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FOREWORD

Greetings!

Ultima InfoSys : Jurnal Ilmu Sistem Informasi is a Journal of Information Systems which presents scientific research articles in the field of Information Systems, as well as the latest theoretical and practical issues, including database systems, management information systems, system analysis and development, system project management information, programming, mobile information system, and other topics related to Information Systems. ULTIMA InfoSys Journal is published regularly twice a year (June and December) by Faculty of Engineering and Informatics in cooperation with UMN Press.

In this June 2024 edition, ULTIMA InfoSys enters the 1st Edition of Volume 15. In this edition there are ten scientific papers from researchers, academics and practitioners in the fields covered by Ultima Infosys. Some of the topics raised in this journal are: Evaluating Banking Sector Stock Values: Relative and Absolute Valuation Approach in LQ 45, 2015-2020; Measurement of Information Technology Management Capability Using COBIT 5.0 in The Facility Management Department of PT Permata Graha Nusantara; A Bibliometric Analysis of The Term DataOps; Enhance the User Interface Design of the booking application at Rana Photo Studio by applying the User-Centered Design (UCD) method; Evaluating IT Capabilities in The Success of Pipe Manufacturing Company; Stakeholder Analysis Using The Enhanced Salience, Power-Interest, and Stakeholder Cube Diagrams; Utilization of Game Techniques as a Test Tool to Measure Persistence of Applicants; Usability Evaluation of Ticket Purchasing Applications, Case Study Public Railways in Indonesia; Using the Scrum Method to Develop Population Information System; and Enhancing Sales Strategies In Prime Market Retail Business Using Tuned Gradient Boosting.

On this occasion we would also like to invite the participation of our dear readers, researchers, academics, and practitioners, in the field of Engineering and Informatics, to submit quality scientific papers to: International Journal of New Media Technology (IJNMT), Ultimatics : Jurnal Teknik Informatics, Ultima Infosys: Journal of Information Systems and Ultima Computing: Journal of Computer Systems. Information regarding writing guidelines and templates, as well as other related information can be obtained through the email address ultimainfosys@umn.ac.id and the web page of our Journal here.

Finally, we would like to thank all contributors to this June 2024 Edition of Ultima Infosys. We hope that scientific articles from research in this journal can be useful and contribute to the development of research and science in Indonesia.

June 2024,

Wella, S.Kom., M.MSI.
Editor-in-Chief

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Evaluating Banking Sector Stock Values: Relative and Absolute Valuation Approach in LQ 45, 2015-2020

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Abstract— **Investment in Indonesia during the COVID-19 pandemic increased. One of the significant and good indices in describing the condition of stocks in Indonesia is LQ45. Dlaam LQ45 The largest market capitalists are held by the financial sector Specifically the bank subsector therefore it needs to be further researched regarding these stocks. One of the interesting things is whether these stocks deserve to be considered a good investment instrument. One of the efforts to assess investment instruments is through the valuation stage. The valuation method used there are two, namely relative valuation with price to book value benchmarks and price earnings ratio and absolute valuation with dividend growth model method and some modifications of the model. From the results obtained, the recommendation of the position of the four financial stocks in LQ45 varies depending on the valuation technique used. Given this, it is imperative to understand and ensure that the valuation techniques employed are appropriate, sound, and ethically grounded.**

Index Terms—**DDM, PER, PBV, Stock, Time Series**

I. INTRODUCTION

The COVID-19 pandemic is a bad thing and disrupts economic performance almost all over the world, not least in Indonesia. As for the phenomenon of "Force Corona" stock players increasing, this can be seen from the number of investors in the Indonesian Capital Market throughout 2020 consisting of stock, bond, and mutual fund investors, increasing by 56 percent to reach 3.87 million Single Investor Identification (SID) until December 29, 2020. This increase in investors is 4 times higher since the last 4 years than 894 thousand investors in 2016. In addition, stock investors also rose by 53 percent to a total of 1.68 million SID. Then, when viewed from the number of daily active investors, until December 29, 2020 there were 94 thousand investors or up 73 percent compared to the end of last year. The increase in the number of investors and daily investor transaction activities is certainly the result of the efforts of the Financial Services Authority (OJK) together with the Self-Regulatory Organization (SRO) in prioritizing socialization and education related to investment in the capital market to the community. Along with the increasing participation of domestic retail investors, a record new trade transaction was achieved in 2020, which is the highest daily transaction frequency of shares on December 22, 2020 as many as 1,697,537 transactions.[1]

For reference, the Indonesia Stock Exchange has several benchmark indices such as the composite stock price (JCI) which measures the price performance of all stocks listed on the Main Board and Development Board of the Indonesia Stock Exchange and LQ45, an index that measures the price performance of 45 stocks that have high liquidity and large market capitalization and are supported by good company fundamentals. Shares in LQ45 consist of several sectors and sub-sectors, one of which is financial. As illustrated in Fig. 1, 42.5% of LQ45's weight comes from the financial sector while 4 of the 6 largest stocks with the largest capitalization in LQ 45 come from the financial sector, namely the banking sub-sectors respectively, namely BBRI, BBCA, BMRI, and BBNI [1].
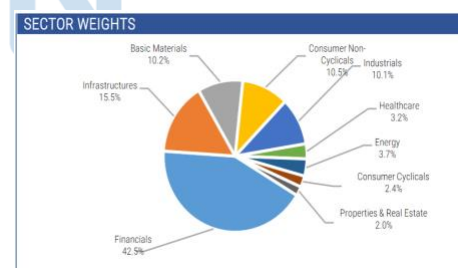
Fig. 1. LQ45's Sector Weights

With a large capitalization and reaching 596.7 trillion Rupiah, the financial sector specifically the banking subsector is very interesting to review. This sector should be a very attractive sector for investors to be interested in. To determine whether the stock is worth buying, there are many ways that are done such as technical analysis and fundamental analysis.

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[1] https://www.idx.co.id/berita/press-release-detail/?emitenCode=1444

The COVID-19 pandemic's impact on global financial markets has necessitated a reevaluation of stock valuation methodologies. Studies such as Berkman and Malloch [2] highlight the importance of adapting valuation models in response to market changes during the pandemic. The ramifications of COVID-19 were felt across various sectors, significantly impacting economies and stock markets as detailed by the OECD [3] and Jabeen et al. [4].

He et al. [5] and Ramelli and Wagner [6] further illustrate the pandemic's profound impact on global financial markets, underscoring the challenges faced by investors and analysts in market valuation during this period. This global context sets the stage for a focused examination of the Indonesian financial sector, particularly the banking stocks within the LQ45 index, during these tumultuous times.

For fundamental analysis, one of the things to note is the financial ratio that can be reflected in the financial statements. Of the many financial ratios and data in the financial statements, all data can be processed in such a way that it can judge a stock is worth buying or not. The process of being able to assess an investment instrument is worth or not purchased is called valuation. In this case it is called the valuation of the stock because the financial instrument to be reviewed is the stock.

For the stock valuation process, it can be divided into 2 large parts, namely absolute valuation and relative valuation. Relative valuation is the valuation of shares based on other stocks that are one sector so that the position of the competitor can be seen, who is the best. As for the absolute valuation, the intrinsic value of the stock will be seen so whether it is worth it or not.

Prior research, such as Leong et al. [7], has explored stock valuation theories in banking, showing models like P/E multiples closely correlate with actual stock prices. However, there's limited research on these valuation methods in the Indonesian banking sector during economic challenges like the COVID-19 pandemic. This study addresses this gap, focusing on the valuation of banking stocks in Indonesia's LQ45 index.

In this study, the four banking stocks with the largest market capitalization will be evaluated using both relative valuation and absolute valuation. The hope is that with the results obtained, investors can make the right decisions based on data. Thus, research will be conducted on the stock valuation of BBCA, BBRI, BBNI, and BMRI based on absolute and relative valuation.

II. Literature Review

A. Stock Valuation

Stock valuation can be defined as a method of being able to calculate the fair value of a stock. Fair value of a stock is often referred to as intrinsic value, which is the value of stock which is considered to represent the performance of a company in real terms. Stock valuation is more needed by active investors than passive investors because passive investors only need a minimal process. For long-term active investors, you need a smaller business to sell stocks than market timers. In the field of portfolio management stock valuation is an important role in fundamental analysis and little in technical analysis [8].

