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Restructuring of Undergraduate Information Technology Curriculum in Fulfillment of SKKNI Industry 4.0 with an Independent Learning Campus Approach

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ABSTRACT

Information technology has played an important role in the business and industrial environment. The suitability of the competence of graduates of information technology graduates and competency standards in the industry is a problem that is quite complicated to explore. The purpose of this study was to analyze the suitability of the undergraduate-level information technology curriculum with the competency map required by the industry which is always developing rapidly in the industrial era 4.0. This study also tries to recommend an information technology curriculum restructuring model with an independent campus learning approach. The method used in this study is a qualitative method with a traditional literature review approach that specifically analyzes documents in depth to gain new knowledge. The results of this study indicate that there is a large gap between the education process at the undergraduate level in the competencies students acquire and the occupations provided by industry which results in many undergraduate graduates not being absorbed by industry. The results of this study also show that the independent approach to independent campus learning is also not enough to bridge this gap because several stages do not go well. This study concludes that a comprehensive restructuring of the undergraduate curriculum is needed to obtain a curriculum that is good and adaptive to change.

Keywords: industry 4.0, information technology curriculum, SKKNI occupation, independent learning independent campus

INTRODUCTION

In the business environment, information technology has enabled greater efficiency and productivity, as well as providing greater accessibility and ease of access to information. In addition, ICT has opened up new opportunities in various industrial and economic sectors (Bianchi & Sousa, 2016). Along with these developments, many countries, including Indonesia, recognize the importance of expertise in information technology in facing the challenges and opportunities offered by the digital era. Therefore, an information technology curriculum was developed to prepare students with the necessary expertise in this field. The information technology curriculum is designed to introduce students to the basic concepts of information technology and provide them with the skills necessary to operate and utilize information technology devices and applications. This curriculum covers topics such as computer programming, computer networks, databases, information security, and web design (Karseth & Wahlström, 2023). As such, the information technology curriculum aims to prepare students with the skills and knowledge necessary to succeed in the current and future digital age.

Even though the information technology curriculum at the undergraduate level has been designed to prepare graduates with the skills needed in today's digital era, there are still some problems that need to be overcome in facing the challenges of Industry 4.0. Some of these problems include a Lack of practical skills and field experience: Information technology curricula often focus on basic theory and concepts, but do not provide enough practical opportunities and field experience in dealing with the latest technologies and trends (Roehrig et al., 2023). Students often face difficulties in applying the concepts and theories they have learned in real situations. Very fast speed of technological change: Information technology continues to develop and change very quickly, making it difficult to keep up with changing technological developments and update curricula immediately. As a result, the information technology curriculum may become obsolete or irrelevant if it is not updated regularly (Winter & Hyatt, 2023). Lack of integration between information technology and other disciplines: Information technology is no longer an independent discipline, but is integrated with other disciplines such as business, health, environment, and others (Southworth et al., 2023). The information technology curriculum must be able to integrate these aspects so that graduates have broader skills and can adapt to various work environments. Lack of communication and collaboration skills: Students often focus on technical skills only, without paying attention to the communication and collaboration skills that are so important in today's world of work. In fact, these skills are also needed in Industry 4.0 which is increasingly complex and global.

To overcome this problem, information technology curricula should be updated regularly by integrating the latest technologies and developing stronger practical skills and field experiences. In addition, the curriculum should be more integrated with other disciplines and provide more opportunities to develop communication and collaboration skills. The solution built is to build industry standards by explaining competency standards according to job descriptions in the field of information technology carried out in the industry. This description also contains a description of the profession for each level of competence to facilitate the intended explanation and competence (Leat & Whelan, 2023). This model is referred to as Occupational SKKNI. SKKNI (Indonesian National Work Competency

Standards) is a standard developed by the Indonesian Ministry of Manpower as a reference for measuring the competency level of workers in Indonesia. OCCUPATION SKKNI (Indonesian National Occupational Competency Standards) is a complete list of jobs or positions in Indonesia accompanied by a complete description of the duties and skills required to pursue a career in that occupation. SKKNI OCCUPATIONS consist of various job categories, ranging from management and finance, information technology, and health, to transportation and logistics. Each job category has a different list of jobs or positions, and each position has a clear and detailed job description, as well as work competency standards that must be mastered by workers who want to pursue a career in that field (Yang, 2023). The work competency standards in the OKUASI SKKNI cover various aspects, such as the technical skills needed to complete tasks, communication skills, time management skills, skills to adapt to change, and the ability to work in a team. SKKNI OCCUPATION is very important for workers and employers in Indonesia. By having clear and transparent work competency standards, the workforce can prepare well and improve their skills to match the demands of the current labor market. Meanwhile, employers can use the SKKNI OCCUPATION to evaluate and select workers according to their business needs, as well as develop training and development programs that are in accordance with the desired work competency standards.

The independent campus learning approach is an approach that gives students the freedom to choose the courses they want to take and study independently with the guidance of the lecturer. In this research, this approach is used to update the information technology curriculum which is more adaptive to the evolving requirements of the SKKNI. By using this approach, the curriculum can be more easily updated and adapted to the latest developments in information technology. In addition, students can choose courses according to their interests and needs, thereby increasing their involvement in the learning process.

The novelty of this research lies in its focus on fulfilling the SKKNI in Industry 4.0. By integrating the SKKNI requirements into the curriculum, graduates of the information technology study program will have skills that are more relevant to current industry needs. This will help increase the competitiveness of graduates in an increasingly competitive job market. Thus, this research makes a significant contribution to efforts to improve the quality of information technology education in Indonesia with an innovative and adaptive approach to the latest developments in information technology and industry needs. The purpose of this study was to analyze the suitability of the undergraduate-level information technology curriculum with the competency map required by the industry which is always developing rapidly in the industrial era 4.0. This study also tries to recommend an information technology curriculum restructuring model with an independent campus learning approach.

