Local Human Resource Development Strategy In Facing Industry 4.0 For The Economic Welfare Of The Community In Medan City

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ABSTRACT
The Industrial Revolution 4.0 brings significant transformations in the global production and economic system through the integration of digital technology, artificial intelligence, and automation. Medan City, as one of the main economic centers in Sumatra, faces serious challenges in preparing its local human resources (HR) to face these changes. This study aims to identify the skills gap of local HR in Medan City in the context of Industry 4.0 needs and provide policy recommendations to improve the competitiveness of local HR. The research method uses a mixed-method approach by combining quantitative methods through a survey of 100 local workers and qualitative methods through in-depth interviews with 10 key stakeholders. The results show that only 23% of respondents have a good understanding of Industry 4.0 technology, and 67% have basic digital literacy skills but only 18% have advanced skills. The highest skills gaps are in data analysis and big data interpretation (78%), programming (71%), and cybersecurity (69%). This study formulates an Integrated HR Development Model consisting of 5 main pillars: adaptive formal education, competency-based vocational training, multi-stakeholder collaboration, lifelong learning, and soft skills development. The implementation of the strategy is projected to increase the employability rate by 45%, reduce unemployment from 6.8% to 4.2%, increase average income by 25-35%, and create 15,000-20,000 new jobs in a 5-year period.

Keywords **:** *Strategy; Local Human Resource Development; Industry 4.0; Economic Welfare; Medan City Society*

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INTRODUCTION

Indonesia, as a developing country, is facing significant global challenges with the advent of Industry 4.0. This fourth industrial revolution is characterized by the integration of digital technology, artificial intelligence, the Internet of Things (IoT), and automation across various sectors of life, including the manufacturing and service industries (Schwab, 2016). As one of Indonesia's largest metropolitan cities, Medan has significant potential to develop and capitalize on the opportunities presented by this digital transformation.

Medan is the economic center of North Sumatra, contributing significantly to the province's Gross Regional Domestic Product (GRDP). According to data from the Statistics Indonesia (BPS) of North Sumatra (2023), Medan contributed approximately 32% of North Sumatra's total GRDP. However, despite this growth potential, a gap remains between the needs of modern industry and the quality of local human resources. The rapid pace of technological transformation has not been matched by the rapid adaptation of the local workforce.

Industry 4.0 demands a workforce with diverse qualifications, particularly in digital technology proficiency and strong analytical skills. Without rapid adaptation, the skills gap will widen and could lead to rising unemployment (Prasetyo & Sutopo, 2018). This poses a serious challenge, given that the unemployment rate in Medan City is projected to reach 6.8% by 2023 (BPS Medan City, 2023).

Digital transformation in Industry 4.0 has the potential to fundamentally change the structure of the workforce (Hasibuan, 2019). Conventional, repetitive jobs are at high risk of being replaced by automation, while a new need for workers with technological and digital skills is emerging. Research conducted by Siagian (2022) shows that 67% of companies in Medan City experience difficulty recruiting local workers with adequate digital skills. As a result, many strategic positions are filled by workers from outside the region or even foreign workers.

The Medan City Government has initiated several human resource development programs, such as vocational training and collaboration with the private sector. However, Lubis (2021) argues that these programs are still sporadic and not yet integrated into a comprehensive human resource development strategy. A systematic approach is needed that aligns formal education, vocational training, and industry needs to face the Industry 4.0 era.

Situmorang (2020) underscored the importance of triple helix collaboration between government, academics, and industry players in building a sustainable human resource development ecosystem. This collaboration is key to ensuring the relevance of human resource development programs to actual job market needs and future technological trends (Goulart et al., 2021). Successful adaptation to Industry 4.0 will determine the long-term competitiveness of regional economies (Scherrer, 2021).

Based on this background, this study aims to: (1) identify the condition of local human resource readiness in Medan City in facing the transformation of Industry 4.0; (2) analyze the challenges and opportunities faced by the people of Medan City related to the development of Industry 4.0; (3) formulate an effective local human resource development strategy to increase the competitiveness of the people of Medan City in the era of Industry 4.0; (4) analyze the impact of the implementation of local human resource development strategies on the level of economic welfare of the people in Medan City; and (5) analyze the role of the government, educational institutions, and the private sector in developing the capacity of local human resources in Medan City to face Industry 4.0.

METHODS

This research uses a mixed methods approach, combining quantitative and qualitative methods to gain a comprehensive understanding of the research problem. The research location is Medan City, North Sumatra, with a focus on various industrial sectors that have adopted or are currently adopting Industry 4.0 technology.

Data collection

Quantitative data was collected through a survey of 100 local workers from various industrial sectors in Medan City to measure digital readiness and competency. Additionally, secondary data analysis was conducted from Statistics Indonesia (BPS), the Manpower Office, and related institutions regarding workforce structure and industry needs.

Qualitative data was obtained through in-depth interviews with 10 key stakeholders, including representatives from local government, industry players, academics, and the community. Case studies were also conducted on existing human resource development programs in Medan to identify best practices and lessons learned.

