Correlation among components of the Indonesian industry readiness index 4.0 and its implementation on socioeconomic along with the demographic aspects

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Correlation among components of the Indonesian industry readiness index 4.0 and its implementation on socioeconomic along with the demographic aspects

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Abstract

Purpose – This study aims to analyze how ready a firm is to transform into Industry 4.0 using the Readiness Index (INDI 4.0) assessment. It also investigates the differences (before and after) of the program "Making Indonesia 4.0" in 2018 in socioeconomic and demographic aspects.
Design/methodology/approach – The INDI 4.0 assessment involved a self-evaluation by 622 companies across 13 industry sectors, subsequently verified by the Ministry of Industry. This study incorporates discussions with industry experts to enhance the interpretation of the analytical findings.
Findings – This study explores the interrelation among the components of INDI 4.0 across different levels, assessing the readiness of each sector for Industry 4.0. The findings reveal the diverse impact of implementing Industry 4.0 in Indonesia on socioeconomic and demographic aspects. Furthermore, the study proposes several policy recommendations for the Indonesian government's consideration.
Research limitations/implications – This study's scope is confined to the industrial context of Indonesia, as the assessment components are tailored to the specific characteristics and culture of the country's industry. Subsequent research endeavors can leverage this study as a foundational reference, adapting the components to align with the particular interests of other nations.
Practical implications – Businesses, especially those in Indonesia, can employ these findings to evaluate their position in the context of Industry 4.0 transformation compared to their industry. Simultaneously, the Indonesian government can use these results as a starting point to evaluate and potentially enhance their policies related to Industry 4.0. We recommend five policy proposals for the Indonesian government:

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diversifying measurement models, shifting terminology, emphasizing soft skills, promoting continuous learning and implementing Center of Digital Industry Indonesia 4.0 (PIDI 4.0) initiatives.
Social implications – This study offers a broad impact of Industry 4.0 implementation in socioeconomic and demographic aspects in Indonesia, such as income, job-shifting, age, educational background and gender.
Originality/value – To the best of our knowledge, no prior research has explored the repercussions of industrial implementation on socioeconomic and demographic facets.

Keywords INDI 4.0, Industry 4.0, Transformation, Industrial revolution, Socioeconomic, Demographic
Paper type Research paper

1. Introduction

The fourth industrial revolution, originating in Germany, has significantly and positively impacted various aspects of life, supported by quantitative and qualitative evidence (Maresova *et al.*, 2018). Industry 4.0, characterized by adopting modular, intelligent and efficient systems utilizing software for enhanced performance through data analysis, provides substantial advantages for companies (Lee, Bagheri, & Kao, 2014). This technological transformation is expected to yield short and long-term profits by reducing production and delivery times and optimizing the value chain, consequently minimizing costs (Meyer, Wortmann, & Szirbik, 2011; Rudtsch, Gausemeier, Gesing, Mittag, & Peter, 2014; Tseng, Lim, Wong, Chen, & Zhan, 2018).

In response to the benefits presented by the fourth industrial revolution, the Indonesian government initiated the "Making Indonesia 4.0" (MI 4.0) program in 2018, assigning the ministry of industry as the primary sector responsible for its implementation. The integration of Industry 4.0 practices is envisioned to propel Indonesia towards becoming a developed nation, projecting a gross domestic product (GDP) increase to 120 billion USD by 2025 and the creation of 23 million new jobs by 2030. Consequently, this transformation is expected to have far-reaching effects on socioeconomic and demographic aspects.

Building on initiating the MI 4.0 program in 2018, our analysis focuses on 662 companies within the thirteen industry sectors. These companies underwent assessment using the Industry 4.0 Readiness Index (INDI 4.0), and our objective is to delineate the diverse effects of this implementation on various socioeconomic and demographic aspects. The structure of this study is as follows: Section 2 presents a literature review on Industry 4.0. Section 3 delineates the research methodology. Section 4 explores the impact of Industry 4.0 implementation before and after the MI 4.0 program. For a more comprehensive understanding of our analytical inquiries, Section 5 incorporates discussions with experts. Section 6 concludes the study, highlighting its limitations and outlining avenues for future research.

