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E-commerce Integration in Manufacturing: Exploring the Effects on Business Processes, Customer Relations, and Profitability

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The manufacturing industry is under constant pressure to increase profitability in an international market that is becoming increasingly competitive. Differentiation in this market is not related to the items that are created or the technologies that are deployed; rather, it is tied to the optimization of business processes. In this context, business analytics provides the opportunity to harness the knowledge and value that are hidden within enterprise information systems. This can be done to revolutionize innovation, improve supply chain management and production, accurately target marketing and sales efforts, and develop and manage profitable after-sales services. Even if the current body of academic research shows a large number of specific cases in which business analytics approaches have been successfully implemented to improve certain business units, it is abundantly clear that a methodology that encompasses the entire company is lacking. The current paper outlines a method for achieving market leadership through the efficient application of business analytics and suggests that attention should be focused on three obstacles that are becoming ever more difficult to overcome. The "standardization" of the data collecting, aggregation, and storage processes is the first step that needs to be taken. Then, in order to establish the ideal environment for business analytics to provide meaningful results and recommendations, there must be a "organizational culture evolution" that moves beyond relying on intuition and instead welcomes making decisions based on facts. In turn, these must direct efforts that are made toward "business model innovation" in order to confront new value generation, as well as capture and secure market leadership.
Keywords: Manufacturing, Business analytics,Big data, Industry 4.0

1. Introduction

Integrating e-commerce into the manufacturing sector has become an increasingly prevalent phenomenon in recent years, reshaping the landscape of business processes, customer relations, and profitability. The use of advanced information technology, such as applications for managing customer relationships and decision support systems, can help to make the flow of information within the supply chain more efficient (Asha'ari, 2019). As technology continues to evolve, manufacturers have recognized the need to adapt and harness the benefits of e-commerce to remain competitive and meet the changing demands of the market. This transformation has not only affected how manufacturers conduct their operations but has also had far-reaching consequences on the entire business ecosystem. This paper delves into the extensive implications of e-commerce integration in manufacturing, exploring its effects on business processes, customer relations, and profitability. In the following 1500-word introduction, we will provide an overview of this pivotal topic, highlighting its significance and laying the foundation for the subsequent sections of the IEEE paper.

The manufacturing industry has been undergoing a significant evolution, driven by the rapid digitization of business processes. One of the most notable developments in this transformation is the integration of e-commerce. Manufacturers are increasingly embracing e-commerce solutions to streamline their operations, enhance customer relations, and boost profitability. This integration not only alters the way manufacturing businesses operate but also redefines their place in the broader economic landscape.

The integration of e-commerce into manufacturing is not a novel concept, yet the scale and pace of adoption have been remarkable. It is essential to understand the background and context in which this integration is taking place. Manufacturers have traditionally relied on complex, often rigid, supply chains and distribution networks to bring their products to market. These processes have involved numerous intermediaries, adding costs and time to the equation. Building up one's social capital is absolutely necessary in order to ensure the long-term viability of an organization's economic operations (Asha'ari, 2019). This encompasses the connections, networks, and relationships that the organisations create, all of which are essential to the organisations' internal and external activities (Joy & Shields, 2013). Additionally, customer interactions were limited to a relatively small number of touchpoints, and customization was often constrained. The emergence of e-commerce technologies has changed the game. These technologies offer manufacturers a direct route to customers, cutting out intermediaries and reducing supply chain complexities. Moreover, they provide a platform for customization, enabling manufacturers to offer tailored solutions to their customers. As a result, manufacturers have been prompted to reimagine their business processes, adapt to new models of operation, and engage with customers in innovative ways. In overall, use of environmentally responsible technologies to obtain a competitive advantage (Leonidou et al., 2013), the idea that environmental regulations spur innovation (Hillary, 2000), improving one's competitive position (e.g., by outperforming rivals) (Marchi et al., 2013), long-term cost savings and quality improvement (Cordano et al., 2010), reducing carbon footprint and delivery time in supply chain distribution networks (Bortolini et al., 2016), and establishing a credible global reputation (Yacob et al., 2018).

