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A Frame Work for Development of Hybrid-teaching Factory (H-TEFA) Model on Virtual Lab application

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The core of Industry 4.0 is the extensive use of Information System in organizational business processes. The competency of System Analysis and Design is required by companies as an expert in Information System development. UNITAMA, a higher education institution, is developing a program of study in Information Systems that produces competent professionals with a discipline in Analysis and Information System Design. The university will strengthen student competencies through a collaborative approach between the learning process and IDUKA. The type of research is Research & Development (R&D) research so that the process of developing virtual learning media technology media for the Hybrid Teaching Factory (H-TEFA) model is directed and systematic, so in this research and development using the ADDIE development model which consists of five development stages (analysis, design, product manufacturing, implementation and evaluation). The Virtual Lab is a modern learning method based on the Learning Management System (LMS) that provides students with more dynamic and customized educational materials for practical learning.

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The Virtual Lab UNITAMA is the development of a practical learning method designed and adapted to the needs of the Analysis and Information System Design course based on the IDUKA Information System, utilizing web-based IT technology that allows learning to take place remotely, not limited to the classroom and specific hours. The model of collaboration between teachers, students, and IDUKA in the Analysis and Information System Design course is enabled by the rapid development of technology and information systems in the era of Industry 4.0, using e-learning/LMS systems that are integrated with Virtual Lab. The Link & Match policy between the education sector and IDUKA is expected to improve the competencies of graduates and align them with IDUKA's specific needs.

Keywords: Information system; system analysis; development technology.

1. INTRODUCTION

The industrial revolution 4.0 demands IDUKA to adapt Information System (IS) technology in business processes for maximum efficiency and productivity. IS has played a crucial role in IDUKA's Information System development. [1] state that IS was initially used for organizational management improvement, known as Information System Management (ISM). [2] discuss how IDUKA focused on business process development by adapting IS technology of the industrial revolution 4.0. Digitalization and virtualization in business processes are crucial for IDUKA to enhance organizational efficiency and effectiveness, as mentioned by [3 and 4]. [5] note that since the beginning of Industry 4.0, more companies have adopted the principles and technologies of the new industrial revolution to improve performance and productivity in organizations. Digitalization is a prerequisite for IDUKA's supply chain from the business process perspective. [6] reveal that the implementation of Industry 4.0 technology is aimed at managing the increasing data flow in IDUKA's business chain for effective next-generation management.

The core of Industry 4.0 is the extensive use of Information System in organizational business processes. According to [7], the utilization and optimization of digital technology-based infrastructure, including hardware and software, are digital-oriented. As revealed by [8], the characteristics of the Industry 4.0 era include big data, internet of things, cloud computing, and cognitive computing. New facilities that have become essential in IDUKA's business processes are based on Information System implementation, which also requires proper handling and continuity for planning, optimization, development, maintenance, system failure prediction, system classification, and effectiveness/efficiency enhancement. [9] mentioned that Information Systems running or being used by organizations or companies will continue to be developed to improve their deficiencies.

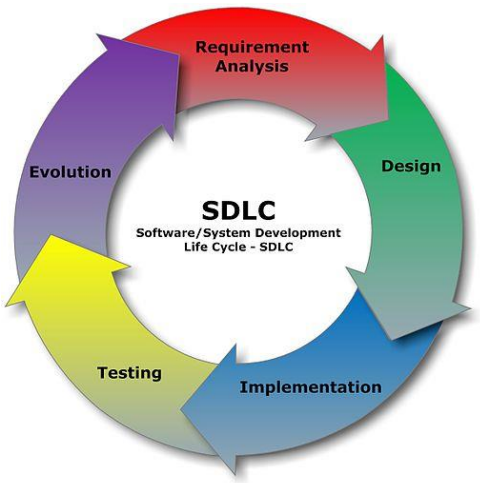

Fig. 1. Four system development life cycle information system [10]

IDUKA's rapid implementation of Information System must align with the needs of specialized workforce, as IDUKA graduates have been equipped with good skills in handling Information System in the industry and work environment. According to [11], educational institutions can provide competent workers, both in terms of hard skills and soft skills, according to their field and competencies such as teamwork, motivation, and communication skills. [12] state that modern company productivity, efficiency, and competitiveness are now determined by the ability to use digital management systems quickly and flexibly.