2. Literature review

2.1 Industry 4.0

Industry 4.0 comprehensively defines integrating the Internet of things (IoT) into industrial processes, fostering digitization, connectivity, intelligence and value chain optimization. This integration enhances efficiency and profitability for companies by imparting flexibility to adapt business structures based on market demands and time constraints (Piccarozzi, Aquilani, & Gatti, 2018; Prause, 2015). The adoption of technology in companies is influenced by factors such as location, infrastructure, culture, education level, economy, political stability and the company's technological investment capacity (Castellacci, 2008; Frank, Dalenogare, & Ayala, 2019).

The Industry 4.0 revolution transforms the traditional product life cycle by emphasizing management and organizational aspects, combining production with electronics and the internet, and integrating digitalization into the value chain (Monizza, Bendetti, & Matt, 2018; Jovanovski, Seykova, Boshnyaku, & Fischer, 2019). This paradigm shift encompasses not only technology but also communication, automation and computer technology (Horák, 2016). Additionally, technologies like the IoT, cyber-physical system (CPS), service-oriented architecture (SoA), Blockchain and cloud technologies further contribute to the Industry 4.0 landscape (Viryasitavat, Xu, Bi, & Sapsombon, 2018; Jazdi, 2014). In this era, companies gain enhanced flexibility to customize products on both small and large scales, leading to increased efficiency and product quality, which is unattainable with conventional production systems (Jazdi, 2014; Saad, Bahadori, & Jafarnejad, 2021; Lassnig, Müller, Klieber, Zeisler, & Schirl, 2022).

Despite its positive aspects, the implementation of Industry 4.0 introduces certain challenges and negative impacts. Transparency, while a key feature, can expose companies to piracy risks (Sony, 2020). Implementing Industry 4.0 in isolation may not yield long-term benefits, and organizations with standard platforms might struggle to compete as they lack distinctive product features, potentially facing bankruptcy (Zhou, Piramuthu, Chu, & Chu, 2017). Moreover, the transformation requires adjustments to the production system, company size and structure, posing financial challenges due to the need for substantial investments in technology, systems and human resource capabilities (Erol, Jäger, Hold, Ott, & Sihn, 2016; Hirsch-Kreinsen, 2014; Sony & Naik, 2019).

Furthermore, Industry 4.0 has negative repercussions on socioeconomic and demographic aspects. In the socioeconomic realm, it contributes to employment and income gaps, ultimately increasing unemployment rates and reducing economic levels (Rainie & Anderson, 2017; Avis, 2018; Sony, 2020). On the demographic front, Industry 4.0 induces changes in the workforce demographics, favoring skilled workers and leading to the elimination of temporary positions. This shift poses challenges to environmental security and ecological threats (Avent, 2016; Hajkowicz *et al.*, 2016; Goodhart & Pradhan, 2017).

2.2 Socioeconomic

Socioeconomic indicators encompass a blend of social and economic factors, with an individual's socioeconomic status determined by both social and income elements. A person's status is higher when both factors are elevated (Umar, Derashid, Ibrahim, & Bidin, 2019). The implementation of Industry 4.0 significantly influences socioeconomic factors, as it integrates vertically, horizontally and end-to-end across industries (Sony, 2020).

The evolution of business models resulting from the fourth industrial revolution reshapes the industrial workforce, leading to the creation of new jobs, shifts in job roles and an increased demand for productivity and efficiency (WEF, 2016). The era of Industry 4.0 presents opportunities for industrial workers to acquire updated skills aligned with current industry requirements (Rohida, 2018). Failure to meet the rising demand for skilled industrial personnel due to advanced technology implementation may result in a talent crunch a disparity between the need for skilled labor and its availability (Flynn, Dance, & Schaefer, 2018). In such instances, upskilling and/or reskilling become imperative solutions. Education plays a crucial role in addressing the talent crunch issue, serving as a means to acquire new skills or enhance existing ones (Postel-Vinay, 2002).

