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Design of Real-Time Project Monitoring Dashboard Using Kimball's Data Warehouse Approach and Google Data Studio

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Abstract: The growth of the construction industry in Indonesia triggers an increasing need for an efficient project management system, especially in presenting project data accurately and in real-time. PT Dream Island Development (PT DID), a specialist MEP contractor company, faces challenges in presenting project reports to executives because the data is still presented in the form of Excel tabulations which require up to three days of processing time and are difficult to interpret quickly. This research aims to design an interactive dashboard-based project data visualization system using Google Data Studio (Looker Studio) to present project information intuitively and responsively. The method used includes a software engineering approach with five main stages: requirements analysis, data warehouse design, ETL process using Pentaho Data Integration, visualization using Google Data Studio, and testing using User Acceptance Test (UAT). Project data from 2022-2024 was modeled using a star schema and displayed in four main dashboards: project cost, project value, project progress, and details per project. The test results showed a high level of user satisfaction with a functionality score of 93.5%, reliability 91.33%, usability 96%, and efficiency 94.66%. These findings indicate that the developed system effectively supports PT DID's needs in project monitoring and data-based decision-making. The system also has the potential to be replicated in other construction companies as an efficient and scalable business intelligence solution.
This research contributes to the growing body of construction informatics by integrating Kimball's nine-step methodology with modern data visualization tools to enhance project transparency and decision-making.

Keywords: Data Visualization, Google Data Studio, Project Management, Interactive Dashboard, Data Warehouse

INTRODUCTION

Indonesia is one of the fastest growing economies in Southeast Asia, and the construction sector plays a strategic role in supporting this growth rate. Population growth, urbanization, and increased infrastructure needs have led to a surge in development projects across various sectors. Along with the increasing scale and complexity of construction projects, an adaptive information management system is needed that is able to present data accurately, quickly, and easily understood, especially to support decision-making at the executive level .(Syafe'I et al., 2023)

One of the challenges faced by construction companies is the presentation of project data that is still static, uninformative, and time-consuming. This can be seen at PT Dream Island Development (PT DID), a specialist MEP (Mechanical, Electrical, and Plumbing) contractor company based in Canggu, Bali. Based on interviews with management, it is known that project data such as Bill of Quantity (BoQ) and Time Schedule (TS) are still stored in tabular form. Preparation of reports to the leadership requires a manual data processing process that takes up to two to three days. In addition, data in tabular format is difficult to read and analyze quickly by management, thus hampering operational efficiency and responsiveness of decision-making .(Nurul Rival et al., 2024)

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To overcome this problem, the solution offered is the implementation of an interactive dashboard-based project data visualization system using Google Data Studio. Data visualization enables the transformation of complex numerical information into intuitive graphical representations, accelerates understanding, increases transparency, and reduces analysis time(Akbar et al., 2020; Allaymoun et al., 2022; Riani et al., 2024) . By utilizing the Google Data Studio platform, project data stored in various sources can be unified, processed, and presented in real-time through dynamic graphs and visual indicators.

The methodology used in this research includes building a data warehouse with Kimball's Nine Step approach and the Extract, Transform, Load (ETL) process using Pentaho Data Integration. Project data from 2022-2024 was consolidated into a data mart before being visualized in the form of an interactive dashboard(Madyatmadja et al., 2022; Sakti et al., 2025; Widjaja et al., 2023) that displays information such as project cost, quantity of work, comparison between planning and realization, and project distribution. Although data visualization and dashboards have been widely used in business and educational contexts, there is still a research gap regarding the integrative application of Google Data Studio and data warehouse design methods (Kimball) in the context of construction project management in Indonesia. This research aims to fill the gap with a systematic approach and based on a real case study at PT DID.

Although data visualization and dashboards have been widely used in business and educational contexts, there is still a research gap regarding the integrative application of Google Data Studio (Mucchetti, 2020; Saputro et al., 2024) and data warehouse design methods (Kimball) (Intan et al., 2022; Oslan & Kristanto, 2019) in the context of construction project management in Indonesia. In particular, there is a lack of empirical studies that evaluate the effectiveness of Kimball's dimensional modeling approach when applied to real-world construction environments in Indonesia. Most studies focus on retail, finance, or education sectors, leaving a void in sector-specific business intelligence practices in construction.

The problem addressed in this study is the inefficiency and lack of interpretability in project reporting at PT DID caused by the use of conventional tabular formats. This leads to the formulation of the research question: How effective is the integration of Google Data Studio with a Kimball-based data warehouse in improving project data presentation and executive-level decision-making in the construction industry.

