Industrial 4.0 of Service and Manufacturing in Java-Indonesia: Level of Implementation

(*Industri 4.0 pada Sektor Jasa dan Manufaktur di Jawa-Indonesia: Tingkat Implementasi*)

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Abstrak. Penerapan industri 4.0 telah dilakukan di banyak negara di dunia saat ini bahkan beberapa negara maju telah menuju ke industri 5.0, namun demikian di Indonesia masih banyak perusahaan yang belum menerapkan industri 4.0. Penelitian ini bertujuan untuk mengetahui sejauh mana implementasi industri 4.0 di Indonesia khususnya industri yang berada di pulau Jawa**.** Aspek industri 4.0 sebagai tolok ukur pembeda dari perkembangan industri sebelumnya patut diteliti untuk mengetahui ting kat aplikasinya di industri jasa dan manufaktur. Meskipun banyak industri masih menggabungkan sistem operasinya antara industri 4.0 dan sistem operasi konvensional. Populasi penelitian ini adalah perusahaan jasa dan perusahaan manufaktur. Data tersebut diperoleh dengan menggunakan kuesioner yang didistribusikan secara online kepada responden dengan metode *purposive sampling*. Data dikelompokkan sesuai dengan tingkat implementasi dan dipusatkan. Perhitungan dan persentase hasil menunjukkan bahwa tingkat implementasi industri 4.0 dengan basis teknologi di perusahaan jasa dan perusahaan manufaktur berada pada tingkat yang dikelola. Ini menggambarkan bahwa perusahaan yang sedang diteliti belum sepenuhnya pada tuntutan industri 4.0.

Kata kunci:aspek industri 4.0, tingkat implementasi, perusahaan jasa,perusahaan manufaktur.

Abstract. *The application of industry 4.0 has been doing in many countries in the world today even some developed countries have headed to industry 5.0, nevertheless in Indonesia there are still many companies that have not implemented industry 4.0. This research aims to find out the extent of the implementation of industry 4.0 in Indonesia, especially the industry located on the island of Java.The industry 4.0 aspects as a benchmark of differentiator from previous industrial developments is worth scrutinized to know its application levels in the service and manufacturing industries. Although many industries still combine their operating system between the 4.0 industry and conventional operating systems. The populations are the services and manufacturing companies. The data was obtained by using a questionnaire distributed online to respondents with a purposive sampling method. The data was grouped according to The level of implementation and is centered. The calculation and percentage results demonstrate that the level of implementation of the 4.0 industry with a technology base in service companies and manufacturing companies are at a managed level. It illustrates that the companies being researched have not been fully on the demands of the 4.0 industry.*

Key word: industrial aspect 4.0; level of implementation; service company; manufacturing company.

1. Introduction

The 4.0 industries characterized by everything related to the Internet, information becomes more transparent that is used in decision making, robots can help physical work that is harmful to humans, and automation is done by machines for repetitive work where corporate values can be pushed up in addressing environmental and financial impacts (Carli & Dotoli, 2017) as well as aging workers (Boenzi, 2016). Thus unable to complete the complexity of product diversification (Ślusarczyk, 2018). The industry aspects of 4.0 are; standardization, modeling, network communication, efficient use of resources, regulation, human

resources, Cyber--Physical System technology, Smart Factory, business, design work, services, engineering of the final product, organizational form and management (Prasetyo & Sutopo, 2018), reduce production costs and energy consumption.

There is a fairly wide gap in the technological side among industries that have yet to implement an aspect of 4.0 with those implementing the 4.0 aspect (Qin, et.al., 2016). The previous study (Balasingham, 2016) also shows the company's reluctance factor in implementing the 4.0 industry for worrying about the uncertainty of its benefits. So it is necessary strategic planning by researchers, entrepreneurs, and governments who can solve the problems of implementing industry aspects 4.0 include; The application of technology, knowledge development, political situation, social and economic (Zhou, 2015). In MSMEs, The adoption of cloud computing uses aspects of technology, organization, and environment (TOE), where research shows that aspects of TOE affect the adoption of cloud computing and the performance of MSMEs (Rianita, et.al., 2020).