The context of industrial transformation 4.0 is intertwined with industrialization, emphasizing the necessity to enhance the quality of industrial human resources and optimize the utilization of other resources. This approach aims to stimulate and enhance the development of various sectors, ultimately elevating the industrial human development index (HDI) (Lincolin, 2004; Ilyas, Rostin, Djawa, & Nur, 2019; Susantun & Riana, 2014).

2.3 Demography

The global population is experiencing rapid growth during the industrial revolution era. A demographic bonus refers to a period wherein the proportion of the total productive age exceeds that of the nonproductive age in a country or region. Indonesia is anticipated to reach its peak demographic bonus between 2030–2040, constituting an estimated 64% of the total population.

Demographic plays a crucial role in the industrial revolution, encompassing factors such as age, gender, education, facilities for special needs, immigrants and population growth (Klingeberg, 2017; UNDP, 1990). Within the realm of employment, studies suggest that women exhibit a higher commitment to working in improved organizational settings than men (Popoola, 2009). Women are often characterized by greater perseverance, thoroughness and discipline. Age and gender emerge as pivotal factors, with young women facing increased pressures and discrimination in the workforce, especially if they possess lower levels of education (Gander, 2014).

Furthermore, women face heightened challenges during the fourth industrial revolution (4.0). The automation of domestic work, traditionally carried out by women, poses a threat to their ability to secure employment in more advanced sectors, including the industrial domain. Gender and age play significant roles in implementing industry 4.0, with women aged 30–45 facing a higher risk of job displacement due to potential disparities in information and technology (IT) skills compared to their male counterparts (Soukupová, Adamová, & Krninská, 2020).

2.4 Research gap

Since 2018, the implementation of the MI 4.0 program has been underway, yet there remains a dearth of studies scrutinizing the policy's impact on socioeconomic and demographic aspects. To address this gap, evaluating companies' preparedness for the transition to Industry 4.0 becomes imperative. Various metrics exist for gauging industry readiness in embracing Industry 4.0, such as the German Verband Deutscher Maschined und Anlagenbau (VDMA) (Association of German Machine and Plant Construction) Industrial 4.0 readiness, Singapore Smart Industry Index (SSTR) and the smart small and medium-sized enterprise (SME) technology readiness assessment (SSTRA) employed by Saad *et al.* (2021) to assess the readiness of industries, particularly micro, small and medium enterprises (MSMEs), for the transition to Industry 4.0. Furthermore, Ramanathan and Samaranayake (2022) used readiness assessment framework (I4.0 RAF) to assess manufacturing firm in transition to Industry 4.0.

However, within the Indonesian context, this study employs the Indonesia INDI 4.0 to assess companies' preparedness for the Industry 4.0 transformation. INDI 4.0, initiated by the ministry of industry of the republic of Indonesia in conjunction with the government's introduction of MI 4.0, distinguishes itself from other measurement tools as it is grounded in Indonesian industry characteristics and culture. It encompasses five pillars specifically tailored to Indonesia's unique features and culture: management and organization, people and culture, products and services, technology and factory operations in more detail, as shown in Figure 1. In summary, the primary objectives of this study are as follows:

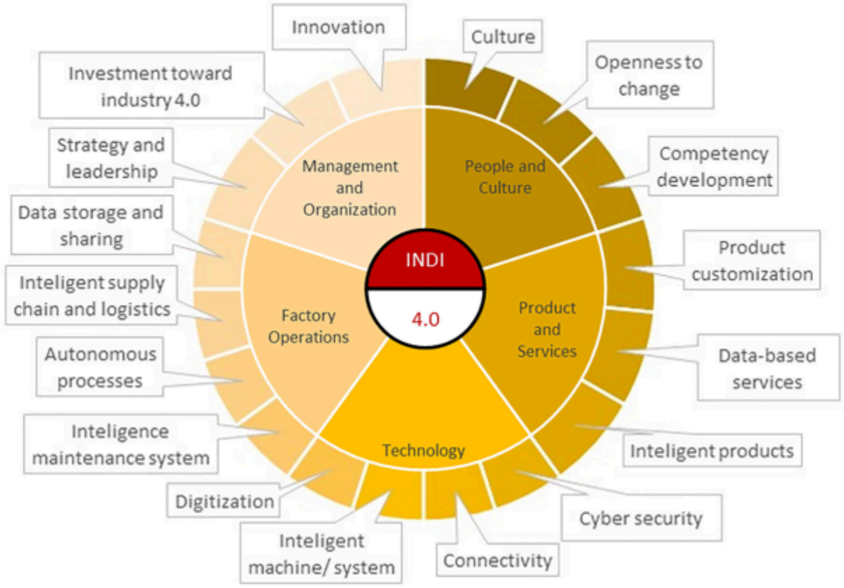
(1) To scrutinize the preparedness levels of companies for the transition to Industry 4.0, categorized by their respective sectors.

(2) To examine the disparities in socioeconomic and demographic aspects before and after initiating the Indonesian government's MI 4.0 program.

3. Methodology

3.1 Research framework

This study endeavors to discern disparities in socioeconomic and demographic aspects in Indonesia before and after the initiation of MI 4.0 in 2018, setting the baseline at the year 2018. The implementation of Industry 4.0 is operationalized through the INDI 4.0, as designated by



Source(s): Figure by Ministry of Industry the Republic Of Indonesia (2018)

Figure 1.
5 pillars and 17 components of Indonesia readiness index 4.0

the ministry of industry, spanning from 2019 to 2021. The assessment process entails two stages: initially, companies undergo self-assessment, followed by the ministry of industry deploying experts to scrutinize responses and cross-reference them with on-site evaluations. This evaluation gauges the readiness level for industry 4.0 implementation, categorized into five levels: 0 (not ready), 1 (early readiness), 2 (moderate readiness), 3 (mature readiness) and 4 (already implemented).

Concurrently, the socioeconomic aspect is represented by the number of unemployed individuals, the HDI and the growth of the average monthly income of the upah minimum regional (UMR) (minimum regional wage). The demographic aspect is encapsulated by the age distribution of workers in the industry and gender.

To analyze the differences, this study employs the *t*-statistic test, adopting the research model from Pollak and Cohen (1981) expressed through the following

$$t_p = \frac{\left(\overline{X} - \overline{Y}\right)\left(n(n-1)\right)^{1/2}}{\left(\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2 + \sum_{i=1}^{n}\left(Y_i - \overline{Y}\right)^2\right)^{1/2}}$$

The paired samples *t*-test is employed to assess the socioeconomic, demographic and gender factors before and after implementing MI 4.0 in Indonesia. This method is particularly suitable when dealing with paired sample values (X⁻, Y⁻) for which the correlation value is unknown. The objective is to discern any significant differences or changes in these factors resulting from the adoption of INDI 4.0.

3.2 Data collection

Data for INDI 4.0 was sourced from the ministry of industry database, encompassing 622 companies categorized as large-scale industries across various sectors such as textiles (125 companies), automotive (216 companies), chemical (94 companies), food and beverage (42 companies), electronics (30 companies), metal (35 companies), medical devices (25 companies), pharmaceuticals (9 companies), miscellaneous (19 companies), engineering, procurement and construction (EPC) (3 companies), machinery (7 companies), agro (9 companies) and others (8 companies). Socioeconomic and demographic data spanning from 2014 to 2021 were extracted from Badan Pusat Statistik (BPS)-Statistics Indonesia for comprehensive analysis.

