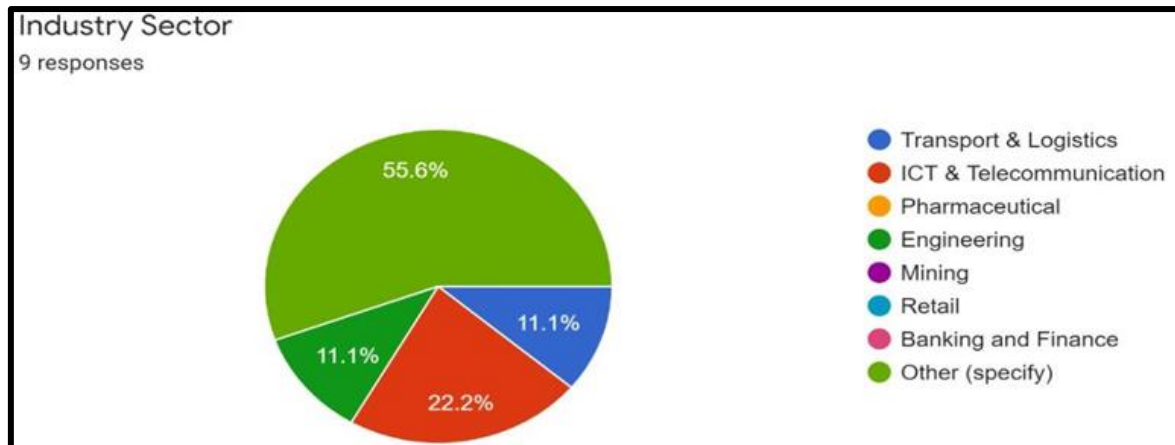


Figure 17: Individual's particulars

5.2.3. Current job or position

The number of participants who participated is indicative of the level of experience and knowledge that the majority hold. Figure 18 provides a graphical view of the participant's current job or position. The breakdown of positions held by participants is as follows; 11.1% CEO/EXCO/etc., 33.3% Senior Management, 22.2% Middle Management, 22.2% Operations and 11.1% Other. The researcher endeavoured to include a wide range of positions that are held by the participants. The positions reflected their level of experience.

Current job/position
9 responses

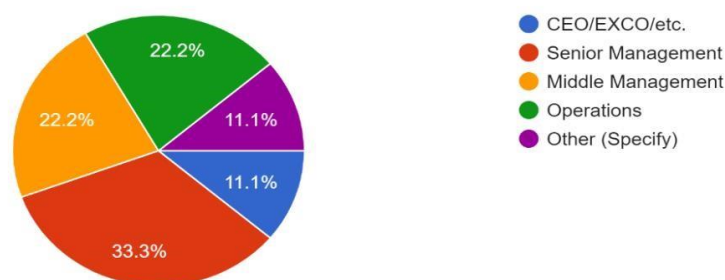


Figure 18: Current: Job/position

5.2.4. Years of experience

Figure 19 provides a graphical view of the total experience of participants, which adds up to 115 years. It is important to source data from the participants who have sufficient knowledge and experience regarding the topic being studied.

Years of experience in the field or position
9 responses

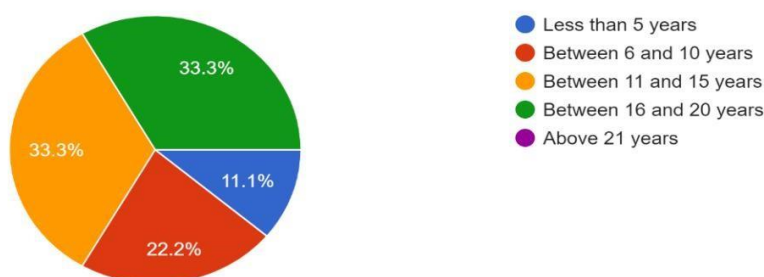


Figure 19: Years of experience

5.2.5. Highest academic qualification

Figure 20 provides a graphical view of the level of education of the participants. 67% of the participants hold a Bachelor's Degree/Advanced Diploma/B.Tech Degree.

Highest academic qualification achieved
9 responses



Figure 20: Highest Academic Qualification

5.2.6. Age category

Figure 21 provides a graphical view of the age categories. It is comforting to note that most of the participants were old enough to show that have had working experience after they attained their academic qualifications.

9 responses

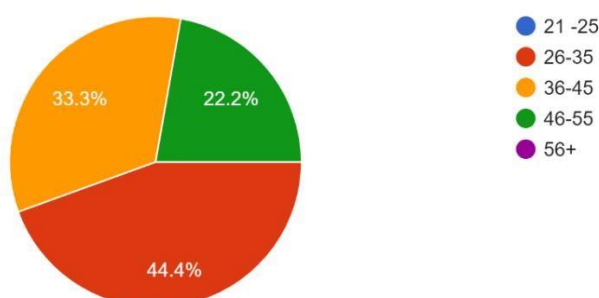


Figure 21: Age Category

The researcher has observed all the Personal Demographic Information input from the participants. Section 5.1.1 to 5.1.7 and their applicable figures provide a graphical view of the various categories that the participants fall into. These categories provide the researcher with an overview of the participants and the ability to deduce that the sample was 'representative' for the study's objectives.

5.3. Data Condensation

This section of the questionnaire is formulated based on a literature review, a research question and the research objectives. This section of the research instrument consists of eight questions (i.e. Likert Scale questions and motivation for each selection)

(Refer to Appendix "A", Section "B"). Each of the responses to the questions is discussed in Section 5.2.1.

5.3.1. Likert scale questions and discussion

Out of the nine participants, all of the participants responded to both the Likert Scale questions and they provided motivations for their respective selections. (Refer to Appendix A for the Likert Scale questions and the participants' motivations).

The participant's motivation was copied verbatim from Google Forms and the respondent's response for all nine questions are tabulated for ease of reading and referencing.

5.3.1.1. Question 1

"Do you believe manufactures of FMCGs might benefit by having their finished goods delivered directly to retailers, instead of working through third or fourth-party logistics?" (Refer to Appendix "A", Section "B" for the research instrument).

Figure 22 shows a graphical representation of the response to question 1.

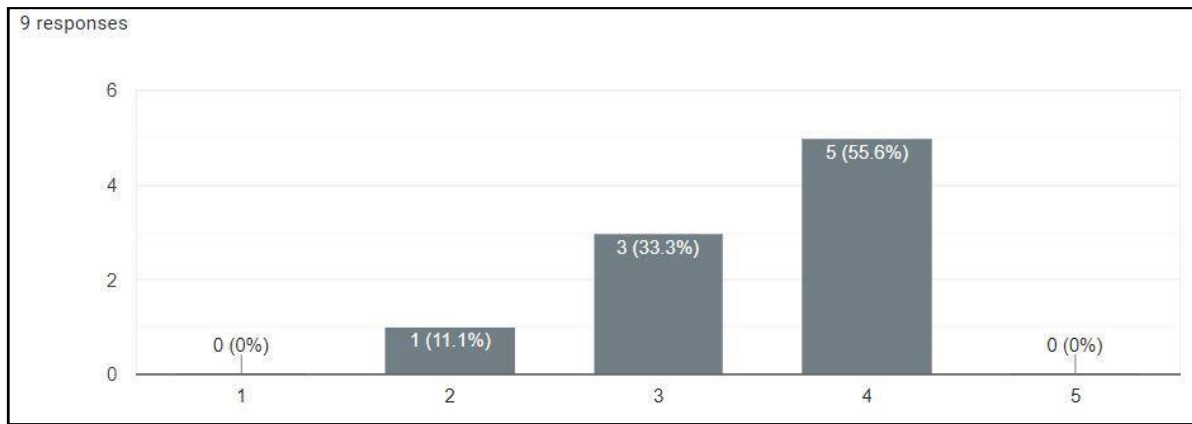


Figure 22: Question 1 participant's feedback

55.6% of the participants believed that the manufacturers of FMCG are more likely to benefit by delivering their finished goods directly to retailers, instead of utilising 3PLs, while 33% were uncertain and only 11% thought that it is unlikely.

Table 8 is the participant's motivations. There are mixed views on the direct delivery of FMCGs directly to retailers. Some participants feel that there will be benefits (e.g. yes, there will be enough data available, enable FMCGs to maintain greater control of handling and reducing waste, it will be cheaper for the consumer, etc.), while others do not agree (e.g. the value added by 3PLs is costly, the turnaround time per truck will increase, there will be more heavy-duty trucks in big cities, they will have to deal with lots of retailers, etc.).

Table 8: Participants' Motivations to Question 1

Question	Do you believe manufactures of FMCGs might benefit by having their finished goods directly delivered to retailers, instead of working through 3rd or 4th Party Logistics?
Respondent 1	Best information
Respondent 2	it depends on the strategy of the company and the strategic importance of this service to the company. Our company used to deliver directly to the customers but however this was costly so we have decided to outsource the service at a lesser cost.
Respondent 3	The turnaround time per truck will increase and there will be more heavy-duty trucks
Respondent 4	Delivering directly to retailers will enable FMCGs to maintain greater control of handling and reducing waste.
Respondent 5	Online platforms are available to do such, and it will be cheaper for the consumer.
Respondent 6	They will have to deal with a lot of retailers
Respondent 7	Yes, as there will be enough data available
Respondent 8	It all depends on the strategy of the business or the cost leadership
Respondent 9	The value added by 3PL is costly

5.3.1.2. Question 2

“Do you believe that the manufacturers of FMCGs will be able to meet the fluctuating demand from retailers without the use of third- or fourth-party logistic warehouses?”
(Refer to Appendix “A”, Section “B” for the research instrument).

Figure 23 provides a graphical representation of the participants' responses to question 2. 89% of the responses follow a normal distribution and only 11% selected “less likely” from the Likert Scale.

