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Transformation of Vocational Education Assessment Architecture: Integration of Digital Portfolio-Based E-Report Card System and Industry 4.0 Competencies in the Communication Study Program

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Abstract

In the rapidly evolving vocational education ecosystem under the shadow of the Industrial Revolution 4.0, there is a fundamental disconnect between conventional scholastic assessment methods and the dynamic competency demands of the creative industry. This research report presents an in-depth investigation into the design and validation of an academic information system architecture (e-Rapor) expanded, specifically calibrated to the needs of the Communication Study Program (Multimedia, Visual Communication Design, and Broadcasting). Against the backdrop of the high Open Unemployment Rate (TPT) of Vocational High School (SMK) graduates in Indonesia, which reached 8.62% in 2024, this study identified the failure of the standard numerical assessment system in capturing the essence of students' productive competencies and creativity. Adopting the methodology Design Science Research(DSR) which is synergized with development techniques Rapid Application Development(RAD), this research has successfully designed a hybrid assessment ecosystem. This system functions not only as an administrative assessment repository but also as a talent management platform that integrates a digital portfolio based on cloud, project-based authentic assessment (Project-Based Learning), and competency validation aligned with the Indonesian National Work Competency Standards (SKKNI). A case study was conducted in the strategic context of the Karawang industrial area, West Java, involving a network of local vocational schools and universities to test the system's relevance to the needs of the international industrial area. The research findings indicate that the integration of multimedia artifact curation features, dynamic assessment rubrics, and industry feedback mechanisms significantly improves the validity of the measurement. hard skills And soft skills(4C), as well as providing more accurate competency verification instruments to bridge the gap between supply vocational graduates and demand professional workforce.

Keywords: *E-Rapor, Industry Ready,Education Assessment Architecture*

1. Introduction

The global education landscape, particularly in the vocational education and training (TVET) sector, is undergoing unprecedented tectonic shifts. In Indonesia, this transformation is driven by the ambitious "Golden Indonesia 2045" vision, which places human capital development as a key pillar of economic growth.1However, the statistical reality presents a disturbing paradox: despite increasing access to digital technology, the absorption of vocational graduates in the formal job market is facing stagnation, even decline in certain sectors.

Data from the Central Statistics Agency (BPS) provides a sharp quantitative picture of this challenge. In February 2024, the Open Unemployment Rate (TPT) for Vocational High School (SMK) graduates was recorded at 8.62%, a figure consistently higher than other levels of education, including Senior High School (6.73%) and Diploma/University (5.63%).2Trend analysis longitudinal shows that despite a decline from the peak of the pandemic (13.55% in 2020), the unemployment rate among vocational high school graduates remains persistently high, ranging from 9% to 11% in the last five years.3This phenomenon indicates the presence of a deep structural problem, which is often referred to as skills mismatch or a mismatch of competencies between the school curriculum and industry needs.5

This issue becomes even more complex when we examine the digital economy and creative industries sectors .Indonesia Digital Society Index The 2024 projection released by the Ministry of Communication and Information Technology projects that Indonesia's digital talent needs will reach 12 million people by 2030.6However, the talent availability gap (talent gap) This is not solely due to a shortage of graduates, but rather a lack of graduates with "work-ready" competencies and advanced technology adaptability. Studies show that 50%

of Indonesia's current workforce only has basic to intermediate digital skills, while advanced skills (advanced digital skills) required by industry 4.0 is still very rare, represented by less than 1% of the workforce.[7]

The root of this problem can largely be traced back to the architecture of the current educational assessment system. The current nationally used Student Information Management System (SIS), or e-Rapor, while digitizing administrative processes, still essentially replicates the logic of conventional paper report cards.8This system is designed to handle rigid textual and numerical data—very effective for normative subjects like Mathematics or Language, but completely fails to capture the productive dimension of competence in communication and creative media. In Multimedia or Visual Communication Design (DKV) majors, a student's competence cannot be reduced to a single number, "85." The industry demands authentic visual evidence: quality color grading on video, workflow efficiency editing, originality of design concepts, and collaboration skills within the production team.[8]

