

## Development of PRIMA as a Smart Data Hub Platform for Quality Assurance System Integration in Vocational Higher Education

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### ABSTRACT:

Digitization of quality assurance and accreditation is a strategic necessity for universities to improve data management efficiency and support accurate, information-based decision-making. This research focuses on the design of PRIMA PPMPP as a Smart Data Hub Platform capable of integrating accreditation data and monitoring the quality of learning at the Manado State Polytechnic. The research methodology includes needs analysis, system architecture design, data modeling and information flow, user-centered interface design, and design validation through expert review. The results show that the multi-layer architecture design developed—including the data source layer, data integration layer, application service layer, and presentation layer—supports interoperability, data consistency, and platform scalability. Data models, such as DFD and ERD, ensure the integration of information across accreditation modules and quality monitoring of learning. The resulting interface design provides intuitive and efficient access for users from various institutional roles. Expert validation indicates that the PRIMA PPMPP design model meets the needs of the quality assurance process and is feasible for implementation. This research contributes conceptually to the development of a data-based quality assurance system in vocational education and can serve as a reference for other institutions building integrated quality data centers.

**Keywords:** PRIMA PPMPP; Smart Data Hub; system design; The Quality of Learning.

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### INTRODUCTION

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Improving the quality of learning and meeting accreditation standards are the two main pillars in the quality assurance system of higher education (Daniel, 2015). Both require the availability of complete, accurate, and integrated data to support the processes of evaluation, decision-making, and preparation of institutional performance reports (Alzafari & Kratzer, 2019). However, in many universities, the management of accreditation data and learning quality is still spread across various units, stored in different formats, and not connected in one integrated digital ecosystem (Suryadi, 2021). This condition poses various obstacles, such as data duplication, delays in reporting, low validity of information, and difficulty in conducting comprehensive performance analysis (Prasetyo et al., 2020).

As a vocational education institution, Manado State Polytechnic needs a digital solution that can integrate all data related to study program accreditation, learning implementation, lecturer performance evaluation, and academic quality achievement in a sustainable manner (Sá & Serpa, 2018). This need is the background for the development of PRIMA, a platform designed to be an integrated Smart Data Hub that supports the learning quality monitoring

process while facilitating the provision of accreditation data in a more efficient, real-time, and analytics-based manner (Alammary et al., 2019; Renz et al., 2016).

The Smart Data Hub concept in PRIMA PPMPP allows the collection, processing, integration, and visualization of data from various sources in one unified system architecture (Kaur & Singh, 2021). With this approach, institutions are not only able to manage accreditation documents but can also monitor the quality of learning on an ongoing basis through relevant and measurable indicators (Vlachopoulos, 2016). On the other hand, the design of the platform must consider the components of architecture, data flow, modularity, and system integration that align with the needs of the quality assurance process in vocational colleges Ifenthaler & Yau, 2020; Viberg et al., 2018).

Previous studies have explored similar data integration platforms in higher education contexts. Al-Ismail and Nuaimi (2021) developed a framework for quality assurance digitalization, while Hussein and Abdul Rahman (2021) identified critical challenges in educational data integration. However, these studies primarily focused on conventional universities rather than vocational institutions. Zhang et al. (2022) examined smart data hubs for performance monitoring but did not specifically address the unique accreditation requirements of polytechnic education. The gap identified in this research is the absence of comprehensive design models specifically tailored for vocational higher education institutions that integrate both accreditation management and real-time learning quality monitoring in a single unified platform. PRIMA PPMPP addresses this gap by providing a specialized solution that considers the distinctive characteristics of vocational education, including competency-based learning, industry partnerships, and practice-oriented assessment systems (Kim & Park, 2020).

Although the PRIMA PPMPP platform has been developed and used, scientific studies on the application design model are important to publish as an academic contribution. This research focuses on the formulation of the conceptual design and architecture of the PRIMA PPMPP system as a Smart Data Hub platform, including component structures, data flow models, and information integration mechanisms in the context of accreditation and learning quality monitoring. Thus, this research provides added value for educational institutions and academic communities that are developing a similar approach in digitizing quality assurance, as well as serving as a reference for the development of data-based quality systems in vocational universities (Lytras et al., 2020; Păcurari, 2021; Wicaksono & Prasetyo, 2020).

The primary aim of this research is to develop and validate a comprehensive design model for PRIMA PPMPP as an integrated Smart Data Hub platform that addresses the specific needs of quality assurance and accreditation processes in vocational higher education. Specifically, this study seeks to: (1) formulate a multi-layer system architecture that supports seamless data integration from diverse institutional sources, (2) design data models and information flows that ensure consistency and standardization across accreditation and learning quality modules, (3) develop user-centered interfaces that accommodate various stakeholder roles, and (4) validate the feasibility and applicability of the proposed design through expert review. The benefits of this research extend to both practical and theoretical domains. Practically, the PRIMA PPMPP design model provides educational institutions with a blueprint for implementing efficient, data-driven quality assurance systems that reduce manual

workload, minimize data redundancy, and enable real-time performance monitoring. Theoretically, this research contributes to the body of knowledge on educational information systems by offering a specialized framework for vocational education contexts, which can serve as a reference for similar institutions seeking to digitalize their quality management processes.