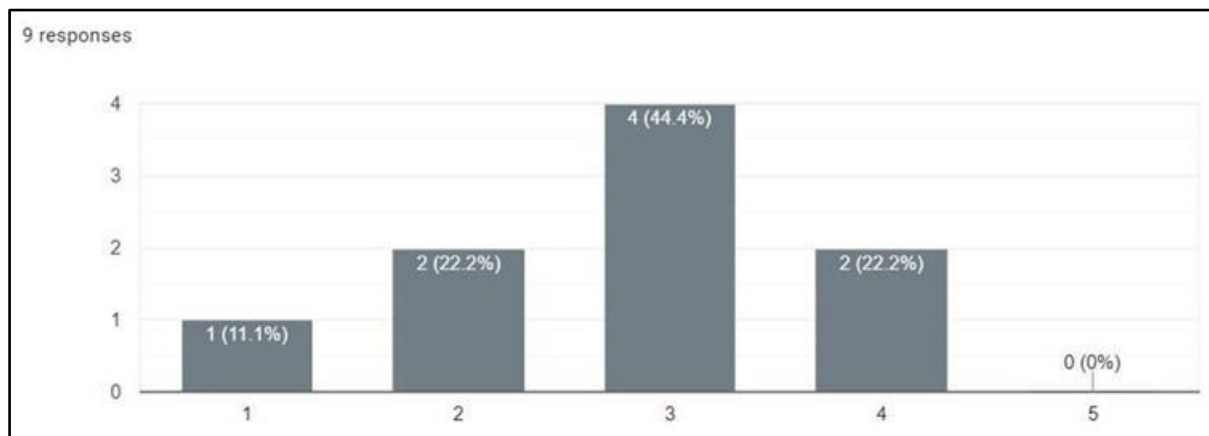


Figure 23: Question 2 participant's feedback

Table 9 is the participant's motivations. There are mixed views on manufacturers of FMCGs ability to meet fluctuating demand from retailers without the use of 3PLs. Some participants agree that they will be able to meet the fluctuating demand (i.e. If they have enough trucks, dedicated team to logistics, type of products, internal capabilities within the business, etc.), while others do not agree (i.e. they would have less or no buffer/safety stock to respond to customer needs, it will consume a lot of their time, the logistic part of 3PLs add value, etc.).

Table 9: Participants' Motivations to Question 2

Question	Do you believe that manufactures of FMCGs will be able to meet the fluctuating demand from retailers without the use of 3rd or 4th Party Logistic warehouses?
Respondent 1	Buzz
Respondent 2	it depends on the demographic conditions of the customers/retailers. The general principle is that if you want to reduce the 3rd party warehouses you need to ensure that the manufacturing process is efficient enough to cope with fluctuating demands.
Respondent 3	They would have less or no buffer/safety stock to respond to customer needs closest to the customers proximity, therefore not being agile.
Respondent 4	If they have enough trucks and team dedicated to logistics and central distribution centre.
Respondent 5	I wouldn't be too sure on this one, on the one hand i would say yes, because they manage the whole value chain, however when they try to do it all they may lose focus on what's important and that's the core business.
Respondent 6	It will consume a lot of their time to deal with retailers
Respondent 7	There are certain things or goods who don't need 3PLs

5.3.1.3. Question 3

"In your opinion, does the traditional Supply Chain Management (SCM) value network (i.e. Manufactures to Warehouses to Retailers) still need to be entirely followed in that sequence for the distribution of FMCGs in the 21st Century, with BDA in the equation?" (Refer to Appendix "A", Section "B" for the research instrument).

Figure 24 provides a graphical representation of the participants' responses to question 3. 66% of the participants believe that there will not be a need for SCM value networks to change. 22% believe there is a possibility to change the SC value network, while only 11% took a neutral position on the question.

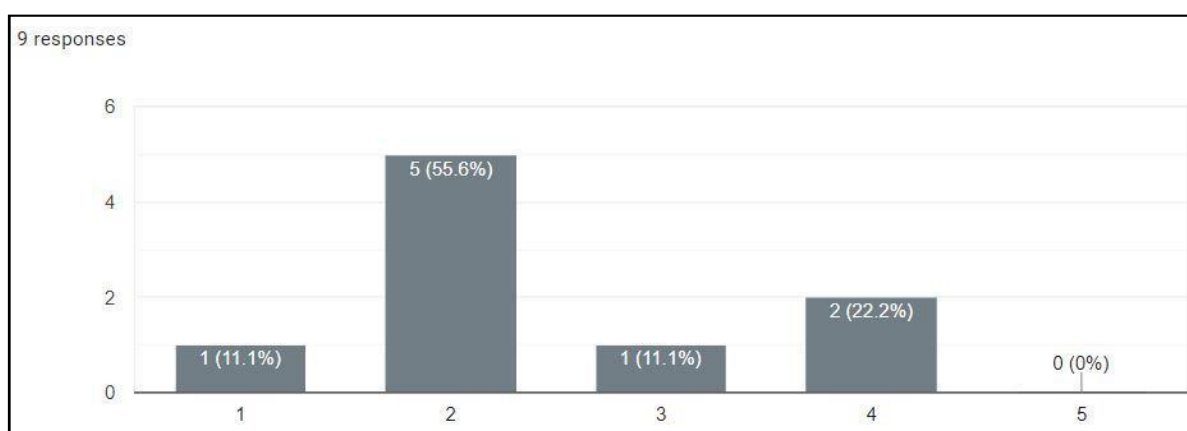


Figure 24: Question 3 participant's feedback

Table 10 is the participant's motivations. There are mixed opinions, though slightly leaning towards a streamlined SCM value network (i.e. upgrade their supply chain management, BDA provides insight in decision making, we are in the digital era and we can do better, with real-time data from retailers the warehouse can be eliminated, companies should evolve with technology, accuracy and efficiency, etc.), while others do not agree (i.e. it is still applicable and will be for a long period, not entirely, challenges and constraints in the SCM, etc.).

Table 10: Participants' Motivations to Question 3

Question	In your opinion, is the traditional Supply Chain Management (SCM) value chain (i.e. Manufactures to Warehouses to Retailers) still need to be entirely followed in that sequence for the distribution of FMCGs in the 21st Century, with BDA in the equation?
Respondent 1	Less
Respondent 2	Yes, it is still applicable and will be for long period. the question would be how the system can be optimized in order to improve efficiency.
Respondent 3	There is no absolute numbers in demand therefore companies need to respond to an increase, loss of products, pilferage and force majeure through warehousing
Respondent 4	Companies should evolve with technology. They need to keep track of the latest technologies and upgrade their supply chain management. The supply chain of the 21st century is more about where and when. It's about management of data and services, flexibility, accuracy and efficiency.
Respondent 5	Not entirely, I think the challenge would be that consumers are accustomed to going to one place to get everything they need. Will they be able to adjust?
Respondent 6	With accurate real time data from retailers the warehouses can be eliminated
Respondent 7	We are in a digital era and we can do better
Respondent 8	It depends on what is the goal of the organization and what are the challenges and or constraints in the SCM
Respondent 9	BDA provides insight in decision making

5.3.1.4. Question 4

“Each role player (i.e. Retailers, Warehouses and Manufactures, etc.) in the SCM value network plays a unique and specific role. Do you believe that BDA has the potential to affect warehousing infrastructure?” (Refer to Appendix “A”, Section “B” for the research instrument).

Figure 25 provides a graphical representation of the participants' responses to question 4. More than 77% of the participants believe that BDA will affect warehousing infrastructure and only 22% do not share that sentiment.

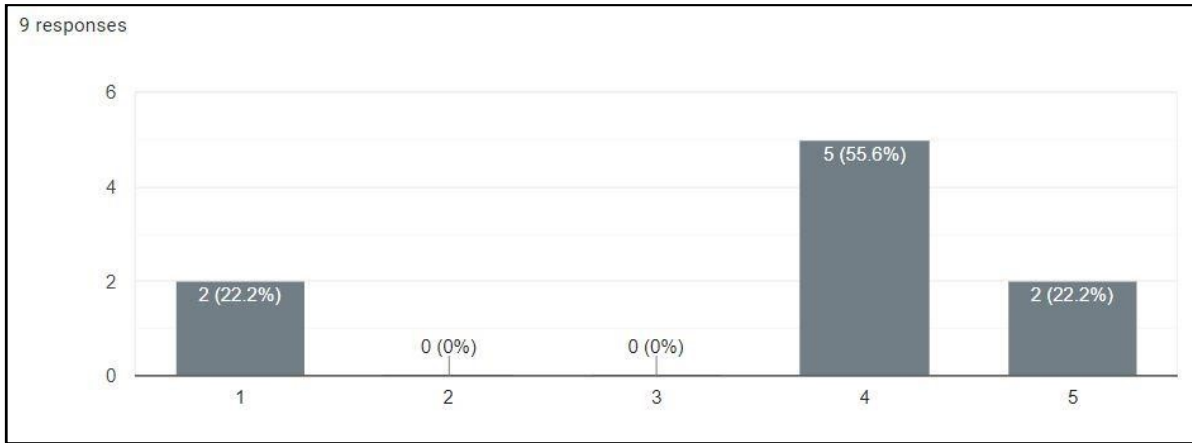


Figure 25: Question 4 participant's feedback

Table 11 is the participant's motivations. There is an absolute belief from the participants that the implementation of BDA will positively affect warehousing infrastructure (definitely, improved SC operations, empower each role player, etc.), while others do not agree (i.e. not really, not sure).

Table 11: Participants' Motivations to Question 4

Question	Each role player (i.e. Retailers, Warehouses and Manufactures, etc.) in the SCM value network plays a unique and specific role. Do you believe that BDA has the potential to affect warehousing infrastructure?"
Respondent 1	Improved SC operations
Respondent 2	BDA provides potential for change in warehousing infrastructure
Respondent 3	Yes
Respondent 4	Not really as normal process will stick need to be
Respondent 5	I think it will
Respondent 6	Not sure, but doubt if it will
Respondent 7	The availability of data, will empower each role player
Respondent 8	Definitely
Respondent 9	If BDA implemented properly

5.3.1.5. Question 5

"Do you believe that the implementation of BDA will improve/enhance information flow throughout the SCM value network?" (Refer to Appendix "A", Section "B" for the research instrument).

Figure 26 provides a graphical representation of the participants' responses to question 5. 88% of the participants believe that the implementation of BDA will

improve the flow/exchange of information throughout the SCM value network and only 11% do not necessarily agree.

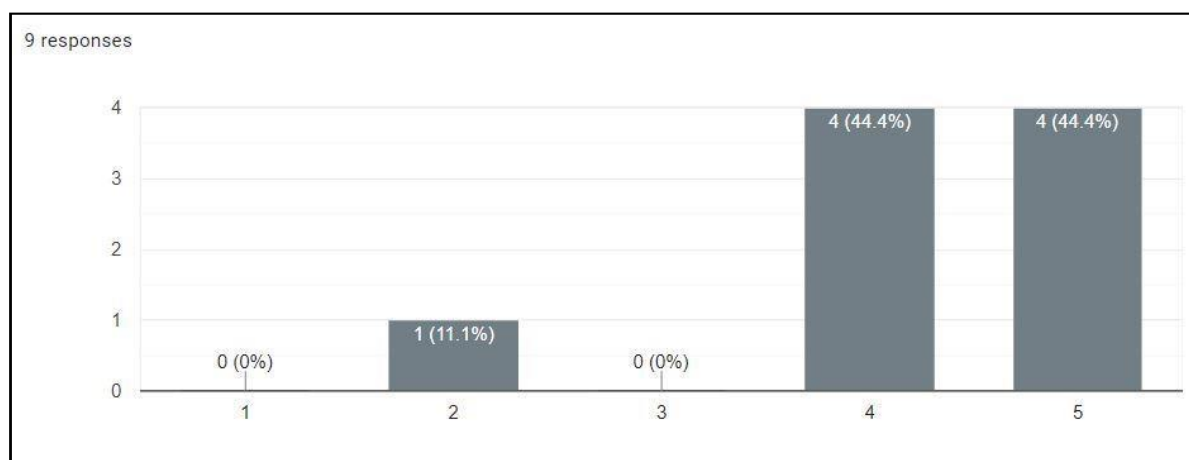


Figure 26: Question 5 participant's feedback

Table 12 is the participant's motivations. There is an absolute belief from the participants that the implementation of BDA will improve/enhance information flow throughout the SCM value network (i.e. BDA will reduce errors, improve information flow, most definitely, all nodes in the value network will be integrated, increase supply chain efficiency, information is an enabler to decision making, improve quality of the decision made, etc.).