The competency of System Analysis and Design is required by companies as an expert in Information System development. System Analysis and Design is part of the Information System development process. The System Development Life Cycle (SDLC) of an Information System will continue to evolve, as illustrated in the following figure.

According to [9], SDLC is a logical process used by a System Analyst to develop an Information System, involving requirements, validation, training, and system owners. In [13] presentation, a System Analyst is a key individual in the system development process. A System Analyst identifies problems and needs of the organization to determine how people, data, processes, communication, and information technology can improve business performance. A System Analyst at least has six main tasks: 1) responsible for overall analysis results, 2) analyzing problems and providing solutions, 3) determining system requirements, 4) implementing the system, 5) providing data requirements during software creation/development, and 6) preparing technical documentation or processes in developing the system [9].

The low adoption rate of graduates for the Analysis and Information System Design (APSI) position in IDUKA, as mentioned by [14], is due to the gap between the skills expected by the job market and the skills possessed by graduates, as well as the uneven development of educational infrastructure in higher education institutions. [15] also identified that the mismatch between the skills of graduates and the needs of IDUKA is a major factor in the low adoption rate. [16] further explained that this mismatch occurs both vertically, between the level of education and job requirements, and horizontally, where there is a lack of alignment between the field of study and the job.

[17] identified that the mismatch between the skills of graduates and the needs of IDUKA is due to the lack of attention paid to the relevance of the curriculum in the development of education, which is essential for keeping up with the needs of the IDUKA industry. [18] emphasized that there is dissatisfaction among IDUKA regarding the quality of education provided by universities in terms of producing graduates with the necessary skills, abilities, and work orientation. [19] added that the high unemployment rate is caused by poor educational management, resulting in graduates who lack the necessary skills.

The curriculum and learning outcomes are also identified as factors contributing to the mismatch, as they do not promote the development of soft skills and hard skills required for work, such as critical thinking, analysis, innovation, leadership, negotiation, and teamwork [20]. [17] further explained that the mismatch between the skills of graduates and the needs of IDUKA is due to the lack of attention paid to the relevance of the curriculum in the development of education, which is essential for keeping up with the needs of the IDUKA industry.

Data from field surveys conducted through tracer studies and interviews with 372 graduates, in response to questions such as "How relevant is the knowledge of Analysis and Information System Design to your work?" and "How long did you wait to get a job for the Analysis and Information System Design position after graduating from UNITAMA?", revealed:

The relevance of Analysis and Information System Design knowledge to work.

The duration of waiting for a job for the Analysis and Information System Design position after graduating from UNITAMA.

To make computer science graduates in the field of Analysis and Information System Design relevant to IDUKA's current needs, universities are advised to enhance their teaching approaches and focus on the latest technologies in Analytics, Design, and Develop System Information, aligning them with the needs of Industry 4.0, so that students can learn their applications [21]. Higher education institutions should focus on the competencies required by

IDUKA [16]. Additionally, according to [2], it is part of the responsibility of the education sector to prepare graduates who can adapt and understand the conditions of IDUKA in planning and developing Information System infrastructure, management models, business models, and some scenarios of Industry 4.0.

The government has been successful in promoting the enhancement of graduate competencies to match IDUKA's needs through the Link & Match policy between the education sector and IDUKA. According to [22] involving IDUKA in the development of education and training is expected to improve the competencies of graduates. The Link and Match policy aims to identify the competencies needed by the IDUKA market and become a paradigm for education that is not supply-driven but demand-driven [19].

In light of these circumstances, it is necessary to implement measures to align graduate competencies with IDUKA's specific needs in the process of strengthening student competencies in the field of Analysis and Information System Design while studying at higher education institutions. As mentioned by [20] policies are needed to increase the relevance of graduates to the job market, businesses, and industries. Innovative steps are required to make education in Indonesia produce competent and qualified professionals in their respective fields. [20] further suggests several steps to achieve the alignment of education with the job market, industry, and business, including:

a. In the design of programs and curricula,
b. In the provision of expert and instructor staff,
c. In the provision of educational facilities, such as setting up lab factories on campus,
d. Through collaboration, as shown by the provision of scholarships, and
e. By issuing certificates for graduates.