METHODS

This study uses a qualitative method with a traditional literature review approach. Traditional literature review methods are usually carried out by collecting literature or references related to a

particular topic, then analyzing and compiling the literature into a report that can be presented (Ward & Peppard, 2002). Here are the general steps in the traditional method of literature review:

1. Selection of topics and literature review
   Researchers choose topics to be studied, then collect library materials related to these topics. Usually, the library materials used are scientific articles, books, and journals.
2. Literature selection
   Researchers then select relevant and high-quality literature to include in the analysis. Selection of literature is usually based on certain criteria, such as relevance to the topic under study, year of publication, and quality of research.
3. Literature analysis
   After the relevant literature has been selected, the researcher then conducts an analysis of the literature by reading and evaluating the contents of the literature. This literature analysis can be carried out by different methods, such as descriptive, critical, or systematic methods.
4. Compilation of reports
   After the literature analysis was completed, the researcher then compiled a report on the results of the literature review. The report usually contains a summary, synthesis, and evaluation of the literature that has been analyzed.
5. Presentation
   The report on the results of the literature review can then be presented in various forms, such as a written report, poster, or oral presentation.

The traditional method of literature review can provide a broad and in-depth understanding of the topic under study, but sometimes this method is not able to capture new and up-to-date information and can ignore the social, political, and cultural context that can influence the results of a literature review.

RESULTS AND DISCUSSION

Curriculum Study in the Industrial 4.0 Era in the Context of Industrial Occupational Maps

Industry 4.0 is an industrial revolution that occurs in the digital era, where digital technology and data are the main factors in various industries. Therefore, to keep abreast of Industry 4.0 developments, the Curriculum of the Bachelor of Information Technology study program needs to be restructured to meet the current and future needs of the industry.

One approach that can be taken in curriculum restructuring is to use the Merdeka Learning Kampus Merdeka approach. This approach emphasizes independent and student-centered learning, where students have full control over their learning process and are given the freedom to choose and manage the courses they want to take. This approach allows students to choose courses that are relevant to industry needs and their personal interests so that they can better prepare themselves to enter the

world of work. In addition, with this freedom, students can learn additional skills that can increase their competitiveness in the job market (Hassan et al., 2023).

In restructuring the curriculum, it is also necessary to pay attention to the fulfillment of the Indonesian National Work Competency Standards (SKKNI) for Industry 4.0. SKKNI is a standard that describes the qualifications and competencies that must be possessed by workers in a certain field, including the field of Information Technology. By fulfilling the SKKNI for Industry 4.0, the Bachelor of Information Technology study program can produce graduates who have competencies and qualifications that are relevant to current and future industry needs. In order to comply with SKKNI Industry 4.0, the curriculum can be restructured by strengthening courses related to digital technology and data, such as the Internet of Things (IoT), Big Data, and Artificial Intelligence (AI). In addition, courses can also be directed at developing skills needed in Industry 4.0, such as programming skills, data analysis, and project management (Dilekçi & Karatay, 2023).

Overall, the restructuring of the Bachelor of Information Technology curriculum with the Independent Learning Campus approach and fulfillment of Industry 4.0 SKKNI can increase the relevance of study programs to current and future industrial needs, so that graduates can be ready and able to compete in the job market. SKKNI (Indonesian National Work Competency Standards) is a competency standard used to assess and measure a person's skills in a particular field of work. See Figure 1.

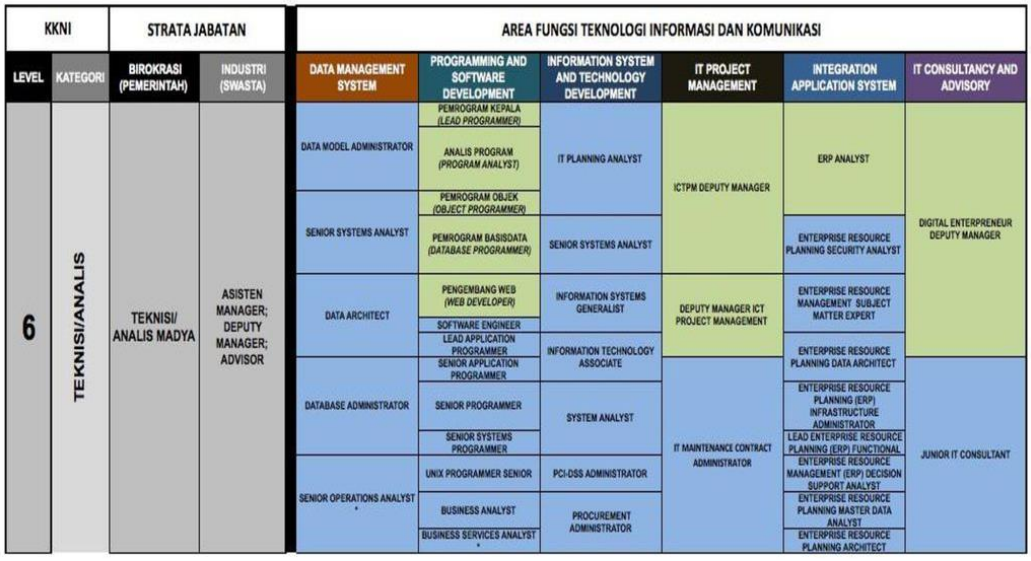

Figure 1. Occupation Map of SKKNI in information technology sector

SKKNI (Indonesian National Work Competency Standards) is a standard that describes the qualifications and competencies that must be possessed by workers in a particular field. Level 6 in the SKKNI refers to the highest competency level for the Information Technology field, where the

workforce is expected to have very high knowledge and skills in that field. At level 6 of SKKNI, the competency required is at the level of expertise or special expertise.