Three key values are commonly used when assessing a company: market value, book value, and intrinsic value. Market value is the current stock price influenced by supply and demand. Book value reflects a company's financial position based on accounting records. Intrinsic value, determined through comprehensive analysis, serves as a benchmark for making investment decisions [9].

Decision-making based on stock valuation can result in 3 types of conclusions, namely undervalued, overvalued, and par valued. If the intrinsic value is more than the market value, then it can be concluded that the stock is undervalued whereas if the intrinsic value is less than the market value then the stock is overvalued. The last thing that may happen is that the intrinsic value is equal to the market value called fair valued [10].

In the banking sector, stock valuation is crucial for investors seeking stability and long-term performance. Pastor and Pietro [11] emphasize its importance in identifying potential gains while managing overvaluation and undervaluation risks. Their study highlights the role of profitability in stock valuation.

B. Dividend Discount Model

Dividend Discount Model (DDM) is a method of devaluing a stock's price based on the theory of whether the stock is worth buying based on the sum of the entire dividend payment withdrawn to its current value. In other words, the valuation of this stock uses the Net Present Value of future dividends. The most commonly used method is the Gordon Growth Model [12].

$$V = \frac{D}{k_e - g} \qquad (1)$$

where

D: dividends paid at the 1st time

g: stock growth rate

k_e: interest rates that investors expect

In addition, the version of the method modified based on the period and value of the stock in a given period is called the Adjusted Dividend Growth Model. This method takes the present value of the stock price in the nth year and the amount of the entire dividend paid up to the n-th year [12]. Mathematically it can be written with

$$V = \frac{Div_1}{(1 + k_e)} + \frac{Div_2}{(1 + k_e)^2} + \cdots + \frac{Div_n + Price_n}{(1 + k_e)^n} \quad (2)$$

where

Div_q: dividends paid at the q st time

$Price_n$: stock price in the nth period

k_e: interest rates that investors expect

Specifically, k_e or more commonly known as the Cost of Capital. Cost of capital is the niaya needed by a company to get capital from the company itself. One way to calculate the Cost of Capital can be calculated through, namely the weighted average cost of capital which comes from the proportional amount between the Cost of Debt and the Cost of Equity. Cost of Equity obtained from CAPM (Capital Asset Pricing Model) with mathematical model WACC [13].

$$\sum R_i = R_{f} + \beta_i (R_m - R_f) \quad (3)$$

where

R_i = cost of equity i-th emitent

R_f = Risk free rate

β_i (beta) = Non- diversifiable risk from the i-th emitent

R_m = Market Return

C. Time Series

A time series $\{Y_t\}$ can be said with the ARIMA model (p, d, q) if the difference to d can be expressed in $\nabla^d Y_t = W_{it}$ which is the autoregressive moving average (ARMA (p, q)) which is stationary for the i-th subject with:

p: states order of autoregressive

d: states how many times it is necessary to decrease (differentiation) on the time it takes from $W_{i,t}$ to be stationary

q: indicates an error of the delayed prediction in the predicted equation obtained

Thus, the general equation of this prediction would be:

$W_{i,t} = \phi_{i,1} W_{i,t-1} + \phi_{i,2} W_{i,t-2} + \ldots + \phi_{i,p} W_{i,t-p} + e_{i,t} - \theta_{i,1} e_{i,t-1} - \theta_{i,2} e_{i,t-2} - \ldots - \theta_{i,q} e_{i,t-q}$

To be able to determine a suitable ARIMA model, d must be selected first to be able to get an average time series and stable variance [14].

This process of differencing, as discussed by Box and Jenkins [15], is instrumental in achieving stationarity, making it easier to identify and model underlying patterns and trends within financial time series data.

III. DATA AND METHODOLOGY

In this study, financial data from 2015 to 2020 for four leading banks in the LQ45 index of the Indonesia Stock Exchange were analyzed. This data, including financial statements and ratios, was sourced from the Indonesia Stock Exchange's official website, Yahoo Finance, and S&P Platform. These banks were selected based on their notable market capitalization and liquidity within the LQ45, highlighting their importance in the Indonesian banking sector. Additionally, their significant role in the index and the financial sector makes them key subjects for understanding investment dynamics in Indonesia, especially during challenging economic periods such as the COVID-19 pandemic.

In a flowchart, this study can be described as follows:
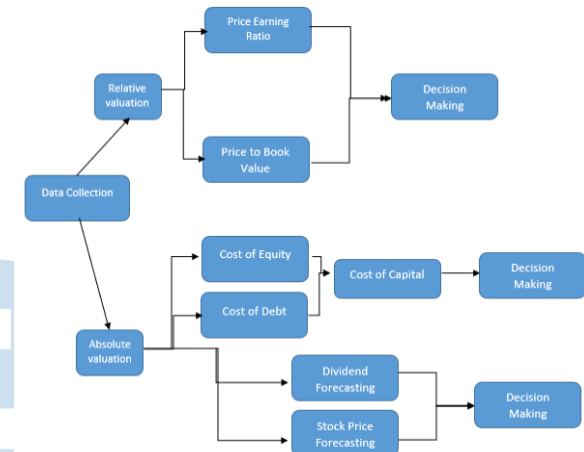
Fig. 2. Flowchart

IV. RESULTS AND DISCUSSION

A. Absolute Valuation

Based on the data obtained, the financial data of these 4 banking companies will be processed based on the results available in 2004-2020. For Absolute Valuation itself will be used 1 model, namely Dividend Discounted Model (DDM) with 3 model modifications namely Dividend Discounted Model: Gordon Growth Model (DDM GGM), Adjusted Dividend Discounted Model with Exponential Smoothing approach and Adjusted Dividend Discounted Model with time series approach.

In accordance with the definition, DDM will basically calculate the valuation of the stock based on the dividend price given in the first year and see the comparison with the difference in the rate desired by the investor (k_e) as well as the growth rate of the stock (g). The dividend growth rate is taken from historical dividend growth data. k_e is a Cost of Capital which is the sum of the Cost of Equity and the Cost of Debt. Cost of Debt taken from Interest expenses and Cost of Equity (COE) is assumed to be calculated by CAPM (Capital Asset Pricing Model). Interest Expenses can be directly accessed through recapitulation of data on financial statements but for COE it takes some other data, namely R_f (Risk free rate) is assumed to come from State Bonds, Non-diversifiable risk (β) taken from secondary data, and R_m (Market Return) taken from the rate of return on JCI throughout 2015-2020.

1) Dividend Discounted Model: Gordon Growth Model (DDM GGM)

From the results obtained, it was found that:

TABLE I. DDM GGM RECAPITALTION

	BBNI	BMRI	BBRI	BBCA
Average k_e	0,03996	0,039105	0,043073	0,031296
Average g	0,10	0,22	0,22	0,29
Valuasi	-3537,229	-1939,297	-938,215	-2152,814

From this table it is obtained that all valuation results are negative and less than the existing market price (market value). It can therefore be said that based on the gordon growth type dividend discounted model, these four stocks are **overvalued** and not worth buying.

2) Adjusted Dividend Discounted Model: pendekatan Exponential Smoothing

Based on the definition of adjusted dividend discounted model, the stock price in the 19th year along with the amount of all dividends paid up to the n-th year will be seen in value in the current period. The value of the stock in the nth year is predicted using exponential smoothing with data from July 2004 to December 2020.

