Artificial intelligence and its applications in the garment industry

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Abstract:
In coping with different business challenges, the apparel industry has witnessed various Big Data and artificial intelligence (AI) applications during the last decade. With the increasing demand for the personalization of goods and services that enhance their brand experience and satisfaction, supply chains managers in clothing firms continually pursue ways to develop their market strategies so that their companies benefit from speed and cost-efficiency. (AI) techniques that can be used at different stages of the apparel supply chain to improve business operations, (AI) techniques are used to develop data-driven solutions using product-related data furnished by apparel product manufacturers and designers, Big data assist in providing personalized offerings to customers through apparel ecommerce retailers. **Objectives**: The study aims to investigate whether apparel firms can improve their business operations by employing big data and (AI), and in so doing, seek significant data management opportunities using (AI) solutions. **The methodology** of this research follows the descriptive-analytical approach, **Discussion**: The study emphasizes the importance of big data and AI in the garment supply chain to determine whether apparel manufacturers could improve company operations using big data and (AI), as well as give opportunities with extensive data management using AI. It also goes over the existing literature on supply chains, big data, AI, and organizational theories in the context of big data, with the garment sector as the core focus. **Recommendations**: to incorporate other emerging digital technologies such as virtual reality, augmented reality, the internet of things, and block chain technology. ٢٤th of February 2022, accepted 6th of April 2022,

Introduction
With the emergence of globalization and digitalization, the concept of extensive data management and AI to connect businesses globally has gained attention (Kim and Lee, 2018). In its simplest form, big data is a massive amount of data available in various formats (image, text, audio). It is often stored in distributed systems or the cloud (Ward and Barker, 2013). While extensive data management entails the organization, handling, and use of this big data, it usually requires specific technologies and analytical methods. AI is one of the technologies that can help in extensive data management as it uses the gained information from big data machines to do things that once were the human domain (Hutter, 2012).

Research Queries:
1- What are the (AI) techniques that can be used at different stages of the apparel supply chain to improve business operations?

2- How can (AI) techniques be used to develop data-driven solutions using product-related data furnished by apparel product manufacturers and designers?

3- How can big data assist in providing personalized offerings to customers through apparel ecommerce retailers?

Research importance:
1- Identifies and categorizes AI techniques that can be used to improve existing business operations at various stages of the supply chain.

2- Presents product-related data to create a classification model and design rules that can make personalized recommendations or customization opportunities, allowing customers to have a better shopping experience.

3- Draws on industry evidence and existing literature to make recommendations that may help managers develop data-driven strategies for

improving customer satisfaction through personalized services.

4- Demonstrates the effectiveness of data-driven analytical solutions in sustaining competitive advantage through the use of data and knowledge already present in the apparel supply chain.

5- Makes a contribution to the field by identifying specific opportunities with extensive data management through AI solutions. These possibilities can serve as a starting point.

Objectives:

1- The (AI) techniques that can be used at different stages of the apparel supply chain to improve business operations.

2- (AI) techniques be used to develop data-driven solutions using product-related data furnished by apparel product manufacturers and designers.

3- Big data assist in providing personalized offerings to customers through apparel ecommerce retailers.

Methodology:

Analytical Descriptive method

Theoretical framework:

The importance of AI techniques has become even more significant (Grewal et al., 2017). Actively collected data methods and passively acquired data can provide a massive amount of data, providing companies with opportunities to track customer behavior and gain trend prediction insights. By collecting large amounts of data from different sources at each step of the apparel supply chain and turning it into useful information, companies can quickly make critical decisions based on the most popular styles, colors, fabrics, and sizes. Ericsson, D. & Sandstorm, M. (2012).

Some current apparel businesses have recognized the overhead requirements and are proactively implementing (AI) techniques to increase business profit. For example, two well-known and prominent retail players, Zalando and Myntra, are experimenting with these technologies. Myntra has used deep learning to train classification models that can identify garment attributes in images. On the other hand, Zalando has used AI to create recommendation systems that can provide personalized recommendations to customers. Freno, A.(2017).