The following are several occupational levels of SKKNI Information Technology:

Information System Architecture

Workers in this field are responsible for designing, developing, and implementing information systems architectures. They must be able to analyze business and information technology needs and ensure that the information systems developed can meet the requirements and standards set (Yandri et al., 2019).

Data analysis

Workers in this field are responsible for analyzing large amounts of data and information to generate insights and information that can be used for decision-making. They must be able to use data analysis tools and techniques, as well as develop predictive models that are accurate and relevant (Ruiz et al., 2018).

Cryptography

Workers in this field are responsible for developing security systems and data encryption. They must have a solid understanding of cryptographic algorithms, security protocols, and encryption technologies used to protect data and information from security threats.

Web Application Development

Workers in this field are responsible for designing, developing, and maintaining web applications that comply with business standards and requirements. They must have a strong knowledge of web technologies, programming languages, and web application development tools (Kiss & Godó, 2014).

Mobile Application Development

Workers in this field are responsible for designing, developing, and maintaining mobile applications that meet business standards and requirements. They must have a strong knowledge of mobile technologies, programming languages, and mobile application development tools (Alfalah, 2023; Pal et al., 2023).

IT Project Management

Workers in this field are responsible for planning, organizing, and controlling IT projects from start to finish. They must be able to identify business requirements and develop project plans, as well as ensure projects are completed within the stipulated time, cost, and quality.

IT Network and Infrastructure

Workers in this field are responsible for designing, implementing, and maintaining IT networks and infrastructure. They must be able to identify business requirements and develop network and infrastructure solutions that comply with business standards and requirements.

Information Security

Workers in the field design, implement and maintain information security on IT infrastructure and networks. They must be able to identify various security factors for business needs and develop information security systems as network and infrastructure solutions that comply with business standards and requirements.

Enterprise Architect

The enterprise architect is responsible for designing and building an IT architecture that fits the organization's business strategy. They also ensure that the systems and applications built comply with industry standards and meet user requirements.

Solution Architects

Solution architects are responsible for designing complex, business-oriented information technology solutions. They must understand business and technology requirements, and ensure that the solutions they design are effective, efficient, and meet industry standards.

Cyber Security Architect

A cyber security architect is responsible for designing and developing effective and efficient cybersecurity solutions. They must understand the security risks associated with applications and systems, and determine how best to mitigate those risks.

Data Scientist

Data scientists are responsible for analyzing data and generating useful business insights. They must have a deep understanding of data analysis, statistics, and related technologies, and be able to develop complex machine-learning algorithms and models.

Artificial Intelligence (AI) Engineer

AI engineers are responsible for developing and maintaining complex AI solutions. They must have a deep understanding of machine learning, deep learning, and related AI technologies, and be able to develop and implement effective AI solutions.

DevOps Engineer

DevOps engineers are responsible for developing and maintaining complex IT infrastructures. They must have a deep understanding of software development, testing, and infrastructure management, and be able to implement effective and efficient solutions.

Cloud Architects

A cloud architect is responsible for designing, developing, and managing complex cloud solutions. They must have a deep understanding of cloud technology, security, and cloud service management, and be able to implement effective and efficient cloud solutions.

Those are some level 6 occupations in the SKKNI Information Technology field that require very high knowledge and skills. All of these occupations require a deep understanding of information technology, business, and security, as well as the ability to design and implement complex and effective solutions.

In terms of undergraduate level information technology curriculum and SKKNI, several issues need attention related to the requirements and qualifications that must be possessed by graduates of the information technology study program to be able to fulfill the SKKNI requirements, including:

1. Lack of practical skills: Graduates of the information technology study program may have strong theoretical skills, but lack the practical skills required in the increasingly complex industry 4.0. This can lead to gaps between the SKKNI requirements and the skills possessed by graduates.
2. Not accommodated by the rapid development of information technology: The information technology curriculum is often difficult to keep up with the ever-changing developments in information technology and update the SKKNI requirements immediately. This can lead to a lack of skills needed in Industry 4.0.

3. Does not focus on industry needs: Information technology study programs may only study general information technology and concepts, but do not consider the specific needs of certain industries. This can cause graduates of the information technology study program to lack specific skills for the industry they want to work in.
4. Lack of collaboration and communication skills: Graduates of an information technology study program may focus on technical skills only, but lack the development of collaboration and communication skills that are very important in today's world of work.

To overcome this problem, the information technology curriculum must be designed by taking into account the requirements of the SKKNI better and continuously updated according to the latest developments in information technology. Curricula should be more integrated with industry needs and provide more opportunities to develop practical, collaboration, and communication skills. In addition, graduates of the information technology study program must continue to attend additional training and courses to update their skills to meet the evolving requirements of the SKKNI.

Approach with independent learning independent campus

Figure 2. independent campus learning activities

Education is about the ability to learn from experience, think, solve problems, and use knowledge to adapt to new situations. Curriculum restructuring is a process of rearranging the structure, content, and teaching methods in a study program to ensure that the curriculum meets the latest industry needs and demands. In the context of Information Technology, curriculum restructuring is very important to accommodate technological developments and industrial paradigm shifts brought about by the Industrial Revolution 4.0.