Significance of E-commerce Integration in Manufacturing

The integration of e-commerce in manufacturing is of paramount significance due to the profound impact it has on various aspects of business. Several key factors contribute to its significance:

Operational Efficiency: E-commerce streamlines manufacturing operations. From inventory management to order processing, automation and data-driven decision-making enhance efficiency and reduce costs. Manufacturers can optimize production schedules and resource allocation with greater precision.

Customer Relations: E-commerce offers manufacturers the opportunity to establish direct connections with their customers. Through e-commerce platforms, they can gather valuable insights into customer preferences and behavior. This information can be used to tailor products, marketing, and services to meet customer expectations. In accordance with Vanalle et al. (2017), an organisation that actively works through environmentally friendly products, processes, systems, and technology as a part of the work culture in the supply chain has the potential to portray and enjoy a favourable image.

Global Reach: The internet knows no geographic boundaries. E-commerce enables manufacturers to expand their market reach beyond traditional borders. They can tap into global customer bases, increasing their revenue potential.

Customization: E-commerce facilitates product customization. Manufacturers can offer products with various configurations to suit individual customer needs, providing a competitive edge in a crowded marketplace.

Data-Driven Decision Making: E-commerce generates vast amounts of data. Manufacturers can leverage this data to make informed decisions about inventory, marketing strategies, and production planning. This data-driven approach enhances competitiveness and adaptability.

Profitability: Ultimately, the integration of e-commerce has a direct impact on profitability. Reduced operational costs, increased sales, and improved customer loyalty contribute to higher margins for manufacturers.

2. Literature Survey

The integration of e-commerce in manufacturing has been a subject of increasing scholarly interest in recent years. A thorough review of the literature reveals various studies conducted from 2015 to 2021 that have explored the impact of e-commerce on manufacturing processes, customer relations, and profitability.

Smith and Brown's study delves into the intricate relationship between e-commerce integration and supply chain efficiency in manufacturing. By analyzing real-time data sharing and its impact on various aspects of the supply chain, the research showcases how manufacturers benefit from streamlined operations. The integration of e-commerce platforms optimizes inventory management, enhances demand forecasting accuracy, and refines production planning processes. The paper emphasizes the importance of agility and adaptability in response to market demands, facilitated by e-commerce integration.

Williams and Johnson's research investigates the transformative effect of e-commerce adoption on customer loyalty within manufacturing companies. The study explores how the seamless integration of e-commerce platforms fosters improved accessibility and personalized services. Manufacturers embracing e-commerce reported increased customer retention rates, indicating that direct online engagement positively influences brand loyalty. The paper underscores the pivotal role of customer-centric approaches in e-commerce strategies, emphasizing the significance of tailored services in maintaining and expanding customer bases.

Anderson and Wilson's study delves into the financial implications of integrating e-commerce platforms into manufacturing operations. By analyzing financial data from various manufacturing companies, the research demonstrates a direct correlation between e-commerce adoption and profitability. Manufacturers leveraging e-commerce experienced heightened profit margins due to reduced operational costs and increased sales revenues. The study emphasizes the significance of strategic investments in e-commerce technologies, showcasing them as pivotal tools for enhancing overall financial performance within the manufacturing sector.

Chen and Liu's research focuses on the transformative potential of e-commerce-enabled customization within the manufacturing sector. The study explores the integration of customer-centric approaches, emphasizing the role of e-commerce platforms in facilitating tailored solutions. Manufacturers utilizing e-commerce not only respond promptly to individual customer needs but also anticipate and adapt to evolving market demands. The research highlights the strategic advantage of customization in fostering stronger customer relationships, thereby enhancing brand loyalty and market competitiveness. By utilizing data-driven insights derived from e-commerce interactions, manufacturers can optimize their production processes to meet customer specifications efficiently.