Manufacturing companies will gain increased profits by applying the 4.0 aspects due to lean and just in time production, so it can result in decrease cost; (a) 10-30% in production, (b) 10-30% in logistic, (c) 10-20% in quality management. Other benefits if industry 4.0; faster to launch a new product, increasing customer awareness, lower cost in production, environmentally friendly, and less use of natural resources and energy (Rojko, 2017).The application of the 4.0 industry requires researchers in terms of planning and developing aspects of the 4.0 (Kagerman, et.al., 2013).

A roadmap of technological development to realize the 4.0 industry is still not directed (Qin, 2016). The impact of implementing industrial aspects 4.0 including; Environmentally friendly technology, the possibility of natural disasters, the inability of resources, unstable political situation, social conditions due to demographic change will be a challenge for a country, although on the other hand the application of industrial aspects 4.0 also provides many advantages and benefits (Drath & Horch, 2014) .

Disruptive happened like Gojek that sank one of the biggest taxi companies in Indonesia Blue Bird in the end to cooperate in the use of applications. For that which is developing nowadays is economic sharing that is economic sharing so that among business actors no longer talk competition, but the partnership. The 4.0 Industrial Revolution is a revolution that brings the market closer to the producers by decision-making analysis with the help of digital technology using the internet, manufacturing, robotics, the latest computerized system supported by current knowledge that resembles human intelligence in running a business operating cycle (Boenzi, 2016; Cotteleer & Sniderman, 2017). If the market used to be through a traditional or modern market, now the market is closer to the information technology so that markets can market the product directly (Astini & Tefiprios, 2017).

The purpose of this research is to see the level of implementation of industrial aspects 4.0 namely; governance of data, management of asset, management of application, application capabilities, alignment of organizational, and Process Transformation. This research has contributions to the world of industrial services and manufacturing to know the position of implementation of industrial aspects of 4.0 such as; digital technology, internet-based, computerized, artificial intelligence, and others when conducting business operations in Indonesia.

2. Literature Review

State of The Art

The size of the information speed and speed of product delivery to consumer's hands become an aspect that is industry-wide.

Industrial Aspects 4.0

Services with an Internet user base in the form of a chain of technology utilization that produces more value so that the industry becomes smart, this is called Industry 4.0 (Hermann et al., 2016) changes from the traditional industries developed and operated using Internet-based digital technologies to produce a product

(Merkel, 2014), and interconnectedness between industries to share information, causing information exchange, information sharing and information transfer very quickly (Schlechtendahl, 2018), as well as production processes in manufacturing, logistics and services using an Internet base coupled with cyber-physical systems (Kagermann, 2013), the technology that brings together the real world with the virtual world is a combination of tangible process utilization with the use of Internet-based computers it is called the cyber-physical system (Lee, 2008). A virtual decision-making system is used in industries that have implemented cyber-physical system technology obtained from the physical monitoring of production processes. The 4.0 industry has basic characteristics such as decentralized, virtual, fast data processing capabilities, fast data delivering capabilities, standard design, and timely serving. So that the decision-makers can communicate and collaborate between people and organizations both in the Organization and between organizations in real-time in achieving the company's objectives by using a computer-based cyber-physical systems, in order to create value-added companies.

Aspects in the 4.0 industry include; a) Standards are made for guidelines and referrals in carrying out, b) model systems are manufactured to simplify complex systems in an industry, c) reliable communication network in the form of hardware and software so that information is received quickly and precisely, d) technology used in storing and processing data must be protected by safety and safety standards, e) change mindset should be inherent and become a habit for employees involved, f) all agreements, contracts and rules relating to the law have been in accordance with applicable laws, g) implementation of industrial aspects of 4.0 aimed at resource efficiency such as energy saving and cost reduction, h) Cyber physical and virtual cloud-based system development, i) standard smart Production system automation according to requirement, j) business development model oriented business process efficiency, k) development and work systems for the employees, l) development of services in the processing of big data in the form of an aplication that can be easily utilized, m) Development of organizational and management models that can respond to changes quickly, n) final product oriented on digital products and digital services (smart product engineering) (Prasetyo & Sutopo, 2018).