The absence of a systematic mechanism to record, curate, and validate these digital artifacts in official school academic records results in the loss of crucial competency data. Diplomas and transcripts become "silent" documents, unable to convey a student's true abilities to potential employers. As a result, vocational high school graduates often lose out due to the lack of verified portfolios, while industry must incur additional costs for conducting basic skills tests that should have been validated by the school.[10]

This research focuses specifically on the Karawang region of West Java, a decision based on the region's strategic significance within the national economic landscape. Karawang is home to some of the largest industrial areas in Southeast Asia, includingKarawang International Industrial City(KIIC), which houses hundreds of multinational companies in the automotive, electronics and manufacturing sectors.8This ecosystem creates unique and specific demands for the quality of vocational labor.

Educational institutions such as SMK Buana Industri and its network of vocational schools operate at the forefront of the interaction between education and the world of work (DUDI). Competency requirements in this area extend beyond operational technical capabilities (hard skills), but also encompasses "industrial work culture," discipline, problem-solving, and effective visual communication skills—skills often overlooked in conventional assessment systems. Furthermore, the existence of local universities such as Buana Perjuangan University (UBP) Karawang provides a vertical educational pathway for vocational school graduates.8However, the transfer of competency data from vocational schools to universities is often interrupted, causing inefficiencies in the selection process for new student admissions and credit recognition (Recognition of Prior Learning).

In this context, developing an adaptive e-Report system is not merely an administrative necessity, but a strategic imperative for enhancing regional competitiveness. This system must be able to function as a digital bridge connectingsupplycompetencies from schools with strict standards of demand from industry in the KIIC area, as well as the academic requirements of partner universities.

2. Theoretical Basis

2.1. Assessment Paradigms in Modern Vocational Education.

21st century vocational education demands a paradigm shift from Assessment of Learning (summative assessment to measure final achievement) towards Assessment for Learning (formative assessment to improve the process) and Assessment as Learning (assessment as a student metacognitive process). In the context of the Communication Study Program, this means that assessment should no longer be merely a "judge" at the end of the semester, but rather a "mirror" that reflects the growth of student competencies in general real-time.

Research consistently shows that Project-Based Learning (PBL) is the most effective instructional method for vocational education, particularly in developing higher-order skills. An empirical study in 2024 showed that implementing PBL in vocational high schools significantly increased student learning completion, from 63.33% to 93.33%, and increased student active engagement in the learning process. [14]

However, the biggest challenge in PBL is the complexity of its assessment. A "Short Film Production" project in the Broadcasting department involves pre-production stages (script writing, story boarding), production (shooting, lighting), and post-production (editing, color grading, sound mixing).8Conventional assessment systems that only provide a single grade column for the “Final Project” reduce this complexity and fail to provide specific feedback. An ideal e-Report system should support task-based assessment. Milestone , where each stage of the project has its own assessment rubric which is recorded digitally.

In addition to technical competence (hard skills), industry 4.0 demands mastery soft skills which is summarized in the 4C framework: Critical Thinking, Creativity, Collaboration, dan Communication.17Statistical analysis shows that the integration of 4C skills in vocational learning has a simultaneous influence of 61.9% on increasing employability skill
sand student learning achievement.18Therefore, the e-Rapor assessment architecture must provide instruments to measure these aspects, such as features peer assessment(peer assessment) to measure collaboration, and a self-reflection column to measure critical thinking.

2.2. E-Portfolio: From Storage to Professional Identity Management.

The concept of an electronic portfolio (e-Portfolio) has evolved from a static digital folder into a dynamic learning management system. In IEEE literature and technology education journals, an e-Portfolio is defined as a purposefully curated collection of digital artifacts designed to demonstrate a student's competency, development, and achievement to a specific audience.[19]

Research shows a strong positive correlation between the use of structured e-Portfolios and increased graduate bargaining power (employability). A systematic review study found that e-Portfolios help students recognize their own competencies (self-recognition of competence), which in turn increases confidence during job interviews.21In the creative industry, a portfolio is often more valuable than a

GPA. Industry reports show that 91.1% of company leaders consider portfolios a valuable tool for gaining detailed information about candidates that isn't readily apparent on a standard resume.[23]

The key component that differentiates e-Portfolio from just “Google Drive” is the element of reflection. Theory Self-Determination (SDT) suggests that when students are given the autonomy to choose their best work and explain the creative process behind it, their intrinsic motivation increases.24The e-Rapor system should facilitate this process by providing features input Reflective texts that link directly to each uploaded artifact, allowing students to narrate their learning journey.