There will be 2 things that are predicted, namely dividend growth and stock price. Each price will have a forecast, lower confidence, and upper confidence.
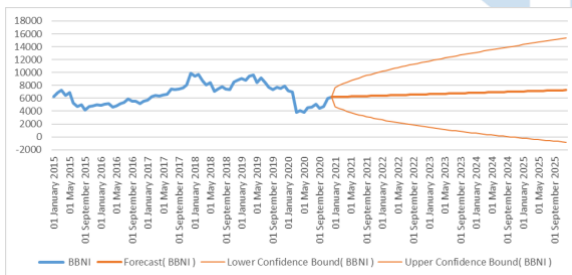
Fig. 3. BBNI Stock Price Prediction
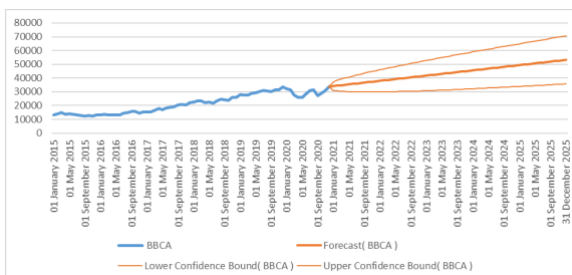
Fig. 4. BBCA Stock Price Prediction
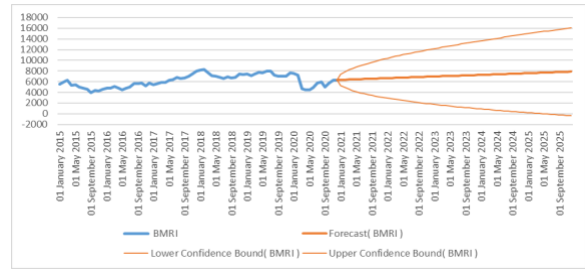
Fig. 5. BMRI Stock Price Prediction
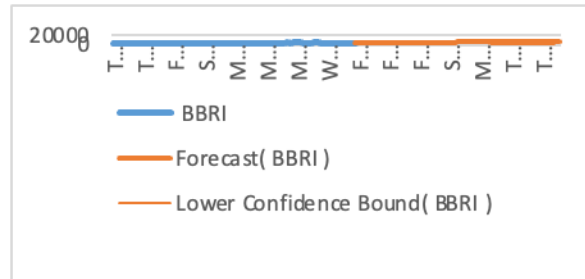
Fig. 6. BBRI Stock Price Prediction

For dividend growth will also be predicted, because using the same technique (exponential smoothing) then the output obtained includes prediction / forecast, lower limit, and upper limit.

Fig. 7. BBNI Dividend Growth Prediction
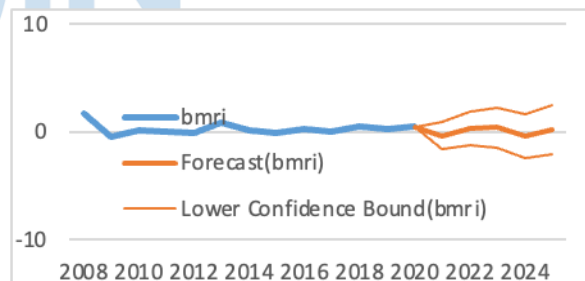
Fig. 8. BMRI Dividend Growth Prediction
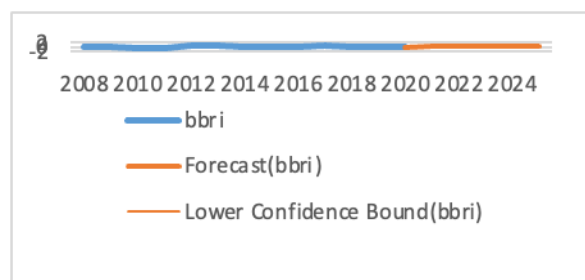
Fig. 9. BBRI Dividend Growth Prediction
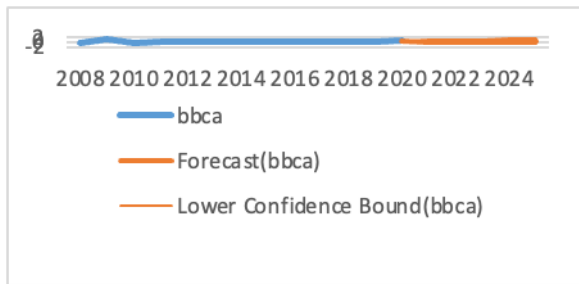
Fig. 10. BBCA Dividend Growth Prediction

From the results of predictions that have been obtained will be processed with the following results:

TABLE II.   ADJUSTED DIVIDEND GROWTH MODEL RECAP WITH EXPONENTIAL SMOOTHING

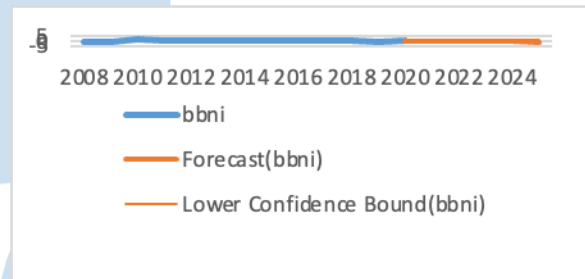|	BBNI	BMRI	BBRI	BBCA
Stock Price in 2020	6175	6325	4170	33850
Dividend in 2021	358,182 84	528,216 90	231,316 44	861,433 80
Dividend in 2022	510,124 60	703,092 10	294,430 70	1169,86 761
Dividend in 2023	662,066 37	877,967 29	357,544 95	1478,30 141
Dividend in 2024	814,008 13	1052,84 249	420,659 21	1786,73 521
Dividend in 2025	965,949 89	1227,71 768	483,773 46	2095,16 901
Expected stock price (best case): Exponential smoothing on 2025	15344,6 8662	16096,7 758	10462,6 2933	70601,6 1681
Expected stock price (worst case): Exponential Smoothing on 2025	- 823,251 1629	- 350,321 0435	3096,80 5429	35760,6 4209
Best Valuation price with adjusted multistage discounted divident model with divident growth increasing	17445,3 5944	19955,3 3858	12017,2 3167	77260,1 1359
Worst Valuation price with adjusted multistage discounted divident model with divident growth increasing	2071,52 2032	3508,24 1733	4651,40 7768	42419,1 3887

From Table II, it is inferred that BBRI and BBCA are undervalued, suggesting they may represent attractive investment opportunities at both the best and worst-case scenarios. Conversely, BMRI and BBNI appear overvalued in the worst-case scenario,

implying potential investment risks. In the best-case scenario, however, they too are undervalued, highlighting a possible market mispricing. The implications of these findings are crucial for investors seeking to optimize their portfolio in the Indonesian banking sector, as they suggest a strategic approach to buying or selling these stocks based on the different valuation outcomes presented.

3) Adjusted Dividend Discounted Model: pendekatan Time Series

In accordance with its definition, adjusted dividend discounted model with a real time series approach In financial science is the same as adjusted dividend discounted model with exponential smoothing approach. The difference is the approach of predicting the stock price based on the time series. This approach can be said to be one of the best approaches because the nature of the stock price time series data is a random walk, which means that the stock price in the t-th year is influenced by the stock year t-1. From the results obtained below is the time series model obtained.

TABLE III.   RESULTS OF VALUATION RECAPITULATION WITH ADJUSTED DIVIDEND GROWTH MODEL BASED ON PENDEKATAN TIME SERIES

	BBNI	BMRI	BBRI	BBCA
Obtained models	*ARIMA (0,1,0)*	*ARIMA (0,1,1)*	*ARIMA (0,1,0)*	*ARIMA (0,1,0)*
Stock price prediction in 2025 (best case)	9525,77 9832	8770,25 9724	5425,98 682	38739,1 8596
Stock price prediction in 2025 (worst case)	1624,22 0168	3162,90 2178	2674,01 318	25460,8 1404
Best Case Valuation scenario: time series	9975,70 8737	11632,7 7862	7304,06 467	45815,0 451
Worst Case Valuation scenario: time series	2074,14 9073	6025,42 1073	4552,09 1031	32536,6 7318

The valuation analysis in Table III suggests BBRI remains undervalued across both best and worst-case scenarios, indicating a consistent investment opportunity. In contrast, BBCA, BMRI, and BBNI are projected to be overvalued in the worst-case scenario, which may deter investment during uncertain market conditions. However, in the best-case scenario, these stocks are undervalued, presenting potential for growth. This dichotomy in valuation highlights the importance of market conditions on stock assessment and suggests a more nuanced investment strategy that takes into account economic forecasts and market sentiment.