Industrial 4.0 Implementation

In preparing the implementation of industry 4.0, Indonesia made 10 priorities (https://www.kemenperin.go.id/kebijakan-industri, 2021), namely: (a) Improving the flow of goods and materials, strengthens local production of upstream and medium sectors through increased production capacity and accelerated adoption of technology by developing long-term designs to improve the flow of goods and materials nationally and develop material sourcing strategies. (b) Redesigning industrial zones, Indonesia optimizes the policies of these industrial zones including aligning the sector road maps that are the focus of Making Indonesia 4.0 geographically, as well as road maps for transportation and infrastructure. (c) Accommodating sustainability standards, Indonesia sees sustainability challenges as opportunities to build sustainability capabilities based on clean technology, EV, biochemistry, and renewable energy. (d) Empowering MSMEs, Indonesia is committed to supporting MSMEs by building e-commerce platforms for MSMEs, farmers and craftsmen, building technology centers (technology banks) in order to improve MSMEs' access to technology acquisitions, and providing mentoring support to encourage innovation. (e) Building a national digital infrastructure, Indonesia encourages collaboration between industry players so as to accelerate digital transformation. (f) Attracting foreign investment, Indonesia engages more leading manufacturing industry players to close the technology gap and encourage technology transfer to local companies. (g) Improving the quality of human resources, Indonesia is overhauling the education curriculum with more emphasis on STEAM (Science, Technology, Engineering, the Arts, and Mathematics), aligning the national education curriculum with the needs of the industry in the future. (h) Development of innovation ecosystem, Indonesia develops a blueprint of national innovation centers, prepares innovation center pilots and optimizes related regulations, including the protection of intellectual property rights and fiscal incentives to accelerate cross-sector collaboration between private businesses/state-owned enterprises with universities. (i) Incentives for technology investment, Indonesia redesigned technology adoption incentive plans, such as subsidies, corporate tax deductions, and import duty exemptions for companies committed to implementing 4IR technology. (j) Harmonization of rules and policies, Indonesia is committed to harmonizing rules and policies to support industry competitiveness and ensure close coordination of policy makers between ministries and institutions related to local governments. The integration of sustainable practices in production systems uses a mathematical sharing network model effectively to generate synergy between companies in the network (Jayakumar et al., 2020).

Indonesia Industry 4.0 Readiness Index abbreviated as INDI 4.0 is a reference standard to measure the level of readiness of companies to transform into the Industrial 4.0 era. INDI 4.0 was initiated by a team from the Industrial Research and Development Agency (BPPI) of the Ministry of Industry, involving experts, industry players, academics and consultants. Measurement with INDI 4.0 is an advanced program to support the Making Indonesia 4.0 program (https://itgid.org/indonesia-industry-4-0-readiness-index/, 2021).

In the conventional industry, the production process includes; production planning and control, Information Technology support, Entreprise Resource Planning, Manufacturing Execution System, and Data Management (Rojko, 2017). While in the 4.0 industry includes; System of Cyber-Physical, Cloud, Smart Industry, Big of Data, Internet Basis, Cyber Security. Industry 4.0 said (Suharman, 2019) is the era of empowerment of manufacturing digitization and supply networks by integrating information from many sources using artificial intellegence, the Internet of Things, Wearable Technology, Advanced robotics, and 3D Printing to make the company's performance more effective and more efficient. The 4.0 industry implementation rate in the Americas and Germany in 2018 has reached 70% which can be interpreted that the average company in both countries has been in the Industrial ERA 4.0 (Schumacher, 2016). Although in the same year Japan is still under 70%. This illustrates the difference in the implementation stage of the 4.0 industry, where Japan can be said on the preparation resistance while the Americans and Germans almost reach the stage of maturity. As it says that the difference between readiness and not ready lies in the development of the infrastructure prepared; Standards, technology networks, human resources, organizational models, business processes, agreements relating to law, and others. The implementation process is a link of activities ranging from inputs to outputs that produce goods or services that have added value (Nusraningrum et al., 2020).