2.3 Competency Standards Framework (SKKNI and Digital Framework)

For an assessment system to be industry-relevant, it must be based on nationally and internationally recognized standards. In Indonesia, the primary reference is the Indonesian National Work Competency Standards (SKKNI).
The SKKNI breaks down complex tasks into measurable units of competency. For Multimedia, these units include specific competencies such as "Creating, manipulating, and combining 2D images" (Unit Code: TIK.MM02.032.01) or "Combining video into multimedia presentations" (Unit Code: TIK.MM02.074.01).16The e-Report system must be designed to performmappingor automatic mapping: every task given by the teacher must betagwith the relevant competency unit code. This allows the system to generate a legally and industry-valid “Competency Transcript” report.

In addition to SKKNI, global frameworks such asDigital Competence Framework for Citizens(DigComp) and IEEE standards provide guidance on the dimensions of digital literacy that need to be assessed, including information literacy, digital content creation, cybersecurity, and digital problem solving.26The integration of these standards ensures that Indonesian vocational school graduates have competencies equivalent to global standards.

2.4 System Development Methodology: Justification of RAD and DSR

In the development of complex educational information systems, the selection of software development methodology is crucial. This study proposes the use ofRapid Application Development(RAD) under the umbrella of research methodologyDesign Science Research (DSR).

Traditional methodsWaterfallis often too rigid for a dynamic educational environment, where the needs of users (teachers and students) can change rapidly as the curriculum changes. Comparative analysis shows that RAD is superior in this context because it emphasizesprototypingfast, intensive user involvement, and short development iterations.12The feature comparison table shows that RAD allows changing requirements to be accommodated at any stage, minimizing the risk of user rejection late in the process.29In the context of e-Rapor Multimedia, RAD allows developers to quickly test the video upload feature with a small group of teachers, get feedback onusability, and fixed it in a matter of days.

DSR is a research paradigm focused on the creation and evaluation of IT artifacts to solve real-world organizational problems. In this context, the "artifact" is an expanded e-Report system. DSR ensures that system development is not driven solely by technical capabilities but also guided by sound pedagogical theory and validated through rigorous empirical

3. Research Methods

This research uses an approach Design Science Research (DSR) which consists of four cyclical stages, as defined by Peffers et al. (2007) and adopted in various studies of educational information systems.

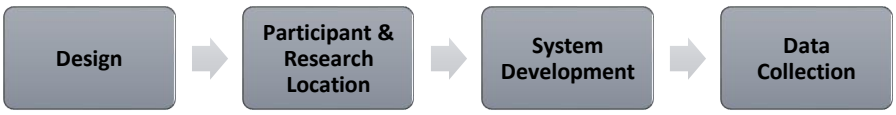

Fig. 1: Research Method

3.1. Research Design:

Problem Identification and Motivation:This stage involved an in-depth analysis of the gaps between the existing e-Rapor assessment system and the specific needs of the communication study program. Data was collected through literature review, analysis of SKKNI documents, and initial interviews with students.stakeholderat the Karawang area vocational school. Definition of Solution Objectives:Based on the identified problems, the system's functional and non-functional specifications were established. The primary goal was to create a system capable of handling multimedia artifacts, supporting rubric-based assessment, and integrating with industry standards. Design and Development:This stage is the technical core of the research, where the method Rapid Application Development(RAD) is applied. The development team designs the database architecture, user interface (UI/UX), and system logic. Prototypes are developed in rapid iterative cycles. Demonstration:The developed system was tested in a limited environment (pilot testing) in a Multimedia class at a partner vocational school. The goal is to prove the technical feasibility of the system in a real-world usage scenario. Evaluation:System effectiveness is measured using quantitative and qualitative instruments. Evaluation metrics include user satisfaction (User Satisfaction), accuracy of competency assessment, and increased efficiency of teacher administration. Communication:Research results and findings are disseminated through this report and scientific publications to contribute to the knowledge base of vocational education.