B. Relative Valuation

Of the existing financial ratios, there is a lot that can be taken and used as a benchmark for valuation. Relative valuation is done by selecting sectors / sub sectors and compared. Stocks that have a better ratio (small) than the average can be said to be undervalued as well as a worse ratio relative to other stocks reflected in the average ratio in the same sector can be said to be an overvalued stock.

TABLE IV.   PBV 2015-2020 RECAPITULATIONS

	BBNI	BMRI	BBRI	BBCA	Average
PBV 2020	104,28	156,05	259,01	452,11	242,86
PBV 2019	119,49	175,06	260,99	473,50	257,26
PBV 2018	151,84	189,93	244,52	422,68	252,24
PBV 2017	187,26	223,93	266,13	411,22	272,14
PBV 2016	118,22	179,51	194,29	339,89	207,98
PBV 2015	121,78	184,36	247,66	366,92	230,18

TABLE V.   PER 2015-2020 RECAPITULATIONS

	BBNI	BMRI	BBRI	BBCA	Average
PER 2020	NM	27,45	28,16	29,40	28,34
PER 2019	10,73	12,38	14,06	26,95	16,03
PER 2018	11,47	12,43	12,65	21,81	14,59
PER 2017	13,56	16,76	13,14	20,87	16,08
PER 2016	9,06	37,65	10,53	17,44	18,67
PER 2015	10,25	9,38	10,09	17,63	11,84

Based on existing data, no PER was found for BBNI in 2020. But from the results obtained from existing data, at relative valuations, BBNI is an undervalued stock therefore worth investing in while BMRI based on PBV is an undervalued stock but based on PER the results vary. For BBRI, based on PBV varies however for PER, it is said to be an undervalued stock. For BBCA if based on PER, it is alternated from overvalued and undervalued but if based on PBV, BBCA is an overvalued stock.

V.   CONCLUSION

The valuation of shares in the largest sector on the LQ45 of the Indonesian stock exchange has been implemented with 2 approaches, namely relative valuation and absolute valuation. The results of stock recommendations from relative valuation are different from the absolute valuation method. Based on absolute valuation, BBRI is a stock that tends to be undervalued but not so for relative valuation because it varies between overvalued and undervalued depending on the ratio used. As for BBCA just like BBRI with the absolute valuation approach, it is a stock that tends to be undervalued but if with a relative valuation approach is a stock that is almost always overvalued. For BBNI through a relative valuation approach is a stock that is always undervalued but with an absolute valuation approach, it is not so and varies. And lastly, BMRI both through a relative approach and absolute valuation has varying results.

On the basis of a wide variety of methods and some of the largest stocks used as examples it can be said that the stock valuation process has a wide variety of ways and can produce different conclusions. The final decision in the investment is still held by the investor regardless of the outcome of the valuation because the valuation is only a tool to measure the intrinsic value of the stock and the position / condition of the stock compared to competitors in the same sector.

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Measurement of Information Technology Management Capability Using COBIT 5.0 in The Facility Management Department of PT Permata Graha Nusantara

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Abstract— **IT governance, overseen by a company's board of directors and executive management, plays a crucial role in ensuring that the organization's information technology aligns with and furthers its strategic goals. However, when IT governance lacks support for individual departments, it can adversely impact their functionality. Recognizing this, it becomes imperative to assess the current level of IT governance in place. This study focuses on the Facility Management Department of PT Permata Graha Nusantara, responsible for building management services. The department aims to evaluate if its existing IT system effectively supports operational activities and enhances customer service. The evaluation employs the COBIT 5.0 framework as a benchmark, testing five domains: Manage Portfolios, Manage Suppliers, Manage Quality, Manage Availability and Capacity, and Manage Problems. Each domain serves distinct purposes and objectives, measured against COBIT 5.0 standards. The results are presented in Capability Levels ranging from 0 to 5. Despite the Facility Management department setting a target of Level 4, the actual results indicate Level 3 in all tested domains. Consequently, the department must implement improvements guided by recommendations derived from the COBIT 5.0 framework to align with its desired IT governance capabilities.**

Index Terms— **Capability Level, COBIT 5.0, IT Governance**

I. INTRODUCTION

IT Governance is a responsibility of the board of directors and executive management of a company that ensures that the company's information technology supports and expands the company's strategy and goals through leadership, organizational structure and Information Technology processes [1], [2]. IT Governance is closely related to corporate governance [3]. IT governance impacts all levels of the organization, from operational management to senior and executive management, and the board of directors [4], [5]. PT Permata Graha Nusantara (PERMATA) is a subsidiary of PT Perusahaan Gas Negara located in West Jakarta and focuses on supporting the business activities of the PGN Group and companies outside the PGN Group in the form of: Facility Management (FM), Asset Management (AM), Entrepreneurial Real Estate (ERE), Developer and Archive Management. Business processes at PT Permata Graha Nusantara refer to ISO 9001: 2015, ISO 14001 standards and the Safety and Health Management System (SMK3).

The Department of Facility Management at PT Permata Graha Nusantara have goals to provide quality and excellent services in services such as: Building management services, area and office facilities, office support services, operational support services, document / archive management and maintenance services, HBB management services and inventory, Temporary Facilities services, supporting services for network operations and facilities, transportation supply services, and stationery supply services. To achieve these goals, the Facility Management Department must integrate the IT system with ongoing business processes. The ongoing IT system must be able to support operational activities and be able to provide better services to their customers. To achieve this goal, the Facility Management department wants to ascertain whether the existing IT system can provide more value to PT Permata Graha Nusantara's business portfolio for business development (Manage Portfolios), check whether supplier performance is satisfactory for the department of Facility Management operations (Manage Suppliers), ensuring the quality of the existing IT system in accordance with the expectations of the Stakeholders (Manage Quality), checking whether the existing IT system has sufficient resources for now until the future (Manage Availability and Capacity), and checking whether the IT division of the

Facility department Management can overcome problems related to IT systems (Manage Problems).

To measure the level of IT governance, standards are required to be used as a guide to make the measurement results valid [6]. Some standards that are often used to measure the level of IT governance include: ITIL (Information Technology Infrastructure Library), ISO / IEC 17799, and COBIT (Control Objectives for Information and Related Technology) [7]. This study only focuses on the deparment of Facility Management to measure the level of IT capabilities currently running using COBIT version 5 standards and questionnaires distributed to selected respondents. COBIT standards provide the most detailed information about strategies and controls in IT so they can run in line with business strategies and achieve company goals [8], [9]. From this research, PT Permata Graha Nusantara will find out the results of the pre-assessment for the ongoing IT capability level. Based on the findings from the results of the measurement of IT capability level, it produces recommendations for the IT management so that it runs along with business processes to bring the company towards better business goals.

II. THEORITICAL BASIS

A. Information System Audit Goals

Template ini there are several objectives to be achieved from information system audit. According to Gondodiyoto [10], there are 5 objectives such as:

1. Asset security, in a company that is used an information system asset such as hardware, software, and human resources. All assets must be maintained. Therefore, securing assets is one of the most important goals and must be met.

2. Maintaining data integration, in a data there are certain attributes where each attribute has a completeness that must be maintained because it is very important. This makes data integration one of the important things and is one of the objectives in conducting an information system audit.

3. System effectiveness, the next goal in conducting an information system audit is to maintain the effectiveness of the system. Therefore, information systems can be said to be effective if the information system is always available to meet user needs.

4. System efficiency, this is one of the important things to maintain the company's system so that it has adequate capacity. If the quality of the company's system decreases, management must immediately conduct an evaluation. A system can be said to be efficient what if the

system can meet user needs with the use of very minimal resources.

5. Economically, the purpose of this audit is to pay attention to the costs and benefits so that the investment results that have been made are in accordance with the costs incurred.