Thus, the main objective of this research is to design and build a project data visualization system that can present information in an interactive, real-time, and easy-to-understand manner to support the evaluation, reporting, and decision-making processes in the construction project environment (Anagha & Urolagin, 2021; Fernández et al., 2022). It is expected that the results of this system can improve the efficiency of project monitoring, strengthen the role of data in strategic decision making, and become a model that can be replicated in other construction companies.

The contribution of this research lies in bridging the gap between business intelligence methodologies and construction sector needs in Indonesia. It offers a practical reference model for integrating Google Data Studio with a Kimball-based data warehouse using free and accessible tools. The model is designed based on real organizational needs and validated through user acceptance testing, making it both applicable and scalable. This work is expected to inform both academic discourse and industry adoption strategies.

State of The Art

Dashboard systems have become integral to business intelligence (BI) in various industries, including construction, due to their ability to present real-time data in a visual and interactive format. Prior studies such as those by (Akano et al., 2024; Al-Sulaiti et al., 2021) have emphasized the importance of dashboards in executive decision-making, particularly in environments where data from multiple sources needs to be unified. In the construction sector, Madyatmadja et al. (2022) and Riani et al. (2024) demonstrated the application of dashboards for tracking budget usage and project milestones. However, many existing systems are built using proprietary or high-cost platforms such as Tableau, Power BI, or SAP Analytics, which limit accessibility for small to mid-sized companies. In contrast, Google Data Studio offers a lightweight, browser-based, and cost-effective alternative for interactive visualization, although its application in construction contexts remains underexplored.

In terms of data visualization for construction, Nurul Rival et al. (2024) investigated the use of visualization for project progress monitoring but focused mainly on Gantt chart-based visual tracking without integrating data warehouse architecture, also addressed the need for real-time project dashboards, but their solution relied on static Excel sheets and lacked a structured backend. This research extends previous work by integrating dynamic dashboards with a structured data warehouse backend, providing richer, real-time analytics (Mohd et al., 2019).

Regarding data warehouse implementation and ETL tools, Kimball's nine-step methodology remains one of the most widely adopted frameworks in dimensional modeling due to its simplicity and effectiveness in supporting OLAP-based queries. Kimball's approach emphasizes usability and performance in query execution, making it ideal for construction reporting (Gara et al., 2021), where timely comparisons between planned and actual data are critical. Pentaho Data Integration (PDI) is often used in open-source environments for performing ETL tasks, particularly when integrating legacy file formats such as Excel or CSV into structured warehouse schemas (AL-

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Zubaidi, 2019). The flexibility and GUI-based transformation capabilities in PDI make it suitable for non-programmer analysts in construction firms.

Thus, this research contributes to the construction informatics field by bridging the gap between low-cost dashboard technology (Google Data Studio), robust dimensional data modeling (Kimball), and an open-source ETL process (Pentaho), forming a complete and replicable model for interactive project data visualization in mid-sized contractor settings.

METHOD

This research uses a case study-based software engineering approach focused on building a project data visualization system using Google Data Studio . The research was conducted through five main stages structured as shown in the process flow diagram, including: requirement analysis, data warehouse design, ETL (extract, transform, load) process , data visualization process, and system testing stage.

