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# AGILE ANALYTICS: ADOPTION FRAMEWORK FOR BUSINESS INTELLIGENCE IN HIGHER EDUCATION

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**ABSTRACT**

Agile analytics is a strategy that focuses on improving DW and BI that characterizes program developers on how they should own the characteristics of DW. In Higher Education, data is an important asset. The unmanaged data available in the database is only transactional because it has to be transferred to a data warehouse. In Higher Education Data Warehouse is a method in data processing, data processing must provide the final results that can be evaluated and provide recommendations. The value of suitable methods or structures is needed to reduce the risk of technological failure in the data warehouse growth environment. The goal of this study is to develop an adoption framework by applying the concept of agile analytics. The System Development process included Manado State University as a research case study by performing business process analysis, and even recognizing issues and problems in the design of DW and BI. Adoption Framework testing is conducted at the end of the project construction to see the level of acceptance, and the architecture and framework feedback.

**Keywords:** *Agile Analytics, Data Warehouse, Business Intelligence, Higher Education, Adoption Framework*

## 1. INTRODUCTION

Developments are currently growing rapidly and constantly in the field of information technology. This is seen through the presence of Information Technology in the market, health and government aspects of every human activity [14]. Information Technology is used based on the needs and goals of its use. In the field of education, information technology can be used as a learning medium, enabling administrative processing, even as a decision-making guideline. Even to compete with other educational institutions, the use of technology in decision making in the field of education to assist the agency or institution in reacting to the needs of still exists. Data warehouse (DW) is one aspect of information technology that can help decision making decisions where all data in an enterprise has been incorporated and data stored in accordance with its historical data [4].

In its implementation, data warehouse will assist the strategic management of academic and institutional leaders through deciding the policies within the company. This is critical, so that the educational institution can make decisions quickly and accurately based on the data and facts available research results [25]. The presence of Data Warehouse will simplify and support Business Intelligence Software, Decision Support System (DSS), Executive Information System (EIS) and Decision-Based System, since the purpose of data warehouse is to support the Analysis process for the decision-making leaders of organizations [11].

Developing a data warehouse will give Higher Education a strategic advantage. This is due to the Higher Education's high demand for improving its work performance in evaluating needs and issues, so it can be used as a guideline and as a solution to the problem [22]. Warehouse capability to access large, reliable, and high performance of data features for quick analysis [28]. Academic data is important data in universities. The management needs information on academic data to know the state and the situation.

Data on the academic information system database was not used as a decision-making supporter but only as a transactional one, for it is necessary to apply a data warehouse in order to accommodate the data to be converted into useful management information as well as data warehouse can serve the knowledge extraction needs from more than one subject area [12].

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Methodology as one of the four solutions outlined in the Data Warehouse development, where Data Warehouse in its development includes an implementation guideline that describes the development process in detail either in the form of a method, system development approach or a particular framework for data warehouse growth [26].

Applying the correct approach or system would make the production of DW and BI simpler for developers, as well as reduce the risk of failure in the development of DW and BI. This issue is also still popular in Data Warehouse development, where the system design has still not paid attention to using methodology in its development.

Universities ' high competitiveness is rapidly affecting technology development. In this research, to achieve the desired goals of a higher education is university, information technology plays a role in making business strategy-related decisions, and in reality the university as an educational institution is actually using a range of information technology to provide better education services [16]. Nevertheless, it is difficult for the current University to get information quickly and accurately because often the University continues to adopt database-based information technology that stores data constantly and the amount of data continues to grow and grow big. This also becomes a challenge in the University, it is difficult to search for information in large data because the data collected is comprehensive and not yet converted into details that can help the decision-making process [23].

Business intelligence (BI) will play a significant role in the strategic planning process at the University. University can store, review, access, and analyze its data through BI [1]. At some point the outcomes of cross-department data set review will help strategic decision-making in high school. BI in its capacity is responsible for processes and activities for developing, evaluating and managing large volumes of market environment-related information and promoting action by decision-makers [30]. Development of the data warehouse requires infrastructure to support BI system running. Data warehouse is one of supporting BI framework infrastructure, where data is collected from Business Environment in data warehouse [8].

