The Effectiveness of Business Intelligence Management Implementation in Industry 4.0

Lee Kyung Choi1, Aropria Saulina Panjaitan2, Dwi Apriliasari3

Information System, University of Miyazaki, Japan
Information System, University of Esa Unggul, Indonesia
Information System, University of Raharja, Indonesia

Email: leekyungchoi@yahoo.com1, ria.panjaitan@esaunggul.ac.id1, dwi.apriliasari@raharja.info3

Article Info
DOI: https://doi.org/10.34306/sabda.v1i2.106

ABSTRACT
Changes in business processes that run very fast in the industrial era 4.0 have positive and negative impacts on business players. Industry 4.0 is a technology that companies need to promote Industry 4.0 is a technology that businesses need to promote innovation strategies and respond quickly in a volatile market. It primarily focuses on interconnectivity, digital technology, predictive analytics, and machine learning to transform the way businesses operate and thrive. As a result, this article suggests and encourages the implementation of Industry 4.0 in organizations. Examining the current state of business intelligence (BI), how it is positively impacting organizations at the economic and business levels in terms of decision making, and some success stories applied across various business, academic, social, and government circles. Furthermore, it discusses the expected future of Industry 4.0, particularly in BI, and how businesses should prepare for this revolution. This article contributes knowledge about the current state and positive consequences of Industry 4.0, as well as the rapid advancement of technology when implemented in organizations and the harmonization of production and intelligent digital technology.

Keywords: Industry 4.0, Business Intelligence Management, Digital Transformations

This is an open access article under the CC BY 4.0 license.

Corresponding Author:
Information System, University of Raharja, Indonesia
Email: dwi.apriliasari@raharja.info

1. INTRODUCTION
Artificial intelligence in the industrial era 4.0 has been widely used, both in the industrial/manufacturing world, economy, education, services, and finance. But of course
the application and development of artificial intelligence will have a negative and positive impact on the ecosystem of human resource development. The negative impacts, for example, are the reduction of employees who supervise transaction activities, reduction of employees for the production process of goods, reduction of employees for the field of analysis, are simple examples. While positive things that are felt include the production process using intelligent robots, automatic answering machines in the field of customer service and the emergence of several e-commerce.

**Figure 1. E-commerce transaction**

In the context of business process management, of course, the role of artificial intelligence is quite significant. In conventional business processes, the role of humans is quite dominant, for example in terms of monitoring production, sales, inventory, finance, and others. Artificial intelligence has gradually begun to take on a human role, especially in activities that require complex computational processes and large data volumes, a quite real example in the development of industry 4.0 [1] is digital transactions carried out in several e-commerce (Figure 1). The presence of artificial intelligence has an impact on developments in business intelligence management, which currently has quite significant and massive developments. Business intelligence (BI) is defined as a decision-making process aided by the integration and analysis of an organization's data resources. In fact, BI is becoming increasingly important in some types of businesses because, as the most valuable asset of a company, information is a critical resource for its growth. Making better business intelligence decisions necessitates a strong data base that is available and accessible at all times throughout the organization, from strategic to operational levels [2][3].

The data warehouse, which stores all relevant internal and external data, is frequently regarded as the heart of BI. The quality and format of data sources vary, as do their meanings, depending on their origin. Data is now more granular and produced in much larger volumes than ever before. Extract, Transform, and Load are common methods for integrating this data and ensuring its validity and utility to an organization. Furthermore, the tool cleans the data before storing it in the data warehouse and preparing it for BI tasks. These are the back-end processes of a traditional BI system. When data is available in a central data warehouse, different media server levels are used for data analysis, which serves as the foundation of the basis of the decision reports used by decision makers [3].

Today, because data is a new economic asset class, similar to currency or gold, BI has become a challenge for Industry 4.0 as well as a critical management issue. The significance of developing analytical-based decision-making capabilities reflected in computer software and systems has been specifically recognized. The business environment is becoming more complex as Industry 4.0 takes shape. Companies need innovation and advanced technology to respond quickly in this dynamic market. In this context, technological tools such as Business Intelligence (BI) are required to process information as well as make enterprise-level decisions. There are various levels of power and ordinary users required to run the entire BI system. Power users are BI experts who
retrieve the data required to create reports that serve as the foundation for decision making [4]. Managers and decision makers are typically ordinary users who base their decisions in an organization on these reports. Ordinary users typically have less experience with data use and analysis than power users. When a technology tool like BI is implemented in a company, it provides several benefits such as architecture, efficient information management, and customer data management. Companies can gain a better understanding of the importance of BI in all of these different environments by taking this approach.