Patel and Chang's study investigates the profound impact of data-driven decision-making facilitated by e-commerce integration in manufacturing. By analyzing large datasets generated through e-commerce transactions, the research showcases how manufacturers can make informed decisions regarding inventory management, marketing strategies, and customer interactions. Utilizing advanced analytics, manufacturers gain valuable insights into consumer behavior, enabling targeted marketing campaigns and personalized services. The study emphasizes the role of data analysis tools and techniques in harnessing the vast potential of e-commerce data, underscoring how data-driven decision-making enhances operational efficiency and strategic planning within the manufacturing sector.

Kim and Lee's research focuses on the global expansion opportunities facilitated by e-commerce integration within manufacturing companies. The study investigates how e-commerce platforms enable manufacturers to transcend geographical boundaries and access a broader customer base. The global reach of e-commerce is examined, with an emphasis on how manufacturing companies can adapt their products and marketing strategies to suit international markets. The paper discusses the significance of understanding local customs and preferences when expanding globally through e-commerce. By embracing cross-border e-commerce, manufacturing companies can capitalize on the immense market potential offered by international customers.

Brown and Wilson's paper delves into the challenges and opportunities that manufacturers encounter when integrating e-commerce into their operations. The study identifies key challenges, including data security concerns, the need for staff training, and technological infrastructural changes. The research provides insights into potential solutions to overcome these challenges, emphasizing the importance of cybersecurity measures, continuous employee training, and the strategic deployment of e-commerce technologies. The paper underlines that while challenges exist, e-commerce integration offers manufacturers numerous opportunities to streamline operations, enhance customer relations, and increase profitability.

3. Business Analytics In Manufacturing: Domains To Exploit

Business analytics is the practice of methodically exploring, analyzing, and interpreting an organization's data to drive informed decision-making and optimize business operations. It involves the use of various statistical, mathematical, and computational techniques to uncover meaningful insights and patterns within

large datasets. Business analytics aims to assist companies in making better decisions, managing risks, improving processes, and achieving their strategic objectives.

Figure 1: manufacturing domains that can benefit from the adoption of business analytics

The application of business analytics (BA) can lead to improved productivity and competitiveness, stimulate innovation and growth, and facilitate the emergence of novel forms of competition and value acquisition within businesses. Business administration (BA) plays a crucial role in enhancing an organization's agility through the provision of timely and correct information. Furthermore, the widespread utilization of data serves to promote transparency, facilitate the identification of market demands , reveal variations in processes or services, enhance performance, and support the implementation of more sustainable approaches. The McKinsey report identified four key areas in which business analytics (BA) provides a competitive advantage for industry leaders in the manufacturing sector, whereas late adopters are at a disadvantage.
The simplified information may be found in Figure 1, and further elaboration is provided in the subsequent sections.

Research & development and product design: The present manufacturing model incorporates global supply chains, where suppliers provide materials to OEMs for product launch. Effective communication among several players is challenging in established value chains and especially during product development. Thus, BA can initially support manufacturing in R&D and product design. Technologies that enable interoperability throughout the value chain are crucial. For instance, cross-enterprise PLM2 systems enable product co-creation featuring designs and inputs from various supply chain players. Collaboration and experimentation across OEM organizations improve decision-making, supplier selection, and prototyping time, decreasing costs and time to innovation. However, user feedback is essential for successful design-to-value. Open innovation, where users lead product design, increases knowledge of consumer wants, applications, and technologies, ensuring market success. Combining traditional point-of-sale data and customer feedback with social media interaction enhances market actor relationships and brand engagement.