In an enterprise, data is a significant tool used to execute a plan or take a decision. Data processing can take place in different locations, e.g. in the organizational database, operational systems and data warehouse technology [3]. Several universities currently already have applications which use the database. With the passing of time, the cumulative data is so much that there is huge accumulation of data. The data is never used, so that it can't be available to help decision-makers decide something strategic. There is also quite a lot of data on new admissions in each University [21].

Provides information on vulnerabilities in the creation of data warehouse. In one of his writings he stressed the challenges that are a long development in the development of Data Warehouse, this is seen in the development process up to two years through the time consumed long enough [6]. Ineffective technique or structure employed can trigger obstacles to data warehouse creation. Some of the causes of failure in the creation of data warehouse projects that often seem to be unfitting changes in each process. This problem becomes the cause of delaying the project with the requirement that keeps on through and becoming high. Data Warehouse architecture must be scaled so that it can be adapted to suitable methodologies and frameworks, as the use of incorrect methodologies or frameworks often poses a high risk of failure. The University requires a program that can work to turn data into knowledge that is useful to its organization in facilitating decision-making and providing adequate information needs easily to understand. Business Intelligence (BI) is the right solution for helping Data Warehouse (DW) growth correctly so it can run the BI program well [10].

## 2. RELATED WORK

### 2.1 Higher Education in Indonesia

Higher education has a strategic role as a center of culture, science and technology growth and as a center of moral strength. Efforts to improve the standard of higher education are becoming increasingly important because Higher Education is a research institution that aims to give birth to educated and productive societies in order to meet the needs of modern society. As a developing country, Indonesia is looking for a type of how and how to become an advanced country, especially in the field of education. Figure 1 and Figure 2 show the number of Higher Education and Students in Indonesia.

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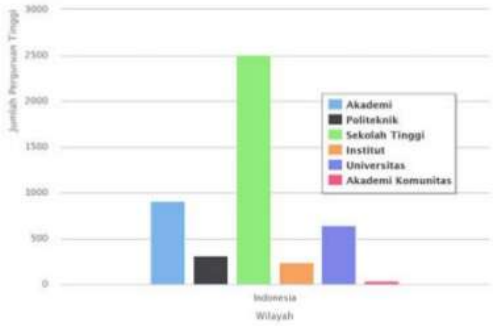


*Figure 1: Higher Education in Indonesia [18]*

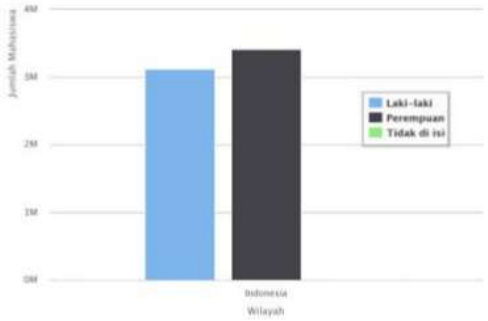


*Figure 2: Number of Students in Higher Education [17]*

In Indonesia, nine years, six years in elementary school / madrasah ibtidaiyah and three years in junior high school / madrasah tsanawiyah are expected of all people to follow the mandatory basic education program. Currently Indonesian education is governed through the National Education System Law Number 20 Year 2003. Indonesian education is divided into three main lines: formal, non-formal, and informal. Education is also divided into four stages, the early, major, secondary, and high childhood. The Indonesian Education System is shown in Figure 3.