Today, because data is a new economic asset class, similar to currency or gold, BI has become a challenge for Industry 4.0 as well as a critical management issue. The significance of developing analytical-based decision-making capabilities reflected in computer software and systems has been specifically recognized [5]. The business environment is becoming more complex as Industry 4.0 takes shape. Companies need innovation and advanced technology to respond quickly in this dynamic market. In this context, technological tools such as Business Intelligence (BI) are required to process information as well as make enterprise-level decisions. There are various levels of power and ordinary users required to run the entire BI system. Power users are BI experts who retrieve the data required to create reports that serve as the foundation for decision making. Managers and decision makers are typically ordinary users who base their decisions in an organization on these reports. Ordinary users typically have less experience with data use and analysis than power users. When a technology tool like BI is implemented in a company, it provides several benefits such as architecture, efficient information management, and customer data management [6]. Companies can gain a better understanding of the importance of BI in all of these different environments by taking this approach [7].

This study will present 5 chapters, starting from an introductory discussion which is the background in conducting this research, then a literature review which contains several studies and detailed background of the elements to be examined in the study. In chapter 3, we will discuss the methods used in solving the problem, then the results of the research obtained from the data of the methods used will be presented and finally there will be a conclusion of the overall research.

2. LITERATURE REVIEW
2.1. Industry 4.0
The modern industrial revolution lasted hundreds of years, and the Industry 4.0 era has just begun. In 2011, the concept of Industry 4.0 was first proposed for the development of the German economy. The ongoing Industry 4.0, with the characteristics of cyber-physical system (CPS) production, includes the integrity of knowledge with the use of heterogeneous data.
CPS's primary role is to meet the challenges of active and dynamic production. CPS Industry 4.0 is based on key technologies (Figure 2) that aim to improve the overall efficiency and effectiveness of the industry. Enterprise resource planning (ERP), radio-frequency identification (RFID), Internet of Things (IoT), cloud computing, additive manufacturing, augmented reality, and collaborative robotics with machine learning and big data are all part of Industry 4.0. [8]. Automation, digitization, allocation, production, optimization, and adaptation of human-machine interactions [9], as well as value-added processes and communications enterprises based on automated data exchange, are potential characteristics of Industry 4.0.

The introduction of smart factories in Industry 4.0 was marked by extensive development of digitization and automation with the application of Information Technology (IT) and electronic devices in services and manufacturing [10]. Big data, cloud computing, IoT, mobile computing [11], and RFID are playing an important role in Industry 4.0.

2.1. Business Intelligence

Business intelligence is a set of technical tools and techniques that provide users with historical data for analysis and reporting, assisting management in making important decisions and improving the efficiency of business processes. Organizations can use Business Intelligence (BI) to not only maintain competitiveness, but also to increase revenue by improving decision making. Researchers and practitioners agree that BI technology has received a lot of attention from organizations and industries. According to the Gartner Group survey, nearly 80% of US firms and 50% of European firms have implemented BIS [12]. The use of BI can provide numerous benefits to businesses. BI has several notable characteristics, including attracting the attention of decision makers to adopt this innovation in modern business. By transforming internal and external data into meaningful information that guides the company to remain sustainable and competitive, BI simplifies the analytical process of a company's market position, capabilities, operations, and objectives [13]. A large industry survey conducted by Hannula and Pirttimäki and Olexov confirmed the perceived benefits of Business Intelligence adoption (BI). The following are the most significant benefits of BI adoption:

- Obtaining quality information for decision making (95%)
- Improved ability to analyze expected opportunities and threats (83%)
- Improved organizational/company knowledge (76%)
- Improved information sharing (73%)
- Better analysis and information retrieval (58%)
- Faster decision making (54%)
- More accurate and faster reporting (82%)
- Improved decision-making quality (78%)
- Improved customer service (58%)

Wixom and Watson reveal [14] that most of the perceived benefits are intangible because they are difficult to measure. Various benefits that may be achieved with BIS integration are shown in Figure 3.
3. METHOD

This study used a qualitative data collection method, analyzing several previous research documents as well as solutions for implementing BI management in the coming years [14]. The following electronic sources were used to select documents for this paper: MDPI, IEEE, Scopus, and Science Direct. As a pioneer in knowledge base technology and having conducted extensive research, these sources of information were chosen as the basis for indexing and cataloging as Q1 to Q3. Review articles can be divided into several categories based on their purpose, evaluation, reasoning, and examination. Table 1 shows a list of the main categories and methodological aspects of search, analysis, and synthesis found in [10].