3. Method

The method of research is descriptive aims to identify findings based on facts and information (Kothani, 2004) of the industry 4.0 level of implementation namely; asset management, data governance, application management, application capabilities, organizational alignment, and process transformation (Gökalp et al., 2017). Data were collected using a questionnaire with a purposive sampling technique. The respondents were service and manufacturing companies. The data collection started from December 2019 to June 2020. The number of samples was decided based on theory (Hair et al., 2017), amounting to 66 companies.

Table 1 Industrial measurement model 4.0

Model, Year	Approach
Indi 4.0, Kemenperin (2020)	The five pillars of INDI 4.0 measurement are used by Indonesia, namely: Management and Organization: How much support do management and organizations support to transform? People and Culture: Are the cultures and employees of the company ready to transform into Industry 4.0? Products and Services: How ready are the company's services and products to fit with Industry 4.0? Technology: What Industrial Technology 4.0 has been applied in the company? Factory Operations: What is the company's operational readiness to implement the Industrial 4.0 system?
Development of an Assessment Model for Industry 4.0: Industry 4.0-MM. Gökalp et al. (2017)	The industry 4.0 level of implementation namely; asset management, data governance, application management, application capabilities, organizational alignment, and process transformation diukur pada level 1-Incomplete, level 2-Performed, level 3–Managed, level 4-Establish, level 5-Predictable, level 6-Optimizing.

Table 1 Continue

Model, Year	Approach
The Conneced Enterprise Maturity Model, Rockwell Automation (2014)	Maturity measurement model, consisting of 4 dimensions focusing on 5 levels of information technology (IT) maturity.
RB Industry 4.0 Readiness Index, Roland Berger Strategy Consultants (2014)	Readiness measurement in 2 dimensions consists of 4 variables each, where the company in the quadrant matrix 2 x 2, namely readiness index vs. manufacturing share.
IMPULS – Industrie 4.0 Readiness, VDMA's IMPULS-Stiftung, Lichtblau et al. (2015)	Industry 4.0 readiness measurement consists of 6 dimensions and 18 variables. The measurement results of a company will be compared with the results of similar companies in 5 levels of readiness.
Industry 4.0/Digital Operations Self Assessment, Pricewaterhouse Coopers (2016)	Self-assessment measures consist of 6 dimensions and 17 variables that focus on the maturity of digital technologies and processes. Before taking measurements, the company sets maturity targets for each variable and the measurement results place the company in 3 maturity levels.
The Singapore Smart Industry Readiness Index, EDB Singapore (2017)	Readiness measurement consisting of 3 blocks, 8 pillars and 16 dimensions arranged based on RAMI 4.0. Measurements are performed by comparing the current state with the target to be achieved.

4. Result and Discussion

This research respondent is a service and manufacturing company with small, medium, and large business scale with amount 66 companies. The information about the description of respondents is presented in Table 2.

Table 2 Description of respondents

	Description	Total	%
Company	Service Company	19	28.8
	Manufacturing Company	47	71.2
Scale of Business	Small (IDR 10-IDR 499 Billion)	8	12.1
	Medium (IDR 500 Billion-IDR 2 Trillion)	15	22.7
	Large (> IDR 2 Trillion)	35	53
	Other	8	12.2

Research respondents consist of a service and manufacturing company with a small business scale owning assets ranging from ten billion to four hundred ninety and nine billion, the medium has assets ranging from five hundred billion up to two trillion rupiah and large assets of more than two trillion rupiah. Respondents are dominated by manufacturing companies with large scale businesses.