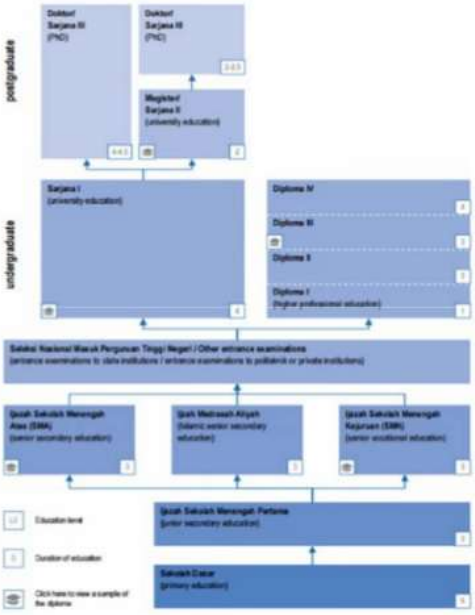


*Figure 3: Education System in Indonesia [13]*

## 2.2 Business Intelligence in Higher Education

BI is a technology and a system by which managers use it in their decision-making activities as a help. This BI system and technology makes use of large amounts of data expenditure and the effects of long-term accumulation. Where such huge amounts and scale of data require special management to be used in decision making in their use. BI's methodology and technologies allow data to be analyzed so that data from multiple dimensions can be examined and used to generate a pattern that can be extracted from existing data [9]. The use of BI in commercial enterprises and educational institutions is little different. Where BI is more commonly used in commercial enterprises to respond to business needs such as the number of sales, how much time it takes to market, and this becomes an important thing to know while running a business and as managing profitability and resources within a corporation [5]. It is specific for educational institutions where use of BI in general is more likely to achieve learning activities undertaken.

One of the management activities at educational institutions is to determine how the systems of the company are working. The BI approach is very important for that. Specially for tasks done in teaching. This activity becomes very difficult to measure so difficult to find success

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levels in a learning process. By using the BI in educational institutions, organizations such as evaluating and understanding more about learning process performance and student engagement are expected to gain the skill (Figure 4).


*Figure 4: Business Intelligence in the Higher Education Sector [27]*

### 2.3 Previous Project

Previous research [19] on extracting data from OLTP to OLAP using Pentaho Data Integration carried out a preliminary study project at Manado State University to improve BI. In this project the researchers in the Faculty of Engineering performed a case study on the Department of Education of ICT (PTIK). The analysis was carried out by designing PTIK's data warehouse infrastructure where the data was taken from the study system database which will be carried out by the ETL process. Also, the researchers conducted dimensional data modeling designs that included student dimension, faculty dimension, subject dimension, time dimension, value dimension, and student concept fact table outcome (Figure 5).

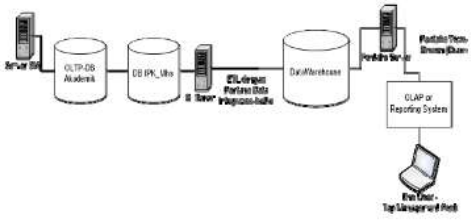


*Figure 5: Physical DW Architecture of PTIK Department [19]*

Manado State University's implementation of the DW and BI uses PDI. Where the researchers used multidimensional data model design according to the Kimball method used in this study includes 4 phases. This approach highlights four main processes that begin with selecting the business process, declaring the product, selecting the measurements and defining the details. Research results defined that the data generated GPA to make the next BI development process simpler and more ready to be processed on the Pentaho Schema Workbench and the dashboard will view the results using the Pentaho BI server.

For all the core activities ranging from admission, registration, alumni, graduate and academy operations, a majority of Higher Learning Institutions are implemented with information management systems. The data generated by these integrated information systems is transactional in nature, and has been exponentially increasing. The use and utility of the data, however, was not fully explored to guide decision making processes (Figure 6). This paper discusses the value of Agile Analytics for higher learning institutions in the creation of business intelligence and data warehouse [20].