4. Results

The descriptive statistics for INDI 4.0 across industry sectors, as presented in Table 1, reveal that the pharmaceutical sector boasts the highest mean value at 2.435, surpassing other sectors. Following closely is the food and beverage sector with a mean value of 2.257, while the machinery sector exhibits the lowest mean value at 0.833. Despite having the lowest mean, the machinery sector demonstrates the highest data variability, as evidenced by its maximum variance (0.386), followed by the EPC sector (0.113). In contrast, the food and beverage sector exhibits the lowest variability with a variance of 0.019. Notably, all dominant sectors exhibit left-skewed data, indicated by negative skewness values, except for the textile sector (0.239), electronics (0.187), EPC (0.723) and machinery (1.632).

Table 2 provides an overview of the INDI 4.0 components, showcasing that "people and culture" have the highest average value (2.087), followed closely by "product" (2.058). Generally, the variables demonstrate data distribution close to the average value due to their low variance. Specifically, "people and culture" indicates left-skewed data with a negative skewness value, while "product and service" exhibits the highest sharpness among the variables.

Descriptive statistics for socioeconomic factors, which are not reported in this summary, indicate positive skewness for unemployment and UMR, whereas HDI and work participation display the opposite trend. The age group 25–29 holds the highest mean, while the age group 15–19 has the lowest (details not reported). All variables exhibit a normal data distribution based on the normality test, with a probability value above 0.05 (details not reported).

4.1 Statistics test

4.1.1 Relationship between components of INDI 4.0 readiness index. We did a correlation analysis to examine the relationship between the sub-components of the INDI 4.0 readiness index, as presented in Table 3. The empirical findings reveal a noteworthy positive correlation, significant at the 10% alpha level, between the dimensions of management and organization and the dimensions of technology with other components. This suggests that enhancing the dimensions of management and organization, along with technology, is crucial for fostering the successful transformation of surveyed companies. It underscores the notion that industry 4.0 transformation involves not only technological mastery but also the preparation of management and organizations to respond adeptly to these transformative changes.

4.2 Socioeconomic

4.2.1 t-test UMR growth. A *t*-test was conducted on the growth of the average worker's income (UMR) to examine the differences before and after the implementation of MI 4.0, as depicted in Table 4. The results indicate that the *t*-statistic exceeds the t-table value (1.98), suggesting a significant difference in UMR growth before and after the implementation of MI

	F&B	Textile	Chemical	Auto-motive	Electronic	Metal	Various	EPC	Pharmacy	Medical eqp	Agro	Machinery	Others
Mean	2.257	1.925	1.925	1.700	2.057	1.807	1.695	2.087	2.435	1.500	2.082	0.833	1.625
Std Dev	0.137	0.249	0.215	0.240	0.229	0.232	0.293	0.337	0.208	0.215	0.137	0.622	0.220
Variance	0.019	0.062	0.046	0.058	0.053	0.054	0.086	0.113	0.043	0.046	0.019	0.386	0.048
Skewness	−0.733	0.239	−0.459	−0.295	0.187	−0.535	−0.309	0.723	−0.274	−0.311	−1.383	1.632	−0.676
Kurtosis	2.133	−0.081	−0.822	−0.141	−0.202	−0.228	−0.195	2.352	1.642	−1.345	1.999	3.117	1.478

Source(s): Table by authors

Table 1. Descriptive statistics INDI 4.0 based on industry sectors

4.0. This finding aligns with Sony (2020), asserting that the integration of industry 4.0 in the industry influences socioeconomic factors vertically, horizontally and end-to-end. Workers possessing enhanced skills and technological knowledge are favored, leading to an increase in the income of industrial workers compared to the preimplementation period (Rüßmann *et al.*, 2020; Rohida, 2018; Flynn *et al.*, 2018; Birkel, Veile, Müller, Hartmann, & Voigt, 2019).

The mean value indicates that UMR growth before implementing MI 4.0 was higher than after by 4.75%. The observed decline in the minimum wage could be attributed to the impact of the COVID-19 pandemic, influencing companies to prioritize liquidity to avert financial distress or constraints.