SKKNI Industry 4.0 is a work competency standard set by the Indonesian government to describe the skills and knowledge needed in an information technology-based industry in the Industry 4.0 era. The aim of restructuring the Bachelor of Information Technology curriculum is to ensure that graduates of the study program have skills and knowledge that are relevant to current industry needs.

The Independent Campus Learning Approach is a learning approach introduced by the Indonesian Ministry of Education, Culture, Research, and Technology (Kemendikbudristek). This approach encourages students to have independence in learning and access a wide range of learning resources, including digital platforms and distance learning. This approach also encourages the development of soft skills and the ability to adapt quickly to technological developments.

In restructuring the Bachelor of Information Technology curriculum in fulfilling SKKNI Industry 4.0 with the Independent Learning Campus approach, several steps can be taken as follows:

1. *Industry Needs Analysis*

The first step is to conduct an in-depth analysis of the needs of the Information Technology industry that is relevant to Industry 4.0. This involves identifying the skills, knowledge, and competencies expected of the graduates of the study program.

Analysis of industrial needs is an important step in ensuring that the Bachelor of Information Technology curriculum meets the demands and developments of the industry related to Industry 4.0. The following are some of the key components that need to be considered in an industrial needs analysis:

- Identification of Industry Changes
  The industry needs analysis must include an in-depth understanding of the changes that have occurred in the Information Technology industry in the context of Industry 4.0. This involves studying the latest developments, trends, and paradigm shifts taking place in industries, such as the use of the Internet of Things (IoT), Big Data, Artificial Intelligence, cloud computing, and cybersecurity technologies.
- Consultation with Industry Parties
  Involving industry parties, such as technology companies, startups, and industry experts, in the needs analysis process is very important. This consultation can be carried out through meetings, surveys, or interviews with industry stakeholders to understand their perspectives and needs for Bachelor of Information Technology graduates.
- Identification of Competency and Skills
  Based on industry changes and input from the industry, identify the competencies and skills needed by graduates of the Bachelor of Information Technology in the Industrial 4.0 era. This includes technical skills such as programming, application development, data analytics, and cybersecurity, as well as non-technical skills such as critical thinking skills, creativity, collaboration, and leadership.
- Complete Analysis of Existing Curriculum
  Conduct an in-depth analysis of the ongoing Bachelor of Information Technology curriculum to identify strengths, weaknesses, and gaps in meeting industry needs. This involves evaluating existing courses, teaching content, teaching methods, and current assessments.
- Customize Courses and Content
  Based on an analysis of industry needs and an evaluation of the existing curriculum, it is necessary to restructure the curriculum to adapt courses and content to industry needs related

to Industry 4.0. This could include adding new relevant courses, integrating the latest technology into teaching, and increasing focus on required competencies and skills.

- Involvement of Industry Experts in the Teaching Process
  In fulfilling SKKNI Industry 4.0 and the Independent Learning Campus approach, it is important to involve industry experts as guest lecturers or mentors in teaching. This helps ensure that students gain first-hand insight into industry needs, the latest trends, and the practical applications of related technologies.

Analysis of industry needs in the restructuring of the Bachelor of Information Technology curriculum is a crucial step in preparing graduates who are relevant, competent, and ready to face challenges in the Industry 4.0 era. By understanding industry changes and integrating industry needs into the curriculum, educational institutions can produce graduates who are in line with the demands and expectations of the Information Technology industry.

2. Adjustment of Curriculum Content

Based on an analysis of industry needs, curriculum content needs to be adjusted to cover topics relevant to Industry 4.0, such as Big Data, the Internet of Things (IoT), Artificial Intelligence, cybersecurity, cloud computing, and data analytics. Curriculum content must also include aspects of the expertise required in the development of applications and systems related to this technology (Kvamme, 2023).

Adjustment of curriculum content is an important step in restructuring the Bachelor of Information Technology curriculum to ensure that the material taught includes aspects relevant to Industry 4.0. The following are several components that need to be considered in adjusting curriculum content:

- Introduction of Industry 4.0 Concept
  Curriculum content needs to include an understanding of the basic concepts and principles of Industry 4.0. This includes an understanding of digital transformation, connectivity, automation, and technology integration that underlies Industry 4.0. Students need to understand how technologies such as the Internet of Things (IoT), artificial intelligence (Artificial Intelligence), data analytics, and cloud computing (cloud computing) play a role in Industry 4.0.
- Latest Technology and Platform
  The curriculum needs to include teaching the latest technologies and platforms that are relevant to Industry 4.0. This includes training in developing cloud-based applications, using data analytics tools, using Internet of Things (IoT) technology for data collection and analysis, as well as an introduction to the concepts of artificial intelligence (Artificial Intelligence) and machine learning (machine learning).
- Cybersecurity
  In the increasingly connected Industry 4.0 era, cybersecurity is a critical factor. Therefore, curriculum content needs to cover cybersecurity aspects, including an understanding of

cyberattacks, security practices, data encryption, security testing, and cybersecurity risk management. Students also need to be given knowledge about policies and regulations related to cyber security.

- Data Analytics and Big Data
  The use of data analytics and big data processing is important in Industry 4.0. Therefore, curriculum content needs to include an understanding of data analytics concepts and techniques, big data processing, data analysis methods, and the use of data analytics tools and platforms. Students also need to be taught about ethics and privacy in data use.
- Soft Skills Skills
  In addition to technical skills, curriculum content needs to pay attention to the development of soft skills needed in Industry 4.0. These include critical thinking skills, creativity, collaboration, effective communication, leadership, and adaptability to changing technology.
- Industrial Projects and Internships
  Curriculum content should include industry projects and internships that provide students with practical experience. These projects can involve developing applications based on the latest technology, solving problems relevant to Industry 4.0, or collaborating with technology companies.