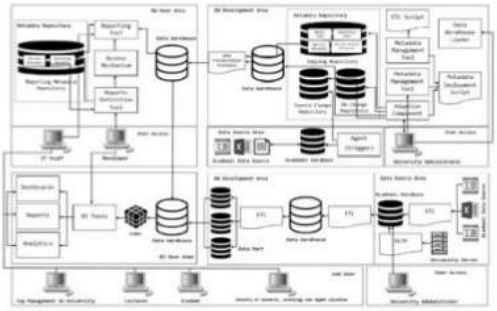

*Figure 6: Design Architecture of DW and BI in Higher Education [20]*

## 3. METHDOLOGY

### 3.1 Research Approach

Two kinds of research methodology which is quantitative and qualitative analysis can be classified in the study. All methods have differing definitions, goals, features, and procedures. The question, however, does not lie in the advantages or disadvantages of each strategy, but in the degree to which the researcher can react by designing the right design for his study. Research is a systemic operation, with a sequence of organized procedures. Which stage of the process is interconnected, where a process is performed is part of the stage which decides the next phase. Therefore, in order to carry out these stages carefully and systematically, a research methodology is needed as a step. And illustrated in Fig, to make it easier to understand.

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*Figure 7: Research Approach*

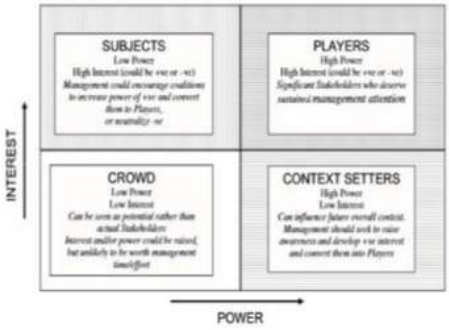


*Figure 8: Outline Stakeholder Power Interest Grid [2]*

### 3.2 Framework Validation

In addition to finding out the truth, qualitative research connects the subject matter to the world around it. Interview and evaluation are the main element in qualitative research, the accurate research tool. The most common way to check the validity of the used data is triangulation. This is done by exploiting something else for checking outside the data, or as a data comparison. Check the validity of the data by checking the data obtained from the data source and the expert to ensure that existing data are accurate [29]. It then takes multiple approaches to determine the validity of data starting from Data Triangulation, Audit Trail, Expert Opinion, and Member Review to obtain data that really supports and in line with the characteristics of this study's research focus and goals.

### 3.3 Stakeholder Power Interest

Data analysis [7] is a method of systematically searching and compiling data obtained from interviews, field observations, and documents, organizing data into categories, translating data into units, synthesizing, compiling patterns, choosing which ones are relevant and which ones to know, and drawing conclusions that are easily understood by themselves and others. The data obtained are observation, documentation, interview and triangulation as descriptive. Research Interactive is then the phase research of the data used to present the data to be more informative and easier to understand. Stakeholder Power Interest Grid will also be used for the data analysis. The four grid quadrants can be interpreted as defining the 4 stakeholder groups within an entity.

## 4. RESULT

### 4.1 Stakeholder Analysis

Manado State University can achieve its aim because it is assisted by influences inside and outside (Stakeholder) around Manado State University and is affected by that. An overview will be performed in this section using the Stakeholder Power Interest Grid to define the parties involved in issues addressed in the system, their positions, priorities and the impact the parties have on the issue. Through defining, the University may become responsive to stakeholder interests; and a long-term plan can be established to ensure the support of certain stakeholders.

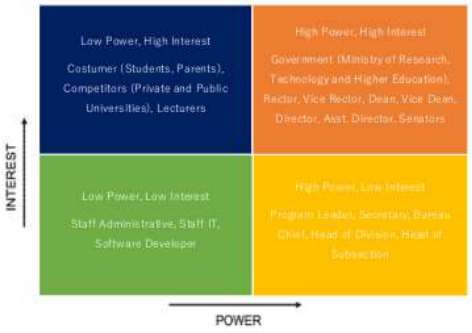


*Figure 9: Stakeholder Power Interest Grid*

Study using Stakeholder Power Interest Grid at Manado State University found that high interest is government (Ministry of Science, Technology and Higher Education), Rector, Vice Rector, Dean, Vice Dean, Director, Asst, in the high power portion. Manager, and Senators where in this community the institution's owner is in this case the government and other stakeholders authorized to

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take the decision at Manado State University. This community is a component this affects the University directly and indirectly. Low Interest is included in the High-Power sector as the Leader Group, Secretary, Chief of Bureau, Head of Department, and Head of Subsection, which in this division is a group of parties that have the authority to take decisions. I have no interest in, and no desire to actively engage. Execute decisions at a higher level in the implementation of the members participating in that group based on the guidance of the current leadership. Low interest in Low Power includes administrative staff, IT workers, and software developers, who are not supposed to be actively involved in the University process within this community. This party doesn't even know about every operation within the University and doesn't want to know more. This is because only the tasks are performed by this community in compliance with the defined and not the decision maker.