B. IT Governance

According to Weill [11], IT Governance is an authority and responsibility correctly in making a decision in the use of information technology in companies. Meanwhile, according to Van Grembergen [12], IT Governance is a capacity that has been determined by the board of directors, executive management, and IT management to control the entire IT strategy by ensuring the integration of business and IT companies. From the two explanations above, it can be concluded that IT Governance is a standard set by the executive branch of company that deals with standards of the authority and responsibility of IT strategies by ensuring the integration of business and IT companies. With IT Governance, the information management system within the company runs smoothly and in harmony. IT Governance allows one division to be well connected and integrated with other divisions [13]. IT Governance is a structure of relationships and processes to direct and control a company in achieving goals by providing added value when balancing risks by adapting the company's IT and business processes [15]. The relationship between IT Governance and Business Management is very important because IT Governance is the main support in carrying out business governance [15], [16].

C. COBIT

Based on information from the International Professional Association (ISACA) [17] Control Objectives for Information and Related Technologies (COBIT) is a framework developed for Information Technology (IT) management and IT governance. COBIT is known as a very popular IT governance framework and is widely used by various large companies in the world. If you dive deeper, COBIT is very complex and there are many things that are not widely known by the general public [18], [19]. COBIT 5 is the overarching business and management framework for governance and management of enterprise IT. This volume documents the five principles of COBIT 5 and defines the 7 supporting enablers that form the framework. COBIT 5 is the only business framework for the governance and management of enterprise IT [20]. COBIT 5 was published in 2012. Since then, other frameworks and standards have evolved, resulting in a different landscape. The emergence of new technological and business trends in the use of IT [21].

III. RESEARCH METHODOLOGIES

PT Permata Graha Nusantara (PERMATA) is a subsidiary of PT Perusahaan Gas Negara Tbk, located in West Jakarta. PT PERMATA was established in 2014 as a company to support the operational activities of the PGN Group. PT PERMATA engaged in the field of asset management, property development, and providing services to support operational activities. During its journey, PT PERMATA continued to grow to provide the best service for the PGN Group and expand to include several SOEs in Indonesia. The vision of the company is to become a developer of an integrated natural gas-based area that are environmentally friendly and a professional manager of Building Management and Facility Management and its derivative products. The missions of the company are provides Building Management and Facility Management services including building management, office support services, and other supporting services as well as professional asset management. Besides that, provide integrated industrial and residential areas based on natural gas energy that are clean and environmentally friendly.

A. IT Process

In accordance with the framework COBIT 5.0 and the results of consultations with the department, This selected IT process is based on the results of joint discussions with the auditee. Of the 37 processes, 5 processes were selected to be evaluated. The main factor in selecting these five processes is based on the main focus that the company is facing. These are the IT process that will be evaluated:

1. APO05 Manage Portfolios
2. APO10 Manage Suppliers
3. APO11 Manage Quality
4. BAI04 Manage Availability and Capacity
5. DSS03 Manage Problems

B. Research Method

During the research process the research method that will be used is observation, interview and questionnaire to collect the data needed and COBIT 5.0 framework to process the results of data collection. The research conducted was pre-assessment. The nature of this study is used to provide an estimate of the level of IT capability owned by the Facility Management department.

C. Data Collection Techniques

In this research there are 3 kinds of data collection techniques to get the data needed. These techniques include:

1. Observation of documentation made and managed by the company as well as field observations, during the process of collecting data-data will be monitored by the operational conditions of the department. In making observations are based on the Process Assessment Model from COBIT 5.0.

2. Interview, data collection will be done by interviewing several sources to find out the purpose of pre-assessment and choosing what domain to be tested. resource persons in the interview process are:

   1. The head of the Facility Management department, in this interview it was found that this department had obtained ISO 9001 certification and wanted to conduct an audit of the IT system used in the department.

   2. The head of the IT division of the Facility Management department, in this interview stage, gave several questions for each process chosen by the head of the Facility Management department. The number of questions asked can be seen in table 1 below:

Table 1. Number of interview questions

Process Name	Number of Questions
APO05 Manage Portofolio	8
APO10 Manage Suppliers	8
APO11 Manage Quality	9
BAI04 Manage Availability and Capacity	5
DSS03 Manage Problems	5

3. Questionnaire, following the conditions set in COBIT 5.0 framework, the questionnaire was distributed according to the criteria contained in the COBIT 5.0 framework. At the stage of filling out the questionnaire the respondents were 3 IT staffs and 1 senior IT person along with the head of the IT division. Each process tested has a number of questions which can be seen in table 2 below:

Table 2. Number of questions for each process

Process	Number of Questions				
	Level 1	Level 2	Level 3	Level 4	Level 5
APO05	28	10	11	11	8
APO10	27	10	11	11	8
APO11	34	10	11	11	8
BAI04	25	10	11	11	8
DSS03	23	10	11	11	8

D. Research Theory Framework

Based on the COBIT 5.0 framework there are 5 domains where each domain has a different process. In this study, 3 domains from COBIT 5.0 were

selected, namely the Align, Plan, and Organize, Build, Acquire, and Implement, and Deliver, Service, and Support. The domain tested are chosen by the Facility Management department.

From the domains which have been selected previously, 5 processes will be taken, namely APO05, APO10, APO11, BAI04, and DSS03. Every process tested will be calculated with the capability level that is divided into 6 levels, Level 0 Incomplete, Level 1 Performed, Level 2 Managed, Level 3 Established, Level 4 Predictable, Level 5 Optimizing.

IV. RESULT AND DISCUSSION

A. Questionnaire Results

The distribution of questionnaires for this study was distributed to 5 people in the IT division consisting of 1 head of division, 1 senior IT person and 3 IT staffs assigned to maintain and manage the application system used by the department to manage suppliers, provide services continuously continuously to the client namely PGN and members of the PGN group, and develops application systems to adapt to changes in business processes that will occur in the future. Questionnaire questions were made according to the domains tested in the study. From the results of filling out the questionnaire, the capability level of the department will be calculated. The following are the results of the questionnaire calculations for each domain.

Table 3. Achievement of every process tested

No.	Process	Level 1	Level 2	Level 3	Level 4	Level 5
1	APO05	89.07%	88.86%	78.44%	N	N
2	APO10	88.20%	89.40%	78.67%	N	N
3	APO11	90.88%	89.33%	79.55%	N	N
4	BAI04	90.19%	85.68%	82.07%	N	N
5	DSS03	91.13%	87.06%	82.72%	N	N

Based on table 3 it was found that all domains tested in the Facility Management department were declared to have been carried out completely at level 1 and 2. However, problems were still found such as making documents that were not according to standards, lack of establishing good relationships with suppliers, lack of supervision and management of the capacity of the department division, and the problems that still occur in the department that cannot be resolved, making all domains tested stopped at level 2.

B. Audit Findings

From the results of the questionnaire, several audit findings were found which can be seen in the following table 4.

Table 4. Audit Findings

Audit Findings
APO05 Manage Portofolio
1. The required infrastructure and work environment for managing departmental portfolios have not been identified as part of the standard process for portfolio management.
2. A standard, including guidelines, has not been determined to explain the important elements that must be included in the department's portfolio management.
3. Lack of sequence and interaction that occurs between department portfolio management and other processes.
4. The infrastructure and work environment needed to manage a portfolio are not yet fully available, regulated and maintained.
5. Appropriate data has not been taken and analyzed as a basis for understanding behavior and demonstrating the effectiveness and compatibility of departmental portfolio management, and has not evaluated the improvements that can be made.
6. The roles, responsibilities and authorities needed to manage the department's portfolio have not been assigned and communicated.
APO10 Manage Suppliers
1. There is no standard, including guidance to explain important elements that must be incorporated into supplier management.
2. The infrastructure and work environment needed to manage supplier departments have not yet been identified as part of the standards for supplier management.
3. There is no order and interaction between department suppliers and other processes.
4. Management of supplier department contracts has not been determined based on a standard.
5. Appropriate data have not been collected and analyzed as a basis for understanding behavior and demonstrating the effectiveness and suitability of supplier contract management, and a lack of evaluation related to improvements to supplier contract management.
6. Resources and information needed to manage supplier contracts are not yet available, regulated, and maintained.
APO11 Manage Quality
1. The infrastructure and work environment required by quality management have not yet been identified as part of the standard for maintaining service quality.
2. Competence and roles for quality management have not been identified as part of a standard that has been tested.
3. Lack of order and interaction between quality management and other processes has been determined.
4. Management of quality management has not been determined based on any standard.
5. Resources and information needed to maintain the quality of services are not yet available, regulated, and poorly maintained.
BAI04 Manage Availability and Capacity
1. The infrastructure and work environment needed by the management of the availability and capacity of departments are less identified as part of the standard.
2. There is no sequence and interaction between the

availability management and the capacity of the department with other processes.