Data analysis

Quantitative data analysis used descriptive and inferential statistics to identify patterns and relationships between variables. Qualitative data was analyzed using thematic analysis to identify key themes emerging from interviews and case studies. Furthermore, a SWOT analysis was conducted to formulate a human resource development strategy tailored to the conditions of Medan City. A comparative policy analysis was also conducted by comparing best practices from other regions that have successfully developed human resources for Industry 4.0.

RESULT AND DISCUSSION

Condition of Local Human Resource Readiness in Medan City

A survey of 100 local workforce respondents from various industrial sectors in Medan City found that the level of preparedness of local human resources in facing the Industry 4.0 transformation is still in the low to moderate category. The analysis results show that only 23% of respondents have a good understanding of Industry 4.0 technologies, such as the Internet of Things (IoT), Big Data, Artificial Intelligence (AI), and Cloud Computing. This is in line with the findings of Xu et al. (2018) who stated that the digital skills gap is a major obstacle to industrial transformation in developing countries.

In terms of digital literacy, 67% of respondents have basic computer and internet skills, but only 18% have advanced skills in industry-specific software or programming. Data shows that 45% of the local workforce has a high school/vocational high school education, 38% a bachelor's degree (S1), and 17% a diploma. However, the majority of respondents (72%) stated that their formal education was inadequate to meet the needs of modern industry.

Regarding vocational training, only 31% of respondents had participated in digital technology-related training in the past two years. Existing training programs tend to be sporadic

and not integrated with current industry needs. This indicates the need for a redesign of educational curricula and training programs that are more responsive to technological developments (Goulart et al., 2021).

The psychological readiness aspect showed quite positive results, with 64% of respondents stating a willingness to learn new technologies and adapt to change. However, 58% of respondents expressed concern about potential job losses due to automation and digitalization. This finding is consistent with research by Venkatesh & Davis (2000), which showed that technology anxiety can be a barrier to adopting new technologies.

Challenges and Opportunities of Industry 4.0 in Medan City

Skills Gap

In-depth interviews with 10 key stakeholders revealed that the skills gap is a major challenge. Representatives from five large companies in Medan reported difficulties recruiting local workers with adequate digital competencies. Positions such as Data Analyst, Digital Marketing Specialist, and IoT Engineer often have to be filled by workers from outside the region.

The gap analysis shows that the most needed but least available skills among the local workforce include: (1) Data analysis and big data interpretation with a gap of 78%; (2) Programming and software development with a gap of 71%; (3) Cybersecurity with a gap of 69%; (4) Automation system design and maintenance with a gap of 65%; and (5) Digital marketing and e-commerce with a gap of 52%.

Limited Digital Infrastructure

Despite Medan's metropolitan status, unequal access to digital infrastructure remains. Surveys show that 34% of respondents experience challenges with stable internet access, particularly in suburban areas. This presents a barrier to the implementation of online training programs and digital skills development.

Education and Training Costs

Sixty-one percent of respondents stated that the cost of technology education and training is a significant barrier. Quality training in Industry 4.0 technologies often requires investments that are out of reach for most people. On the other hand, there are several opportunities that can be exploited. First, the digital sector in Medan City grew 18.7% annually between 2020 and 2023. The e-commerce, fintech, and digital services sectors experienced rapid growth, opening up new job opportunities for skilled human resources. Second, the Medan City Government has launched the Medan Smart City program, which provides a platform for digital human resource development. This program includes coworking spaces, digital business incubators, and technology entrepreneurship training programs. Third, there has been significant growth in the startup ecosystem in Medan City, with 47 active technology startups in 2023, opening opportunities for local talent to engage in innovation and develop digital solutions.

Integrated Human Resource Development Model

Based on SWOT analysis and comparative studies with other successful regions, this study formulates an Integrated Human Resource Development Model consisting of 5 main pillars:

1. Adaptive Formal Education Pillars. This strategy includes revising the higher education curriculum by integrating Industry 4.0 content into every study program, strengthening industry-academia collaboration through mandatory internships of at least six months, developing dual-degree programs that combine formal education with industry certification, and training lecturers in digital competencies and technology-based learning methods.
2. Competency-Based Vocational Training Pillars. Strategic recommendations include the establishment of a Digital Skills Training Center equipped with Industry 4.0 technology, the development of a modular training curriculum tailored to industry-specific needs, the implementation of an industry-recognized competency certification system, and upskilling and reskilling programs for the existing workforce.
3. Multi-Stakeholder Collaboration Pillars. The Triple Helix model implemented involves the government in providing incentive policies, infrastructure, and funding; academia in curriculum development, research, and knowledge transfer; and industry in providing

internships, mentoring, and job security. Interviews indicate that effective collaboration requires a permanent coordination platform and clear monitoring mechanisms.