### 4.2 Business Process

Higher Education is an institution with a series of structured activities or work related to one another. In its business process, Universitas Negeri Manado refers to Higher Education Tri Dharma which this has an impact with Graduates, Academic Lecturer, Research and Dedication. There are two main components in the implementation of business processes at Universitas Negeri Manado, which include the implementation of the learning process (degree and non-degree), study and commitment, new student activity acceptance, cooperation and marketing activities and subsequent support activities, activities that support the core process, which includes academic services (Facilities and Infrastucture).

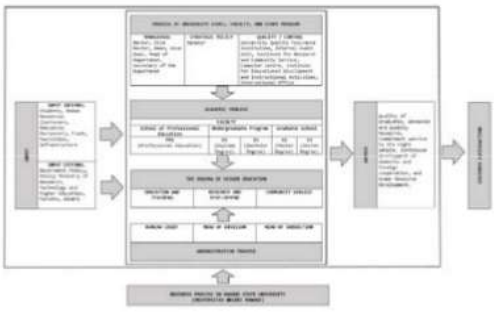

*Figure 10: Business Process in Universitas Negeri Manado*

The academic business process includes many interdependent processes including the registration of new students or current students, the process of supervising, choosing module, getting final GPA, and the process of lecturing. The curriculum is a collection of plans and arrangements relating to goals, content, and instructional materials as well as forms to be used as guidance for incorporating learning experiences to achieve specific educational objectives. Scheduled intracurricular work is done. Extracurricular activities are informal student events, and are not strictly monitored and unplanned. Universitas Negeri Manado's intracurricular Academic activities are focused on the Semester Credit System (SKS / *Sistem Kredit Semester)*. SKS is an instructional implementation framework using semester credit units (credits) to convey student study load, instructor workload, learning experience, and program implementation burden that does not include rate increase system. Semester credit units (credits) are the dose of gratitude for learning experience acquired through scheduled activities per week over the course of one semester (Figure 11).

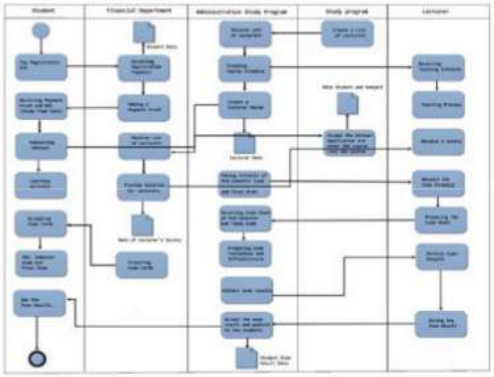

*Figure 11: Academic Process*

### 4.3 Business Process

A Higher Education Data Warehouse Planning Guide (Agile Analytics) aimed at understanding DW and BI's development process in higher education by asking questions that reflect the characteristics of Agile Analytics. In this segment, the researcher divides the emphasis on eleven sections such as Satisfying the DW / BI user community, changing requirements, regular delivery of applications, working together, expert feedback, face-to-face interaction, development, consistency, Agility enhancement, self-organizing teams, and reflection.