Table 12: Participants' Motivations to Question 5.

Question	Do you believe the implementation of BDA will improve/enhance information flow throughout the SCM value chain?
Respondent 1	Answer
Respondent 2	BDA will reduce errors that are normally due to personnel inputs.
Respondent 3	Information is an enabler to decision making. BDA should be easily accessible to decision makers in real time to improve the quality of decisions made.
Respondent 4	Implementation of BDA will improve information flow by identifying patterns that enable manufactures to improve processes and increase supply chain efficiency.
Respondent 5	Most definitely
Respondent 6	The information from bda will enhance the information in the scm
Respondent 7	All the nodes of SC will be integrated
Respondent 8	Yes, it can...
Respondent 9	Every stakeholder in the value chain will be involved

5.3.1.6. Question 6

“Big data acts as a catalyst throughout the SCM value network. Do you believe that the manufacturers of FMCGs are investing enough in data mining technologies to mine information which will assist them to make informed and reliable decisions?” (Refer to Appendix “A”, Section “B” for the research instrument).

Figure 27 provides a graphical representation of the participants' responses to question 6. 66% of the participants believe that the manufacturers of FMCG are not investing enough in data mining technologies and the rest of the participants are spread across the distribution curve, from “neutral” to “most likely” (i.e. 11% each).

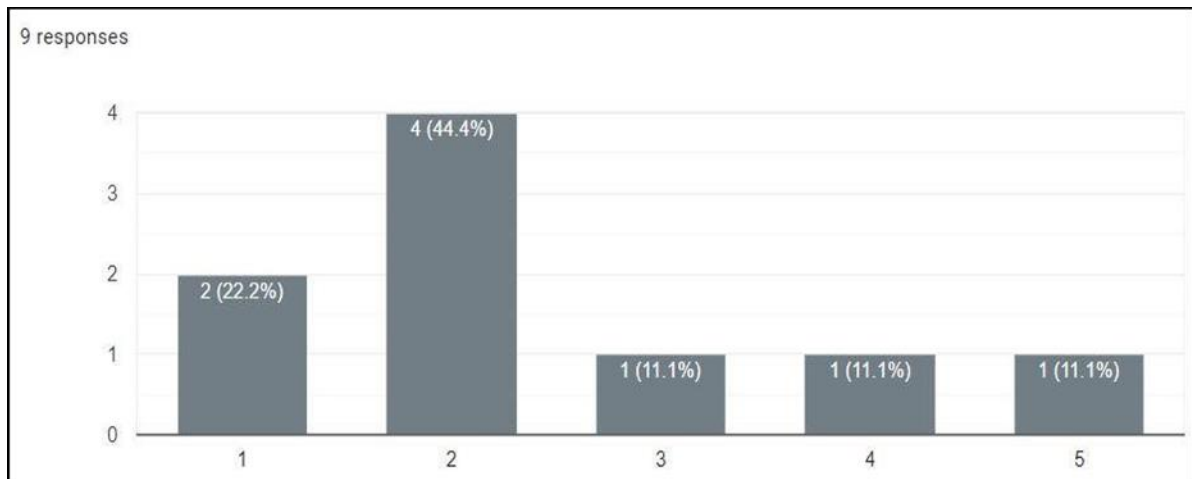


Figure 27: Question 6 participant's feedback

Table 13 is the participant's motivations. There are mixed views, but leaning towards no sufficient investment is made by manufacturers of FMCGs on data mining technologies (i.e. Nope, manufacturers are not good at accepting new technologies, No, I don't think manufacturers of FMCGs are investing enough in data mining, I have not seen evidence of such, etc.), while a small number believe they are investing enough (i.e. It will assist in making sense of large amounts of data, making it easy for decision making, data can help in planning for the future, companies are using big data to make decisions for planning, etc.).

Table 13: Participants' Motivations to Question 6

Question	Big data act as a catalyst throughout the SCM value chain, do you believe that manufacturers of FMCGs are investing enough in data mining technologies in order to mine information which will assist them to make informed and reliable decisions?
Respondent 1	Nope
Respondent 2	Manufacturers are not good at accepting new technologies in general because of cultural shock associated with this.
Respondent 3	A lot of these companies are using big data to make decisions for planning, organizing and executing on a daily basis.
Respondent 4	No, I don't think manufactures of FMCG are investing enough in data mining technologies. If they were, they would be hiring data analysts and scientist to mine data for them. I don't see that happening.
Respondent 5	It will assist in making sense of large amounts of data making it easy for decision making using data. Data can be and helps in planning for the future.
Respondent 6	Forecasting is still a challenge
Respondent 7	I don't think they are investing enough as they don't fully understand it
Respondent 8	it depends on their budget and how they understand the benefits of the tool
Respondent 9	I have not seen evidence of such, as some decision are still made manually

5.3.1.7. Question 7

“In your opinion, through the use of BDA, do you believe that the FMCGs manufacturers will be able to reduce warehouse costs?” (Refer to Appendix “A”, Section “B” for the research instrument).

Figure 28 provides a graphical representation of the participants' responses to question 7. 77% of the participants believe that the use of BDA will have a positive effect on warehousing costs, with only 22% not agreeing.

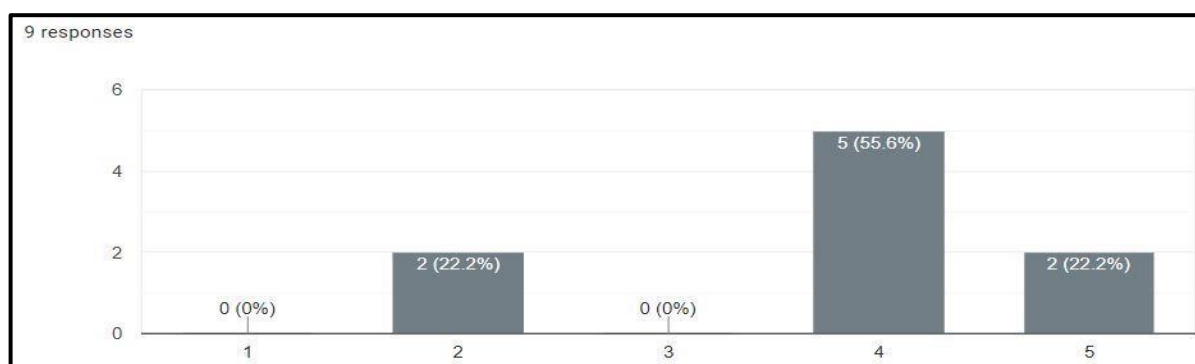


Figure 28: Question 7 participant's feedback

Table 14 is the participant's motivations.

Table 14: Participants' Motivations to Question 7

Question	In your opinion, through the use of BDA, do you believe FMCG's manufacturers will be able to reduce warehouse costs?
Respondent 1	Most
Respondent 2	Throughout the history, companies that have embraced data have managed to reduce costs.
Respondent 3	The geographical locations of the manufacturers and the economic hubs and the need to be agile, security and adaptability of the warehouses may require advanced systems which could be costly therefore, increasing warehouse costs.
Respondent 4	Using BDA will enable manufactures to plan properly using data and thus reducing wastage.
Respondent 5	It is Real time, allows better management of stock. No over stocking or understocking, ensuring that transport is monitored and deliveries can be made timeously.
Respondent 6	Smaller warehouses will be needed
Respondent 7	The amount of goods used or stored will be reduced
Respondent 8	Not sure if by simply applying BDA you will reducing costs
Respondent 9	there will be no need to store too much

5.3.1.8. Question 8

“BDA forms an integral part of the Industrial Revolution (IR) 4.0 and acts as a catalyst throughout the SCM value network.

Do you believe that enough investment needs to be made by the manufacturers of FMCG to be able to make speedy, informed reliable decision(s) at any given point of SCM?” (Refer to Appendix “A”, Section “B” for the research instrument).

Figure 29 provides a graphical representation of the participants' responses to question 8.

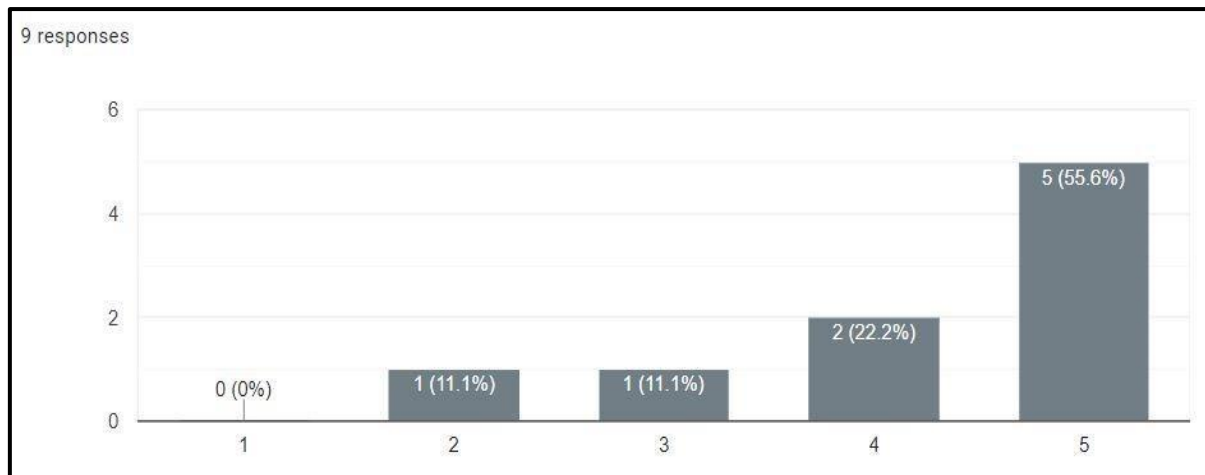


Figure 29: Question 8 participant's feedback

77% of the participants believe that sufficient investment needs to be made across the SCM value network to enable managers to arrive at reliable information.