## METHOD

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This research employed a software engineering approach with a focus on designing the architecture and design model of the PRIMA PPMPP platform as a Smart Data Hub for data integration, accreditation, and learning quality monitoring. The methodology was formulated in several stages, namely: (1) needs analysis, (2) system architecture design, (3) data model and information flow design, (4) interface design, and (5) design validation.

- 1) System Needs Analysis: The initial stage identified the functional and non-functional needs of the platform based on the business processes of Learning Quality Assurance and Accreditation at Manado State Polytechnic. The analysis included accreditation data management processes (LKPS, LED, form instruments), learning quality monitoring flows, inter-unit integration needs, data reporting and visualization needs, security needs, user access, and data management. Needs data were obtained through institutional documentation, analysis of PPMPP SOPs, interviews with quality managers, and observation of the work processes of related units.
- 2) System Architecture Design: At this stage, the PRIMA PPMPP architecture model as the Smart Data Hub Platform was formulated. The design included the structure of the platform's main components, inter-module relationships (accreditation, learning quality, data management, dashboard), integration with internal data sources, data exchange and centralized storage mechanisms, service architecture, and interoperability standards. The architectural model was described using component diagrams, system architecture models, and high-level system blueprints.
- 3) Data Model Design and Information Flow: This stage focused on the design of the data flow within the platform to ensure the integration and consistency of information. The design was carried out through Data Flow Diagrams (DFDs) at the context level to the detail level, Entity-Relationship Diagrams (ERDs) for mapping the database structure, Use Case Diagrams to describe the interaction between actors and systems, metadata definitions, and database schemas for accreditation data and learning quality. This data model ensured that the platform managed data in a standardized manner and supported quality learning analytics.
- 4) Interface and User Experience (UI/UX Design): The interface design was carried out to ensure that the platform was easy to use by quality managers, lecturers, study programs, and leaders. UI/UX design included navigation structures, prototypes of dashboard pages, displays of accreditation modules and learning quality, principles of usability, visual consistency, and accessibility. The design was created using a user-centered design (UCD) approach with the needs of the main users in mind.
- 5) Design Validation: Validation was carried out to ensure that the developed design model met the needs of stakeholders. The validation process was conducted through expert review,

involving information system experts, quality managers, and accreditation teams; assessment of suitability between design and functional needs; verification of the feasibility of architecture for implementation; and evaluation of the suitability of data models with accreditation reporting structures and quality indicators. This validation ensured that the platform's design was feasible to use as a basis for implementation and aligned with the university's quality assurance business processes.

## RESULT AND DISCUSSION

This section presents the results of the design of the PRIMA PPMPP platform as a Smart Data Hub along with a discussion of its relevance to the needs of data integration of accreditation and monitoring of learning quality at the Manado State Polytechnic. The results of the research are presented based on methodological stages, including (1) needs analysis, (2) architectural design, (3) data models and information flows, (4) interface design, and (5) design validation through expert review.

### 1. System Needs Analysis Results

The needs analysis shows that the accreditation process and monitoring the quality of learning at the Manado State Polytechnic still faces several main obstacles:

- a. data is scattered across multiple units and is not integrated,
- b. manual and time-consuming accreditation data collection process,
- c. the absence of a standardized repository of learning quality data,
- d. The performance monitoring dashboard is not yet available in a systematic form.

From the results of interviews and document studies, the main functional needs of the system include:

- a. management of accreditation documents (LKPS, LEDs, instruments),
- b. provision of learning quality indicators (RPS, attendance, evaluation, learning outcomes),
- c. integration of lecturer data and learning activities,
- d. quality dashboard for PPMPP leaders and units,
- e. tracking the progress of study program accreditation,
- f. multi-level access control system.

Meanwhile, non-functional needs include:

- a. scalability of the data,
- b. security and user authentication,
- c. ease of use,
- d. visual consistency between modules,
- e. interoperability with academic and staffing systems.

Needs analysis is the main basis in forming the PRIMA PPMPP design model.

## 2. System Architecture Design Results

Based on the above needs, the PRIMA PPMPP architecture was formulated as a Smart Data Hub Platform consisting of four main layers:

### a. Data Source Layer

Contains internal data sources of the institution, such as:

- 1) Faculty, Faculty, and Faculty Members,
- 2) Teaching and Learning Activities,
- 3) learning evaluation data,
- 4) Accreditation form data and documents.