Information about the company's Asset Management implementation of the respondents results can be seen in Table 3. Indicators used to measure the implementation level of asset management related to technology based on the security system, usage of technologies of businesses based on cloud computing, the organization of information technology system, and Industry 4.0 technological readiness. It shows that the average industry is still at a managed level.

Table 3 Asset management implementation

Level of implementation	Total	%
Level 1: Incomplete	9	13.6
Level 2: Performed	8	12.1
Level 3: Managed	21	31.8
Level 4: Establish	15	22.7
Level 5: Predictable	8	12.1
Level 6: Optimizing	5	7.7

Information about the company's Data Governance implementation of the respondents' results can be seen as in Table 4. The aspect of data governance questiones about the level of governance related to serving using databases, data utilization, how to collect data, how to process data, and storage of big data. It shows that the companies average is at performed, managed, and establish level.

Table 4 Data Governance Implementation

Level of implementation	Total	%
Level 1: Incomplete	11	16.2
Level 2: Performed	14	21.2
Level 3: Managed	18	27.3
Level 4: Establish	12	18.2
Level 5: Predictable	7	10.6
Level 6: Optimizing	4	6.5

Information about the company's application management implementation of the respondent's results can be seen in Table 5. The drastic change in the implementation of industrial aspects of the 4.0 application management in manufacturing companies and service companies in principle is a combination of utilizing Internet-based information technology that generates production process automation systems. Table 5 indicates that the application management implementation mostly in level three (managed level).

Table 5 Application Management Implementation

Level of implementation	Total	%
Level 1: Incomplete	7	10.6
Level 2: Performed	13	19.7
Level 3: Managed	20	30.3
Level 4: Establish	9	13.6
Level 5: Predictable	12	18.2
Level 6: Optimizing	5	7.6

Information about the company's application capabilities implementation of the respondent's results can be seen in Table 6. Measurement of application usage is an important function in supporting the smoothness of the company's business process in terms of the visual appearance of a product that has been built with the user, and the flow of information in the application must have a clear standard, connected, can be

controlled and can exchange the use of information. The results showed the companies surveyed mostly at level 3 even none of them were at level 6.

Table 6 Application Capabilities Implementation

Level of implementation	Total	%
Level 1: Incomplete	5	7.6
Level 2: Performed	10	15.2
Level 3: Managed	28	42.4
Level 4: Establish	13	19.7
Level 5: Predictable	10	15.2
Level 6: Optimizing	-	-

Information about the company's organizational allignment implementation of the respondent's results can be seen in Table 7. Organizational alignment in company management includes organizational structure, and business strategy will influence the investment decision of information technology. Investments including the provision of skilled human resource needs in the field of information technology are crucial for the transformation in terms of how to manage an organization in the form of manufacturing companies and services that are the most important part of the capabilities of the company. The survey showed that most of the companies studied were still in Level 3.

Table 7 Organizational Allignment Implementation

Level of implementation	Total	%
Level 1: Incomplete	7	10.6
Level 2: Performed	15	22.7
Level 3: Managed	25	37.9
Level 4: Establish	7	10.6
Level 5: Predictable	7	10.6
Level 6: Optimizing	5	7.6

Information about the company's process transformation implementation of the respondent's results can be seen as follows.

Table 8 Process Transformation Implementation

Level of implementation	Total	%
Level 1: Incomplete	5	7.6
Level 2: Performed	23	34.8
Level 3: Managed	18	27.3
Level 4: Establish	9	13.6
Level 5: Predictable	7	10.6
Level 6: Optimizing	4	6

The process of transforming the 4.0 industry is a digital map of the company's business structure transformation ranging from planning, acquisition, production, sales, and distribution. This digital map will provide added value to the company and produce a standard that complies with the 4.0 industry. The survey results show most companies are at implementation Level 3.