3. Management of department availability and capacity has not been fully determined based on a standard.

4. Appropriate data has not been fully retrieved and analyzed as a basis for understanding behavior and has not yet demonstrated the effectiveness and compatibility of the management of department availability and capacity, and no evaluation of improvements can be made.

5. Resources and information needed to manage the availability and capacity of departments are not yet fully available, regulated, and maintained.

6. The infrastructure and work environment needed to manage the availability and capacity of departments is not yet fully available, regulated, and maintained.

DSS03 Manage Problems

1. Not using the appropriate method to monitor the effectiveness and appropriateness of the management of problems in the department.

2. The infrastructure and work environment needed to manage and resolve problems within the department are not yet fully available, regulated, and maintained.

3. Management of problems within the department is not determined based on an appropriate standard.

4. Appropriate data has not been fully collected and analyzed as a basis for understanding behavior and does not demonstrate the effectiveness and appropriateness of problem reporting within the department, and no evaluation of improvements can be made.

5. People who manage problems in the department do not have competence based on education, training, and experience.

6. The roles, responsibilities and authorities needed to manage problems within the department have not been fully assigned and communicated.

C. Recommendations

From the audit findings that have been collected there are a number of recommendations that can be given to the Facility Management department to increase the level of IT capabilities to the level expected. Following is table 5 about the recommendations that can be given to Facility Management Department:

Table 5. Audit Recommendations

APO05 Manage Portofolio

1. Defining standards includes the guidance needed to explain important elements that must be included in the portfolio management process.

2. Make a sequence and interaction between portfolio management processes with other business processes.

3. Identify the competencies and tasks required to manage a portfolio.

4. Identify the infrastructure and work environment needed to manage the department's portfolio.

5. Determine the appropriate method for monitoring the effectiveness and suitability of the portfolio management process for the department.

6. The specified portfolio management process must be carried out with an appropriate standard.

7. Must communicate the roles, responsibilities and authority to manage the department's portfolio.

8. The person assigned to manage the portfolio must have competencies based on the level of education, training, and work history according to the standards.

9. Resources and information needed to manage portfolios must be available, allocated, and organized in the department.

10. The infrastructure and work environment needed to manage the portfolio must be available, regulated, and maintained by the department.

11. Take and analyze the data needed to demonstrate the suitability and effectiveness of the portfolio management process, and evaluate the improvement in portfolio management that can be done.

12. Information needs in support of predetermined business objectives have been created in the portfolio.

13. The purpose of measuring the process is taken based on the information needs in portfolio management.

14. Quantitative objectives for portfolio management performance in support of the department's business goals have been made.

15. Measurements and measurement periods are identified and determined with the aim of measuring portfolio quality and quantitative objectives for departmental portfolio management performance.

16. Measurement results are collected, analyzed and reported to see whether the quantitative objectives for department performance have been achieved

17. The measurement results are used to categorize the performance of the department's portfolio management.

18. Analysis and control techniques have been determined and applied to the management and manufacture of departmental portfolios

19. Control limits of variation have been determined for departmental portfolio performance

20. Measurement data are analyzed for special variation cases in departmental portfolios

21. Resolving issues related to special variation cases in the portfolio.

22. Control limits are determined if necessary, following the resolution of issues related to portfolio management.

APO10 Manage Suppliers

1. Defining standards includes guidelines needed to explain important elements that must be incorporated into supplier management.

2. Make a sequence and interaction between supplier management processes with other business processes.

3. Identify the competencies and tasks required to manage suppliers and supplier contracts.

4. Identify the infrastructure and work environment needed to manage suppliers for the department.

5. Determine the appropriate method for monitoring the effectiveness and suitability of the supplier management process for the department.

6. The specified supplier management process must be carried out with an appropriate standard.

7. Must communicate the role, responsibilities and authority to manage suppliers and their contracts.

8. The person assigned to manage suppliers for the department must have competencies based on the level of education, training, and work history according to the standards.

9. Resources and information needed to manage suppliers must be available, allocated, and regulated in the department.

10. The infrastructure and work environment needed to manage suppliers must be available, regulated, and maintained by the department.

11. Take and analyze the data needed to demonstrate the suitability and effectiveness of the supplier management process, and evaluate the improvement in supplier management that can be done.

12. Information needs in support of good relations with predetermined suppliers have been made.

13. The purpose of measuring supplier contract performance is based on the information needs of the department.

14. Quantitative objectives for supplier contract performance in support of relevant business objectives have been made

15. Measurements and measurement periods are identified and determined with the aim of measuring the process and quantitative objectives for supplier performance

16. Measurement results are collected, analyzed, and reported to see whether quantitative objectives for supplier performance and contracts have been achieved

17. The measurement results are used to categorize the performance of the supplier.

18. Analysis and control techniques have been determined and applied

19. Control of variation limits has been determined for supplier performance based on the results of the analysis conducted.

20. Measurement data are analyzed for cases of special variations in supplier performance

21. Resolving issues related to special variation cases on supplier performance

22. Control limits are determined if necessary following the issue resolution

APO11 Manage Quality

1. Defining standards includes the guidance needed to explain important elements that must be included in the quality management process of the services provided by the department.

2. Make a sequence and interaction between the quality management process department services with other business processes.

3. Identify the competencies and tasks required to manage the quality of department services.

4. Identify the infrastructure and work environment needed to manage the quality of services provided by the department.

5. Determine the appropriate method for monitoring the effectiveness and suitability of the service quality management process and department performance.

6. The process of managing the quality of service of a predetermined department must be run with an appropriate standard.

7. Must communicate the roles, responsibilities and authority to manage the quality of the department.

8. The person assigned to manage the service quality of the

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department must have competency based on the level of education, training, and work history in accordance with the standards.

9. Resources and information needed to manage the quality of the department must be available, allocated, and regulated within the department.

10. The infrastructure and work environment needed to manage the quality of this department must be available, regulated, and maintained.

11. Take and analyze the data needed to demonstrate the suitability and effectiveness of the department's quality management, and conduct an evaluation of the department's quality improvement that can be done.

12. Information needs in support of the quality of service that has been determined previously has been made.

13. The purpose of measuring service quality is based on the information requirements obtained.

14. Quantitative objectives for departmental performance in supporting relevant business objectives have been made

15. Measurements and measurement periods are identified and determined with the aim of measuring service quality and quantitative objectives for the department's performance in providing services to its clients.

16. Measurement results are collected, analyzed and reported to see whether the quantitative objectives for department performance have been achieved.

17. The measurement results are used to categorize the performance of this department.

18. Analysis and control techniques have been determined and applied to measure the performance of this department.

19. Variation control limits have been set for the service performance that the department provides its clients.

20. Measurement data are analyzed for special variation cases.

21. Resolving issues related to special variation cases.

22. Control limits are determined if necessary following the resolution of the issues that occur in the provision of services to clients from this department.

BAI04 Manage Availability and Capacity

1. Defining standards includes the guidance needed to explain important elements that must be incorporated into the management process of the department's availability and capacity.

2. Make a sequence and interaction between the availability management process and the department's capacity with other business processes.

3. Identify the competencies and tasks needed to manage the department's capacity.

4. Identify the infrastructure and work environment needed to manage the department's portfolio.

5. Determine the appropriate method for monitoring the effectiveness and suitability of the portfolio management process for the department.

6. The departmental capacity management process that has been determined must be carried out with an appropriate standard.

7. Must communicate the role, responsibilities and authority to manage the capacity of the department.

8. The person assigned to manage the availability and capacity of the department must have competencies based on the level of education, training, and work

history in accordance with the standards.

9. Resources and information needed to manage the availability and capacity of departments must be available, allocated, and regulated.

10. The infrastructure and work environment needed to manage the department's capacity must be available, regulated, and maintained.