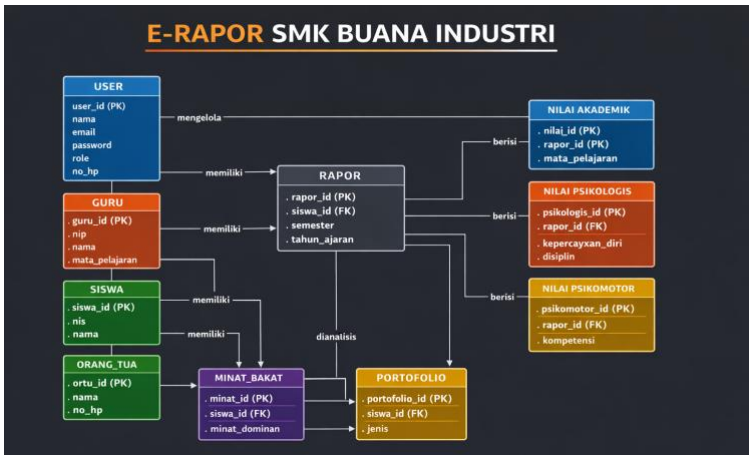

Fig. 2: ERD E-Rapor SMK Buana Industri

3.2. Participants and Research Location:

This research focuses on the vocational education ecosystem in Karawang Regency, West Java. The research subjects include: Productive Teacher:Teachers from the Multimedia, Visual Communication Design (DKV), and Broadcasting departments at SMK Buana Industri and networked schools around the KIIC area. They serve as the primary users of the system andsubject matter expertsfor content validation. Vocational School Students:Students in grades XI and XII who are currently taking productive subjects and final project assignments.Industry Partners:Representatives from companies in the KIIC region act as external validators to ensure the relevance of the assessment rubric to industry standards.

3.3. System Development Procedures (RAD Cycles):

According to the RAD method, the development process is divided into several iterative cycles:
Cycle 1: Data Modeling & Requirements:Focus on designing an extended database schema to accommodate multimedia artifact metadata and complex rubric structures.
Cycle 2: UI/UX Prototyping:Development of an intuitive user interface, includingdashboardvisuals for teachers and portfolio pages for students.
Cycle 3: API Integration:Implementation of connections to third-party services (YouTube, Google Drive) for digital asset management.
Cycle 4: Testing & Refinement: User Acceptance Testing(UAT) is carried out with teachers to identifybugand usability issues, followed by immediate fixes.

3.4. Data Collection Instruments:

Data was collected using several instruments:
Interview Guide:To explore teachers' specific needs and current assessment challenges.
System Observation Sheet:To analyze the existing e-Report features and compare them with SKKNI requirements.
User Satisfaction Questionnaire:Adapted from the modelTechnology Acceptance Model(TAM) to measure perceived ease of use (perceived ease of use) and usefulness (perceived usefulness) new system.

4. Results And Discussion

4.1. System Architecture and Implementation

This section describes the results of the design of the improved e-Report system (enhanced e-Rapor), includes technical architecture, database design, and key functional features that answer the problem formulation.

Conventional e-Report systems are generally built on simple relational databases, focusing on Student, Subject, and Grade (numeric) entities. This structure is inadequate for the needs of data-rich communication study programs. This study proposes significant normalization and extension of the database schema.