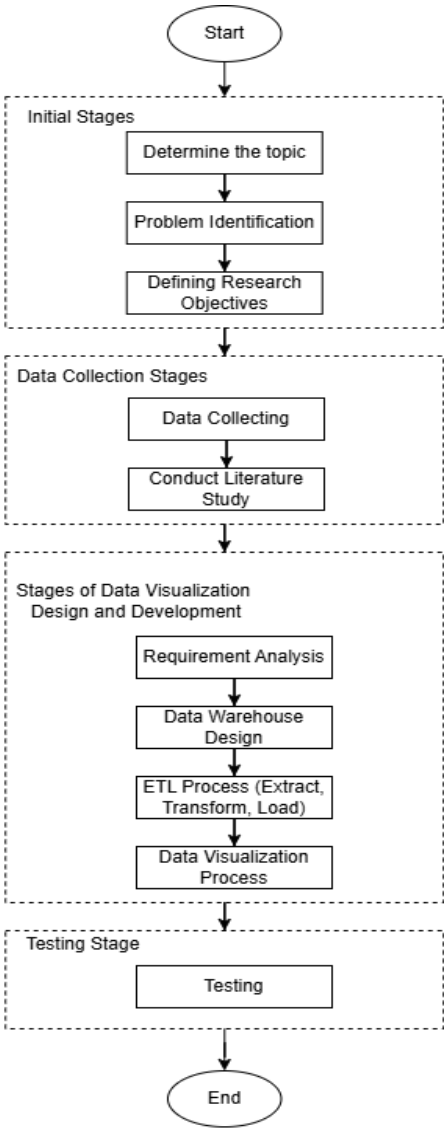

Figure 1. Research Flow Stages

Based on figure 1, it can be explained that The first stage is requirement analysis, which aims to understand the information needs of the management of PT Dream Island Development. This analysis is carried out through interviews and project document studies, especially Bill of Quantity (BoQ) and Time Schedule (TS) data, to identify the types of data, formats, and indicators that need to be visualized in the dashboard. The second stage is data warehouse design. At this stage, project data sourced from various files (mainly Microsoft Excel) is modeled

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into a multidimensional data structure using a star schema. The goal is to support the need for efficient data analysis and visualization. The database used is MySQL, and the design is done by referring to the Kimball principle. The third stage is the ETL (Extraction, Transformation, Loading) process. This process is carried out using the Pentaho Data Integration (PDI) tool . Project data is extracted from Excel files, then transformed to equalize data formats and types, and clean up inconsistent data. After that, the data is loaded into the data warehouse to be ready for analysis and visualization. The fourth stage is the data visualization process using Google Data Studio. Data from the structured warehouse is displayed in the form of interactive charts, including visualization of planning and realization costs, weekly project progress, project location, and quantity of work. The dashboard is designed to support fast, intuitive, and web-based visual analysis so that it is easily accessible to company stakeholders. The fifth stage is system testing (testing) which is carried out to evaluate the functionality and level of user acceptance. Testing is done through User Acceptance Test (UAT) with four evaluation aspects, namely: functionality, usability, reliability, and efficiency . The assessment was obtained from internal users of PT DID who were directly involved in project management, with the evaluation results showing a satisfaction level above 90% in all aspects. Through this stage, the visualization system developed is expected to be able to answer the problem of project data presentation at PT DID and support faster, more accurate, and visual data-based decision making.

Information Systems Project ETL Process Architecture

In this data warehouse, the data source comes from BoQ (Bill of Quantity) and TS (Time Schedule) data at PT Dream Island Development. In this data source, there are several data such as planning and realization price comparison data, as well as project implementation data. Furthermore, the database will go through the extract, transformation, loading (ETL) process before being stored in the data warehouse. After the ETL process, this data warehouse will be implemented in data visualization using google data studio software. Extraction, Transformation, Loading (ETL) process . After getting the excel data recapitulation, further processing needs to be done. The stages that will be carried out in data processing are the ETL process using Pentaho Data Integration and using batch processing techniques, where the imported data will be organized into groups according to what has been previously determined. After that, the data will go through the ETL stage starting with the data cleaning process, where unused data will be deleted so that the stored data matches what is expected and there is no duplication of data. The next step is the data transforming process, where the extracted data will be processed so that it has the same format. The last process is the data loading process, where the data that has been processed will be stored in the data warehouse. Data that has been stored in the data warehouse can be visualized in the form of graphs to facilitate analysis and understanding of information.

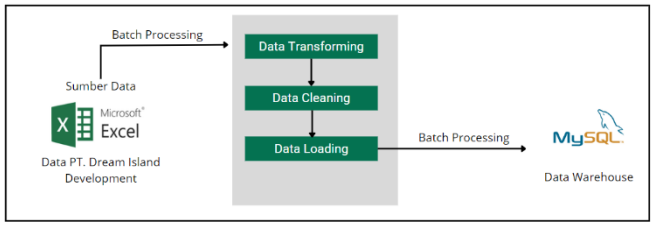

Figure 2. ETL (Extract, Transform, Load) Process of Information System Project

The figure above is the Extraction, Transformation, Loading (ETL) process. Excel data is entered into the google data studio data reader then the data cleaning stage is carried out, data cleaning is carried out on empty data rows in the worksheet. The next stage is the data transforming stage, which is changing the form of data according to the needs of dashboard visualization such as changing the date. After the transformation process is carried out, then the data is stored (loading) in the data warehouse. The process of data flow from the source to the data warehouse is carried out by batch processing, namely data integration processing at a certain period. The entire series of data flow ETL processes from the source to the data warehouse uses the Google Data Studio application.