4.2.2 t-test human development index. The HDI, encompassing education, health and economic indicators, reflects differences before and after the MI 4.0 Readiness Index, as indicated by the t-count value in Table 5 (−8.369). The mean value suggests that the HDI after

	X1	X2	X3	X4	X5	INDI
Mean	1.607	2.087	2.058	1.584	1.841	1.867
Std Dev	0.597	0.281	0.529	0.389	0.471	0.377
Variance	0.357	0.079	0.280	0.152	0.221	0.142
Skewness	−0.762	1.096	−2.012	−0.155	−1.787	−0.741
Kurtosis	3.770	3.789	7.050	3.567	6.247	3.717

Note(s): X1 is management and organization; X2 is people and culture; X3 is a product and a service; X4 is Technology; X5 is factory operation
Source(s): Table by authors

Table 2. INDI 4.0 components statistics descriptive

	X1	X2	X3	X4	X5
X1	1.0000	0.6018*	0.7814*	0.9097*	0.9243*
X2	0.6018*	1.0000	0.1378	0.7162*	0.4546
X3	0.7814*	0.1378	1.0000	0.6762*	0.8948*
X4	0.9097*	0.7162*	0.6762*	1.0000	0.9236*
X5	0.9243*	0.4546	0.8948*	0.9236*	1.0000

Note(s): X1 is management and organization; X2 is people and culture; X3 is a product and a service; X4 is Technology; X5 is factory operation
Source(s): Table by authors

Table 3. Correlation among INDI 4.0 components

Variables	Difference		*T*-stat
UMR	4.753 (1.647)		2.887
Normality test		0.601	

Source(s): Table by authors

Table 4. *t*-test result on UMR growth

Variables	Difference		*T*-stat
IPM	−2.025 (0.242)		−8.369
Normality test		0.535	

Source(s): Table by authors

Table 5. *t*-test result on human development index

the MI 4.0 readiness index is higher than before, with a difference of − 2.03% and a standard error of 0.242.

This implies that the fourth industrial revolution has an impact on HDI, as the presence of Industry 4.0 influences a country's industrialization (Lincolin, 2004; Ilyas *et al.*, 2019; Susantun & Riana, 2014). Achieving this requires high-quality industrial human resources and the optimization of other resources, leading to increased development in various sectors, ultimately elevating the HDI of a country.

Moreover, the national MI 4.0 program contributes to an enhanced HDI by fostering transparency and digitalization. The program makes public services, such as health and education, more accessible, enabling people to reap benefits easily. Consequently, the economic indicator, specifically the level of public expenditure, is expected to rise automatically.

4.2.3 t*-test the number of unemployment based on education.* The outcomes presented in Table 6 reveal that, across vocational, high school and undergraduate unemployment categories, the unemployment rate before MI 4.0 was lower than before MI 4.0 (indicated by negative coefficients). However, in the case of uneducated unemployment, the situation reversed, with higher unemployment before MI 4.0 (indicated by a positive coefficient). This shift is attributed to the pandemic's impact, causing a reduction in job opportunities for the existing workforce. Notably, *t*-test scores for senior high school and diploma unemployment show insignificant differences, possibly due to a trend toward pursuing higher education among these graduates. Conversely, vocational high school and undergraduate individuals tend to enter the workforce directly after graduation.

Moreover, these statistical findings align with the insights of Aurachman (2018), who posits that the advent of industry 4.0 may lead to a reduced demand for human workers in the industry, replaced by smart systems employing robots, machines and digitization. However, under normal conditions (without a pandemic), the need for industrial workers in the era of the fourth industrial revolution is expected to increase, provided there is a concurrent enhancement of skills through upskilling or reskilling programs (Zagler, 2005; Ilyas *et al.*, 2019). This conclusion is substantiated by a study from Badan Pengembangan Sumber Daya Manusia Industry (Agency of Human Resources and Industry Development) (BPSDMI)-Ministry of Industry and McKinsey (2019), projecting an additional 20–30 million new jobs due to the industrial revolution 4.0.