Customers necessitate businesses to become even more data-driven and managing (AI) and other advanced analytics to provide customer-centric propositions. Following the same line of thought as described above, Stitch Fix is another company that recognizes the importance of big data. Zielnicki, K(2019)

1- The Apparel Industry:

1.1. The apparel industry accounts for a significant portion of household consumption. The estimated purchase of textiles and clothing by EU households in 2017 was € 510.9.(www.statista.com/statistics/417674/eu-european-union-textile-clothing-household-consumption/).

1.2. This is influenced by low product prices and shorter manufacturing and delivery lead times for garments to customers. According to Nikolina S. (2019), apparel accounts for 10% of EU waste because most clothes are discarded or dumped in landfills. The apparel industry accounts for 10% of carbon emissions and is the second-largest commercial polluter, trailing only oil. Conca, J.(2015).

1.3. **The Apparel Supply Chain:**

As illustrated in the Figure below, an apparel supply chain includes design, production, marketing, distribution, and customer service (1). According to a study by (Ariyatum, 2003), these supply-chain processes are carried out with five factors that distinguish the apparel supply chain from other industries. The first factor is the product development phase, influenced by fashion and seasonal trends. The second is its emphasis on displaying a clothing line to the rest of the world. The third step in the product development process is iteration. Because of the short life cycle of garments, the fourth focuses on systematic planning and development. Finally, retail buyers are the ones who make the final decision on the products. Because of the significant direct(Memedovic, O & Gereffi, G. (2003).

As a result, one of the more essential solutions required to improve the efficiency and effectiveness of an apparel supply chain and gain a competitive advantage is a supply chain managed and integrated with data. Extensive data management combined with AI has the potential for rethinking the garment supply chain by enabling new forms of interactive communication, better supply-chain organization, and a digitally connected supply chain. It can aid in providing customers with personalized products and services. One method of providing customers with products that meet their needs is demonstrated. A data-driven approach is illustrated in the above figure. Data management is combined with various digital technologies, including (AI), to give customers personalized products, experiences, and services. Business executives may discover new methods to organize their businesses and gain a competitive advantage with this strategy.
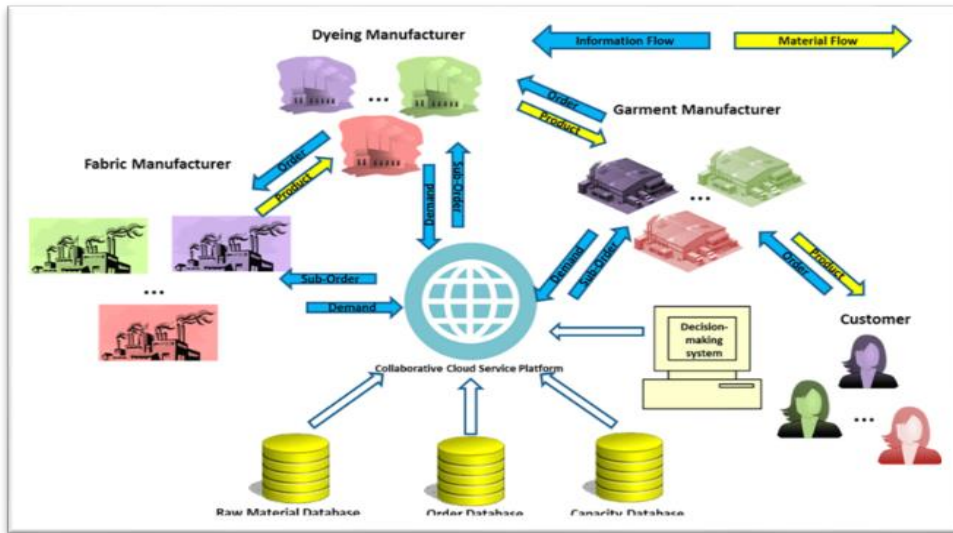
Figure (1) A data-driven management strategy for apparel supply chain

1.2. Big Data

Big data is exactly what it sounds like: a vast amount of information. But, more broadly, it refers to an extensive collection of unstructured or structured data that has been digitally compiled and organized in a way that allows humans to quickly acquire valuable insights (Oussous, A. et al., (2018)

As such, big data could be one of the solutions for answering previously unanswered questions about what customers buy, how and when they buy, and how they pay. As a result, by evaluating big data in real-time or over a certain period, businesses may make better decisions about pricing and product assortment, cut inventory costs, and reduce markdowns Aktas, E& Meng, Y. (2017)

However, big data alone will not be sufficient; advanced analytical tools such as (AI)will be required. To be more specific, big data is the fuel that drives (AI) performance. The more data fed into these (**AI)** algorithms, the higher their performance.