Collaboration between universities as higher education institutions and industry is crucial today because collaboration can create solutions to problems in the field of knowledge [22]. The collaboration between the education sector and IDUKA is not a new concept, but the appropriate and suitable implementation of this collaboration is still being found. As revealed by [22], among the challenges are:

a. Higher education institutions still face difficulties in finding industry partners for collaborative research.

The network and resources of academics and business leaders are still limited in creating collaborations, such as requesting business leaders to teach specific courses and universities sending instructors to learn about IDUKA's needs.

Universities are not yet familiar with the market and industry culture.

Universities still do not fully understand the regulations in the market.

Misconceptions about the reality of academia.

UNITAMA, a higher education institution, is developing a program of study in Information Systems that produces competent professionals with a discipline in Analysis and Information System Design. The university will strengthen student competencies through a collaborative approach between the learning process and IDUKA. This collaboration will begin with the formulation of competencies, the preparation of teaching materials, the implementation of activities, and culminate in evaluations and certifications of competence, with the addition of employment opportunities for graduates who meet IDUKA's requirements.

As a core competency in the field of computer science, providing students with competence in the field of Analysis and Information System Design is crucial for them to be absorbed by IDUKA and placed at the appropriate level based on their competence.

In collaboration with UNITAMA, researchers will develop a virtual-based practical learning model, with IDUKA directly involved in the practical learning process. This collaboration will provide students with the opportunity to learn, observe, and understand the System Information used by IDUKA, with the goal of analyzing and improving it.

From the perspective of the lecturer:

a. Understanding IDUKA's needs for System Information development,

Developing a curriculum based on IDUKA, and

Designing a program based on IDUKA.

From the perspective of the student:

Observing, analyzing, and developing System Information for practical learning purposes,

Enhancing competence, and

Understanding how IDUKA's business processes are managed from a System Information perspective.

From IDUKA's perspective:

a. Contribution to the enhancement of competence according to IDUKA's needs,

Availability of documents from the analysis and planning of System Information development and maintenance, and

Support for the government's link & Match program.

The collaboration between IDUKA and UNITAMA in the Information Systems course will use the Teaching Factory (TEFA) model, with the goal of bringing IDUKA's System Information into the learning process as a direct source and also as a product of learning. The development of the H-TEFA model in the Information Systems course will be supported by a learning management system (LMS) application that has been modified and integrated with synchronous and asynchronous classes and a virtual server for System Information cloning from IDUKA.

The development of the Hybryd Teaching Factory (TEFA) model in the Virtual Lab will involve IDUKA collaborating directly with lecturers and students in the learning process of Analysis and Information System Design. IDUKA's System Information will be used as a direct source of learning and also as a basis for planning, improvement, and development for IDUKA.

TEFA Concept

TEFA learning strategy features:

a. Practical learning.

Hands-on approach.

Focus on real-world products or services.

Collaboration with IDUKA.

Assessment based on IDUKA standards.

Experienced IDUKA instructors.

TEFA focuses on transferring knowledge between different partners, such as academia and IDUKA [23].

TEFA Definition

Teaching Factory is a two-way knowledge transfer model, with IDUKA serving as the foundation for a new synergy between academia and IDUKA. Topics of learning in Teaching Factory can be updated to provide the required knowledge for IDUKA at specific times. Transfer of knowledge is used for idea exchange and the development of new solutions, balancing the time and cost required for learning and testing these solutions, while enhancing IDUKA's and academia's knowledge through innovation in production or real-life problems [24].

TEFA Principles

TEFA learning principles include:

a. Efficiency: Improving the use of practical tools and resources.

Effectiveness: Creating a learning environment suitable for the real world of work/industry (IDUKA) for the transfer of skills.

Integration: Combining normative, adaptive, and productive learning materials.

Collaboration: Enhancing cooperation between vocational schools and IDUKA.

TEFA Components

Teaching Factory has three main components:

a. Product: Placed as a tangible or intangible product produced by the laboratory, workshop, or production unit in the school, which can be sold and generate revenue. In the context of Teaching Factory, the product's primary function is as a learning tool to achieve specific skills.

b) Block Schedule: The arrangement of learning and teaching activities designed to

provide optimal learning and support for students in acquiring a specific skill.

c) Job Sheet: Part of the RPP and designed based on the determined product. The job sheet contains the sequence of materials to transfer the student's skills with a final product of high quality and usefulness. In the job sheet, the specific skills to be mastered by the student are clearly identified. The job sheet format includes questions, procedures, rubrics, and assessment formats [25].