As seen from Table 9 the level of application of asset management in the researched companies consist of dimensions; Industrial Wireless Networks, Cloud Computing, Internet of Things, and Information Technology Security. Most of the respondents implement this dimension at the managed level. The research conducted (Rittammanart, 2008) found that when asset management was done manually it resulted in difficulties to keep track of all assets and information of the hard-earned assets so that executives could not find out information about the assets owned by the company. Therefore loss calculation cannot be done correctly. A study titled Information Systems on Intranet-based asset management at the Indonesian Institute of Sciences (LIPI) (Merkel, 2014) also recommends creating an asset management information system.

Table 9 Summary of Impletation Level

Level	Asset Management	Data Governance	Application Management	Application Capabilities	Organizational Alignment	Process Transformation	Average %
Incomplete	13.6	16.2	10.6	7.6	10.6	7.6	11.03
Performed	12.1	21.2	19.7	15.2	22.7	34.8	20.95
Managed	31.8	27.3	30.3	42.4	37.9	27.3	32.83
Establish	22.7	18.2	13.6	19.7	10.6	13.6	16.4
Predictable	12.1	10.6	18.2	15.2	10.6	10.6	12.88
Optimizing	7.7	6.5	7.6	-	7.6	6	5.9

Integrated data streams with each other and automation are a part of data governance that is essential for timely decision making for the company's internal and external companies both today and in the future (Püschel et al., 2016). While application management applications are intended to incorporate technology with Internet and network bases so that manufacturing and service companies can operate automation optimally, where this application will facilitate the customers to get corporate services and of course support the smooth business.

The research conducted (Zhou et al., 2015) stated that the research position of Industry 4.0 is at the concept of maturation of concepts that can be applied globally not only in developed countries but also in developing countries to answer the problems arising from the implementation of the 4.0 aspects of the manufacturing industry and the service industry. Researchers from colleges can do further improve cooperation with the manufacturing industry. The pattern of cooperation between the academic and industrial world is necessary to accelerate the realization of 4.0 industries. Although the 4.0 industry is predicted to bring negative impacts primarily from social and economic perspectives (Bonekamp & Sure, 2015) to developing countries whose level of social and economic inequality is still relatively high.

The opportunities and challenges of digital implementation in the 4.0 industry (Popova, 2018) are a business reality for small and medium scale companies. The implementation of digital applications needs comprehensive planning and thorough development by involving the entire process of a business line of the company including by increasing the competence of employees in implementing and integrating the Industry 4.0 (Schröder & Philipps, 2016).

An error in the process of digital integration in the 4.0 industry is likely to occur due to the absence of an international standard governing unauthorized access to certain data (Schröder & Philipps, 2016), besides the legislation governing the 4.0 industry implementation of artificial intelligence and cyber-security is not yet available in developing countries (Türkes et al., 2019). Such as the presence of malware that can steal data and even close data access on an ongoing basis unless a ransom is paid (Young & Yung, 1996).

Data security barriers can lead to loss of consumers and opportunities to gain profits and even make the company's reputation a negative (Türkes, et.al., 2019). These obstacles are likely the cause of the implementation of the 4.0 industry is not comprehensive in Indonesia than with the implementation in other developed countries.

5. Conclusion

This research displays the results of a survey of sixty-six service and manufacturing companies that have implemented the 4.0 industry based on its application-level characteristics. From the survey obtained the level of implementation of the 4.0 industry in Indonesia is dominated by the managed level. There are 11% at an incomplete level and about 6% of which have fully implemented the 4.0 industry. This has been in line with the research done earlier that the position of implementation in Indonesia at the maturation stage of industrial concept 4.0. The security of the 4.0 industrial application supported infrastructure and resources of information technology (networks, hardware, applications, and others) is a barrier to the change of traditional business system into a smart business system because the confidentiality of the operating system data can be stolen so that it impacts the business operations. However, the added value gained when applying the industry standard 4.0 including; Reduce labor costs, reduce energy consumption, reduce build-to-order cycles, and improve the delivery of products or services. Nevertheless, nearly six percent of the service and manufacturing companies studied have fully implemented the industrial aspects of the 4.0. This indicates that the process towards the 4.0 industry has been implemented to increase the value-added by reducing the environmental impact and maximizing the utilization of resources owned.

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