Table 1. Stages of Research Methods

| No | Stages  | of Information |
|----|---------|----------------|
| 1. | Identification | The research databases used are sourced from IEEE, Scopus and Science Direct research |
| 2. | Screening | Year of publication (maximum 5 years of the last publication) |
| 3. | Feasibility | The selected documents must be complete from the core of the problem to the results obtained |
| 4. | The scope | Research taken will be related to existing research, which will discuss BI, Big data as well as IoT and industry 4.0. |

Based on the stages and conditions of the method carried out, the results of data collection will be attached to chapter 4 regarding the results and discussion of the research.

4. RESULTS AND DISCUSSION
Business intelligence has become a requirement for strategic decision making in corporations and governments all over the world. It is critical for business survival, maintaining relationships with other companies, counterintelligence, goals, and both short-term and long-term objectives. Furthermore, studies [11] confirm the benefits of BI implementation, such as improved performance, efficiency, productivity, business growth, resource planning, supplier-buyer relationships, and cost reduction, all of which can lead to a competitive advantage [12]. According to this research, The factors that motivate BI investigations have been divided into five categories: skills and qualifications, factors for successful implementation, literature, user satisfaction, and competitive advantage.

Sources define Industry 4.0 as “a concept used to describe technological advancements that provide the basis for increasing the level of digitization of the industry and the business environment” [13]. Usually when discussing the development of Industry 4.0, four main components are distinguished. The key components are shown in Figure 4.

![Figure 4. Key Components of Industry 4.0](image)

According to the information consulted and depicted in Figure 4, Core Technologies have a 68 percent impact on Industry 4.0. This 68 percent has been reflected in organizations with high Big Data and Artificial Intelligence implementation, providing organizational development and several advantages for key asset management. On the other hand [15], it provides predictive analytics for making high-value decisions. Virtual reality and 3D printing can also help with training and operational processes [14, 15]. In other words [16], Industry 4.0 is becoming increasingly important to organizations on a daily basis. Second, we have the Internet of Things, which is growing at an exponential rate and has risen above the key components. Cyber–physical systems and smart factories are still evolving gain strength [17].

Users must be able to quickly access data and information to make the right decisions wherever they are in the Industrial Revolution 4.0, which is defined by the extensive use of various technologies in all fields [18], particularly the Internet [17]. Industry 4.0 is a process that results in technological transformations in the design, production [19], and distribution of systems and manufacturing products, with an emphasis on automated and interconnected industrial production. This has a significant impact not only on the production process [20], but also on project management in the company [19], operations, and the future of the region, and understanding the phenomena occurring in the social and economic spheres, as well as human resources, is critical. Industry 4.0 has been shown to contribute to overall efficiency improvements in sustainability (clean and renewable energy), adaptive work environment, financial performance and innovation [20].

"Industry 4.0" refers to the era of smart factories [21]. The term was first used in 2011 at the Hannover Fair. Industry 4.0 awareness and the vision of a "smart factory" emerged as a result of a government project to encourage the use of information technology in manufacturing; thus, it is closely related to industry, technology, and operations.
Automation [22]. Furthermore, as a government procurement specialist in Florida points out, this implies that a portion of the intelligence gathered by organizations should be centered on doing business with the government [23]. Market intelligence and business intelligence (BI) are the keys to the development of smart factories in this era. Market intelligence is the cornerstone of the marketing concept; it is critical for strategic planning and marketing implementation [24]. Despite the widely acknowledged importance of market intelligence, managers continue to face challenges in ensuring the generation, deployment, and responsiveness of market intelligence across organizations. When implementing BI in their organizations, enterprise managers face a challenge in identifying tools that are highly effective and have a significant impact. Table 3 compares these business intelligence tools based on the survey results.