This layer is designed to support both automatic and semi-manual multi-source integration.

### b. Data Integration & Processing Layer

It is the core of the Smart Data Hub that functions to process, unify, and standardize data.

- 1) Key features of this layer include:
- 2) API integration with academic systems,
- 3) ETL (Extract–Transform–Load),
- 4) normalization of the accreditation data structure,
- 5) metadata management,
- 6) Data validation and cleansing.

### c. Application Service Layer

Layers that contain the main functional components of the platform:

- 1) Accreditation Module of Study Program,
- 2) A learning curve for the Student Leadership Team,
- 3) document management module,
- 4) Quality Indicator Dashboard Module,
- 5) User management and access rights modules.

Each module is connected through a service-oriented design mechanism.

### d. Presentation Layer

Contains a web-based user interface designed to be responsive and modular, intended for:

- 1) PPMPP manager,
- 2) Head of Study Program,
- 3) lecturer
- 4) institutional leaders.

This architecture allows PRIMA PPMPP to function as an information integration center that unites various quality assurance processes into one integrated system.

## 3. Results of Data Model Design and Information Flow

### a. Data Flow Diagram (DFD)

The context-level DFD describes the data flow between the main actors (PPMPP, study programs, lecturers, leaders) and the PRIMA PPMPP system. Key data flows include:

- 1) Upload accreditation documents,
- 2) To fill in the data on the quality of learning,
- 3) update of data on learning activities by lecturers,
- 4) Preparation of quality reports for leaders.

DFD level 1 and level-details define the process flow of each module, facilitating data integration analysis between units.

#### b. Entity–Relationship Diagram (ERD)

The developed ERD contains main entities such as user accounts, study programs, quality indicators, RPS data, learning implementation data, learning outcomes, accreditation documents, activity logs, and accreditation progress.

Relationships between tables are designed to ensure:

- 1) no redundancy,
- 2) data consistency is maintained,
- 3) Integration can be done across modules.

This ERD is the main framework for the preparation of the platform database.

#### c. Metadata and Data Schemas

Each quality indicator and accreditation document is mapped to a metadata schema that includes the structure, data type, validation criteria, and data owner.

This design simplifies automated reporting and integration with dashboards.

#### 4. Interface Design Results (UI/UX)

The interface design of PRIMA PPMPP is carried out through a user-centered design approach.

The design results show that the platform has:

##### a. Learning Quality Dashboard

Contains a summary of performance indicators such as:

- 1) the level of implementation of the RPS,
- 2) learning evaluation,
- 3) the progress of filling in lecturer data,
- 4) performance achievement of the study program.

##### b. Study Program Accreditation Page

The resulting features include:

- 1) LKPS and LED management,
- 2) standard-by-standard progress tracking,
- 3) Upload the proof form,
- 4) PPMPP verification status.

##### c. Document Management Page

Provide a repository that is structured by accreditation standards and years.

##### d. User role-based navigation design

Provide a consistent experience and make it easier for users to access functions according to their responsibilities.

The resulting UI/UX design has been proven to increase user understanding in design walkthroughs.

#### 5. Design Validation Results

Validation is carried out through expert review involving:

- 1) two information systems experts,
- 2) A member of the Faculty of Education,
- 3) One study program accreditation manager.

The validation results show that:

- 1) Architectural design meets the needs of the quality assurance process and can be implemented with a realistic level of complexity.
- 2) The data flow model and ERD are considered consistent and in accordance with the nationally applicable accreditation data structure.
- 3) The UI/UX design is considered easy to understand, navigation is clear, and important functions are easy to access.
- 4) The proposed Smart Data Hub has the potential to improve the efficiency of the accreditation process, especially in data consolidation and reporting.

This evaluation strengthens the conclusion that the PRIMA PPMPP design model is feasible and relevant to be applied to the vocational education environment.

## CONCLUSION

This research produced a PRIMA PPMPP design model as a Smart Data Hub platform that integrates accreditation data and learning quality monitoring within a unified system architecture, featuring multi-layered components including data sources, information integration and processing, application services, and user interfaces for real-time, structured data consolidation across units. The resulting data models and information flows—incorporating DFDs, ERDs, and metadata definitions—ensured data consistency, normalization, and interoperability between modules, while user-centered interface designs delivered intuitive experiences for accreditation management and efficient learning quality documentation. Expert validation confirmed the model's alignment with functional and non-functional needs, deeming it feasible for implementation at Manado State Polytechnic and serving as a valuable reference for other vocational institutions developing data-driven quality assurance systems. For future research, empirical testing through full platform prototyping, deployment, and longitudinal performance evaluation in real-world vocational settings would validate its scalability, user adoption rates, and impact on accreditation outcomes.

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