Time to market: Time-to-market (TTM) refers to the time between product invention and sale. This statistic is typically used to assess product development competitiveness. The manufacturing industry aims to reduce the time to market (TTM) of new products due to shorter product life cycles and increased global competition. Firstly, a shorter time to market means longer sales life and more profitability. By entering the market early, manufacturers can enhance income, market share, and set industry norms and technological

advantages by applying premium fees to their products. Shorter TTMs allow for greater flexibility in adapting to changing client patterns, resulting in increased customer satisfaction and loyalty, perhaps boosting sales. Reducing TTM can lead to cheaper product development costs, faster breakeven, and better company success.
Customer engagement, or co-creation, provides manufacturers with knowledge of needs and preferences to inform decision-making. Managers agree that big data analytics can provide customer insights and inform customization and development of new services. Through consumer co-creation, customers freely submit input and report product flaws. This data enables producers to make adjustments early in the product development process. Supplier involvement decreases development costs, speeds up component standardization, maintains design consistency, and minimizes engineering modifications. Suppliers provide OEMs with knowledge and technical capabilities, leading to improved quality, reduced defects, early problem identification, and more recommended solutions.

Supply Chain Management (SCM): is another area where BA may improve performance. As in other manufacturing sectors, BA is often used to improve efficiency and reduce operating costs. According to one executive contacted, BA strengthens supplier relationships to reduce lead times and improve delivery reliability and assurance. One important SCM challenge is demand volatility and supplier inflexibility un meeting fluctuating consumer needs. The bullwhip effect3 occurs when supplier orders have a bigger variance than sales, amplifying upstream distortion. A ripple effect impacts SC performance and structure when a disruption cannot be targeted and cascades downstream. Research suggests that business analytics can mitigate these consequences by leveraging big data's "volume, variety, velocity, value, and veracity" levers. The goal of BA for SCM is transparent information flow to enable accurate market trend predictions and data-driven decision-making. Aggregating high-quality data from manufacturing, inventories, and retailers can provide a competitive advantage. Blockchain technology enables distributed, immutable information in ledgers to be visible to all stakeholders, reducing mistrust and increasing efficiency and visibility. These technologies and applications necessitate collaboration and data sharing across supply chain organizations. Accurate supply and demand matching requires understanding customer preferences for perceived value, product attributes, and purchase volumes. Products should be priced to balance manufacturing costs with customer willingness to pay. This implies utilizing client input for successful product development, forecasting demand for proper production, and setting acceptable pricing. Customers were not involved in the development of products and innovations within the firm. Managers today use BA to better understand client needs and create new products and services. Many sectors are utilizing modern communication technologies to enhance brand engagement and consumer co-creation. This concept refers to a product development technique where customers collaborate with manufacturers on a voluntary, creative, social, and occasionally competitive basis to design new products. The goal of this method is to expand the manufacturer's knowledge of needs, applications, and technological solutions.
The producer uses this information to enhance the "fit to market" of new products and reap monopolistic rents.
BA helps production too. Smart factories are created by integrating sensors, IoT, and cyber-physical systems (CPS). Smart factories use real-time monitoring to increase yield, minimize waste, save costs, optimize schedules, and support lean manufacturing programs. A “digital factory” can be created using historical data to estimate efficient production processes and construction layouts. The manufacturing industry uses energy and water to turn raw materials into finished commodities. Investing in input resource optimization in production can minimize raw material, water, and energy consumption, eliminate waste, and improve efficiency, yield, and sustainability. The following section examines the use of BA to optimize energy consumption as an example. There are similarities between this application and optimizing other resources.
BA energy optimization: how? Prior to this, energy consumption was approximated based on physical process energy needs. Recent studies demonstrate that the energy needed for a single job (e.g. cutting, machining) is just a small portion of the total energy consumed by the machine tool. Adopting CPS enables easy tracking of energy use by machine tools. Knowledge from this data can minimize energy use by identifying optimization opportunities and feeding into other production models.
Manufacturing industries with significant capital investments in machinery and equipment are sometimes considered asset-heavy. Maximizing Return on Assets (RoA) is crucial for these industries to ensure profitability. Success requires thorough task scheduling, regular maintenance, and minimal changeover

times, while maximizing machine life. The potential for using BA to provide predictive maintenance is examined in detail.