Data Warehouse Architecture

Data warehouse design is a stage in preparing a data warehouse into a data warehouse. In this study, the data warehouse was built using the Kimball Nine Step method. At the stage of determining the physical design that will be used in this data warehouse is a star schema.

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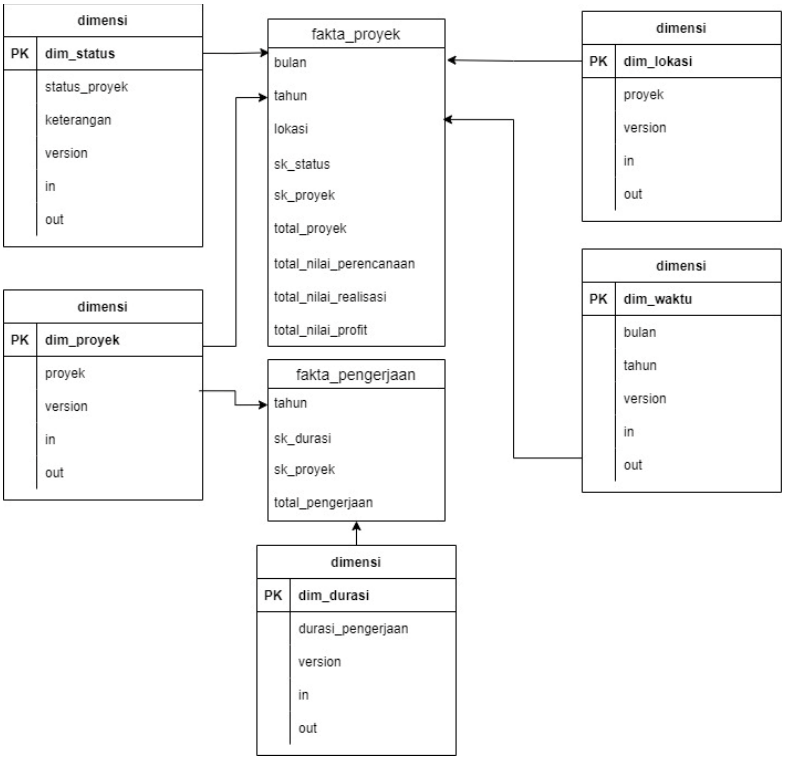

Figure 3. Data Warehouse Schematic

User Acceptance Test (UAT)

The User Acceptance Test (UAT) was designed based on four quality characteristics defined in the ISO/IEC 25010:2011 software product quality model: functionality, reliability, usability, and performance efficiency. Each question in the UAT questionnaire corresponds to these characteristics to ensure the system meets international software validation standards. The UAT table uses a five-point Likert scale consisting of: Strongly Agree (SA), Agree (A), Somewhat Agree (SWA), Disagree (D), and Strongly Disagree (SD).

Table 1. UAT Testing Questions

Aspects	Question	SA	A	SWA	D	SD
Functionality	The project visualization system is easily accessible through the specified platform.					
	Navigation between sections/menus in the project visualization system is intuitive and easy to understand.					
	Interactive elements on the visualization (e.g., tooltips, drill-downs) function as expected.					
	Detailed information for each project is easily accessible and clearly displayed.					
Reliability	Visualized project data is accurate and in line with existing data sources.					
	The visualization system responds quickly when interacting with data and visualizations.					
	The information presented in the visualization is relevant to PT DID's project monitoring needs.					
Usability	The main dashboard presents a clear and concise summary of important project information.					
	The graphs and diagrams displayed are easy to read and understand.					
	The appearance and visualization style is consistent throughout the system.					
	Additional information or explanations (if any) on the visualization helps in understanding the data.					

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	Overall, this project visualization system is useful for monitoring and understanding the development of PT DID projects.	
Efficiency	The visualization system responds quickly when interacting with data and visualizations.	
	Project information (e.g. progress, planning value, realized value and profit value are visualized effectively.	
	The project data filter and sort features work well and make it easy to find relevant information.	