In adjusting curriculum content, it is important to ensure a balance between technical skills and soft skills, as well as integrate elements of the Merdeka Learning Kampus Merdeka approach. This includes using digital learning platforms, developing student learning independence, and providing flexibility in choosing courses that suit their interests and needs.

By adjusting the appropriate curriculum content, the Bachelor of Information Technology will be able to produce graduates who are comprehensively prepared to face the challenges and demands of Industry 4.0 and are able to integrate technical knowledge and skills with the skills needed in today's world of work.

3. Introduction to the Independent Learning Approach

The curriculum needs to incorporate elements of the Merdeka Learning Campus approach, such as the use of digital learning platforms, integration of distance learning, and an emphasis on developing soft skills and adaptability. Students also need to be given the freedom to choose courses or learning modules that suit their interests and needs (Winter & Hyatt, 2023).

The Independent Learning approach is an innovative approach in education that prioritizes the independence and freedom of student learning. This approach aims to provide flexibility to students in determining the course of learning, choosing courses of interest, and developing skills that are relevant to their needs. Following are some of the main principles of the Independent Learning approach:

- Providing Learning Independence
  The Independent Learning approach gives freedom to students to set their own time, place, and study method. Students have an active role in planning and managing their learning, so they can study at their own pace and individual learning style.

- Flexibility in Choosing Courses
  In this approach, students are given flexibility in choosing the courses they are interested in according to their interests, goals, and needs. This allows students to gain knowledge and skills relevant to Industry 4.0, according to their areas of interest.
- Use of Information Technology
  In the Industry 4.0 era, the use of information technology is very important in education. The Merdeka Learning approach encourages the use of information technology, such as online learning platforms, cloud-based applications, digital learning resources, and social networks to facilitate independent and collaborative learning.
- Project Based Learning
  The Merdeka Learning approach encourages project-based learning that engages students in completing real, industry-relevant tasks. Through these projects, students can apply the knowledge and skills they have learned, as well as develop critical thinking, creativity, and problem-solving skills.
- Support and Guidance
  Although this approach emphasizes independence, support, and guidance are still important. Educational institutions need to provide the necessary resources and guidance, such as supervisors, industry mentors, access to learning resources, and discussion forums to facilitate the student learning process.

In restructuring the Bachelor of Information Technology curriculum, the Merdeka Learning approach can be implemented by integrating the principles and elements of this approach into curriculum design. This includes providing flexibility in course selection, leveraging information technology for learning, encouraging project-based learning, and providing needed support and guidance.

The introduction of the Merdeka Learning approach in the restructuring of the Bachelor of Information Technology curriculum can provide students with the opportunity to develop the independence, creativity, and adaptability needed to face the challenges of Industry 4.0.

4. Use of the Latest Information Technology

The curriculum must include teaching and training using the latest information technology that is relevant to Industry 4.0. This can include using online learning platforms, developing cloud-based applications, exploring IoT technology, and using data analytics tools (Leat & Whelan, 2023).

The use of the latest information technology in the Bachelor of Information Technology curriculum is very important to prepare students to face the challenges of Industry 4.0. Following are some of the main components in the use of the latest information technology:

- Online Learning Platform
  The Merdeka Learning approach encourages the use of online learning platforms to facilitate independent and collaborative learning. This platform can be in the form of a Learning Management System (LMS) which provides learning materials, assignments, exams, and

discussion forums. Students can access learning materials flexibly and participate in online learning activities.

- Cloud Based Application
  In Industry 4.0, cloud computing is very important. The curriculum needs to cover understanding and use of cloud-based applications such as cloud computing platforms, cloud-based data storage, and online collaboration tools. Students need to be taught how to use this technology for software development, data analysis, and project management.
- Digital Learning Resources
  There are many digital learning resources available online, such as e-books, video tutorials, online courses, and educational websites. In curriculum restructuring, it is important to integrate these resources as additional references for students. Students can access these resources to deepen their understanding of specific topics, explore the latest technologies, and develop additional skills.
- Industry 4.0 Based Application Development
  The Bachelor of Information Technology curriculum needs to cover application development projects that are relevant to Industry 4.0. Students can learn to design, develop, and implement applications that use the latest technologies such as the Internet of Things (IoT), artificial intelligence, data analytics, and cloud computing. These projects may involve collaborating with industrial companies or organizations to gain practical experience.
- Use of Data Analytics and Big Data Tools
  In the restructuring of the curriculum, it is important to include teaching about data analytics tools and big data processing. Students need to learn to use data analytics tools such as Python, R, or data visualization tools to process and analyze data in the context of Industry 4.0. This teaching can involve case studies, projects, or practicums involving real-time data or big data.
- Augmented Reality (AR) and Virtual Reality (VR) Technology
  The use of AR and VR technology is growing in Industry 4.0. Teaching about the use of this technology can be an important part of the Bachelor of Information Technology curriculum. Students can learn about the development of AR and VR applications, and their application in fields such as games, simulation, design, or training.

Through the use of the latest information technology in curriculum restructuring, Bachelor of Information Technology students will have a deeper understanding of technology relevant to Industry 4.0 and be ready to face the challenges that exist in an increasingly connected and digitalized world of work.