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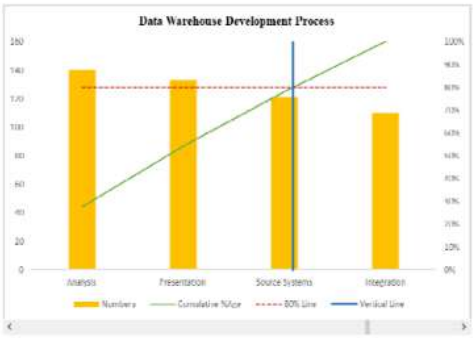


*Figure 12: Pareto Analysis of Development Process*

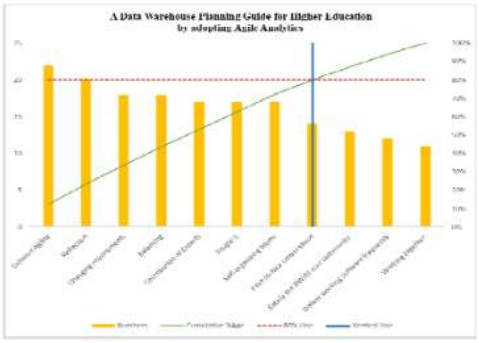


*Figure 13: Pareto Analysis of DW Planning Guide*

### 4.4 Adoption Framework.

Higher Education DW / BI Design Adoption Framework seeks to simplify the design of the framework by DW / BI developers by following the stages and requirements set out in the DW / BI Implementation Adoption Framework for Higher Education.

*Figure 14: Adoption Framework for BI in Higher Education*

The Framework for Adoption addressed four main phases, starting with External View, Conceptual View, Internal View and Development View. Here is a detailed explanation of the four core DW / BI Technology Adoption System Higher Education Processes:

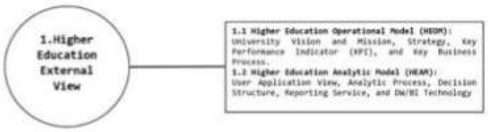


*Figure 15: External View*

HEOM is a sub-part of HEEV where University Vision and Mission, Strategy, Key Performance Indicator (KPI) and Key Business Process will be defined and evaluated by DW / BI developers. Vision is a description of the situation and features the university would like to accomplish in the future. With the likelihood of advancement and developments in science and the uncertain situation over such a long period, the dream itself cannot be written more clearly explaining the detailed picture of the framework that it is striving for. The Statement of Vision must always refer to any possible changes that may arise so that a Vision is versatile. Mission provides a clear description of what to aim for, and sometimes also provides information on how the University is operating. Key Performance Indicator (KPI) includes financial and non-financial matrices used by the University for performance assessments. KPI is used to determine a Higher Education's condition as well as what action is needed to resolve the condition. KBP is the Higher Education's main work, and is a series of interrelated work to solve a specific problem. A business process can be divided into several sub-processes, each with its own characteristics but also contributing to the objective of the process.

HEAM is a subpart of HEEV where DW / BI developers can find out and evaluate User Application Experience, Analytic Process, Decision Structure, Reporting and DW / BI Technology in this segment. User Application View is a personalized Customer Web View. Where users can get what they are looking for through the User Interface View of DW / BI applications, and this responds to users ' needs. This stage is not just about user interaction but a focus on the User Interface View content. Analytic Process addresses the effect on activities of the Analytic Method. At Student-GPA-Analytic University, for example, it will have an effect on the process of selecting

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outstanding students, looking for candidates to get a scholarship or success rate on a subject. In a computer program, the Decision Structure performs the analytical phases of construction that allow the software to be developed. The findings of the University's process analysis are translated into computer software function composition. DW / BI developers at this point developed the decision system that covers the University phase and the computer program development. Reporting Service is a method to assist with reporting and easy to present. Component Reporting Services for example is divided into two parts, namely server components and client components.

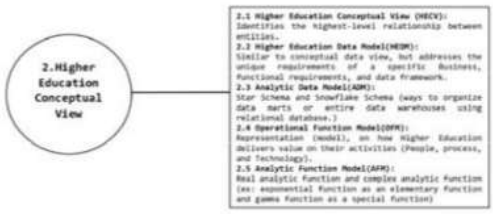


*Figure 16: Conceptual View*

HECV is a view related to the issue of what data is required to be processed in the database and the clarification of the University's relationship with data. HEDM is similar to conceptual view of data but addresses unique requirements of a particular business, practical requirements and data structure. ADM seeks to build an analytical model that defines the business processes that are becoming a norm within the University. OFM is a standardized representation of the task (activity, behavior, process, operation) in developing DW and BI. AFM defines the features of the University's business analytics specifications. The University will at this point design the models and analytical methods that will be used as required.