Table 1 below presents a new table design that is crucial to support the artifact and competency-based assessment ecosystem.7

Table 1: Proposed Additional Database Structure for Multimedia E-Report

Table Name	Function Description & Justification	Primary/Foreign Keys Columns
project_artifacts	Metadata Repository:Stores student work metadata. The system does not store physical files (BLOBs) to maintain performance, but instead stores links (*link*) to external storage. Supports*versioning*for process assessment.	artifact_id, student_id, project_id, file_url, file_type, upload_date, version_number
rubric_definitions	Assessment Instruments:Replaces single grades with multidimensional criteria. Allows teachers to define specific assessment aspects (e.g., Composition, Audio,*Storytelling*).	rubric_id, assignment_id, criteria_name, max_score, weight_percentage
rubric_scores	Detailed Value Data:Storing granular scores for each rubric criterion along with specific textual feedback. This is the essence of "Datafication of	score_id, artifact_id, rubric_id, score_value, feedback_text

	Creativity."	
competency_tags	Industrial Bridge:Linking table (*bridging table*) which maps student artifacts to SKKNI competency unit codes*many-to-many*.	tag_id, artifact_id, competency_code (e.g., TIK.MM02.074.01), competency_source (SKKNI/Industry)
peer_reviews	Collaboration:Facilitate peer assessment in group projects, support development*soft skills*and collaboration (4C).	review_id, reviewer_id, target_artifact_id, comments, rating_collaboration, rating_contribution
industry_validation	External Validation:Keep a trail of validation or*endorsement*from industry mentors, lending professional weight to students' portfolios.	validation_id, artifact_id, industry_mentor_id, status (Verified/Rejected), industry_comment, timestamp

Design Analysis:

The architectural decision to separate project_artifacts from the physical file storage was a strategic one. Student multimedia files (such as 4K resolution videos or raw design .PSD/.AI files) can be very large, reaching gigabytes per project. Storing this data directly on the school's local database server would burden the infrastructure, slow system performance, and rapidly consume storage space. The solution implemented is a*Hybrid Cloud*: metadata, grades, and reflection texts are stored on the school server (guaranteeing the sovereignty and security of academic data), while heavy media files are hosted on the service*cloud*public or private connected via API.[37]