4. The Lifelong Learning Pillar. This strategy includes the development of a freely accessible online learning (e-learning) platform, a micro-credentials program to facilitate continuous learning, and a Community of Practice (CPD) to share knowledge and experiences.
5. Pillars of Soft Skills and Mindset Development. In addition to technical skills, this study identified the importance of developing soft skills such as critical thinking and complex problem-solving, creativity and innovation, communication and collaboration skills, and adaptability and resilience to change.

The strategy implementation is divided into three phases. Phase 1 (Years 1-2) focuses on building the foundation through detailed mapping of industry competency needs, developing training infrastructure, and piloting programs in three priority sectors. Phase 2 (Years 3-4) expands the program by scaling up the training program to all sectors, strengthening industry-academia partnerships, and conducting ongoing monitoring and evaluation. Phase 3 (Year 5) consolidates the program through comprehensive evaluation and refinement, institutionalizing best practices, and replicating the model in other regions.

Impact on Economic Welfare

Based on the developed econometric model, the implementation of the human resource development strategy is projected to have a positive impact on the economic well-being of the Medan City community. Simulations show that with full implementation of the proposed strategy, the employability rate of local human resources could increase by up to 45% within five years. This would result in a reduction in the unemployment rate from 6.8% to a projected 4.2%.

Workers with digital competencies are reported to be 38% more productive than those without them (Brynjolfsson & McAfee, 2014). This increased productivity is projected to increase average worker income by 25-35% over a five-year period. Implementing a human resource development strategy is projected to increase Medan City's contribution to North Sumatra's GRDP from 32% to 37% over a five-year period. The growth of the digital economy is expected to create 15,000-20,000 new jobs.

In addition to economic impacts, the study also identified positive social impacts. More equitable access to digital education and training is projected to reduce Medan City's Gini coefficient from 0.42 to 0.37 within five years. Inclusive programs targeting women, youth, and low-income communities can increase their participation in the digital economy by up to 56%.

The Role of Stakeholders in Human Resource Development

The research results recommend a strategic role for local governments, including the drafting of Regional Regulations on Digital Human Resource Development, a minimum budget allocation of 5% of the Regional Budget (APBD) for HR development programs, fiscal incentives for companies that organize local HR training, the construction of Digital Innovation Hubs in each sub-district, the provision of free internet access in public spaces, the procurement of technological devices for training programs, the formation of a Digital Human Resource Development Task Force, and the facilitation of partnerships between academics, industry, and training institutions.

Universities and educational institutions have a crucial role in curriculum transformation by integrating Industry 4.0 content into existing curricula, developing new study programs relevant to industry needs, implementing project-based and problem-based learning methods, conducting applied research on technological solutions for local industries, developing prototypes and proof of concepts, conducting technology transfer to industry, providing digital literacy-based community service programs, providing free training for the general public, and providing consultation and mentoring to MSMEs in digital transformation.

Industry and the private sector contribute by providing structured internship programs with quotas for local human resources, in-house training accessible to employees and the community, mentoring and coaching by industry practitioners, Corporate Social Responsibility (CSR) that focuses on human resource development, scholarships for technology education and training, sponsorship for competitions and hackathons, a commitment to prioritizing local workers in recruitment, a clear career development scheme, and a retention program through competitive benefits.

CONCLUSION

This study yielded several important conclusions. First, Medan's local human resources are still low to moderately prepared for Industry 4.0, with significant skills gaps, particularly in advanced digital competencies. Only 23% of respondents had a good understanding of Industry 4.0 technologies, and the highest skills gaps were in data analysis (78%), programming (71%), and cybersecurity (69%).

Second, the skills gap, limited infrastructure, and education costs are key challenges. However, the 18.7% annual growth of the digital economy, government support through the Medan Smart City program, and a thriving startup ecosystem present significant opportunities for human resource transformation.

Third, the Integrated Human Resource Development Model consisting of 5 pillars (adaptive formal education, competency-based vocational training, multi-stakeholder collaboration, lifelong learning, and soft skills development) is a comprehensive and implementable strategy to face the challenges of Industry 4.0.

Fourth, implementation of the proposed strategy is projected to increase employability by up to 45%, reduce unemployment from 6.8% to 4.2%, increase average income by 25-35%, and create 15,000-20,000 new jobs within five years. Social impacts include a reduction in the Gini coefficient from 0.42 to 0.37 and an increase in participation of marginalized groups in the digital economy by up to 56%.

Fifth, successful strategy implementation requires strong commitment and collaboration between local governments, educational institutions, and the private sector within an effective Triple Helix framework. The government plays a role in regulation and infrastructure provision, academia in curriculum transformation and research, and industry in providing internship programs and absorbing local labor.

This research provides theoretical contributions to the development of a contextual human resource development model for regions with similar characteristics, as well as practical contributions in the form of concrete and implementable policy recommendations. For future research, it is recommended to conduct longitudinal studies to measure the effectiveness of strategy implementation over the long term and to compare with other cities in Indonesia to identify best practices that can be adopted.

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