11. Take and analyze the data needed to demonstrate the suitability and effectiveness of the department's capacity management process, and evaluate what capacity building can be done.

12. Information needs in support of the management of predetermined departmental capacities have been made.

13. The purpose of measuring departmental service capacity is based on information needs

14. Quantitative objectives for the performance of divisions within the department in supporting relevant capacity management have been made

15. Measurements and measurement periods are identified and determined with the aim of measuring processes and quantitative objectives for the performance of capacity utilization

16. Measurement results are collected, analyzed, and reported to see whether quantitative objectives for the performance of capacity utilization have been achieved

17. The measurement results are used to categorize the performance of the capacity utilization of each division in the department.

18. Analysis and control techniques have been determined and applied

19. Variation control limits have been set for capacity usage performance

20. Measurement data are analyzed for special variation cases

21. Resolving issues related to special variation cases

22. Control limits are determined if necessary following the issue resolution

DSS03 Manage Problems

1. Defining standards includes guidance needed to explain important elements that must be incorporated into the process of managing problems that occur within the department.

2. Make a sequence and interaction between the problem management process within the department with other business processes.

3. Identify the competencies and tasks needed to solve problems in the department.

4. Identify the infrastructure and work environment needed to solve problems in the department.

5. Determine the appropriate method for monitoring the effectiveness and suitability of the problem management process within the department.

6. The problem management process in a given department must be carried out with an appropriate standard.

7. Must communicate the roles, responsibilities and authority to manage problems within the department.

8. The person assigned to manage problems that occur within the department must have competencies based on the level of education, training, and work history that conforms to the standards.

9. Resources and information needed to manage problems within the department must be available, allocated, and

regulated.

10. The infrastructure and work environment needed to manage departmental issues must be available, regulated, and maintained.

11. Take and analyze the data needed to demonstrate the suitability and effectiveness of problem solving in the department, and conduct an evaluation of the improvement in problem management that can be done.

12. Information needs in support of managing problems that occur within the department have been created.

13. The purpose of measuring the problem management is taken based on information needs

14. Quantitative objectives for departmental performance in managing and resolving problems that occur have been made

15. Measurements and measurement periods are identified and determined with the aim of measuring problem management and quantitative objectives for departmental performance in managing and resolving problems that occur.

16. Measurement results are collected, analyzed, and reported to see whether quantitative objectives for departmental performance have been achieved in managing and solving problems.

17. The measurement results are used to categorize the performance of departments in managing and solving problems that occur.

18. Analysis and control techniques have been determined and applied

19. Limitations on variations have been determined for the department's performance in solving problems

20. Measurement data are analyzed for special variation cases

21. Resolving issues related to special variation cases

22. Control limits are determined if necessary, following the issue resolution

V. CONCLUSIONS

The following is the conclusion of the audit activitiy:

1. All domains tested, namely APO05, APO10, APO11, BAI04, and DSS03 only reached level 2 of the Facility Management department's expectation of level 4. The domains tested were only carried out mostly by the department so recommendations were made in order to reach the expected target level.

2. Recommendations given to the Facility Management department are based on each domain chosen and tested in this audit activity. Recommendations were made so that the department would immediately make improvements so that the next audit activity could get the level expected earlier.

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Abstract – **This paper uses bibliometric studies to provide a rigorous analysis of research trends related to the phrase "DataOps". Data were initially taken from the Scopus database from 2018 to 2023 which resulted 34 documents, while in other hands we found more than 1000 documents in the Google Scholar database collected using Publish or Perish. Five years of data is collected because the scientific publications on term DataOps started to increase since 2018. We have implemented the "bibliometrix 3.0" software package, along with the r-package and VOSviewer, to examine important elements of the literature. Observing the emergence of the phrase DataOps, one can note a substantial impact on its definition and actual implementations. DataOps enthusiasts work to provide a standardised approach for consistently implementing the technique across different data operation contexts. DataOps will continue to evolve into an effective and reliable data management system. The results of this study will assist researchers in the field to identify the prevailing research patterns in worldwide DataOps research and propose potential avenues for future research.**

Index Terms – *Bibliometric, Bibliometrix, DataOps, VOSViewer.*

I. INTRODUCTION

DataOps is a new discipline that focuses on efficiently implementing data science on a large scale, inspired by the operational strategies of successful firms like LinkedIn, and eBay. Organizations require more than just cutting-edge AI algorithms, emerging technologies, and skilled individuals to transform data into actionable insights and valuable analytical data products [1]. DataOps involves continuous incremental use of data, utilizing complex systems orchestration techniques which in turns to data insight [2]. It aims to harness the potential of data while addressing the challenges of data deluge.

DataOps can be applied in various domains, such as government financial data analytics [3], drought mitigation in high-risk areas [4], data quality discovery [5], and healthcare analytics [6]. It offers solutions for data preparation, feature selection, and machine learning algorithms. By implementing DataOps, organizations can accellerate the efficiency and effectiveness of their data science and analytics projects, leading to improved business value.

DataOps enables the development of adaptable capabilities that can assist companies in responding swiftly to the constantly evolving digital landscape. It also facilitates the identification of essential prerequisites for organisations to effectively use DataOps processes, using Leavitt's Diamond Model as a basis [7]. DataOps offers a comprehensive and structured method for digital business transformation, and implementing DataOps leads to enhanced organisational performance in digital business transformation [8]. However, we are just at the beginning of data-driven transformation and understanding of the optimal techniques to derive our desired outcomes from raw data [1], in the next few years we'll see a revolution in data science, machine learning, and deep learning.

A. Research Question

This paper examines the research patterns of the term DataOps between 2018 and 2023. It addresses five specific research questions:

a. What is the output profile of DataOps articles from 2018 to 2023 and how geographically distribution of articles worldwide?

b. What is the publication frequency of the term DataOps between 2018 and 2023?

c. What are the findings of the research theme cluster visual analysis conducted on the term DataOps?

B. Data Collection for Literature Review

Bibliometrics is a technique for exploring scholarly material in research articles, books, conference proceedings, and reports from several well-established databases [9]. It is the process of extracting, organizing, and evaluating data in order to make strategic decisions [10]. Bibliometric information for this study is collected in two steps. Firstly, we selected the Scopus database for information collection purposes. The database contains high-impact factors and prestigious research publications. Then, in the second step, we narrow down the subject category and conduct the search query for more holistic data collection. We have applied specific filters to get the desired results. The databases were searched by using the specific related keywords from the period of 2018-

2023 at the date of November 19, 2023. The Final search query is TITLE-ABS-KEY (dataops) AND PUBYEAR > 2017 AND PUBYEAR < 2024. It is expected that the results may change in the future when more papers related to the issue are included.

C. Bibliometric Tools

Bibliometrix is a package used for bibliometric analysis in research to gain insights and coordinate research efforts in the related fields [11]. It provides capabilities for analyzing performance indicators, identifying trends, and mapping technological developments. It can be used to analyze interdisciplinary research in fields like conversation and aphasia [12], patent analysis in areas like virtual worlds [13] or topic like agile IT Governance [14]. The analysis conducted using Bibliometrix helps in identifying predominant themes, emerging concepts, impactful authors, and sources, as well as making theoretical contributions and providing future research directions [15], [16].

VOSviewer is a freely available software utilised for conducting bibliometric analysis and visualising networks. It helps in understanding the structure and evolution of knowledge in scientific disciplines [17]. VOSviewer can be used to build bibliometric maps or networks based on different types of relationships, such as co-authorship, co-occurrence, and co-citation [18]. Researchers can utilise this tool to locate clusters of interconnected articles, determine precise keywords for effective searching, uncover potential collaboration partners, recognise influential papers, and pinpoint areas of knowledge that require further exploration [19], [20].

II. RESEARCH METHOD

The purpose of this study is to establish a basis for future researchers and to outline previous research for scholars to expand upon in order to advance knowledge in the future. In order to accomplish this, a comprehensive literature review is carried out systematically, and the resulting data is examined through bibliometric analysis, keyword analysis, and citation analysis. The data can be summarised using many criteria, including top authors, journals, institutions, keywords, citations, publishing nations, and publication years. This organized data can assist individuals better understand the term of DataOps.