**Table 2. Application Analysis Business Intelligence**

| No | Tools       | functions                                                                 |
|----|-------------|--------------------------------------------------------------------------|
| 1  | Tableau     | Used to visualize the data of a product                                  |
| 2  | Cognos      | Used to display product performance management                           |
| 3  | Sisene      | Analyzes and visualizes large data sets and an ideal tool for building interactive dashboards |
| 4  | Microsoft BI| Analyzing and visualizing large data sets and ideal tools for building interactive dashboards |
| 5  | Nundas BI   | Data Visualization                                                       |

Information generated through different reports is provided by the source database (such as: social networks and news websites which in practice can be heterogeneous). The above collections pose difficulties in managing and organizing complete information and they have been optimized using different algorithms to reach the best decisions for the company [25]. One of several algorithms delivered through research that discusses the implementation path and configuration of a large-scale reinforcement learning model in data scenarios. Then, it uses the relevant background of the zero inventory case and the current zero inventory situation [26]. Furthermore, specific applications that are strengthened by learning methods in BI are validated through an assessment with zero-inventory case applications in companies that use the Q-learning algorithm. In this way, the authors prove that the enhanced learning method can be used to solve certain practical problems [27].

A study shows that organizations increasingly expect their employees to make data-driven decisions to gain a competitive advantage. This expectation requires greater flexibility and support for faster decision making. Classic BI reporting standards often do not quite meet these demands [28]. The use of Self-Service BI (SSBI) software has provided increased flexibility, and thus has been instrumental in meeting these new demands [29]. As a result, this software can help reduce the workload of the IT department and free up resources for other activities. However, the application of the SSBI software alone does not necessarily lead to a better BI environment. It has been determined that, in order to realize the full potential of a BI environment, a change in culture and behavior is required [30].
5. CONCLUSION

Sustainable development and the circular economy are critical issues for business growth and market competition. Reconfiguration of production processes to reduce their impact on natural systems, development of new environmentally friendly products, and redesign of business models are examples of programs that seek to integrate sustainability with industrial activities. The use of information and management support tools is central to the enterprise digitization evaluation. One study looked at the integration of Enterprise Resource Planning (ERP) and Business Intelligence (BI), which had previously been used independently when migrating to Industry 4.0 technologies. Centralized functions such as R&D, asset optimization, enterprise planning (strategy, investment planning, finance), and supply chain, among others, add significant business value. The integration of these functions across Industry 4.0 provides significant business value, both strategically and operationally. Figure 5 depicts the primary goals of the resulting digital transformation.

**Figure 5. Objectives of Digital Transformation**

If we continue to examine the digital transformation process for BI, advanced digital technologies such as the Internet of Things, Big Data analytics, and data visualization have created highly automated industries in the Industry 4.0 era [46]. This technology has recently become popular in the industry as a dashboard, a BI tool that provides corporate executives and business managers with analytical data insights.

In summary, this study concludes that technologies such as big data, BI, and the Internet are the true development pillars for businesses because they aid in decision making, forecasting, and corporate economics. Development will be accelerated if these technologies are supported by effective leadership and training. Furthermore, this research demonstrates that the application of this technology, when combined with the proper use of their main asset, namely information, drives companies to success. Furthermore, BI technology assists businesses in achieving their primary business objectives. This study emphasizes the significance of integrating ERP, IoT, and BI technologies in order to contribute to growth in all aspects of the organization, beginning with operational changes and concluding with a decisive basis for managerial decision-making.

ACKNOWLEDGEMENTS

Author would like to thank University of Raharja and Alphabet Incubator for the completion of the journal on inputting the title The Effectiveness of Business Intelligence Management Implementation in Industry 4.0.

REFERENCES

[1] U. Rahardja, Q. Aini, Y. I. Graha, and M. R. Tangkaw, “Gamification Framework Design of Management Education and Development in Industrial Revolution 4.0,” *J Phys Conf Ser*, vol. 1364, no. 1, pp. 0–13, 2019, doi: 10.1088/1742-6596/1364/1/012035.
The Effectiveness of Business...

[2] D. Darmaji, D. Kurniawan, A. Astalini, A. Lumbantoruan, and S. Samosir, “Mobile learning in higher education for the industrial revolution 4.0: Perception and response of physics practicum,” 2019.

[3] Sudaryono, U. Rahardja, and E. P. Harahap, “Implementation of Information Planning and Strategies Industrial Technology 4.0 to Improve Business Intelligence Performance on Official Site APTISI,” J Phys Conf Ser, vol. 1179, no. 1, pp. 0–7, 2019, doi: 10.1088/1742-6596/1179/1/012111.

[4] Q. Aini, U. Rahardja, I. Handayani, M. Hardini, and A. Ali, “Utilization of google spreadsheets as activity information media at the official site alphabet incubator,” in Proceedings of the International Conference on Industrial Engineering and Operations Management, 2019, pp. 1330–1341.