RESULT

This research produces a project data visualization system built with data warehouse integration and Google Data Studio as an interactive reporting medium. The data used is the project data of PT Dream Island Development (PT DID) during the period 2022-2024, especially those related to the Bill of Quantity (BoQ) and Time Schedule (TS). The results of the system implementation consist of four main types of visualization:

Home Page Dashboard

Dream Island Development's data visualization home page provides a concise overview of the company's project performance. Key information is summarized in several key metrics, including total project value, total budget planning value, total costs incurred, and total number of projects. These figures provide an overview of the scale and activity of the company's projects. For more in-depth analysis, a table presents a breakdown of each project, including name, year of implementation, planned budget value, actual costs incurred, and estimated profitability. This data allows users to evaluate the financial performance of each project individually. The data visualization aspect is enhanced by two types of charts. First, pie charts illustrate the proportion of profit generated by different project categories, highlighting the largest profit contributors. Secondly, horizontal bar charts present a direct comparison between budget planning values and actual costs for recent years, facilitating the identification of budget efficiency trends over time. An additional feature available is a filter that allows users to filter data based on the year of project implementation and specific project names. The combination of summarized numerical data, project details in tabular form, visual representation through graphs, and filter features aims to provide stakeholders with an easily accessible understanding of PT Dream Island Development's project performance, thus supporting more informed decision-making. The design of the savings page can be seen in Figure 4.105.

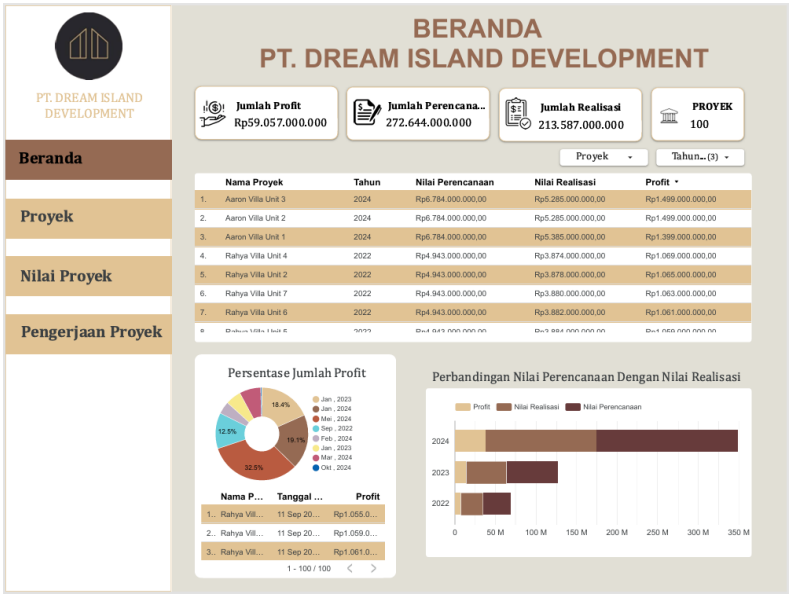

Figure 4. Project Home Page

Project Page Dashboard

The projects page of the PT Dream Island Development data visualization presents detailed information on project status and performance. At the top, a summary of the project value, planning, realization, and number of projects is again displayed as general context. A visual indicator in the form of a progress circle shows the "Percentage of Completed Projects," which in this view shows 100%. The distribution of projects by location is

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visualized through a pie chart in the "location" section where the proportion of projects in various locations such as Canggu and Kutuh can be easily seen, supported by a detailed table of project names and locations. Furthermore, a series of line graphs present the trend of project performance over time in terms of project duration, number of projects by month of commencement and number of projects by month of completion. These graphs allow observation of how the duration, number of projects evolve over time. Overall, this page is designed to provide a clear understanding of the geographical spread of projects and their performance trends in various important metrics.

In addition to the visual information and data summaries already described, the project page also comes with an interactive filter feature. the year filter feature allows users to focus the data view on projects implemented or completed within a specific year range. With this filter, analysis of performance trends (duration, value, completion status) can be done specifically for the relevant time period. For example, users can select the year 2022 to see how projects performed in that year.

project filter feature gives users the ability to select specific projects by name. This is particularly useful if users want to see performance details or compare metrics between specific projects. By selecting one or more project names from the filter list, the graph and table views will update only for the selected projects.

Finally, the location filter feature allows users to limit the data display to only those projects located in a specific location, such as Canggu or Kutuh. This filter is very helpful in analyzing project performance by geographic area and understanding potential performance differences between locations.