1.3.   Artificial intelligence:-

(AI) is a broad field of computer science concerned with developing intelligent machines capable of performing tasks that would typically require human intelligence. It employs a variety of approaches, making it an interdisciplinary science; however, advances in machine learning and deep learning are causing a paradigm shift in nearly every sector of the IT industry. https://builtin.com/artificial-intelligence.

Demands and trends on the market are highly volatile, and businesses face intense competition in a market that is becoming more saturated. Accordingly, big data alone is insufficient to make a tangible difference to compete effectively and efficiently. In addition to growing, Businesses must rely on their experience and the data at their disposal. They must know how to ask the right questions and act on the answers they receive. Big data may be able to provide retailers with more than they could have dreamed, but there must be proper means to gather and preserve this data. To acquire this data, (AI) techniques can provide retailers with strong tools to construct data models and achieve maximum data utilization. (Biesdorf, S. et al., 2013).
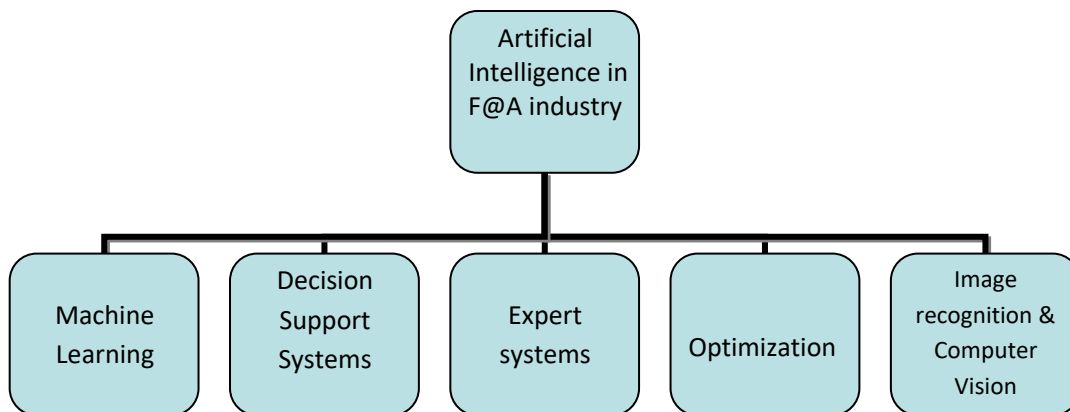

Figure (2) Artificial intelligence techniques characterization

1.4. **Machine Learning**:

Machine learning is a technical process in which computers are trained to do assigned jobs without human intervention and to learn from the patterns in the data itself. Mathematical models are built to identify and predict hidden ways to make future decisions based on historical data. There are two classifications of machine learning: supervised and unsupervised learning. Supervised learning is a parametric model, and with inputs (independent variables) and target variables (dependent variables), a supervised model's performance can be enhanced by iteratively optimizing the model parameters. (Mohri, M. et al., 2012). Based on the research problem, it might be a regression or classification task, and this counts on dependent variables, whether numerical or categorical. However, unsupervised learning models only have input attributes or independent variables, with the main task of grouping similar data points. This grouping of related pattern data points is known as clustering, and the process generates its labels. (Bishop, C. 2006). **(AI) in apparel production:**

Quality assurance:

Manufacturers and designers involve (AI) in their production methods. For example, Quality assurance is enabled by a computerized method for detecting faults in the fabric and color of the textile, which saves time.

For example**, Cognex ViDi** is a vision-based platform designed for fabric pattern recognition in textiles such as weaving, knitting, printing, beading, and finishing. According to the company, they have manufactured the system to be trained using predefined images of what a suitable textile looks like.

Manufacturing:

AI is used by designers not only for quality control but also for garment production. Various technologies, including computer-controlled lasers, knives, water jets, plasma, and ultrasound, can be used to produce large quantities of material.

Furthermore, automated sewing is spreading its wings in the manufacturing process, although it's still in its primitive stage. In 2019, ITMA released the Juki Advanced Network System (JaNet), which combines software and supporting hardware to collect data on production processes involving interconnected sewing machines. As a result, digital sewing machines have become indispensable for detecting sewing errors in mass production.