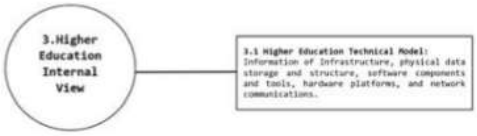


*Figure 17: Internal View*

The purpose of HETM is to examine infrastructure knowledge, physical data storage and structure, software components and resources, hardware platforms and network communications to be used in the production of data warehouse and business intelligence. This stage is done to encourage system developers to adapt the system to be built with the University's existing infrastructure, so that the system can be run optimally later on.

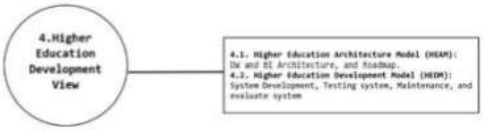


*Figure 18: Development View*

HEAM aims to develop Architecture for DW and BI, and Roadmap. This section is an important part of Design View, where system developers will be able to develop the system easily by making DW and BI Architecture, and the Roadmap as a guide and reference for system development. HEDM aims at system development, system testing, maintenance, and system evaluation. This is the final part of this process aimed at designing, evaluating, and sustaining the program. This stage can also act as a benchmark for a new cycle for the next phase of DW and BI.

### 4.5 Adoption Framework.

Testing is a method for the Framework and its components aimed at examining or documenting the built-up Framework and testing other aspects of the Framework or component. The method of review of Framework objects is carried out in research to identify the benefits and disadvantages of the System. Framework testing is carried out by distributing the framework to 100 Respondents through a questionnaire containing components such as Demographics, Validation of the Proposed Framework.

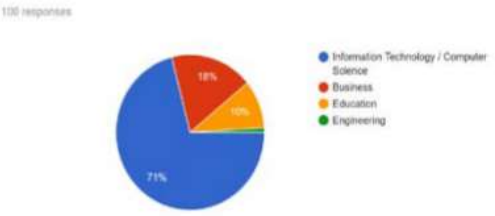


*Figure 19: Development View*

a. Construct efficiency and Simplicity

This section aims at understanding the dimensions of the DW / BI Design System for Higher Education Architecture using 3 distinct but very common differences: syntax, semantics and pragmatics. This is checked by placing on the questionnaire the statement "The system is based on advancement of DW and BI in higher education".

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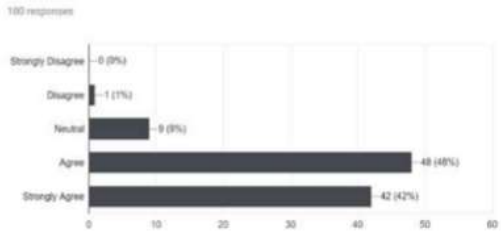


*Figure 20: Construct efficiency and Simplicity*

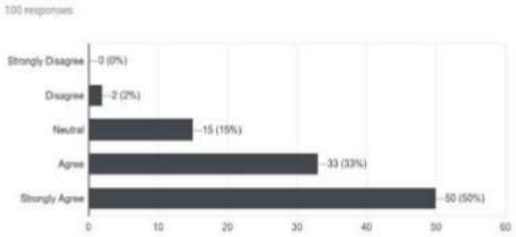


*Figure 23: Orthogonality*

b. Perspicuity

Perspicuity aims at figuring out if it is possible to understand an intuitively built Structure.