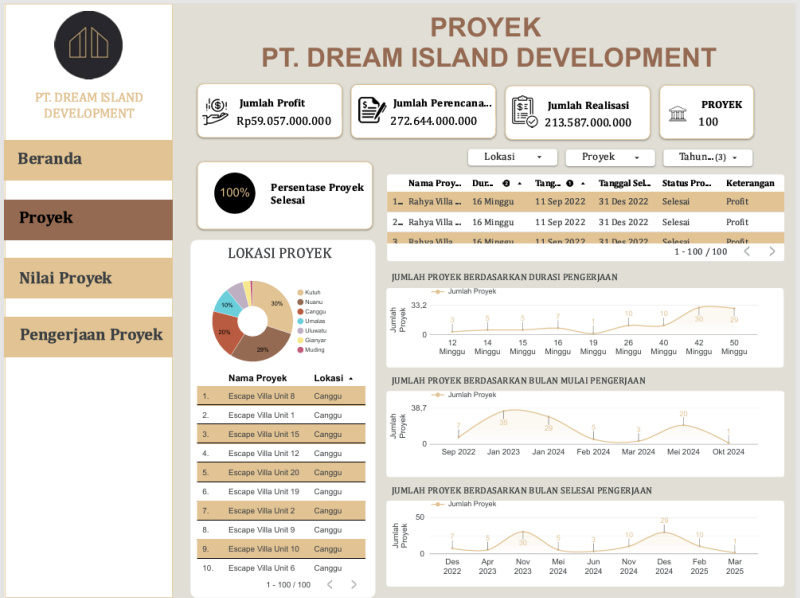

Figure 5. PT. DID Project Page

Project Value Dashboard

The project value page of the PT Dream Island Development data visualization presents information related to the financial value of the project. At the top, the summary of project value, planning value, realized value and number of projects are again displayed as the main context. The main graph on this page is a comparison graph of planning value, realized value and project profit. It is a line graph that displays the trend over time (from December 2022 to March 2025) for all three metrics. The different lines show the planning value, realized value, and project profit. With this graph, users can analyze how these three values evolve over time and see the relationship between them, for example whether the realization matches the planning or how the project profitability trends

Below the main graph, there are three pie charts showing the percentage of planning value, percentage of realized value, and percentage of profit by project, respectively. Each slice in the pie chart represents the contribution of planning value, realized value, or profit from different projects. Below each pie chart, there is a table that details the project name and its planning value, realized value, and profit numerically, according to the visual representation on the chart. Just like the project page, this project value page also comes with a year filter feature and a project filter feature. The year filter will allow users to limit the display of graphs and pie charts to only the project data in the selected year, making it easier to analyze the trend of project value in a certain period of time. The project filter will allow users to select specific projects, so that the graphs and charts only display data for the selected projects, allowing for focused comparison of financial values between projects. This combination

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of trend charts, proportion charts, and filter features aims to provide an in-depth understanding of the financial aspects of PT Dream Island Development's projects.

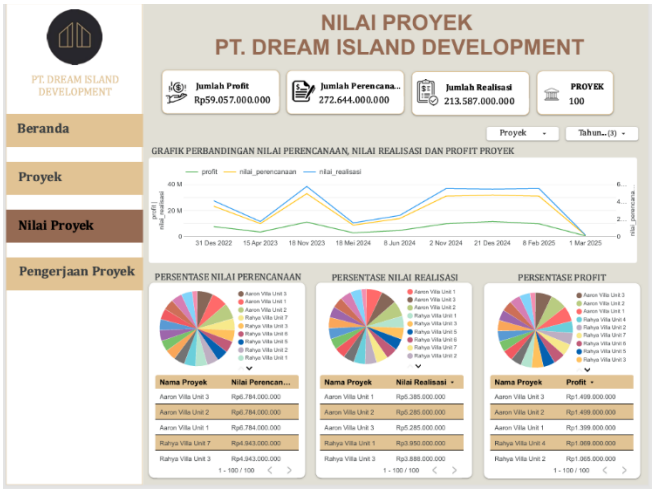

Figure 6. Project Value Page

Dashboard Project Work Page

The project work page on PT Dream Island Development data visualization presents detailed information about the status and progress of project work. At the top, there is a filter to select a specific project, in this case it can be seen that the project "Aaron Villa Unit 1" is being selected. Below the project filter, there is a summary of important information such as the duration of work (12 weeks), percentage of work (100%), project start date (Mar 17, 2024), and estimated completion date (Jun 8, 2024). This information provides a quick overview of the timeframe and completion status of the selected project.

The Sankey diagram on the left side provides information about the progress of the project from week to week visually. The thickness of the flow on the Sankey diagram can be interpreted to see how the progress weight changes over time. The thickest flow leading to a particular week will indicate that the project progress has the greatest value in that week. Conversely, the thinnest flow towards a given week will indicate that the project progress has the least value in that week. By looking at the changes in flow thickness from one week to the next, users can quickly identify periods where the project is experiencing a significant acceleration in progress or a slowdown.