Previously, only e-commerce giants used AI to obtain analytical data about their sales and trends; however, both small and large brands have begun to use machine learning to better understand the market by identifying the analytics and insights found in data about everything from fashion trends and purchase patterns to inventory and forecasting. Khushboo Malhotra (2020)

Digital transformation appears to be the new buzzword in many industries. A Google search for this phrase yields approximately 450,000 results. As a result, what exactly is the definition of digital transformation? "Digital transformation" refers to the economic and societal effects of digitization; digitization is converting analog data and processes into machine-readable formats. Digitalization is defined as "the use of digital technologies and data and interconnection to create new or alter existing activities." In this context, digital transformation refers to two processes: Digitization and digitalization. Digitization is converting information or operations into binary bits (i.e., 0 and 1) that computers can read and modify. It refers to the conversion process.
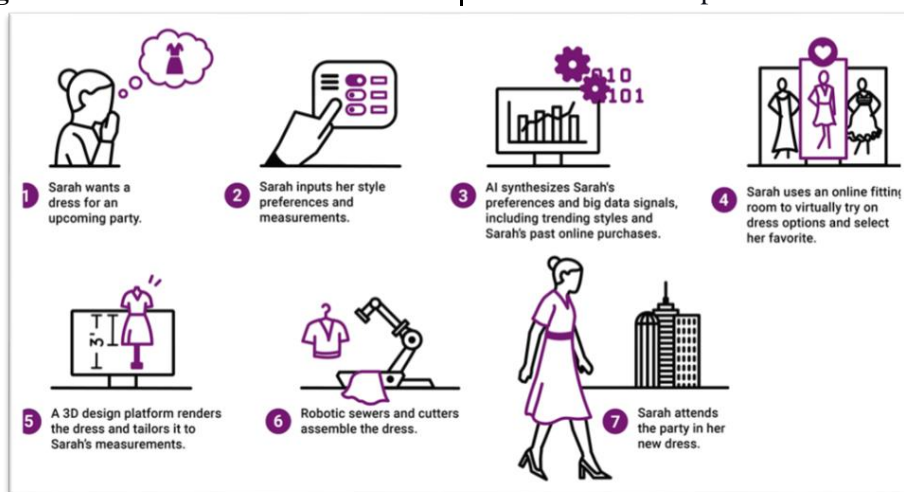
Figure(3) How tech could automate fashion design
www.cbinsights.com/research/fashion-tech-future-trends

Data, digital technologies, and interconnections are used by digitalization to create or change new activities. The interconnection of devices and networks, which has been at the heart of the

spread of Information and Communication Technology, has enabled the development of digitalization (ICTs).

- IT (Information Technology): hardware and software for accessing, copying, memorizing, and using electronic information;
- CT (Communications Technology): infrastructure, devices, and software used to send and receive information (digital networks, modems, high-speed internet access).

Hence, Information and Communications Technology (ICT) integrates information processing, computing, and communications technologies. The widespread nature of ICTs and network digitalization leads to the creation of ubiquitous digital devices, applications, high broadband connections, and services that empower organizations and individuals to change ways of doing business, behaviors, and markets. OECD (2019, p. 17)
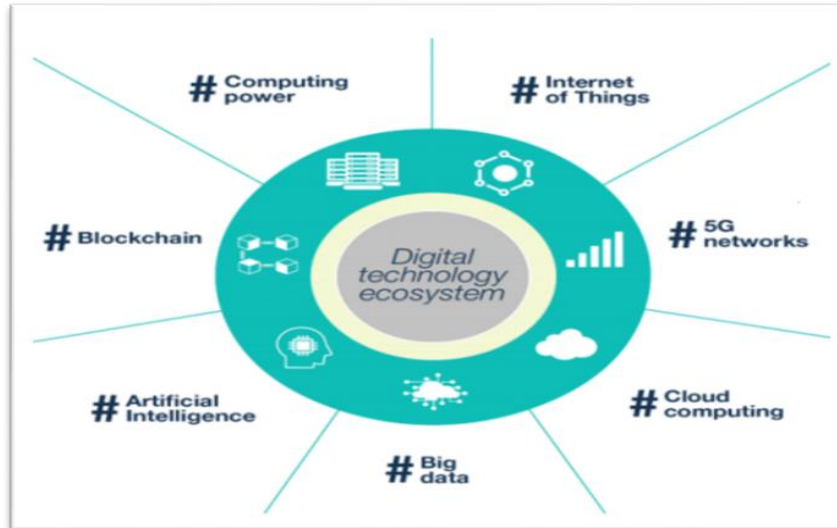