5. Industrial Projects and Internships

To provide students with practical experience, the curriculum may include projects or internships in the Information Technology industry related to Industry 4.0. This helps students apply the knowledge and skills they have learned in real-world contexts.

Industrial projects and internships are important components of the Bachelor of Information Technology curriculum (Klimova & Rondeau, 2017). They help students to apply the knowledge and skills they learn in a real work environment and also broaden their understanding of Industry 4.0. Below is a more detailed description of industry projects and internships:

- Projects
  Projects in the curriculum can be designed to enable students to develop information technology solutions that are relevant to Industry 4.0. These projects can be in the form of application development, system design, data processing, security analysis, or the implementation of the latest technologies such as the Internet of Things (IoT), artificial intelligence (Artificial Intelligence), or big data. Students work in teams to tackle real challenges faced in the industry, developing skills in collaboration, problem-solving, and project management.
- Industrial Internship
  Industrial internships provide opportunities for students to experience practical work experience. Students can work in technology companies, startups, or other organizations related to the Information Technology industry. Industrial internships allow students to apply the knowledge and skills they learn in a real work environment, expand their professional network, and understand real industry perspectives. These internships can also help students develop communication, time management, and adaptability skills.

In the Merdeka Learning Kampus Merdeka approach, industrial projects and internships can be integrated with the flexibility provided to students. Students can choose projects or internships that suit their interests and needs, and broaden their knowledge and experience according to their desired career goals. This flexibility allows students to plan and organize their learning according to their personal preferences while ensuring the fulfillment of the competencies set by SKKNI Industry 4.0.

In addition, educational institutions also need to collaborate with companies or industries to provide beneficial project and internship opportunities for students. This involves partnering with companies, identifying industry needs, and coordinating with them to offer relevant projects and internships. This ensures that students get up-to-date practical experience and are in line with Industry 4.0 developments.

By integrating industry projects and internships in curriculum restructuring, Bachelor of Information Technology students will have the opportunity to develop the technical and professional skills needed in Industry 4.0, as well as expand their networks and increase their readiness to enter an increasingly connected and digitalized world of work.

6. Continuous Evaluation and Update

The curriculum needs to be evaluated regularly to ensure relevance and suitability with developments in the Information Technology industry and the ever-changing needs of SKKNI Industry 4.0. Updates need to be made in accordance with technological developments and industry demands.

Continuous evaluation and updating are key components in maintaining the sustainability and relevance of the Bachelor of Information Technology curriculum. In the era of Industry 4.0 which

continues to develop rapidly, technology and industrial needs are also changing rapidly (Ingaldi et al., 2023). Therefore, it is important to carry out periodic evaluations and updates to ensure that the curriculum remains relevant and meets industry needs. Here is a more detailed explanation of the continuous evaluation and updates:

- Evaluation of Industry Needs
  Evaluation of industry needs is carried out regularly to understand trends, developments, and industry needs related to Information Technology. This can involve consulting with industry experts, companies, and related professional organizations. This evaluation assists in identifying shifts in the skills and knowledge requirements required by Bachelor of Information Technology graduates. With a deep understanding of industry needs, curricula can be updated and adapted to stay relevant.
- Curriculum Review
  Curriculum reviews are conducted periodically to evaluate existing content, structure, and teaching methods. This involves analyzing the suitability of the course to industry needs, integrating the latest technologies, developing additional skills needed, and updating learning materials. This review also allows the identification of weaknesses or deficiencies in the curriculum that need improvement. The results of the review are used as a basis for updating the curriculum.
- Updating of Learning Materials
  Learning materials in the curriculum need to be updated regularly to reflect the latest technological developments and industry needs. This involves introducing or enhancing material related to Industry 4.0, such as artificial intelligence, data analytics, cybersecurity, cloud computing, and the Internet of Things (IoT). Updates may also involve integrating digital learning resources, video tutorials, and case studies relevant to the latest industry trends.
- Use of Active Learning Methods
  In the Merdeka Learning Kampus Merdeka approach, it is important to utilize active learning methods that encourage active student participation. This can include problem-based projects, case studies, group discussions, and practicums. This method helps students to develop critical skills, creativity, problem-solving, and collaboration, which are skills that are very much needed in Industry 4.0. Evaluation of the effectiveness of learning methods also needs to be done to ensure that they are effective in achieving learning objectives.
- Partnership with Industry
  Partnerships with Information Technology companies and industry are important to gain first-hand insight into the latest developments in the industry. Educational institutions need to work closely with companies to get input on industry needs and involve them in curriculum evaluation and updating. Such partnerships can also open up opportunities to integrate industry projects and internships into the curriculum.

With continuous evaluation and updating, the Bachelor of Information Technology curriculum can remain relevant to the needs of Industry 4.0. This ensures that graduates have the necessary knowledge, skills, and competencies to face the ever-evolving industry challenges. In addition, the

Merdeka Learning Merdeka Campus approach provides flexibility to keep up with changes and places an emphasis on adaptive, independent, and sustainable skills development.

With the restructuring of the Bachelor of Information Technology curriculum in accordance with SKKNI Industry 4.0 and the Independent Learning Campus approach, it is hoped that graduates of the study program will be comprehensively prepared to face challenges in the Information Technology industry which is growing rapidly in the Industry 4.0 era.

Evaluation of the Information Technology Curriculum

This evaluation aims to evaluate the sustainability, relevance, and suitability of the curriculum with industry needs and the latest technological developments (Nithyanandam et al., 2022). The following are evaluation steps that can be taken:

1. Industry Needs Analysis:
   - Analyze current and future trends, developments, and needs of the Information Technology industry.
   - Communicate with industry experts, companies, and related professional organizations to gain insight into industry needs.
   - Identify technological trends, skills, and knowledge required by graduates to succeed in the Information Technology industry.