On the right side of the page, there is a more detailed table of the project work schedule. This table has columns "Date" and "Progress_Week". Each row in the table shows a specific date and the percentage of project progress in that week. This table provides a breakdown of the project's progress over time, allowing users to see how progress is increasing each week.

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Figure 7. Dashboard Project Work Page

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Research Findings

An in-depth analysis of PT Dream Island Development's project data visualization system revealed some significant research findings that have implications for construction project management, particularly in the context of digital adaptation and data-driven decision-making.

1. Project Dashboard Page
    a. Efficiency of Macro Performance Information Access: The home page effectively provides a summary of key metrics (total project value, total budget planning value, total costs incurred, and overall project amount). This data integration facilitates a quick understanding of the scale and activity of the company's project portfolio, supporting early strategic decision-making by stakeholders.
    b. Improved Transparency and Financial Accountability of Individual Projects: Detailed project tables, which include name, year of implementation, planned budget value, actual costs, and estimated profitability, are an important instrument for transparency. It enables evaluation of individual project financial performance, measures accountability, and formulates timely interventions.
    c. Identify Strategic Profitability Contributors: A pie chart visualization depicting the proportion of profit by project category intuitively highlights the most profitable project segments. These findings are fundamental for optimal resource allocation and development of business strategies that focus on areas with the highest profit potential.
    d. Historical Budget Efficiency Trend Analysis: A horizontal bar chart comparing budget planning values and actual costs in recent years enables identification of budget efficiency trends. This provides insight into whether the company consistently meets, exceeds, or saves on budget, facilitating the formulation of cost-saving policies and improvement of future estimates.
    e. Early Analytical Flexibility Through Filtering: The implementation of filters based on year of execution and project name on the home page increases analytical flexibility. This allows stakeholders to pre-screen data, supporting more specific data exploration from the overview stage.

2. Project Page Dashboard
    a. Instant Validation of Project Completion Status: The visual indicator “Percentage of Projects Completed,” which displays 100% in this case, provides quick and clear validation of the company's capability to complete projects. This is a key performance metric that users can immediately perceive.
    b. Comprehensive Insight into the Geographic Distribution of Projects: A pie chart visualizing the distribution of projects by location (e.g., Canggu, Kutuh), supported by a breakdown table, offers an in-depth understanding of the geographical spread of project activities. This information is vital for expansion planning, regional resource allocation, and site-specific market analysis.
    c. Time-Based Project Performance Trend Analysis: A series of line graphs presenting trends in project work duration, number of projects by month started, and number of projects by month completed enables identification of patterns and trends in project time and volume management. These findings support schedule optimization, capacity planning, and risk mitigation.
    d. Supports Deep Analytical Flexibility: Interactive filter features by year, project, and location significantly enrich analysis capabilities. These filters allow users to: Perform historical performance analysis on specific time periods. Explore performance details or compare metrics between individual projects. Analyze project performance by geographic area, identifying performance differences and unique challenges between locations.

3. Dashboard Project Value Page
    a. Integrated Financial Trend Analysis: A line graph comparing planning value, realized value, and project profit over time (December 2022 to March 2025) is a key element. It enables analysis of the dynamic relationship between budget estimates, actual expenditures, and profitability, providing the basis for improved financial planning and monitoring processes.
    b. Identify Specific Project Value and Profitability Contributors: Three pie charts showing the percentage of planned value, realized value, and profit by project, complemented by a numerical table, effectively identify the projects that contribute most significantly to the respective financial metrics. These findings are essential for investment strategy, portfolio optimization, and replication of project success.
    c. Filtering for Focused Financial Analysis: The year and project filter features are particularly valuable on this page. Year filters facilitate trend analysis of project values over a period of time, while project filters enable focused financial comparisons between specific projects. This supports more granular and evidence-based financial decision-making.

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4. Dashboard Project Delivery Page
   a. Focus Analysis on Individual Projects: The presence of filters for specific project selection (e.g., "Aaron Villa Unit 1") indicates a dashboard design that enables in-depth analysis at the individual project level. This is crucial for project managers and operational teams who need granular information on progress.
   b. Streamlined and Quantitative Project Status Summary: Providing a summary of key information such as duration of work, percentage of work, start date, and estimated completion date provides a quick overview of the timeline and completion status of selected projects, supporting proactive decision-making regarding schedules and resources.
   c. Dynamic Visualization of Progress Through Sankey Diagrams: The use of Sankey Diagrams to visualize the week-to-week progression of project progress is an innovative methodological finding. The thickness of the flow indicating the weight of progress allows for quick identification of periods of significant acceleration or deceleration, providing insight into the dynamics of project work.
   d. Quantification of Weekly Progress in Tables: Detailed tables that include "Date" and "Progress_Week" complement Sankey's visualizations with quantitative data. This enables visual data verification and detailed tracking of weekly progress improvements, supporting accurate reporting and monitoring.