Figure (4). An ecosystem of interdependent digital technologies

SewBot Is Developing the Clothing Manufacturing Industry. It is known that low-cost manufacturing methods are the reason behind clothing's low retail price. Previously, this meant outsourcing production to low-cost overseas labor markets, but now corporations may employ robots to make consumer goods available at a low cost.

For example, the" LOWRY" automated sewing machine from Soft Wear Automation. This completely automated Sewbot is part of a company-wide push to automate the textile industry in the same way other industries do.

How Does Automated Sewbots Work?

Soft Wear's system, which has at least three patents and several more pending, uses highly calibrated machine vision to analyze and watch fabric. Moreover, it senses distortions and adjusts the material robotically. The robot executes each activity on a 70-foot-long t-shirt production line, including sewing a seam, cutting, inserting a sleeve, and quality checking. The fabric is guided by computer vision every step of the way.

The first step is programming; as Pete Santora said, Vice president of sales and marketing, all the sew data should be extracted from Gerber's Accumark files so that when the designer creates a 2D or 3D model, the sewing data is contained in the file that is sent directly to the robot.

The patented machine vision system follows. "Tracking exact needle placement to within half a

millimeter of accuracy," according to ID Tech Ex, is more accurate than the human eye. According to IEEE, it keeps track of each thread within the fabric. "To do so, [the company] created a specialized camera capable of taking over 1,000 frames per second and a suite of image-processing algorithms to pinpoint where the threads are on each frame."

Using this high-quality machine vision and real-time analysis, the robotics adjusts and manipulates the cloth to ensure proper placement. The Pick & Place machine moves and handles fabric similarly to a sewist. "These micromanipulators, powered by accurate linear actuators, can move a piece of cloth through a sewing machine with sub-millimeter precision, adjusting for material distortions," according to IEEE. The fabric is moved using two methods. The first is a four-axis robotic arm equipped with a vacuum gripper capable of lifting and positioning material. The second is a 360-degree conveyor system consisting of a table with embedded spherical rollers. Each roller, or Badger Ball, moves at high speeds independently, allowing the fabric to be moved or smoothed as needed.

On the other hand, Sewing is done in a slightly different manner. The Sewbots employ a direct sewing technique involving moving the needle rather than the fabric through a stationary sewing machine. In this description of how to sew a buttonhole, engineers explain an earlier version.

New Cloth Market (2021),

Picture(1)   Use of Robots (Automation) in the Garment Industry

What it is: A technology for the automated handling of cut fabric parts in the garment industry, in which parts are collected from a flat and delivered to a transport system in a single step. The devices are as follows:

- a reconfigurable passive hanger with 3 degrees of freedom and 3 clamps on/off;
- a reconfigurable modular robotic gripper with an articulated redundant architecture and 3 fingers and 9 degrees of freedom; and
- 3 pneumatically actuated picking modules embedded in the gripper fingertips.

Picking technique: Each fabric part must be chosen at precise locations determined piece by piece to avoid folding and minimize wrinkling in the hung configuration. To generate holding forces, use a high flow-rate vacuum at each picking location. - secure, robust with porous materials such as fabric, and adaptable to curved contact regions. New Cloth Market (2021).

Discussion:

This study begins by emphasizing the importance of big data and AI in the garment supply chain to determine whether apparel manufacturers could improve company operations using big data and (AI) and give opportunities for extensive data management using AI. It also goes over the existing literature on supply chains, big data, AI, and organizational theories in big data, with the garment sector as the core focus.

The purpose of this study is to address the three research questions and the overarching goal. Provides information on various AI strategies that can automate business operations and create agility in fast-changing market trends and business environments at different stages of the garment supply chain. It discovered a broad absence of AI applications on product and customer data. Objectives without immediately focusing on financial performance. Discussion this thesis begins by emphasizing the importance of big data and (AI) in the garment supply chain to determine whether apparel organizations could improve company operations using big data and AI and give opportunities for extensive data management using AI. It also examines the existing literature on supply chain management.