2. Overview of the Curriculum:
   - Conduct a review of the existing curriculum structure and content.
   - Assessing the relevance and adequacy of learning materials taught in the curriculum.
   - Evaluate whether the curriculum covers skills and knowledge needed in Industry 4.0, such as artificial intelligence, data analytics, cybersecurity, cloud computing, and the Internet of Things (IoT).
   - Identify weaknesses or deficiencies in the curriculum that need to be corrected or updated.

3. Adjustments to SKKNI Industry 4.0:
   - Comparing the existing curriculum with the Indonesian National Work Competency Standards (SKKNI) for Industry 4.0.
   - Ensuring that the curriculum meets the requirements and competencies set out in SKKNI Industry 4.0.
   - Identify whether there are adjustments that need to be made in the curriculum to meet the requirements of SKKNI Industry 4.0.

4. Study of Learning Methods:
   - Evaluate the learning methods used in the curriculum.
   - Ensure that learning methods support the development of skills relevant to Industry 4.0, such as critical thinking skills, creativity, problem-solving, and collaboration.

- Consider using information technology and digital learning tools to increase the effectiveness of learning methods.

5. Industry and Alumni Participation:
   - Involve industry and alumni in curriculum evaluation.
   - Gather feedback from industry and alumni regarding the readiness of graduates to meet industry needs.
   - Obtain information about the success of graduates in pursuing careers in Information Technology and suggestions for curriculum improvement.

6. Updates and Fixes:
   - Based on the results of the evaluation, make updates and improvements to the curriculum.
   - Integrate the latest information technology, industry trends, and skills needed in Industry 4.0 into the curriculum.
   - Adjust learning materials, learning methods, and practical activities that are relevant to industry needs and technological developments.

Evaluation of the Information Technology Undergraduate Curriculum in the Industry 4.0 era must be carried out regularly to ensure the suitability and relevance of the curriculum to industrial and technological developments (Prey et al., 2023). This evaluation helps ensure that graduates have the knowledge, skills, and competencies necessary to succeed in an increasingly digital and connected work environment.

Opinion

The information Technology Undergraduate Curriculum in the Industry 4.0 era in Indonesia has experienced positive developments. Increased awareness of the importance of relevant expertise and skills with technological developments has been reflected in the compiled curriculum. In addition, the Merdeka Learning Kampus Merdeka approach provides students with the flexibility to develop adaptive and sustainable skills, which are essential in a fast-changing world of work.

Evaluation

1. Relevance to Industry Needs
   The curriculum needs to be continuously evaluated to ensure its suitability with industry needs. In the era of Industry 4.0, where technologies such as artificial intelligence, data analytics, cybersecurity, cloud computing, and IoT are gaining importance, the curriculum must include understanding and practical application of these.
2. Integration of the Latest Technologies
   The curriculum should pay attention to the integration of the latest technologies in teaching and learning methods. The use of the latest information technologies, such as online learning

platforms, simulations, and virtual labs, can enrich students' learning experiences and help them develop relevant skills.

3. Soft Skills
   In addition to technical skills, the curriculum also needs to give sufficient attention to the development of soft skills. Communication skills, leadership, teamwork, and critical thinking skills are essential in an increasingly complex world of work.
4. Industry Engagement
   It is important to forge a close partnership with the industry in curriculum evaluation and development. Involving the industry in the evaluation process can help ensure that the curriculum reflects the real needs of the industry and guarantees the quality of graduates.
5. Continuous Update
   Curriculum evaluation should be an ongoing process and carried out regularly. Rapid changes in technology and industry require constant updates in curricula to maintain educational relevance and quality.
6. Career Development
   The curriculum must also pay attention to student career development after graduation. The integration of industry projects and internships, as well as an introduction to the concept of entrepreneurship, can help students prepare to become work-ready professionals or start their own businesses after graduation.

In order to meet the challenges and opportunities offered by the Industrial 4.0 era, evaluation of the Undergraduate Information Technology Curriculum in Indonesia must be continuously carried out to ensure that the curriculum is adequate in preparing graduates who are qualified, competent, and ready to face the demands of an increasingly complex and connected world of work.

CONCLUSION

The research concludes that the restructuring of the Bachelor of Information Technology curriculum in the context of fulfilling the Indonesian National Work Competency Standards (SKKNI) for Industry 4.0 with the Merdeka Learning Campus approach, shows a curriculum restructuring that focuses on industry needs and the latest technological developments, and adopts the Merdeka Learning Merdeka Campus approach, has the potential to increase the relevance and quality of education in producing graduates who are ready to contribute in the Industrial 4.0 era. In fulfilling SKKNI Industry 4.0, curriculum restructuring needs to pay attention to the following aspects as Latest Technology Integration, namely the Curriculum must include an in-depth understanding and practical application of the latest information technology that is relevant to Industry 4.0, such as artificial intelligence, data analytics, cybersecurity, cloud computing, and Internet of Things (IoT). This technology integration can be done through the use of digital learning tools and platforms, simulations, virtual laboratories, and technology-based projects. Development of Soft Skills: Apart from technical skills, the curriculum