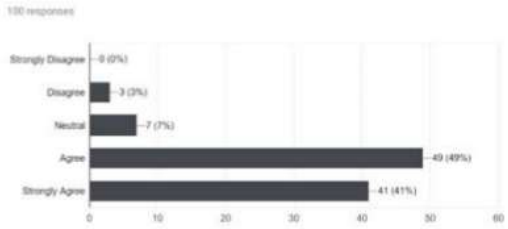


*Figure 21: Perspicuity*

c. Coverage and Completeness

Each portion is intended to assess the fullness of the Framework. Assessment of the System requires the standard of completeness and reasoning.

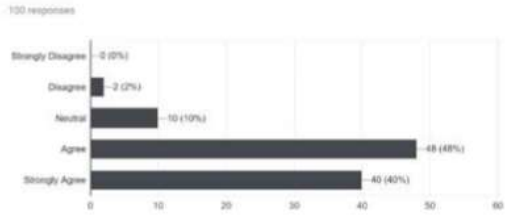


*Figure 22: Coverage and Completeness*

d. Orthogonality

Orthogonality aims to determine whether categories or sections within the Framework overlap.

e. Extensibility, Customizability, Robustness and Flexibility

This part is intended to decide whether adding new requirements is simple, or removing components in the Framework without disrupting the output of the other parts.

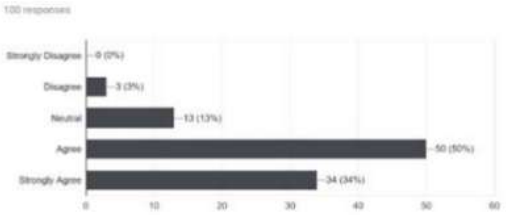


*Figure 24: Extensibility, Customizability, Robustness and Flexibility*

f. Genericity, Universal Applicability, Portability and Reusability

This section aims to determine if the Framework can be easily applied to other areas in certain circumstances.

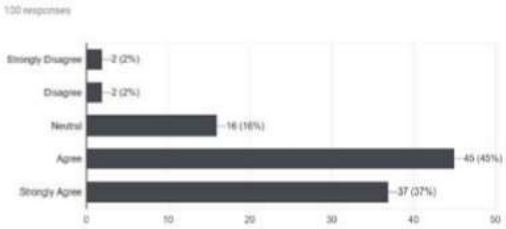


*Figure 25: Genericity, Universal Applicability, Portability and Reusability*

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g. Formality, Objectivity, and Absoluteness

This section seeks to find out whether the Framework and the environmental components have been consistent in providing DW and BI in the development process of higher education.

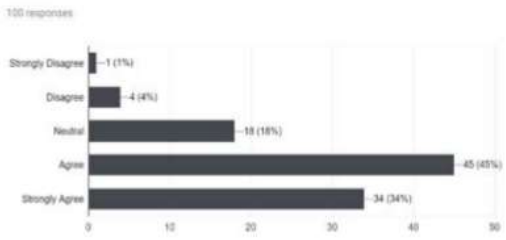


*Figure 26: Genericity, Universal Applicability, Portability and Reusability*

h. Theoretical foundation

This section attempts to decide if the Framework was based on the DW and BI development framework.

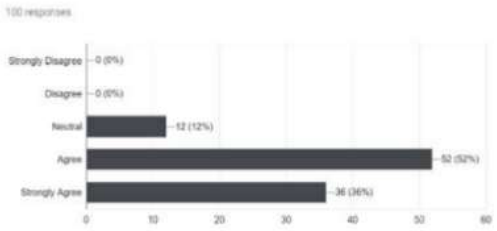


*Figure 27: Theoretical foundation*

## 5. INTRODUCTION

This research was carried out on the Agile Analytics scope and focused on the development of BI in higher education. Where higher education research is conducted and where Manado State University is taken as a case study in higher education. The number of lecturers, researcher, developer, student involved in the study of DW and BI development problems is taken in limited quantities as it has to be adapted to the given time as well as the methods used for data collection. In Higher Education BI architecture needs a deeper and more sustainable process of research. Particularly for University-based business processes. Researcher recommendations to researchers or program developers who will be implementing the project or study in the development of BI in higher education are to use the existing framework that provides guidance on the development of BI in higher education.

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