TEFA Goals

The objectives of TEFA learning include:

a. Improved synergy and integration of planning and implementation of normative, adaptive, and productive learning.

Enhancement of soft skills and hard skills for students.

Strengthening collaboration with IDUKA through curriculum alignment, instructor provision, knowledge and technology transfer, and more.

Development of teachers' competence through interaction with IDUKA.

Promoting learning and work culture changes in educational and training institutions [25].

TEFA is based on the triangle concept to become a new paradigm for both academic and IDUKA education. Its goal is to provide students with practical experience under IDUKA conditions, while using IDUKA research and learning activities for engineers and managerial levels [24]. TEFA has dual goals, one of which is to enable students to develop IDUKA products in prototype form [26].

According to [27], the goals of Teaching Factory include:

a. Improving student competence.

Enhancing professionalism of graduates.

Producing valuable products (goods/services).

Increasing school revenue.

Strengthening collaboration with IDUKA.

TEFA aims to integrate the three pillars of learning, research, and innovation into a single initiative to promote future knowledge-based manufacturing, competitiveness, and sustainability [27].

Hybrid teaching models combine online and face-to-face teaching into one cohesive experience. About half of the class sessions are on campus, while the other half has online students [23]. Hybrid Teaching Factory with the concept of "factory-to-classroom" and "academia-to-IDUKA" tries to transfer the actual production/manufacturing environment into the classroom, using internet network media and virtual-based learning applications to demonstrate the learning process virtually [28].

Information Systems Analysis and Design is a required competency for computer science graduates in the Information Systems study program. This competency includes the ability to analyze Information Systems needs and develop them. The Information System Analysis and Design position is crucial in IDUKA's business process, and the SDLC process for Information System development demands experts with this competency. However, field data shows that IDUKA has a low absorption rate of computer science graduates in this role due to a lack of competence in Information Systems Analysis and Design. The relevance of graduates' competencies does not match IDUKA's needs. The H-TF/TI virtual lab development framework was created to address the "missmatch" between computer science graduates' competencies in System Analysis and Design at Akba Makassar University of Technology and IDUKA's stakeholders' expectations.

2. METHODS

The type of research is Research & Development (R&D) research so that the process of developing virtual learning media technology media for the Hybrid Teaching Factory (H-TEFA) model is directed and systematic, so in this research and development using the ADDIE development model which consists of five development stages (analysis, design, product manufacturing, implementation and evaluation) [29]. The ADDIE model is structured with a systematic sequence of activities as an effort to solve learning problems related to learning resources that are in accordance with student needs.

Data analysis for the Hybrid-Teaching Factory (H-TEFA) Model Development on Virtual Lab

Application includes validation of instrument validity and reliability through expert judgement, using product moment correlation and Cronbach's Alpha techniques, and using SPSS for analysis. The analysis also includes practicality, which evaluates the practicality of the model, and effectiveness, which measures learning outcomes before and after the application of the model.

3. RESULTS AND DISCUSSION

In the development of the teaching factory model, three main components will be integrated into the learning model:

Product: This is the IDUKA Information System, which will be used as a learning tool for analyzing and developing in the planning phase of the development process.

Schedule Block: This is the arrangement of practical learning activities, which is organized according to the RPS to provide optimal time for practical work and guidance during virtual lab practical.

Job Sheet: This is part of the RPS, which is designed based on the chosen product. The job sheet contains practical project assignments to guide students in developing competencies with the final product being a high-quality and useful document from the Analysis and Design of the IDUKA Information System.

The Virtual Lab is a modern learning method based on the Learning Management System (LMS) that provides students with more dynamic and customized educational materials for practical learning.

The Virtual Lab UNITAMA is the development of a practical learning method designed and adapted to the needs of the Analysis and Information System Design course based on the IDUKA Information System, utilizing web-based IT technology that allows learning to take place remotely, not limited to the classroom and specific hours.

The model of collaboration between teachers, students, and IDUKA in the Analysis and Information System Design course is enabled by the rapid development of technology and information systems in the era of Industry 4.0, using e-learning/LMS systems that are integrated with Virtual Lab.