11% took a neutral position and the remaining eleven percent 11% expressed a contrary view.

Table 15 is the participant's motivations. There are mixed views though leaning towards agreeing with the belief that enough investment must be made by manufacturers to make speedy, informed reliable decisions at any given point of the SCM (i.e. it will improve business efficiency and information sharing If it is applied correctly, It is necessary, if the information is available at your fingertips it assists in making quick decisions, enable manufactures to make informed decisions from planning to dispatching, etc.), while others do not agree (i.e. currently it is not enough, investment does not necessarily need to be made by the manufacturers, etc.).

Table 15: Participants' Motivations to Question 8

Question	BDA forms an integral part of Industrial Revolution (IR) 4.0 and acts as a catalyst throughout the SCM value chain, do you believe that enough investment must be made by manufacturers in order to be able to make speedy, informed reliable decision(s) at any given point of the SCM?
Respondent 1	Half
Respondent 2	Investment does not necessarily need to be done by the manufacturer. Even retailers can initiate this in order to improve the performance of the supply chain.
Respondent 3	Any manufacturer not responsive of customer needs at the point of need is likely to incur excessive costs or lose sell opportunities.
Respondent 4	Using data at each stage of SCM will enable manufactures to make informed decision from planning all the way to dispatching
Respondent 5	4 IR is very dependent on data, it is required for digital transformation, and therefore investment into BDA would be worthwhile, currently it is not enough.
Respondent 6	Decisions are key to running successful business if information is available at your it assists in making quick informed decisions
Respondent 7	Yes, it is necessary
Respondent 8	yes, if it is applied properly
Respondent 9	It will improve business efficiency and information sharing

5.3.2. Detailed questions

This section of the research instrument comprises ten questions. Out of the nine participants who responded, only seven completed this section of the research instrument, which amounts to a 77% response to detailed questions. (Refer to Appendix "A", Section "C" for the research instrument).

Appendix "A", Section "C" provides a detailed list of questions and responses from the participants. It is important to read this section in conjunction with Appendix "A", Section "C".

5.3.2.1. Question 1

"What is your understanding of warehousing and distribution centres in general (including third- and fourth-party logistics)?"

Table 16 provides participants' understanding of warehousing and distribution. It may be deduced that the participants have a limited understanding of what a warehouse or a distribution centre is based on their responses (e.g. service providers who assist in the logistics and SC of goods, where manufacturers store their produced goods,

centres where manufacturers store the finished product before distribution, etc.), while others said (e.g. they assist with providing subject matter skills, they are an enabler for the manufacturers to be responsive, 3rd/4th party warehousing can be owned by the manufacture, others did not answer at all, etc.).

Table 16: Participants' Answers to Question 1

Question	What is your understanding of warehousing and distribution centres in general including 3rd and 4th Party Logistics)?
Respondent 1	3rd
Respondent 2	3rd party/4th party warehousing can be owned by the manufacturer based on the strategy and importance to their business but in most cases the manufacturers outsource this to efficient 3rd parties who are more efficient and cost effective.
Respondent 3	They are an enabler for the manufacturers to be responsive and agile to customer needs and that they enable the manufacturer to stick to core business.
Respondent 4	
Respondent 5	
Respondent 6	These are the centers where manufacturers store the finished product before distributing them to retailers and in the current information age deliver directly to end customers e.g. Takealot
Respondent 7	It is where manufacturers store their produced goods
Respondent 8	they assist with provide subject matter skills for manufacturers in terms logistics
Respondent 9	Service providers who assist in the logistics and SC of goods

5.3.2.2. Question 2

“Retailers require adequate shelf replenishment to mitigate stock shortages, which results in loss of sales. Do you believe that warehousing or distribution centres are the best buffers to meet continuous fluctuating demand?”

Table 17 provide respondent's answers to question 2. There is support from the participants that warehousing and distribution centres are the best buffers to meet continuous fluctuating demand (e.g. they are, yes, at present yes, yes if planned properly, to a certain degree, etc.).

Table 17: Participants' answers to Question 2

Question	Retailers require adequate shelf replenishment in order to mitigate stock out which results in loss of sale, do you believe warehousing or distribution centres are the best buffers to meet continuous fluctuating demand?
Respondent 1	Sale
Respondent 2	They are but however there is cost implication in buffering. in an ideal situation you would not need this buffering if the manufacturing process was well designed and is efficient.
Respondent 3	yes.
Respondent 4	
Respondent 5	
Respondent 6	At present yes. With big data analytics growing manufacturers and retailers might be to forecast a lot accurately.
Respondent 7	Yes, if they plan properly
Respondent 8	its not as simple as that. It all depends on the manufacturing capabilities of the manufactures as well as market demand
Respondent 9	To a certain degree, because we cannot afford to not have a minimum buffer for unforeseen circumstances

5.3.2.3. Question 3

“To operate a warehouse or a distribution centre (even third- and fourth-party logistics) includes operational costs (for example storage of raw materials, production material, components, semi-finished products, and finished products, inventory costs, human resource, rent, shrinkage, obsolete stock and insurance, etc.), do you think that these costs could be reduced through the use of BDA?”

Table 18 provide respondents' answers to question 3, The participant's response supports that through the use of BDA distribution centre or warehousing costs can be reduced (i.e. Yes, yes smaller warehouses result in reduced opex and capex, yes because minimum resources will be required, BDA is an enabler to make good decisions, etc.) while only two do not agree (i.e. Not 100% in agreement, No)

Table 18: Participants' answers to Question 3

Question	To operate a warehouse or distribution centre (even 3rd and 4th Party Logistics) includes operational costs (e.g. storage of raw materials, production material, components, semi-finished products, and finished products, inventory costs, human resource, rent, shrinkage, obsolete stock and insurance, etc.), do you think these costs can be reduced through the use of BDA?
Respondent 1	BDA
Respondent 2	Yes.
Respondent 3	Yes and No. The products manufactured, the proximity of the suppliers to the manufacturer and the seasonality of availability of the raw materials, standing procurement agreements and economic factors will have a direct impact on the costs. BDA is an enabler to make good decisions
Respondent 4	
Respondent 5	
Respondent 6	Yes, smaller warehouses result in reduced opex and capex
Respondent 7	Yes, as there will be less stock to keep and space to utilize
Respondent 8	Not 100% in agreement
Respondent 9	Yes, because minimum resources will be required

5.3.2.4. Question 4

“The availability of data across the nodes of Supply Chain provides an opportunity for data exploitation, do you agree with the statement and why?”

Table 19 provide respondents' answers to question 4, the participants agree with the statement that the availability of data across the nodes of SC provides an opportunity for data exploitation (i.e. yes, yes because information will be available throughout the value network, yes, yes, each role player will have information, utilisation for their benefit, etc.) while only one does not agree (i.e. Not true).

Table 19: Participants' answers to Question 4

Question	The availability of data across the nodes of Supply Chain provides an opportunity for data exploitation, do you agree with the statement and why?
Respondent 1	Supply
Respondent 2	Not true. companies need to put control measures for this.
Respondent 3	Yes. It allows for visibility of activities in the nodes and can help highlight possible gaps, bottlenecks and non-conformances to the set standards.
Respondent 4	
Respondent 5	
Respondent 6	
Respondent 7	Yes, because information will be available throughout the value chain
Respondent 8	Yes
Respondent 9	Yes, each role player in the node will have information and be able to utilize it to their benefit

5.3.2.5. Question 5

“What data and/or information categories (for example type of products purchased, days of the week, etc.) should be mined by the warehouse and/or distribution centre operators?”

Table 20 provide respondents' answers to question 5, there is no consensus on specific data types (i.e. SKU, days, expiry date, all data must be stored, the more data the better decisions, there is ample data to be mined, etc.), it may be concluded that the more data the better decision making.

Table 20: Participants' answers to Question 5

Question	What data and/or information categories (e.g. Type of products purchased, Days of the week, etc.) should be mined by the warehouse and/or distribution centres operators?
Respondent 1	Days
Respondent 2	Any information that will help in predicting demands.
Respondent 3	SKUs, # available, where used, how much used, obsolescence flags, date of expiry
Respondent 4	
Respondent 5	
Respondent 6	Everything, the more data the better the decisions
Respondent 7	There is ample of data to be mined, all that is needed is to specify which one and know where to find it
Respondent 8	Not clear on what is being asked in this question
Respondent 9	All data must be stored and each role player configure data requirements according to their operations

5.3.2.6. Question 6

“How can BDA be effectively utilized to mitigate the costs associated with operating warehousing and/or distribution centres (even those operated by the third- or fourth-party logistics?)”

Table 21 provide respondents’ answers to the question, there is support from the participant’s response that utilisation of BDA can mitigate costs associated with warehousing (i.e. BDA can be utilised for planning, BDA provides various analytics, smaller warehouses, improved decision making, warehouses will need to keep fewer products, etc.).

Table 21: Participants’ answers to Question 6

Question	How can BDA be effectively utilized in order to mitigate the costs associated with operating a warehousing and/or distribution centres (even those operated by 3rd or 4th Party Logistics?
Respondent 1	Warehouse
Respondent 2	BDA can be utilized for planning process.
Respondent 3	
Respondent 4	
Respondent 5	
Respondent 6	Warehouses will need to keep less products for a shorter period thus resulting in smaller warehouses
Respondent 7	BDA provides various analytics, that can be used to improve decision making
Respondent 8	Not enough information
Respondent 9	Costs are incurred, because of human resources, insurance, shrinkage, obsolescence, etc.

5.3.2.7. Question 7

“According to you, which warehousing costs can be “eliminated” through the use of BDA?”

Table 22 provide respondents’ answers to question 7, based on the participant’s feedback, BDA may positively “eliminate or reduce” warehousing costs, participants provided costs such as (inventory costs, reduce pilferage costs, transportation costs, material handling costs, etc.).

Table 22: Participants' answers to Question 7

Question	According to you, which warehousing costs can be "eliminated" through the use of BDA?
Respondent 1	Eliminate
Respondent 2	Inventory costs
Respondent 3	Reduce stationery costs, reduce pilferage costs, reduce incorrect data input, reduce wrong allocation of product dispatch therefore (transportation costs and material handling
Respondent 4	
Respondent 5	
Respondent 6	Rental, electricity, water, a reduced workforce
Respondent 7	Rent, Human Resources, insurance and overheads
Respondent 8	N/A
Respondent 9	Human resources, Rent cost, Insurance, Inventory holding

5.3.2.8. Question 8

"What are the important factors to consider and are necessary to adopt BDA?"