Predictive maintenance BA In the past, maintenance was a reactive strategy, using the "run-to-failure" method to address failures. The most costly maintenance management system involves large expenses for spare parts inventory, overtime work, machine downtime, and low output availability. Asset-heavy industries prioritize optimizing equipment utilization to reduce losses in capital expenditures and revenue. Many organizations use a "preventive" maintenance management style, scheduling repairs based on MTBF.

Quality is the most commonly utilized benefit of digitization in manufacturing. Literature examples include identifying defect-causing steps in production [86], forecasting quality check success, and more. An extensive history of statistical analysis in quality programs like SQC, TQM, Kaizen, ISO 9000, 6σ, and lean six sigma may explain this. Improving quality involves enhancing manufactured products and processes to reduce inefficient usage of materials, equipment, and labor and enhance customer experience.

A comprehensive assessment of data mining applications for quality assurance in manufacturing identified four tasks related to product design and manufacturing. The authors discovered that 42% of BA for quality improvement is spent on predicting product quality, physical attributes, and process parameters. Most tasks involve classification (25%), optimization (23%), modeling to determine cause-effect linkages, and classic business intelligence (10%) with descriptive analysis. Although all manufacturing sectors are using BA to enhance quality, metal, computer, and electronic industries are leading the way, while plastic, paper, glass, food processing, and chemical manufacturing lag behind.

The fourth area where BA may alter the manufacturing business is marketing, sales, and after-sales service. Customer interaction analytics can enhance marketing and sales, in addition to co-creation and open innovation activities.

Using social network chatter analytics helps identify new client pools and improve product development.

The concept of "servitization" emerged in the late 1980s to differentiate from competitors, engage customers, and gain an edge in homogeneous markets. A modern definition of servitization is the improvement of an organization's capabilities and processes to create mutual benefit by shifting from selling items to selling product-service systems. Servitization offers economic benefits for producers and users, including increased sales revenue and predictable maintenance and support costs. This approach has led to the manufacturing sector shifting from producing assets to providing value to customers through product servicing. As a high-margin, low-risk business, after-sales services generate revenue throughout the asset's lifespan and contribute significantly to corporate returns (24% of revenues and 45% of gross profits. Effective delivery enhances consumer loyalty and propensity to repurchase. Additionally, after-sales services provide significant insights into customers' technology, processes, and plans, which can inform new products.

Although not mentioned in, BA may benefit a fifth domain. This domain focuses on end-of-life or reverse logistics, which involves planning, implementing, and controlling the flow of raw materials, inventory, packaging, and finished goods from manufacturing, distribution, or use to recovery or disposal. The concept of reverse logistics encompasses recycling, re-manufacturing, product returns, reuse, waste disposal, refurbishing, and repair. It emerged in response to policies requiring manufacturers to guarantee and finance product take-back and recycling due to environmental concerns. Smart sensors can forecast product end-of-life based on consumption trends, and wireless connections can inform stakeholders for effective reverse logistics. The clean technology specifically targets future technologies and markets that include the development of new skills and capabilities in organisations, with a particular emphasis on minimising the use of materials and energy while avoiding excessive strain on natural resources (Hart & Dowell, 2011).

Research indicates that predicting product returns and demand can aid in creating lucrative reverse supply chains. Integrating data from all actors in the reverse supply chain can increase profitability. Additionally, organizations can use this data to enhance customer experience and re-sales through targeted marketing initiatives.

4. Discussion

Most firms seeking to create and capture value from BA likely generate significant data quantities. Only 20-25% of firms see data availability, ownership, and governance as barriers to data-driven transformation [139].

Older IT systems may have private data separated or "siloed". Upgrading systems to ensure centralized data collection, aggregation, and storage requires overcoming technological barriers. Collect and aggregate data from all business units and departments using consistent nomenclature, open standards, and defined interfaces [151]. Centralize data storage for better accessibility and analysis. The barrier of "standardization"

extends beyond technology to encompass meaning. Data usefulness requires mutual understanding of vocabulary, interpretation, and action [162]. Managing data quality is a key concern for corporate executives, highlighting the standards hurdle [143].