The IDUKA Information System, which is a learning-based IDUKA practical approach in the H-TEFA model, will be cloned and placed on a virtual server integrated with the virtual lab to ensure that the IDUKA system used is not affected by the development process.

Tools design based on Object Oriented Design have been integrated into the virtual lab, allowing students to perform practical work directly on the virtual lab application.

The development of the H-TEFA learning model, the collaboration between actors, and the IDUKA Information System will be integrated into the e-learning/LMS system, which is referred to as the Virtual Lab.

The model's synchronous and asynchronous learning interactions are used for collaboration in the Analysis and Information System Design course.

The components of the H-TEFA model are integrated into the virtual lab application.

The learning methods of the H-TEFA model are synchronized and asynchronous.

The H-TEFA model components include Product (IDUKA Information System), Job Sheet (project work based on IDUKA's needs), and Schedule Block (student practical schedule for the Analysis and Information System Design course).

The Virtual Lab focuses on facilitating all the needs of the H-TEFA model's practical learning. The virtual lab uses synchronous and asynchronous learning methods. It is hoped that this model will provide opportunities for IDUKA and UNITAMA to collaborate in enhancing students' competencies as potential experts in the field of Analysis and Information System Design.

The H-TEFA learning model, integrated into the Virtual Lab application, is a collaboration-based teaching model between teachers, students, and IDUKA. The IDUKA Information System is used as a learning resource for students to develop relevant skills for IDUKA. The development of student competencies in the Analysis and Information System Design course is described as follows:The H-

The development of the H-TEFA learning model has been evaluated by experts and found to be valid, reliable, and suitable for implementation and testing. The products and supporting materials for the H-TEFA model are summarized in the table below:

Table 1. Products and supporting materials for the H-TEFA model

Product	Description
Model H-TEFA	A practical learning model for the Analysis and Information System Design course, where IDUKA and practitioners are involved in the learning process.
Virtual Lab	A virtual learning platform used in the Analysis and Information System Design course.
RPS	A learning plan designed to support the H-TEFA model for a semester's worth of practical learning.
Learning Modules	A set of learning materials designed as a guide for practical learning in the Analysis and Information System Design course.
Textbook	A learning textbook designed as a guide for the Analysis and Information System Design course.
User Guide	A user guide to support the use of the Virtual Lab application for the Analysis and Information System Design course.

4. CONCLUSION

The search results indicate that the integration of Information System (IS) technology in business processes is crucial for IDUKA in the context of Industry 4.0. The development of IS has been a focus for IDUKA to enhance organizational efficiency and effectiveness. The implementation of Industry 4.0 technology is aimed at managing the increasing data flow in IDUKA's business chain for effective next-generation management. The core of Industry 4.0 is the extensive use of IS in organizational business processes.

The competency of System Analysis and Design is required by companies as an expert in Information System development. The System Development Life Cycle (SDLC) of an Information System will continue to evolve, and the H-TEFA model is a logical process used by a System Analyst to develop an Information System, involving requirements, validation, training, and system owners.

The low adoption rate of graduates for the Analysis and Information System Design (APSI) position in IDUKA is due to the gap between the skills expected by the job market and the skills possessed by graduates. Universities are advised to enhance their teaching approaches and focus on the latest technologies in Analytics, Design, and Develop System Information, aligning them with the needs of Industry 4.0.

To make computer science graduates relevant to IDUKA's current needs, universities are encouraged to collaborate with IDUKA in the development of education and training. This collaboration aims to improve the competencies of graduates and align them with IDUKA's specific needs. The Link & Match policy between the education sector and IDUKA is expected to identify the competencies needed by the IDUKA market and become a paradigm for education that is not supply-driven but demand-driven.

In conclusion, the integration of IS technology in business processes is essential for IDUKA in the context of Industry 4.0. The development of Information Systems will continue to evolve, and the competency of System Analysis and Design is required by companies. Universities need to collaborate with IDUKA to enhance the teaching approaches and focus on the latest technologies in Analytics, Design, and Develop System Information to align with the needs of Industry 4.0. The Link & Match policy between the education sector and IDUKA is expected to improve the competencies of graduates and align them with IDUKA's specific needs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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