Table 23 provide respondents' answers to question 8, from the participant's feedback, there is no consensus on the important factors (e.g. upskilling the labour force, data collection, benefits for the customer, training costs, skills to use it, availability of technology, etc.) to consider and necessary before adopting BDA.

Table 23: Participants' answers to Question 8

Question	What are the important factors to consider and necessary in order to adopt BDA?
Respondent 1	BDA
Respondent 2	Simplicity of the BDA to ensure adoption.
Respondent 3	Upskilling the labour force, new system should bring benefits for the customer.
Respondent 4	
Respondent 5	
Respondent 6	How are you going to collect the data, the sources of the data, the IT infrastructure to process this data speedily and the algorithms that are going to be used to analyze the data
Respondent 7	The skills of the employees and what training will be required
Respondent 8	N/A (do not have enough information on the subject matter)
Respondent 9	The cost, skill to use it, availability of technology, willingness to adopt it by organizations

5.3.2.9. Question 9

“What are the limitations of BDA? List at least five (5) or more benefits or risks of BDA.

Table 24 provide respondents' answers to question 9, The participants provide few limitations of BDA (i.e. training of staff, cultural change, initial costs, new technology, it is expensive, etc.) while the benefits (i.e. allow quick decision making, improve forecasting, improved profits, etc.) and the risks (i.e. structural unemployment, humans might become reliant on it, etc.).

Table 24: Participants' answers to Question 9

Question	What are the limitations of BDA? List at least five (5) or more benefits or risks of BDA?
Respondent 1	Least
Respondent 2	BDA will require training of the staff, cultural change of the company, initial costs, maintenance cost.
Respondent 3	Data (garbage in, garbage out), structural unemployment for the unskilled labour force, managed organizational change (culture and all), government legislation (red tape), improved customer experience
Respondent 4	
Respondent 5	
Respondent 6	It will allow for quick decision making. It will improve forecasting and demand management, it will result in improved profits if used correctly. Cons: Humans might become too reliant on it to make decisions
Respondent 7	The costs of training. understanding of BDA, training, new technology, redundancy of employees
Respondent 8	Do not have enough information on the subject matter
Respondent 9	It is still new, it is expensive, not all understand it, it requires new technology and not all organizations have it

5.3.2.10. Question 10

“For BDA to be effectively utilised, a vast amount of data needs to be mined.

However, if the mined data is not properly analysed, that might result in an incorrect decision(s) being made. Do you agree or not? and why?”

Table 25 provide respondents' answers to question 10, The participants agree that a vast amount of data will need to be mined (i.e. agree, yes, information is valuable if it improves one's life, quality of input information will determine the results, to facilitate

correct decision-making, etc.). However, if the mined data is not properly analysed, users of the data will arrive at incorrect decisions (i.e. garbage in, garbage out, data on its own is not useful).

Table 25: Participants' answers to Question 10

Question	For BDA to be effectively utilized, a vast amount of data needs to be mined, if mined data is not properly analysed, that might result in an incorrect decision(s) being made. Do you agree or not and why?
Respondent 1	Agree
Respondent 2	As in any computerized environment, quality of the input information will determine the results.
Respondent 3	Yes. Garbage in, garbage out
Respondent 4	
Respondent 5	
Respondent 6	Agree. The right algorithms will be needed to analyze the data. These decisions are key to the
Respondent 7	Agree, information is valuable if it improves one's life or operations
Respondent 8	same as above
Respondent 9	Agree, because data on its own is not useful

6. Chapter 6: Findings of the Research

In the previous chapters, the researcher was able to establish a variety of facts that contributed immensely to the study. This section discusses the findings of the study.

6.1. Study Findings

The findings of the study are as follows:

1. Manufacturers of FMCGs may meet fluctuating demands by delivering their finished goods directly to retailers, rather than utilising 3PLs, this is a result of these manufacturers having sufficient data to forecast and project demand and supply accurately. However, this increases logistics costs because more trucks will be required, the turnaround time per truck will increase as they will need to deal with a lot of retailers and it is costly.
2. Through the utilisation and adoption of BDA, several warehousing costs (i.e. inventory costs, pilferage costs, material handling, reduce the incorrect allocation of products, operational expenses, etc.) may be “eliminated” or reduced. Warehouses will need to keep fewer products for a shorter period, thus resulting in smaller warehouses.
3. BDA will improve/enhance information flow throughout the SCM value network, all stakeholders in the value network will be involved, integrated, the information will be available in real-time, improve SC efficiency, improved decision making and reduce errors.
4. Information sharing and exchange will facilitate integration across the SCM value network. The availability of BD across SC values network will provide opportunities for data exploitation to be utilised by the manufacturers of FMCGs to their benefit (e.g. proper management of demand and supply variances, identification of gaps, bottlenecks, non-conformance to set standards, etc.). Furthermore, BDA will assist in the planning process and used to improve decision making.
5. BDA will avail a variety of information/data categories (e.g. any available data, date of expiry, SKU, any information which will help in predicting demands, etc.) to be mined by warehouses and/or distribution centres for their operational efficiency (i.e. for what purpose and know where to find it).

6. There is an absolute belief from the participants that the implementation of BDA will positively affect warehousing infrastructure.
7. There are several limiting factors in adopting BDA (i.e. the initial costs for adopting BDA, budgetary constraints, upskilling of the labour force, maintenance costs, IT infrastructure, availability of technology, accepting new technology, etc.). These factors discourage manufactures of FMCG not to invest enough in data mining technologies.
8. BDA has several limitations including namely; it is still new, it is expensive, requires new technology which not all organisations have, maintenance costs are high, the IT infrastructure for it, and initial set up. Furthermore, the implementation of BDA does not guarantee to address all issues on warehousing costs.
9. BDA provides pragmatic analytics (descriptive, predictive and prescriptive) that can be utilised to improve decision making, improved forecasting, improved data accuracy, timely deliveries, which will assist in mitigating warehousing costs associated with operating warehouses and/or distribution centers.
10. That warehousing and distribution centers act as buffers to meet continuous fluctuating demand. BDA will assist in accurate and reliable forecasting, provide real-time data from retailers, to mitigate unforeseen circumstances. In an ideal world, there would be no need for buffering if manufacturing processes were well designed and manufacturing capabilities efficient. Buffering is costly but necessary to prevent loss of sale.
11. BDA to be utilised effectively depends on the quality of data/information captured (i.e. garbage in will result in garbage out), correct algorithms will be needed to analyse the data to mitigate arriving at an incorrect decision(s). Data on its own is not useful if there is no correct technology to process it to the benefit of the manufacturers of MFCGs.
12. The traditional SCM value network (i.e. from Supplier to Manufacturer to Retailer and Consumer in that sequence) will still be applicable for a long time, even with the utilisation of BDA. However, BDA will provide insight in decision making, with accurate real-time data warehousing costs may be reduced, the SCM of the 21st century is about when and where must the goods be delivered.
13. There is limited evidence supporting BDA in assisting with arriving at reliable and informed decisions because BDA is still new, the technologies associated

with it are relatively new, its uptake by the various organisation is not well established.

6.2. Summary of Key Findings

The study has managed to identify key takeaways and they include;

6.2.1. The mining and utilisation of applicable data optimise warehousing costs.

BDA facilitates the availability of vast and variety of data/information across the SC network to be mined. Stakeholders in the SC value network will utilise mined data to optimise warehousing costs because their decisions will be data-driven.

6.2.2. Information integration across the SC value network enables warehousing costs optimisation.

Stakeholders in the SC value network will utilise BDA to mine a variety of data to optimise warehousing costs and improve SC process efficiency. The mined data will be an input in the identification of warehousing costs (e.g. inventory costs, material handling, warehouses sizes, transportation costs, etc.) which may be eliminated or reduced through accurate, real-time, data-driven, etc. decisions.

6.2.3. The effects of mined data may decrease warehousing costs.

The utilisation of BDA across the SC value network has several benefits, these benefits include (e.g. improved data accuracy, integrated information across the SC value network, improved profits, quick decision making, improved operations, etc.) associated with pragmatic analytics (i.e. descriptive, predictive and prescriptive) to arrive at accurate and reliable decisions, resulting in reduced or “eliminated” identified warehousing costs.

6.2.4. Several factors influence the implementation of BDA by manufacturers of FMCGs.

The implementation of BDA by manufacturers of FMCGs is influenced by various factors (e.g. skills to use BDA, training requirements, the cost of training, IT infrastructure to process the data speedily, algorithms to analyse the data, maintenance costs, initial costs, etc.) which result in the least uptake by the manufacturers.

6.2.5. The role of warehousing and 3PLs in the SC value network.

The role of warehousing (including 3PLs) acting as a buffer in the SC value network will continue for a long period but reduced because smaller warehouses will be needed, the number of goods to be stored will be reduced, manufacturing planning will be based on accurate data.

7. Chapter 7: Conclusion and Recommendations

7.1. The Conclusion

This study focused on the utilisation of BDA to mitigate the continuously increasing warehousing costs (i.e. holding costs, inventory costs, shrinkage costs, obsolete costs, operational costs, etc.) incurred by the manufacturers of FMCG. It may be concluded from this study that BDA can reduce certain (as identified in the results of the study) warehousing costs which can be managed through the availability of data. The study demonstrates support for BDA and its capabilities while acknowledging various factors to be considered in its adoption.

From the study, it may be reasonably concluded that BDA may have positive effects on warehousing costs while acknowledging several factors to consider before adopting BDA. The study found that the utilisation of warehousing (including 3PLs) and distribution centres will still be in existence in the medium to long term period, but warehouse sizes may be reduced, with the adoption of BDA across the SC value network.

BDA is based on pragmatic analytics (i.e. descriptive, predictive or prescriptive) which will enhance decision making from the mined data to optimise warehousing costs and to arrive at data-driven decisions.

The study found the selection of 3PLs by manufacturers of FMCG is based on operational efficiency, cost reduction, improved turnaround time, to enable manufacturers FMCGs to focus on their core business. Though 3PLs add value in the storage and distribution of finished goods, their service is costly.

The study's critical question and its objectives were met and they are;

- To determine the effect(s) of Big Data Analytics on Warehousing costs in the FMCGs,
- What data should be mined to optimise warehousing costs,
- To determine the effect(s) of the mined data on warehousing costs, and
- To identify the factors which affect the implementation of BDA.

BDA capabilities can assist with warehousing costs. The study found that BDA enables the availability of a variety of data across the SC value network to optimise warehousing costs. Synergies can be achieved through information integration by optimising the mined data to mitigate warehousing costs. The study found various benefits of implementing BDA and limiting factors that affect its implementation.