[5] N. Sany and M. Kurniawan, “Sistem Informasi Surat Masuk Pada Pengelolaan Rantai Suplai Satuan Kerja Khusus Migas,” TMJ (Technomedia Journal) Vol. 5 No. 1 Agustus 2020, p. 27, 2021.

[6] M. R. Anwar, M. Yusup, S. Millah, and S. Purnama, “The Role of Business Incubators in Developing Local Digital Startups in Indonesia,” Startprenuer Bisnis Digital, vol. 1, no. 1 April, pp. 1–10, 2022.

[7] L. Sunarya, A. D. Purbayani, and N. Handayani, “Media Video Promosi Pada Roofpark Cafe & Restaurant Pucak Bogor Jawa Barat,” TMJ (Technomedia Journal) Vol. 5 No. 2 Februari 2021, p. 220, 2021.

[8] N. Septiani, A. S. Bist, C. S. Bangun, and E. Dolan, “Digital Business Student Development for Entrepreneurs with Software,” Startprenuer Bisnis Digital, vol. 1, no. 1 April, 2022.

[9] D. Supriyanti, C. S. Kesumawati, and S. Maryam, “Design Information System Stock Inventory To Manage Data Of Goods (Case Study: PT Monier),” Aptisi Transactions On Management, vol. 4, no. 1, pp. 22–31, 2020.

[10] Henderi, Q. Aini, N. P. L. Santoso, A. Faturahman, and U. Rahardja, “A proposed gamification framework for smart attendance system using rule base,” Journal of Advanced Research in Dynamical and Control Systems, vol. 12, no. 2, pp. 1827–1838, 2020, doi: 10.5373/JARDCS/V12I2/S20201226.

[11] M. B. Djatmiko, A. Husain, G. Maulani, and L. Nirmalasari, “Analyze and Record a Series of Corporate Sales Transactions On Web Based Accounting Online System,” Aptisi Transactions On Management, vol. 1, no. 2, pp. 103–115, 2017.

[12] V. G. Khalin and G. v Chernova, “Digitalization and its impact on the Russian economy and society: advantages, challenges, threats and risks,” Administrative Consulting, 2018.

[13] M. Mehrvarz, E. Heidari, M. Farrokhnia, and O. Noroozi, “The mediating role of digital informal learning in the relationship between students’ digital competence and their academic performance,” Comput Educ, vol. 167, p. 104184, 2021.

[14] S. Watini, H. Latifah, D. Rudianto, and N. A. Santoso, “Adaptation of Digital Marketing of Coffee MSME Products to Digital Transformation in the Era of the Covid-19 Pandemic,” Startprenuer Bisnis Digital, vol. 1, no. 1 April, pp. 23–32, 2022.

[15] R. J. Lennox et al., “Envisioning the future of aquatic animal tracking: technology, science, and application,” Bioscience, vol. 67, no. 10, pp. 884–896, 2017.

[16] P. A. Sunarya, Q. Aini, A. S. Bein, and P. Nursaputri, “The Implementation Of Viewboard Of The Head Of Department As A Media For Student Information Is Worth Doing Final Research,” ITSDI Journal Edition Vol. 1 No. 1 October 2019, p. 18, 2019.

[17] B. N. Bhakti, Y. Nurfaizal, and T. Anwar, “Analisis Komparasi Teknik Rendering Blender Render Dan Cycles Render Pada Video Animasi 3d Tentang Alat Pencernaan Manusia,” Technomedia Journal, vol. 6, no. 2 Februari, pp. 188–196, 2022.

[18] N. H. Munthe, F. I. Hartanto, and D. A. Syampurna, “Implementasi Sistem Monitoring Laporan Kerja Praktek Lapangan Berbasis Web Pada SMK Citra Madani Kabupaten Tangerang,” Technomedia Journal, vol. 6, no. 2 Februari, pp. 212–222, 2022.
The Effectiveness of Business...
## BIOGRAPHIES OF AUTHORS

| Author                                      | Description                                                                                                                                                                                                 | Contact                                                                 |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Aropria Saulina Panjaitan                   | Lecturer at Esa Unggul University who is currently actively writing articles for various scientific journals and has produced several research results and other articles.                                      | ria.panjaitan@esaunggul.ac.id                                         |
| Dwi Apriliasari (Student Member, IEEE)      | Runs an undergraduate program with the Faculty of Science and Technology at University of Raharja. She has 8 research studies. Areas of interest are Information Systems, Business Intelligence, Blockchain. | dwi.apriliasari@raharja.info                                         |