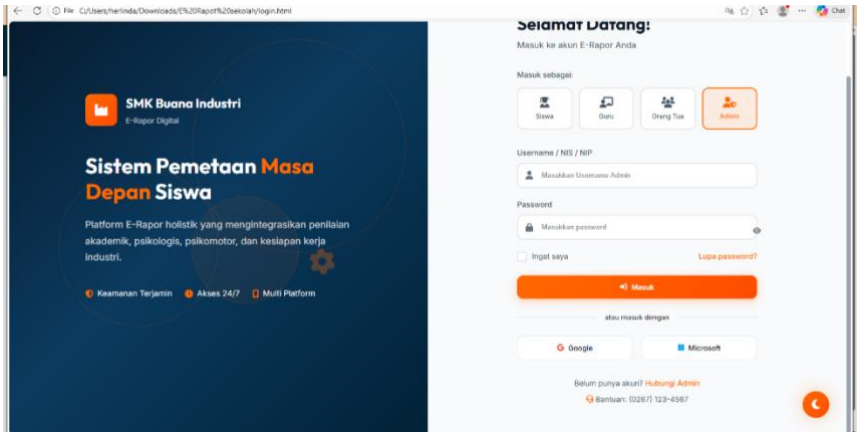

Fig.3: Log In Interface e Rapor

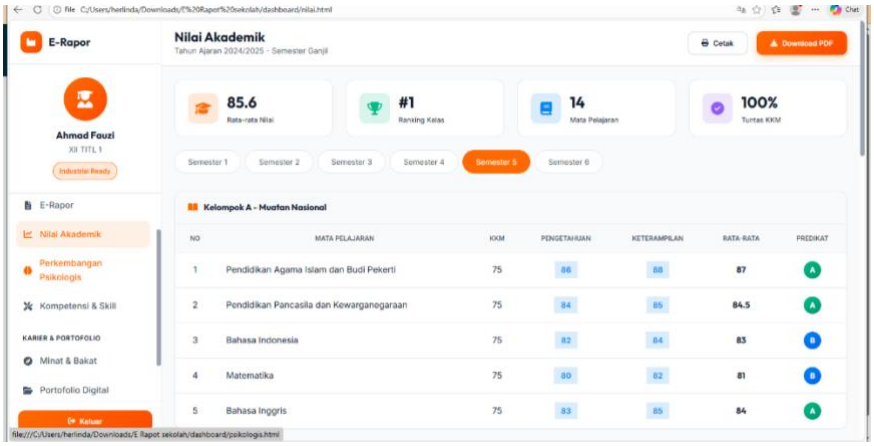

Fig. 4: Dashboard E Rapor SMK Buana Industri

The system's user interface was completely redesigned to abandon the rigid "data table" paradigm.
Dashboard Guru (Gallery View): Productive teachers need a quick way to assess visual quality. Dashboard assessment is designed with a display-based grid which displays thumbnail student work, not just a list of names. This feature allows for quick visual comparative assessment. Teachers can filtering based on tag competencies (e.g., "Show all Typography works" or "Show all videos Stop Motion") to monitor class progress specifically.

Interactive Visual Annotation Features: For DKV majors, the most effective feedback is visual and contextual. The system provides annotation features (similar to the comments feature in collaborative design platforms like Figma). Teachers can digitally mark or cross out specific parts of students' designs and attach specific comments (e.g., "The color contrast in this area is too low" or "The font is illegible"). This provides much more constructive feedback than simply leaving a text note at the end of an assignment.[8]

Time-Stamped Comments: For video assignments, the system adopts a time-based commenting mechanism as on the platform. Sound Cloud or Frame.io. Teachers can pin notes at specific seconds in the lesson. Timeline video (eg: "Minute 02:14 – Transition jump cut too rough, refine the edits"). This feature ensures students understand exactly which parts of their work need improvement.

This study concludes that transforming the e-Report system in vocational education, particularly in the Communications Study Program, is no longer merely an option but an urgent strategic imperative. Conventional, numerical-based assessment systems have proven unable to capture the complexity and richness of students' creative competencies and have contributed to widening the gap between out and the needs of industry 4.0.

The e-Rapor model proposed in this study, which integrates digital asset management, project-based assessment (PBL), and automated alignment with the National Competency Standards (SKKNI), offers a comprehensive and scalable solution. This system successfully transforms the report card from a passive administrative document into a dynamic digital "career passport," validating students' skills in a transparent, authentic, and reliable manner. The methodology usedRapid Application Development(RAD) has proven effective in responding to the need to develop systems that adapt to the dynamics of vocational curricula. Overall, this system has the potential to increase the relevance of vocational education and improve graduate absorption rates in the job market.

Based on the findings and analysis, the implementation of a digital, portfolio-based assessment system in vocational schools should be carried out through a carefully planned and gradual strategy. Rather than adopting a “big bang” approach, schools are encouraged to begin with a phased adoption model by launching a pilot project in a selected class or a leading productive subject such as Graphic Design or Videography. This initial phase allows stakeholders to test system stability, assess network capacity, and evaluate teacher readiness in real learning contexts. At the same time, technology adoption must be accompanied by structured professional development for teachers. Training programs should go beyond technical application use and focus on strengthening digital assessment pedagogy, developing valid and reliable rubrics, and enhancing teachers’ ability to provide meaningful and constructive online feedback to support student learning.

Furthermore, the sustainability and credibility of the system depend on strong institutional and policy support. Schools are advised to formalize partnerships with industry stakeholders (DUDI), particularly those in nearby industrial areas such as KIIC Karawang, to validate assessment rubrics and endorse high-quality student portfolios through controlled system access. In parallel, investment in reliable network infrastructure must be prioritized by local governments, school foundations, and school committees, as stable internet bandwidth is a strategic requirement for cloud-based, data-driven assessment systems. At the policy level, alignment with national regulations is essential; therefore, the Ministry of Primary and Secondary Education is encouraged to consider integrating portfolio-based assessment into national vocational education standards, providing a strong regulatory framework that supports innovation in assessing and reporting student learning outcomes.

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