7.1.1. What data should be mined to optimise warehousing costs?

The study found that through the utilisation of BDA, a variety (e.g. reliably forecast on demand and supply, types of products purchased, date of expiry, obsolescence, supplier patterns, etc.) of data will be available across the SC value network. The available data/information must be harvested to achieve operational efficiency, improve decision making and optimise warehousing costs.

7.1.2. To determine the effect(s) of the mined data on warehousing costs.

The study found that the mined data has positive effects (e.g. provide simplicity, facilitate data collection, process data speedily, etc.) if optimally utilised (i.e. by identifying bottlenecks, identify patterns, reduce errors, improve process efficiencies, etc.) identified warehousing costs will be reduced.

7.1.3. To identify the factors which affect the implementation of BDA.

The study found that BDA has several benefits (e.g. data-driven decision making, quick decision making, improved forecasting, data accuracy, etc.) which can improve FMCGs and warehousing operations. However, there are also challenges (e.g. upskilling of the labour force, training requirements, willingness to adopt BDA, labour skilling costs, availability of technology, etc.) that affect the implementation of BDA.

7.2. Recommendations

The findings of this study cannot be generalised, as it was an exploratory study with a limited number of participants utilizing a non-probability sampling method. However, these findings can be utilised as input into any future research associated with the utilisation of BDA.

7.3. General study recommendation

The recommendation from the study is that a wider sample of expertise from the SC value network (i.e. FMCG and warehousing sectors) be interviewed to arrive at informed findings.

7.4. The Contribution and the Implication of the Study

This study contributes to the existing body of knowledge by providing a better understanding of the utilisation of BDA in mitigating continuously increasing warehousing costs in the SC value network.

The implication of the study is to conduct extensive research covering a wider sample on the utilisation of BDA in mitigating warehousing costs. The following is a list of identified research to be pursued;

1. How to integrate the SC nodes (i.e. from Suppliers of raw materials to Retailers), while retaining their autonomy. This is recommended because this study found that information sharing and exchange might otherwise lead to loss of independence and information competitive edge by SC stakeholders in the SC value network.
2. Strategies or approaches to utilise to mitigate factors that hinder the adoption and implementation of BDA in the FMCG and warehousing sectors. This is recommended because the study found that there are several factors to consider in the implementation and adoption of BDA.
3. The cost comparison between warehousing and direct delivery to retailers by manufacturers of FMCGs. This study is recommended because of BDA's availing of real-time demand and supply data.
4. The manufacturing processes requiring improvement or effectiveness to reduce the utilisation of 3PLs. This study is recommended because 3PLs do add value, but it is costly.
5. The utilisation of IR 4.0, as an enabler in connectivity and processing capacity for the flow and exchange of information in the manufacturing industry. This recommendation is based on this study's finding that IR 4.0 is an enabler for information integration because it is a new industrial paradigm that embraces a set of future industrial developments (namely; Cyber-Physical Systems (CPS))

the Internet of Things (IoT), the Internet of Services (IoS), Robotics, Big Data, Cloud Manufacturing, etc.).

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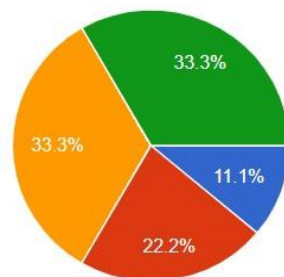
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Appendix A

Section A

Years of experience in the field or position

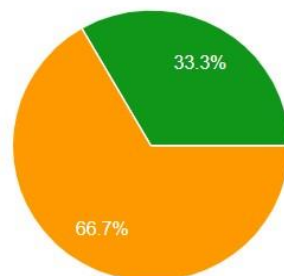
9 responses



- Less than 5 years
- Between 6 and 10 years
- Between 11 and 15 years
- Between 16 and 20 years
- Above 21 years

Highest academic qualification achieved

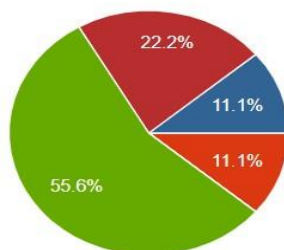
9 responses



- National Senior Certificate/Grade 12
- National Diploma/Advanced
- Bachelor's Degree/ Advanced Diploma/ B. Tech Degree
- Master's Degree/ M. Phil.
- Doctoral Degree/Post doctoral

Industry Sector

9 responses

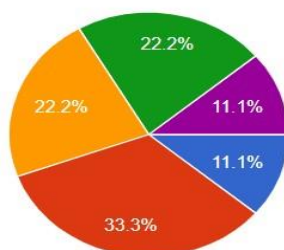


- ICT & Telecommunication
- Transport & Logistics
- Pharmaceutical
- Retail and Warehousing
- Cosmetics and Hair Supply
- Commerce
- Banking and Finance
- Other (specify)

▲ 1/2 ▼

Current job/position

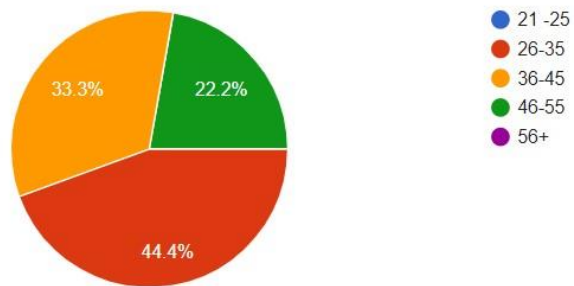
9 responses



- CEO/EXCO/etc.
- Senior Management
- Middle Management
- Operations
- Other (Specify)

Age category

9 responses

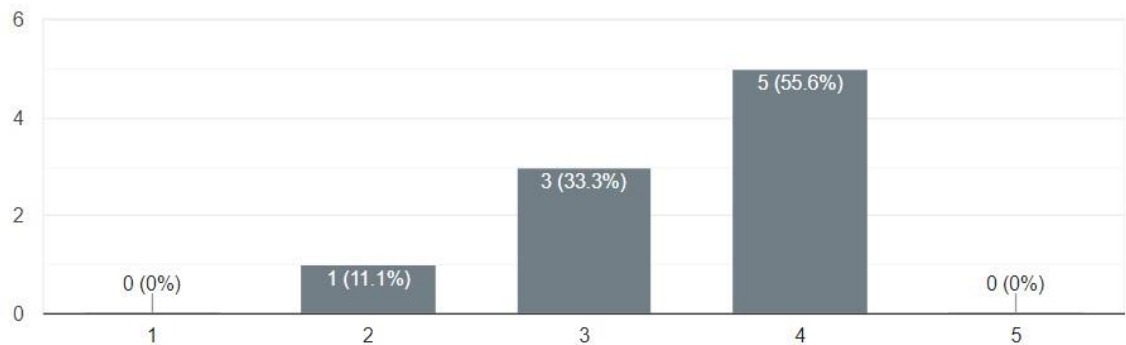


Section B

Section B: Likert questions and Motivation

Do you believe manufactures of FMCGs might benefit by having their finished goods directly delivered to retailers, instead of working through 3rd or 4th Party Logistics?

9 responses



Provide motivation for your above selection.

9 responses

it depends on the strategy of the company and the strategic importance of this service to the company. Our company used to deliver directly to the customers but however this was costly so we have decided to outsource the service at a lesser cost.

It all depends on the strategy of the business or the cost leadership

The value added by 3PL is costly

They will have to deal with a lot of retailers

The turnaround time per truck will increase and there will be more heavy duty trucks in big cities (CBD)

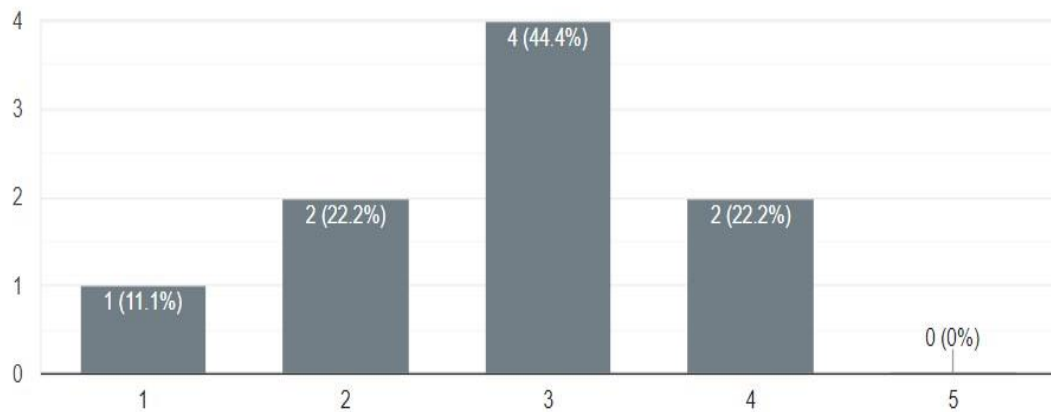
Online platforms are available to do such, and it will be cheaper for the consumer.

Delivering directly to retailers will enable FMCGs to maintain greater control of handling and reducing waste.

Uyazi

Do you believe that manufactures of FMCGs will be able to meet the fluctuating demand from retailers without the use of 3rd or 4th Party Logistic warehouses?

9 responses



Provide motivation for your above selection.

9 responses

strategy is feasible. thirdly driven by cost

The logistics part of 3PL adds value

It will consume a lot of their time to deal with retailers

They would have less or no buffer/safety stock to respond to customer needs closest to the customers proximity, therefore not being agile.

I wouldn't be too sure on this one, on the one hand i would say yes, because they manage the whole value chain, however when they try to do it all they may lose focus on what's important and thats the core business.

If they have enough trucks and team dedicated to logistics and central distribution centre.

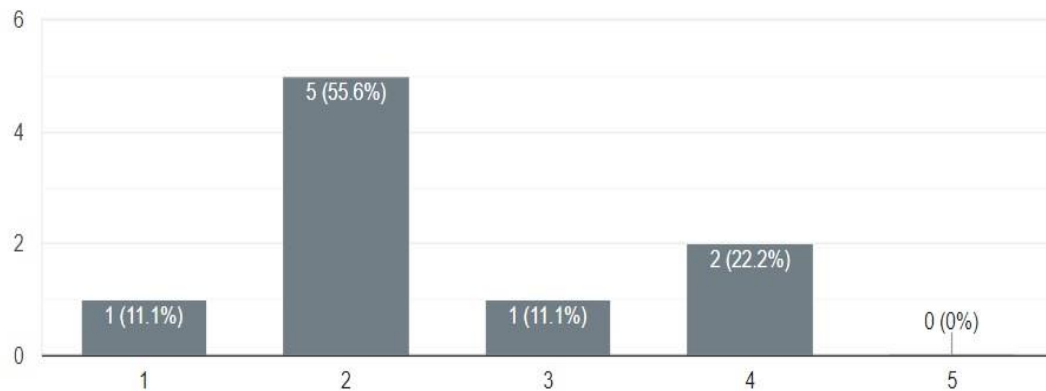
Buzz

There are certain things or goods who don't need 3PLs

In your opinion, is the traditional Supply Chain Management (SCM) value chain (i.e. Manufactures to Warehouses to Retailers) still need to be entirely followed in that sequence for the distribution of FMCGs in the 21st Century, with BDA in the equation?