4.3 Demographic

4.3.1 Age. Table 7 illustrates that there is a significant difference in the average number of workers before and after MI 4.0 across various age categories, with the exception of the 20–24 age category, where the difference is not statistically significant. Before the MI 4.0 era, there was a lower number of workers compared to the period after MI 4.0, except in the 15–19 age category, where the number of workers before MI 4.0 surpassed that of the after MI 4.0 period.

Variables	Difference	*T*-stat	Normality test
Indonesia unemployment	−0.215 (0.594)	−0.362	0.516
Uneducated unemployment	31103 (6268.86)	4.962	0.507
Unemployment without finishing elementary school	3240.25 (24055.59)	0.135	0.847
Elementary school unemployment	−100782.5 (196127.1)	−0.514	0.306
Junior high school unemployment	1082 (194132.8)	0.006	0.243
Senior high school unemployment	−246223.5 (233510.7)	−1.054	0.292
Senior vocational senior high school unemployment	−471410.3 (130985.4)	−3.599	0.452
Diploma unemployment	−13991 (27709.95)	−0.505	0.060
Undergraduate unemployment	−245465.5 (65797.66)	−3.731	0.773

Source(s): Table by authors

Table 6. *t*-test Result on the number of unemployment based on education

Age level	Difference	*T*-stat	Normality test
15–19	357556 (99337.74)	3.599	0.176
20–24	−379027.3 (259738.6)	−1.459	0.651
25–29	−692394 (101527.2)	−6.820	0.154
30–34	−712387.3 (115183.9)	−6.185	0.235
35–39	−747502.3 (75287.14)	−9.929	0.114
40–44	−890001.5 (110998.9)	−8.018	0.316
45–49	−1315433 (87719.25)	−14.996	0.507
50–54	−1420460 (65986.68)	−21.527	0.722
55–59	−1483632 (77427.72)	−19.162	0.569
60+	−3273843 (151293.4)	−21.639	0.270

Source(s): Table by authors

Table 7.
t-test result on age

To ensure the success of the fourth industrial revolution, it is imperative to concurrently enhance the quality of education and human resources within a country. With Indonesia anticipated to experience a demographic bonus in 2030–2040, reaching 64% of the total population, this presents a significant opportunity. Historically, countries tend to witness a substantial increase in GDP growth during the demographic bonus period, followed by a significant decrease afterward. Consequently, Indonesia should leverage this opportunity by promptly preparing for skills improvement programs, augmented by competency certification. This becomes particularly crucial in the context of the ongoing ASEAN Economic Community (MEA) to control the influx of labor from neighboring countries, necessitating a national competency certificate.

4.3.2 Gender. Table 8 elucidates a disparity in the average labor force participation rate based on gender. The average difference in work participation rates between men and women is 7.41, with a standard error of 0.72, indicating that the disparity in the work participation rate of men exceeds that of women, with an increasing trend from before to after the implementation of MI 4.0. This finding aligns with existing research from sources such as (Gender, 2014; Soukupová *et al.*, 2020), which asserts that women over 30 years of age are vulnerable to job loss as they often lack IT skills. Moreover, household and administrative roles are susceptible to replacement by technology.

To ensure the robustness of our findings, we conducted additional tests to assess whether males and females have equal job opportunities before and after MI 4.0. Separate tests were conducted for the male and female labor force, considering individuals aged 15 years and older both before and after MI 4.0. The results (not reported in this table) indicate no significant difference in the average work participation between men and women before and after MI 4.0.

5. Discussion

To stimulate companies to enhance their management and organizational components, we propose implementing a tax deduction policy as a viable alternative. This incentive could encourage organizations to invest in improving these crucial aspects. Additionally, for the technology component, establishing the Center of Digital Industry Indonesia 4.0 (PIDI 4.0)

Variables	Difference		*T*-stat
Gender	7.41 (0.723)		10.25
Normality test		0.069	

Source(s): Table by authors

Table 8.
t-test result on gender

could be a one-stop solution, facilitating and guiding companies in their transition to Industry 4.0 in Indonesia.