User Acceptance Test (UAT)

The test results use the user acceptance test (UAT) testing method. This test involved 10 people from PT DID.

Table 2. UAT Testing Results

UAT Highest Score	Number of questionnaires*number of respondents*highest score of questionnaire (15*10*5 =750)
Strongly Agree (SS)	5 x 104 = 520
Agree (S)	4 x 39 = 156
Moderately Agree (CS)	3 x 8 = 24
Disagree (TS)	2 x = 0
Strongly Disagree (STS)	1 x = 0
Total	520 + 156 + 24 = 700
Percentage	$\frac{700}{750}$x 100 % = 93,33%

Based on the results of the user acceptance test (UAT) conducted at PT Dream Island Development, it can be seen from the percentage table of UAT test results that the system built at PT Dream Island Development received an assessment in terms of overall aspects strongly agreeing with a percentage of 93.33%, which means that this sales data visualization is in accordance with the needs of PT Dream Island Development.

DISCUSSIONS

The results of the system development show that the integration of the data warehouse with Google Data Studio is able to address the initial problem faced by PT DID in presenting project data. Previously, project data was only available in Excel tabulations, requiring 6-8 days for reprocessing and being difficult to interpret. The implementation of an interactive dashboard has significantly accelerated data access, improved clarity of presentation, and enabled real-time reporting, thereby supporting timely decision-making.

In terms of fulfilling user needs, the system successfully meets key functional expectations, as evidenced by the UAT results. All indicators related to functionality, usability, reliability, and efficiency achieved high user satisfaction scores (above 90%). Project cost visualization allows management to easily monitor deviations between planned and actual values. The weekly progress dashboard enables early detection of delays. The geographic distribution of projects is now visible through spatial visualizations, facilitating better resource allocation. Financial dashboards effectively represent profit and budget performance, helping stakeholders evaluate project viability.

However, several limitations remain in the current system. First, the dashboards are designed primarily for descriptive and diagnostic analysis but do not yet include predictive analytics (e.g., forecasting delays or cost overruns). Second, the system does not utilize AI-based recommendation features or machine learning to support decision-making, such as suggesting corrective actions based on historical patterns. Third, the dashboard operates as a standalone platform and has not yet been integrated into the broader enterprise systems such as ERP, which limits seamless automation with procurement, finance, and HR data.

In light of these constraints, future development could include the integration of advanced analytics modules using machine learning models to predict project risk or profitability. Furthermore, enhancing the system with AI-driven anomaly detection could provide automatic alerts for performance deviations. Another strategic direction is to link the dashboard system with the company's ERP, creating a unified, real-time project management

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ecosystem that spans from planning to execution and reporting. These improvements will not only strengthen operational intelligence but also position the system as a scalable and adaptive BI solution for the construction industry.

CONCLUSION

This research successfully designed and built a project data visualization system at PT Dream Island Development using the Google Data Studio (Looker Studio) platform, supported by a data warehouse architecture developed through Kimball's Nine Step methodology. The ETL process was implemented using Pentaho Data Integration to process Bill of Quantity and Time Schedule data for projects during the 2022–2024 period. The resulting system comprises four main dashboards presenting project summaries, detailed project views, project values, and implementation progress. The system delivers data in an interactive, real-time, and easily comprehensible format for executive-level decision-makers. System testing through the User Acceptance Test (UAT) involving ten internal PT DID users demonstrated a very high level of satisfaction across all evaluated aspects: functionality (93.5%), reliability (91.33%), usability (96%), and efficiency (94.66%). These findings indicate that the system effectively meets user needs, enhances reporting efficiency, and supports more responsive, data-based decision-making processes. This study validates the applicability of the Kimball method in real-world construction projects using modern BI tools, contributing to the applied informatics literature, especially in the context of construction management in Indonesia. Future research is encouraged to explore the integration of real-time automation, security enhancements through data encryption and monitoring, and predictive analytics modules for early detection of risks and data-driven recommendations. These additions are expected to increase the system's intelligence, scalability, and strategic value for broader adoption in the construction industry.

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