9 responses



Provide motivation for your above selection.

9 responses

BDA provides insight in decision making

With accurate real time data from retailers the warehouses can be eliminated

There is no absolute numbers in demand therefore companies need to respond to an increase, loss of products, pilferage and force majeure thorough warehousing

Not entirely, i think the challenge would be that consumers are accustomed to going to one place to get everything they need. Will they be able to adjust?

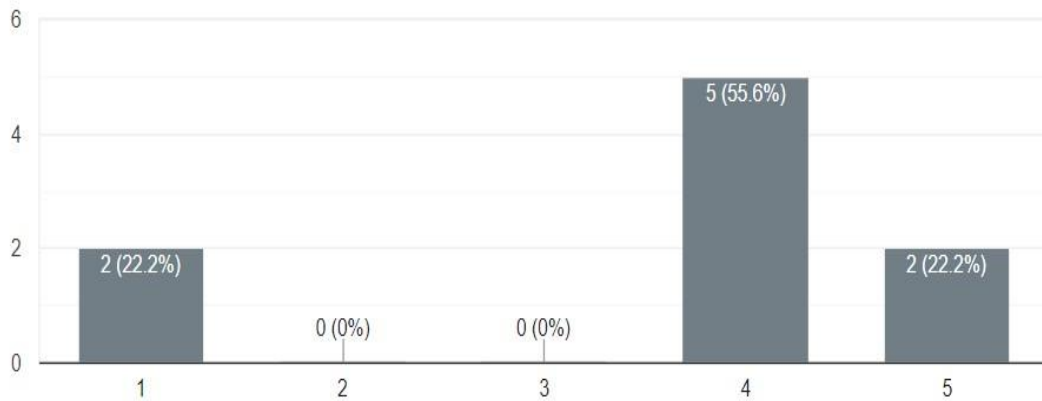
Companies should evolve with technology. They need to keep track of the latest technologies and upgrade their supply chain management. The supply chain of the 21st century is more about where and when. It's about management of data and services, flexibility, accuracy and efficiency.

Less

We are in a digital era and we can do better

Each role player (i.e. Retailers, Warehouses and Manufactures, etc.) in the SCM value chain play a unique and specific role. Do you believe that BDA has the potential to have an effect on warehousing infrastructure?

9 responses



Provide motivation for your above selection.

9 responses

Dont think so

The amount of goods in demand will be known upfront

There might not be a need for large warehouses as we will be able to predict orders more accurately

Warehouses could be built to accomodate immediate need in design changes to accommodate new products with ease, planning for peak season (seasonality products) with better accuracy and accounting for products with less effort and more accurate measures.

Better management of stock, it would make process more efficient. And allows for monitoring.

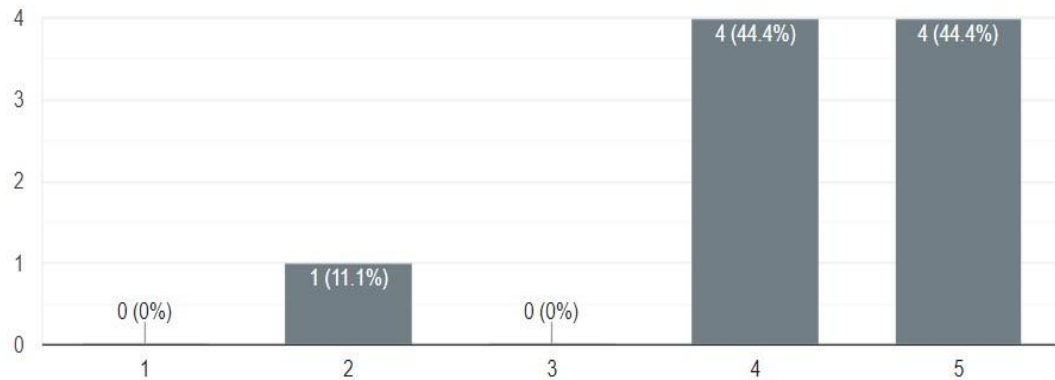
BDA will offer advantages such as better decision-making, increase productivity and improve customer service

Likely

As there will be better ways to do business in this era of IR 4.0

Do you believe the implementation of BDA will improve/enhance information flow throughout the SCM value change?

9 responses



Provide motivation for your above selection.

9 responses

Yes, it can...

Every stakeholder in the value chain will be involved

The information from bda will enhance the information in the scm

Information is an enabler to decision making. BDA should be easily accessible to decision makers in real time to improve the quality of decisions made.

Most definitely

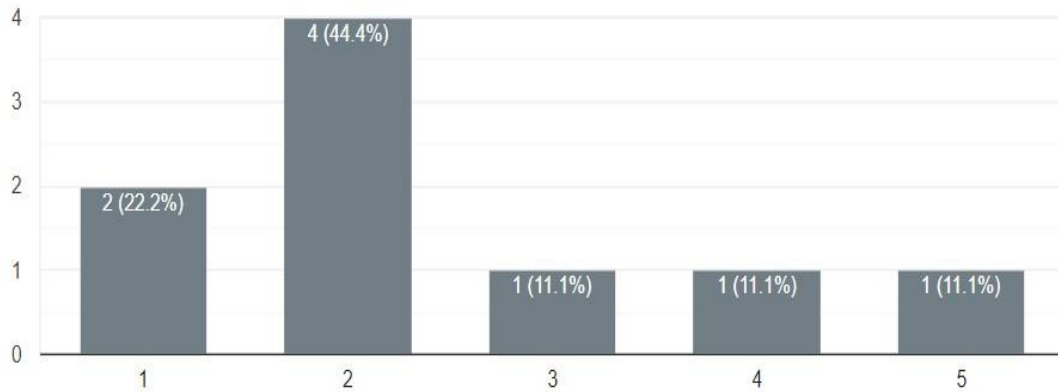
Implementation of BDA will improve information flow by identifying patterns that enable manufactures to improve processes and increase supply chain efficiency.

Answer

All the nodes of SC will be integrated

Big data act as a catalyst throughout the SCM value chain, do you believe that manufacturers of FMCGs are investing enough in data mining technologies in order to mine information which will assist them to make informed and reliable decisions?

9 responses



Provide motivation for your above selection.

9 responses

it depends on their budget and how they understand the benefits of the tool

I have not seen evidence of such, as some decision are still made manually

Forecasting is still a challenge

A lot of these companies are using big data to make decisions for planning, organising and executing on a daily basis.

It will assist in making sense of large amounts of data making it easy for decision making using data. Data can be trended, and helps in planning for the future.

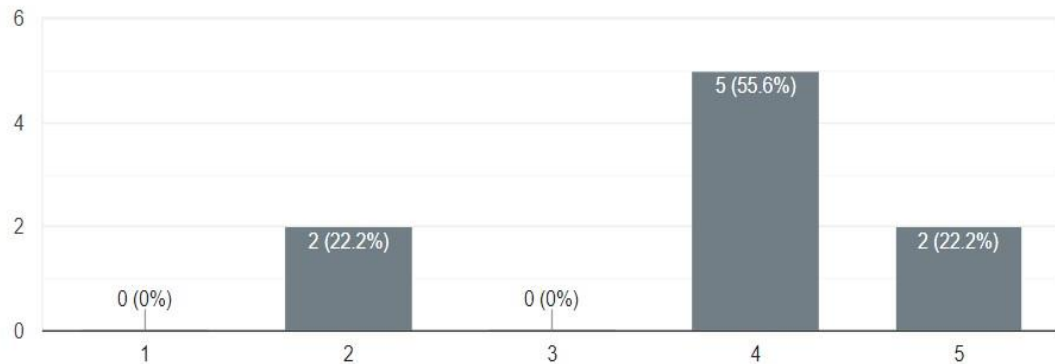
No, I don't think manufactures of FMCG are investing enough in data mining technologies. If they were, they would be hiring data analysts and scientist to mine data for them. I don't see that happening.

Nope

I don't think they are investing enough as they don't fully understand it

In your opinion, through the use of BDA, do you believe FMCG's manufacturers will be able to reduce warehouse costs?

9 responses



Provide motivation for your above selection.

9 responses

Not sure if by simply applying BDA you will reducing costs

there will be no need to store too much

Smaller warehouses will be needed

The geographical locations of the manufacturers and the economic hubs and the need to be agile, security and adaptability of the warehouses may require advanced systems which could be costly therefore, increasing warehouse costs.

It is Real time, allows better management of stock. No over stocking or understocking, ensuring that transport is monitored and deliveries can be made timeously.

Using BDA will enable manufactures to plan properly using data and thus reducing wastage.

Most

The amount of goods used or stored will be reduced

Provide motivation for your above selection.

9 responses

It will improve business efficiency and information sharing

Decisions are key to running successful business if information is available at your fingertips it assists in making quick informed decisions

Any manufacturer not responsive of customer needs at the point of need is likely to incur excessive costs or lose sell opportunities.

4 IR is very dependent on data, it is required for digital transformation, and therefore investment into BDA would be worthwhile, currently it is not enough.

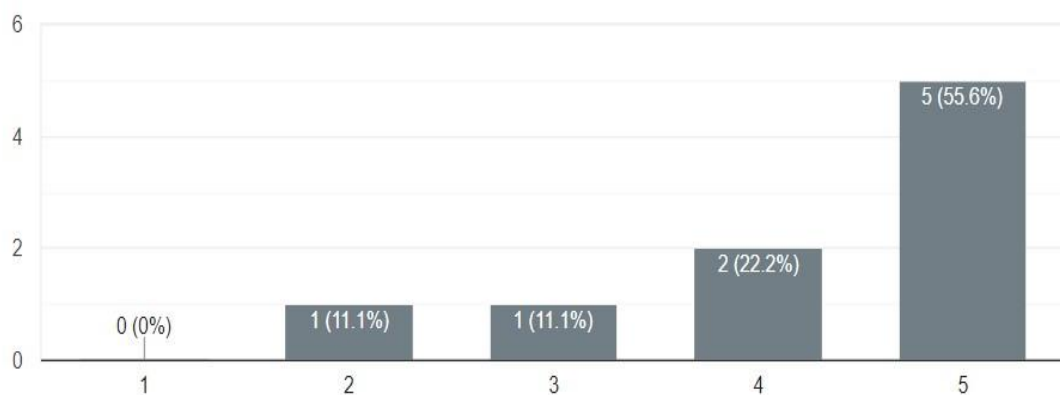
Using data at each stage of SCM will enable manufactures to make informed decision from planning all the way to dispatching

Half

Yes it is necessary

BDA forms an integral part of Industrial Revolution (IR) 4.0 and acts as a catalyst throughout the SCM value chain, do you believe that enough investment must be made by manufacturers in order to be able to make speedy, informed reliable decision(s) at any given point of the SCM?