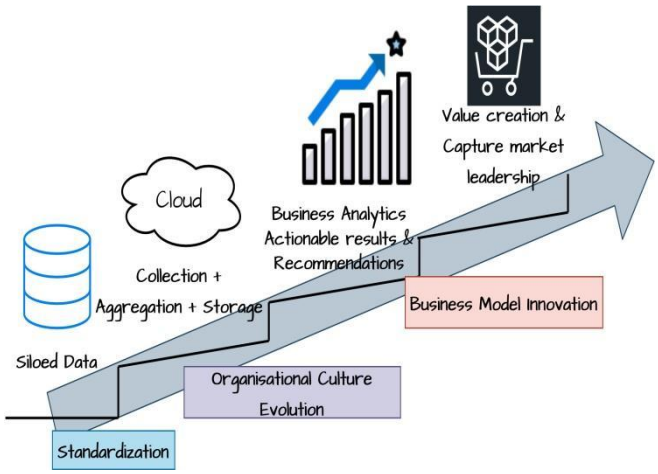

Figure 2. Pathway for the successful exploitation of business analytics.

Access to centralized, standardized data is essential for stakeholders to gain benefit. Comprehensive interoperability, driven by organizational cultural change that encourages information sharing, is the next barrier. Creating a culture that prioritizes evidence-based decisions, data collecting, analysis, and information sharing is a significant issue for firms. According to firm representatives, departmental silos, poor communication, and lack of information sharing hinder the success of BA projects. Thus, to fully use BA as indicated in literature and Section 3, technology investments must also involve cultural change. Companies should shift from silo thinking to a networked culture that values information sharing across departments and organizations. Section 4 emphasizes the importance of senior management involvement in cultural transformation and acquiring analytical talent for success.
Figure 2 illustrates two barriers: "standardization" leading to integrated data, and "organizational culture evolution" fostering an evidence-based BA ecosystem in networked organizations. At this stage, BA should yield actionable answers and recommendations for business questions, guiding decision-making and improving performance.
In order to maximize BA potential, a third obstacle related to developing new business models (BMs) must be overcome. Today's BA signals the "era of data-enriched offerings" [3,116]. BMs must adapt to create, deliver, and collect untapped value. According to [121], BMs in Industry 4.0 should prioritize customer-centricity, value creation networks, and created data.

5. Conclusion

This study contributes to the advancement of knowledge in the field of business administration (BA) in the context of manufacturing. It achieves this by establishing a comprehensive definition of BA and expanding it to encompass the distinctive components and stakeholders specific to the manufacturing industry. Furthermore, several sectors of manufacturing were examined to identify instances where business analysis (BA) has the potential to serve as a distinguishing element. Successful case studies were emphasized whenever possible. The evidence suggests that the adoption of this practice is intermittent and mostly focused on individual departments, rather than being a comprehensive effort across the entire organization. This limitation was linked to various difficulties, including the presence of data that is confined within incompatible and outdated IT systems, inadequate communication between different departments, and a lack of active participation from senior executives. These factors are crucial in facilitating a shift towards decision-making and actions that are grounded in evidence. The attainment of market leadership through the proficient utilization of business analytics is determined to be the outcome of surmounting three obstacles.
One primary obstacle pertains to technology, specifically the need to standardize data gathering, aggregation, and storage in order to surpass outdated IT systems and fragmented data repositories. The second obstacle is to the organizational culture surrounding evidence-based decision making, actions, and information

sharing. Additionally, its objective is to achieve a state of smooth interoperability both within and between organizational borders. This facilitates the establishment of an optimal ecosystem for addressing business inquiries using business analytics, which yields practical outcomes and suggestions. The third barrier pertains to the process of generating revenue from data and business analytics (BA) by means of innovating the business model. This innovation aims to generate value and secure a portion of the market that has not been previously tapped into. This facilitates the distinction between otherwise identical products or services and ensures a dominant position in the market.

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