Drawing from the results of the analysis, which includes the difference test between UMR, the number of unemployed by education level and HDI before and after MI 4.0, there is a need for government policies aimed at fostering the availability of both formal and non-formal education. Such policies should focus on enhancing the competence of industrial workers in line with the evolving needs of the industry.

Based on insights gathered from the focus group discussion (FGD) with three industry experts from IT and telecommunication (PT. Telkom Indonesia), industry consulting (TUV Rheinland Indonesia) and manufacturing sector (Festo Indonesia), the following policy proposals are recommended.

(1) Diverse measurement models: develop distinct models for gauging the readiness and maturity levels of Industry 4.0 implementation, translated into different measurement instruments tailored to the unique characteristics of each industry.

(2) Terminology shift: recognize the evolving nature of the industry and the wider application of 4.0 technologies beyond manufacturing. Shift from the conventional "Industry 4.0" terminology to the more encompassing "digital transformation."

(3) Soft skills emphasis: prioritize the enhancement of soft skills for prospective industrial workers, emphasizing analytical and creative thinking, as well as fostering a robust work mentality (employable skills).

(4) Continuous learning: Encourage industrial workers to demonstrate the willingness and ability to improve their proficiency in the latest applications and technologies continually.

(5) PIDI 4.0 initiatives: To expedite the digital transformation journey in Indonesia, leverage the capabilities of the PIDI 4.0. This can be achieved through a multifaceted approach, encompassing the assessment of readiness for technology 4.0/digital transformation, conducting field surveys and forums to identify industry challenges, proposing tailored solutions and actively assisting industries in implementing digital transformation aligned with their business needs, ultimately fostering efficiency and productivity.

6. Conclusion

The pharmaceutical sector emerges as the most prepared for Industry 4.0 transformation, possibly due to its inherent need for continuous evolution, possibly accelerated by the COVID-19 pandemic. Conversely, the machinery sector exhibits the lowest mean INDI 4.0 score, accompanied by the highest data variability, indicative of significant heterogeneity in technology adoption within this sector.

Moreover, this study underscores disparities in socioeconomic and demographic aspects before and after MI 4.0 in 2018. The research highlights a correlation among MI 4.0 components at different levels. In the socioeconomic domain, UMR growth before MI 4.0 surpassed that after, whereas the HDI and unemployment based on education levels (vocational, senior high school and undergraduate) were lower before MI 4.0 than after. In the demographic context, the number of workers across age groups from 15 to 60+ years was smaller before MI 4.0, except for the 15–19 age group, with no significant difference in the 20–24 age group. Concerning gender, male work participation exceeded that of females both before and after MI 4.0.

The apprehension that technology 4.0 implementation might reduce the workforce is not evident in this study. Instead, a shift in the demand for skilled labor is observed.

Digitalization's impact extends beyond the manufacturing sector, reaching various fields such as services, agriculture and mining, creating a multiplier effect on the economy and, overall, increasing job opportunities.

We recommend five policy proposals for the Indonesian government: diversifying measurement models, shifting terminology, emphasizing soft skills, promoting continuous learning and implementing PIDI 4.0 initiatives. Within the industry context, a critical determinant for successful Industry 4.0 implementation is a thorough understanding of the optimal business model tailored to each company. Furthermore, human resources should not be overlooked, as they play a pivotal role in coordinating the entirety of the operational processes.

Limitations of this study include the lack of detailed data on each company's INDI 4.0 component values and the application of time-series data within a restricted timeframe, so we cannot compare at the firm level. The study is unable to explore the correlation and impact of socioeconomic and demographic factors on the MI 4.0 program. Additionally, the study does not address the pandemic's impact from 2020.

For future research, this research might be the benchmark for similar studies in other countries, especially developing countries. it is recommended to conduct a more nuanced analysis, including correlation and impact tests using a refined model, and obtain data for a firm-level basis. Considering external factors such as geopolitical and economic conditions could further enhance the understanding of the implementation's impact in Indonesia.

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Correlation among components of the Indonesian industry readiness index 4.0 and its implementation on socioeconomic along with the demographic aspects

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