should also pay attention to the development of soft skills. Students need to be equipped with communication skills, teamwork, leadership, critical thinking, and adaptability needed in an increasingly complex world of work. The Merdeka Learning Campus Independent Approach such as the Merdeka Learning Campus Approach provides students with the flexibility to set their own learning path, participate in extracurricular activities, and develop their interests and potential independently. This approach encourages students to take initiative, think creatively, and develop self-relevant skills relevant to Industry 4.0. Industry involvement such as curriculum needs to involve close collaboration with industry in its development and implementation. Industry engagement helps ensure that the curriculum meets the needs and demands of the evolving world of work. Industry can provide insight into industry trends, provide internships and real projects to students, and provide feedback on the quality of graduates. Continuous Evaluation and Updates such as Evaluation of the curriculum need to be carried out periodically to ensure suitability with industry needs, technological developments, and research advances. Continuous updating of the curriculum can be carried out based on the evaluation results so that the curriculum remains relevant and adaptive to changes that occur. This study also concludes that in order to prepare graduates who are competent and ready to face the Industry 4.0 era, the Information Technology Bachelor curriculum is restructured with the Merdeka Learning Campus Merdeka approach, which is supported by the integration of the latest technology, soft skills development, industry involvement, and continuous evaluation and updating. continuously, can be a solid foundation. This research makes an important contribution to directing curriculum restructuring efforts that are relevant to the demands and developments of Industry 4.0 in Indonesia.

REFERENCES

Alfalah, A. A. (2023). Factors influencing students' adoption and use of mobile learning management systems (m-LMSs): A quantitative study of Saudi Arabia. International Journal of Information Management Data Insights, 3(1), 100143.

Bianchi, I. S., & Sousa, R. D. (2016). IT Governance Mechanisms in Higher Education. Procedia Computer Science, 100, 941–946.

Dilekçi, A., & Karatay, H. (2023). The effects of the 21st century skills curriculum on the development of students' creative thinking skills. Thinking Skills and Creativity, 47, 101229.

Hassan, M. U., Alaliyat, S., Sarwar, R., Nawaz, R., & Hameed, I. A. (2023). Leveraging deep learning and big data to enhance computing curriculum for industry-relevant skills: A Norwegian case study. Heliyon, 9(4), e15407.

Ingaldi, M., Ulewicz, R., & Klimecka-Tatar, D. (2023). Creation of the university curriculum in the field of Industry 4.0 with the use of modern teaching instruments - Polish case study. Procedia Computer Science, 217, 660–669.

Karseth, B., & Wahlström, N. (2023). Contemporary trends in curriculum research (R. J. Tierney, F. Rizvi, & K. B. T.-I. E. of E. (Fourth E. Ercikan (eds.); pp. 74–84). Elsevier.

Kiss, G., & Godó, A. Z. (2014). A Comparison of Information Technology Literacy of Students of Slovakian Secondary Schools and Romanian Students of Humanities (Profil Uman). Procedia - Social and Behavioral Sciences, 152, 1293–1299.

Klimova, A., & Rondeau, E. (2017). Education for cleaner production in Information and Communication Technologies curriculum. IFAC-PapersOnLine, 50(1), 12931–12937.

Kvamme, O. A. (2023). Curriculum and the United Nations' sustainable development goals (R. J. Tierney, F. Rizvi, & K. B. T.-I. E. of E. (Fourth E. Ercikan (eds.); pp. 406–413). Elsevier.

Leat, D., & Whelan, A. (2023). Innovative pedagogies in relation to curriculum (R. J. Tierney, F. Rizvi, & K. B. T.-I. E. of E. (Fourth E. Ercikan (eds.); pp. 132–141). Elsevier.

Nithyanandam, G., Munguia, J., & Marimuthu, M. (2022). "Digital literacy": Shaping industry 4.0 engineering curriculums via factory pilot-demonstrators. Advances in Industrial and Manufacturing Engineering, 5, 100092.

Pal, S., Biswas, B., Gupta, R., Kumar, A., & Gupta, S. (2023). Exploring the factors that affect user experience in mobile-health applications: A text-mining and machine-learning approach. Journal of Business Research, 156, 113484.

Prey, B. J., Colburn, Z. T., Williams, J. M., Francis, A. D., Vu, M., Lammers, D., McClellan, J., & Bingham, J. R. (2023). The use of mobile thermal imaging and machine learning technology for the detection of early surgical site infections. The American Journal of Surgery.

Roehrig, G. H., Dare, E. A., Wieselmann, J. R., & Ring-Whalen, E. A. (2023). STEM curriculum development and implementation (R. J. Tierney, F. Rizvi, & K. B. T.-I. E. of E. (Fourth E. Ercikan (eds.); pp. 153–163). Elsevier

Ruiz, M., Moreno, J., Dorronsoro, B., & Rodriguez, D. (2018). Using simulation-based optimization in the context of IT service management change process. Decision Support Systems, 112, 35–47.

Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. Computers and Education: Artificial Intelligence, 4, 100127.

Ward, J., & Peppard, J. (2002). Strategic planning for an information system. In John Wiley & Sons Ltd: Vol. Third Edit.

Winter, C., & Hyatt, D. (2023). Critical curriculum analysis framework (CCAF) (R. J. Tierney, F. Rizvi, & K. B. T.-I. E. of E. (Fourth E. Ercikan (eds.); pp. 35–48). Elsevier.

Yandri, R., Suharjito, Utama, D. N., & Zahra, A. (2019). Evaluation Model for the Implementation of Information Technology Service Management using Fuzzy ITIL. Procedia Computer Science, 157, 290–297.

Yang, L. (2023). Validation of the programmatic assessment survey for college students' expectations and perceptions of the integrative studies curriculum. Studies in Educational Evaluation, 77, 101217.