Recommendation:

The scope of this thesis was limited to extensive data management and (AI). Still, it could be interesting to incorporate other emerging digital technologies such as virtual reality, augmented reality, the internet of things, and blockchain technology. Furthermore, the thesis focused on the RBV and the DCV by evaluating the various data-driven solutions using the VRIO framework. There are, however, other promising theoretical managerial frameworks that may reveal additional interesting managerial implications. The thesis did not address several essential management issues associated with big data, such as security, surveillance, organizational climate, technological structure, high cost, and variety. These, as encapsulated in this thesis, represent an especially promising future research avenue.

References

1. Aktas, E& Meng, Y. (2017), An Exploration of Big Data Practices in Retail Sector", Logistics, Vol. 1 No. 2, p. 12.
2. Biesdorf, S., David Court & Paul Willmott. (2013, Big Data: What's Your Plan?, available at: https://scholar.google.com/scholar
3. Bishop, C. (2006) , Pattern Recognition and Machine learning, available at: http://cds.cern.ch/record/998831/files/9780387 310732_TOC.pdf (accessed 30 August 2020).
4. Builtin.Com. (2002), "What Is Artificial Intelligence? How Does AI Work? | Built In". https://www.builtin.com/artificial-intelligence. (accessed 2 August 2021).
5. Career Design Lab. (2022), "The Future Of Fashion: From Design To Merchandising, How Tech Is Reshaping The Industry". Columbia University - School Of Professional Studies. https://careerdesignlab.sps.columbia.edu/blog/

2021/10/01/the-future-of-fashion-from-design-to-merchandising-how-tech-is-reshaping-the-industry/. (accessed 30 Jan, 2022).

6. Conca, J. (2015), Making Climate Change Fashionable - The Garment Industry Takes on Global Warming", available at: 72b40-warming/#8b979e4 (accessed 30 August 2020).

7. Ericsson, D. Sundström, M. (2012), Value Innovation and Demand Chain Management-keys to future success in the fashion industry", Nordic Textile Journal, Vol. 1, pp. 83–90.

8. Freno, A. (2017), "Practical lessons from developing a large-scale recommender system at Zalando", Proceedings of the Eleventh ACM Conference on Recommender Systems, Association for Computing Machinery, Inc,

10. Memedovic, O& Gereffi,G. (2003), the Global Apparel Value Chain: What Prospects for Upgrading by Developing Countries. available at:
    https://www.researchgate.net/profile/Gary_Gereffi/publication/228150738_The_Global_Apparel_Value_C (accessed 30 August 20201).

11. Mohri, M., Rostamizadeh, A& Talwalkar, A. (2012), Foundations of Machine Learning, MIT Press, available at: https://mitpress.mit.edu/books/foundations-machine-learning (accessed 30 August 2020).

12. Nikolina, S. (2019), Environmental Impact of Textile and Clothes Industry, available at:
    http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633143/EPRS_BRI(2019)633143_EN.pdf (accessed 30 August 2020).

13. Oussous, A., Benjelloun, F.,& Belfkih, S. (2018), Big Data technologies: A survey", Journal of King Saud University - Computer and Information Sciences, King Saud bin Abdulaziz University, October.

14. Zielnicki, K. (2019), "Simulacra and Selection: Clothing Set Recommendation at Stitch Fix", Association for Computing Machinery (ACM), Paris, pp. 1379–1380

15- https://www.builtin.com/artificial-intelligence (accessed 2 August 2021).

16- Khushboo Malhotra (2020) AI in the fashion industry, retieved from https://www.prescouter.com/2020/06/ai-in-the-fashion-industry/ (accessed 10 August 2021).

17- CB insights (2022) The Future of Fashion: From design to merchandising, how tech is reshaping the industry (accessed March 28, 2022) from www.cbinsights.com/research/fashion-tech-future-trends

18- New Cloth Market (2021), Use of Robots (Automation) in the Garment Industry retrieved form https://www.fibre2fashion.com/industry-article/7183/use-of-robots-automation-in-the-garment-industry (accessed 24 Jan, 2022).