9 responses



Section C

Question 1

Section C: Detailed questions

What is your understanding of warehousing and distribution centres in general (including 3rd and 4th Party Logistics)?

7 responses

3rd party/4th party warehousing can be owned by the manufacturer based on the strategy and importance to their business but in most cases the manufacturers outsource this to efficient 3rd parties who are more efficient and cost effective.

they assist with provide subject matter skills for manufacturers in terms logistics

Service providers who assist in the logistics and SC of goods

These are the centers where manufacturers store the finished product before distributing them to retailers and in the current information age deliver directly to end customers eg takealot

They are an enabler for the manufacturers to be responsive and agile to customer needs and that they enable the manufacturer to stick to core business.

3rd

It is where manufacturers store their produced goods

Question 2

Retailers require adequate shelf replenishment in order to mitigate stock out which results in loss of sale, do you believe warehousing or distribution centres are the best buffers to meet continuous fluctuating demand?

7 responses

They are but however there is cost implication in buffering. in an ideal situation you would not need this buffering if the manufacturing process was well designed and is efficient.

its not as simple as that. It all depends on the manufacturing capabilities of the manufactures as well as market demand

To a certain degree, because we cannot afford to not have a minimum buffer for unforeseen circumstances

At present yes. With big data analytics growing manufacturers and retailers might be able to forecast a lot accurately.

yes.

Sale

Yes, if they plan properly

Question 3

To operate a warehouse or distribution centre (even 3rd and 4th Party Logistics) includes operational costs (e.g. storage of raw materials, production material, components, semi-finished products, and finished products, inventory costs, human resource, rent, shrinkage, obsolete stock and insurance, etc.), do you think these costs can be reduced through the use of BDA?

7 responses

Yes.

Not 100% in agreement

Yes, because minimum resources will be required

Yes, smaller warehouses result in reduced opex and capex

Yes andNo. The products manufactured, the proximity of the suppliers to the manufacturer and the seasonality of availability of the raw materials, standing procurement agreements and economic factors will have a direct impact on the costs. BDA is an enabler to make good decisions

BDA

Yes, as there will be less stock to keep and space to utilise

Question 4

The availability of data across the nodes of Supply Chain provides an opportunity for data exploitation, do you agree with the statement and why?

6 responses

Not true. companies needs to put control measures for this.

Yes

Yes, each role player in the node will have information and be able to utilise it to their benefit

Yes. It allows for visibility of activities in the nodes and canhelp highlight possible gaps, bottlenecks and non-conformances to the set standards.

Supply

Yes, because information will be available throughout the value chain

Question 5

What data and/or information categories (e.g. Type of products purchased, Days of the week, etc.) should be mined by the warehouse and/or distribution centres operators?

7 responses

Any information that will help in predicting demands.

Not clear on what is being asked in this question

All data must be be stored and each role player configure data requirements according to their operations

Everything, the more data the better the decisions

SKUs, # available, where used, how much used, obsolescence flags, date ofexpiry

Days

There is ample of data to be mined, all that is needed is to specify which one and know where to find it

Question 6

How can BDA be effectively utilized in order to mitigate the costs associated with operating a warehousing and/or distribution centres (even those operated by 3rd or 4th Party Logistics)?

6 responses

BDA can be utilized for planning process.

Not enough information

Costs are incurred, because of human resources, insurance, shrinkage, obsolescence, etc

Warehouses will need to keep less products for a shorter period thus resulting in smaller warehouses

Warehouse

BDA provides various analytics, that can be used to improve decision making

Question 7

According to you, which warehousing costs can be "eliminated" through the use of BDA?

7 responses

Inventory costs

N/A

Human resources, Rent cost, Insurance, Inventory holding

Rental, electricity, water, a reduced workforce

Reduce stationery costs, reduce pilferage costs, reduce incorrect data input, reduce wrong allocation or product dispatch therefore (transportation costs and material handling costs are reduced).

Eliminate

Rent, Human Resources, insurance and overheads

Question 8

What are the important factors to consider and necessary in order to adopt BDA?

7 responses

Simplicity of the BDA to ensure adoption.

N/A (do not have enough information on the subject matter)

The cost, skill to use it, availability of technology, willingness to adopt it by organisations

How are you going to collect the data, the sources of the data, the IT infrastructure to process this data speedily and the algorithms that are going to be used to analyze the data

Upskilling the labour force, new system should bring benefits for the customer.

BDA

The skills of the employees and what training will be required

Question 9

What are the limitations of BDA, list at least 5 or more benefits and risks of BDA in terms of adding necessary, even if BDA is adopted it will not address warehousing and distribution centre costs?

7 responses

BDA will require training of the staff, cultural change of the company, initial costs, maintenance cost.

Do not have enough information on the subject matter

It is still new, it is expensive, not all understand it, it requires new technology and not all organisations have it

It will allow for quick decision making. It will improve forecasting and demand management, it will result in improved profits if used correctly. Cons: Humans might become too reliant on it to make decisions

Data (garbage in, garbage out), structural unemployment for the unskilled labour force, managed organisational change (culture and all), government legislation (red tape), improved customer experience

Least

The costs of training. understanding of BDA, training, new technology, redundancy of employees

Question 10

For BDA to be effectively utilised, a vast amount of data needs to be mined, however, if the mined data is not properly analysed, that might result in an incorrect decision(s) being made. Do you agree or not and why?

7 responses

As in any computerised environment, quality of the input information will determine the results.

same as above

Agree, because data on its own is not useful

Agree. The right algorithms will be needed to analyze the data. These decisions are key to the success of the business.

Yes. Garbage in, garbage out

Agree

Agree, information is valuable if it improves one's life or operations

Appendix B

This section of the study provides the list of questions (i.e. Section B and C) and their respective sources of inspiration.

Section B	Source of Inspiration for the Questions
Do you believe that the manufacturers of FMCGs might benefit by having their finished goods directly delivered to retailers, instead of working through third- or fourth-party logistics?	Author's contribution.
Do you believe that the manufacturers of FMCGs will be able to meet the fluctuating demand from retailers without the use of third- or fourth-party logistic warehouses?	"Machine Learning in Predicting Demand for Fast Moving Consumer Goods: An exploratory Research", by Tarallo <i>et al.</i> , (2019). Specifically, <i>predicting that the demand for Fast Moving Consumer Goods is a competitive factor for manufacturers and retailers.</i>
In your opinion, does the traditional Supply Chain Management (SCM) value chain (i.e. Manufacturers to Warehouses to Retailers) still need to be entirely followed in that sequence for the distribution of FMCGs in the twenty-first Century, with BDA in the equation?	Authors contribution.
Does each role player (i.e. Retailers, Warehouses and Manufactures, etc.) in the SCM value network play a unique and specific role? Do you believe that BDA has the potential to affect warehousing infrastructure?	Authors contribution.
Do you believe that the implementation of BDA will improve and enhance information flow throughout the SCM value network?	Big data analytics can be defined as the application of advanced analytic techniques including data mining, statistical analysis, predictive analytics, etc. on big datasets as new business intelligence practice (Russom, 2011). It refers to the processes of examining and analysing huge amounts of data of variable types to uncover hidden patterns and correlations, trends, and other businesses' valuable information and knowledge, to increase business benefits, to increase operational efficiency, and

	to explore new markets and opportunities (LaValle <i>et al.</i> , 2013).
Big data acts as a catalyst throughout the SCM value network, do you believe that the manufacturers of FMCGs are investing enough in data mining technologies to mine information, which will assist them to make informed and reliable decisions?	Data mining with R by Zhao and Cen (2014).
In your opinion, through the use of BDA, do you believe that FMCG's manufacturers will be able to reduce warehouse costs?	Author's contribution.
BDA forms an integral part of the Industrial Revolution (IR) 4.0 and acts as a catalyst throughout the SCM value network. Do you believe that sufficient investment must be made by the manufacturers to be able to make speedy, informed reliable decision(s) at any given point of the SCM?	A report by Strategy &, a global team of practical strategists' report on Industry 4.0 "How digitization makes the supply chain more efficient, agile and customer-focused by Schrauf and Bertram (2016).
Section C	Source of Inspiration for the Questions
What is your understanding of warehousing and distribution centres in general (including third- and fourth-party logistics)?	The availability of various academic definitions of what warehousing is; and a "lack" of a uniform definition for what is supposedly known.
Retailers require adequate shelf replenishment to mitigate stock outages, which results in a loss of sales. Do you believe that warehousing or distribution centres are the best buffers to meet continuous fluctuating demand?	Author's contribution.

To operate a warehouse or a distribution centre (even third- and fourth-party logistics) includes operational costs (for example the storage of raw materials, production materials, components, semi-finished products, and finished products, inventory costs, human resources, rent, shrinkage, obsolete stock and insurance, etc.). Do you think that these costs can be reduced through the use of BDA?	Tezuka's (2011), research on "Rationale for utilizing 3PL in supply chain management: A shippers' economic perspective".
The availability of data across the nodes of Supply Chains provides an opportunity for data exploitation. Do you agree with this statement and why?	A report by Strategy &, a global team of practical strategists' report on Industry 4.0. "How digitization makes the supply chain more efficient, agile and customer-focused by Schrauf and Bertram (2016); specifically, the section on a digitally enabled supply ecosystem.
What data and/or information categories (for example type of products purchased, days of the week, etc.) should be mined by the warehouse and/or distribution centre operators?	Author's contribution.
How can BDA be effectively utilized to mitigate the costs associated with operating, warehousing and/or distribution centres (even those operated by third- or fourth-party logistics)?	Tezuka's (2011), research on "Rationale for utilizing 3PL in supply chain management: A shippers' economic perspective".
According to you, which warehousing costs can be 'eliminated' through the use of BDA?	Author's contribution.
What are the important factors to consider as necessary to adopt BDA?	Author's contribution.
What are the limitations of BDA? List at least five (5) or more benefits and risks of BDA in terms of adding necessary information? Even if BDA is adopted it will not address warehousing and distribution centre costs.	Author's contribution.