The research commenced by performing an online search in November 2023 within the Scopus database, which is renowned among the academic world for its collection of articles and conference proceedings considered highly pertinent. The entire procedure is depicted in Figure 1, adhering to the sequential process of doing bibliometric analysis. The 'Biblioshiny' is a specialised R package called 'Bibliometrix 3.0' that is designed for web use. It utilises analytical tools based on Bradford's law to describe selected texts. These tools include global citations, h-index, g-index, and m-index.
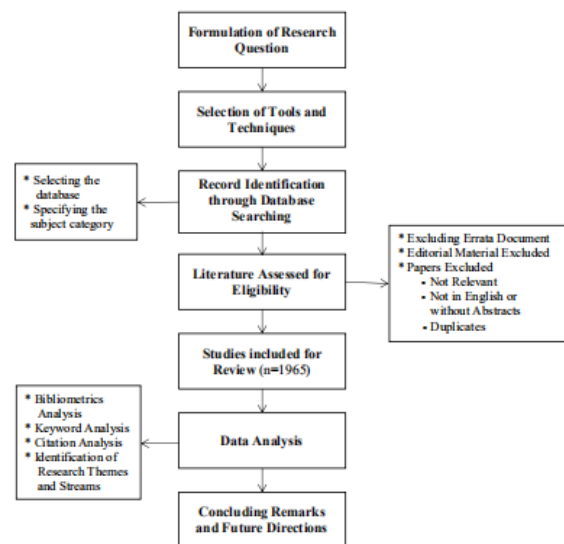
Fig. 1. The process of bibliometrics analysis

The next steps involve identifying important research themes and streams using scientific mapping approaches that analyse the conceptual framework and holistic keywords as input data. Upon completion of these analysis techniques, we will be capable of offering a comprehensive examination of the data and proposing a future research agenda.

The present study on bibliometrics analysis will provide information pertaining to the leading journals, authors, publications, universities, and countries. The study obtained thorough information regarding DataOps terminology through a comprehensive literature review. Table 1 provides a brief explanation of the features of the concepts under research, which is essential for understanding the attributes of the selected literature before proceeding to the analysis section.

TABLE I. DESCRIPTIVE CHARACTERISTICS OF TERM DATAOPS.

Description	Results
Main Information	
Timespan	2018:2023
Sources (Journals, Books, etc)	31
Documents	34
Annual Growth Rate %	37.97
Document Average Age	1.65
Average citations per doc	3.853
References	1
Document Contents	
Keywords Plus (ID)	299
Author's Keywords (DE)	106
Authors	
Authors	116

Description	Results
Authors of single-authored docs	7
Authors Collaboration	
Single-authored docs	7
Co-Authors per Doc	3.68
International co-authorships %	14.71
Document Types	
article	9
book	3
book chapter	1
conference paper	21

III.   RESULTS AND DISCUSSION

A. Publication Output and Document Sources

Based on data obtained from the Scopus database, it was found that the trend in the number of publications focus on DataOps research continued to increase from 2018 to November 2023. The number of publications decreased in 2019, but this downfall was compensated by a significant increase in 2020. The total publications during the 6 years were 34, with an increase of 37,97 % per year.
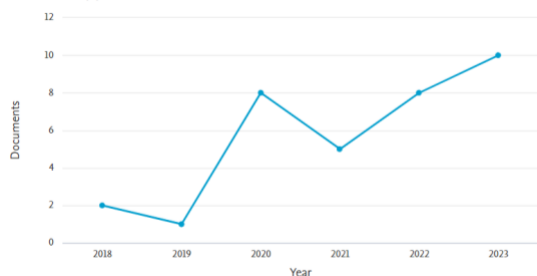

Fig. 2.   Documents per year

More than half of the publications produced by the authors came from conference papers which reached 61.8 %, followed by publications in the form of articles at 26.5%. The remaining publications came from books by 8.8 % and book chapters by 2.9 %.
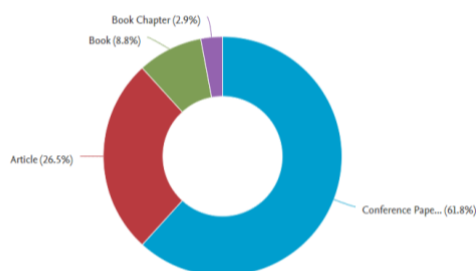

Fig. 3.   Documents by type

It is evident that the research topic of DataOps is mostly focused on the field of Computer Science. The majority of DataOps research, approximately 55%, is conducted within the field of Computer Science. This

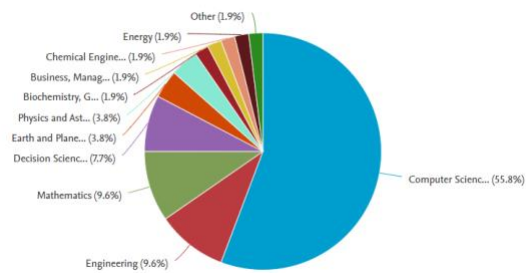is followed by Engineering and Mathematics, each contributing 9.6% of the research.

Fig. 4.   Documents by subject area

During 2018-2023, DataOps-related publications come from 31 sources. Some journals even publish this theme consecutively for several years, these include: The Lecture Notes in Computer Science Including Subseries Bioinformatics (2018-2020), The CEUR Workshop Proceedings (2018,2022), and The ACM International Conference Proceedings Series (2020-2023). While other journals are not publishing research related to this regularly, for example The Communication in Computer and Information Science (2021) and The IEEE Transaction on Knowledge and Data Engineering (2023).
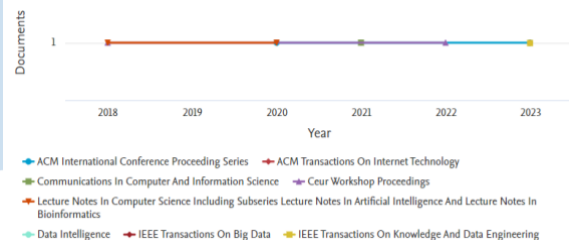
Fig. 5.   Documents per year by source

In line with the increase in publications related to DataOps, the number of CiteScore also tends to increase significantly since 2018. The CiteScore of an academic publication is a metric that represents the average number of citations received by recent articles published in that journal on a yearly basis. This significant increase in citescore was experienced by The IEEE Transaction on Knowledge and The Data Engineering. Increased citations are also experienced by The ACM Transaction on Internet Technology, which experienced a decline in the 2012-2014 period, then increased again and achieved significant improvements in 2019-2022 period. Meanwhile, other citation sources such as The Lecture Notes in Computer Science and The Communication in Computer and Information Science tend to stagnate and do not experience a significant increase in citations.

The ACM International Conference Proceedings Series and The CEUR Workshop Proceedings has also been a source of citations since 2016. However, the number of citations is not much and tends to decline.

The latest developments in 2020-2021, The IEEE Transaction on Big Data and The Data Intelligence began to become a source of citations, even the number of citations from The IEEE Transaction on Big Data in 2021-2022 has exceeded the number of citations in The ACM Transaction on Internet Technology.
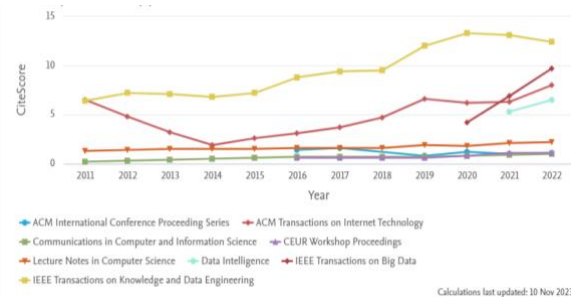
Fig. 6.   CiteScore publication by year of the source

When discussing the legitimacy of publication sources, it is worth noting that certain journals have a high SCImago Journal Rank (SJR). The SJR indicator is a metric that quantifies the prestige of academic journals by considering both the number of citations received by a journal and the prestige of the journals from which the citations originate. For 22 years, The Lecture Notes in Computer Science, and The CEUR Workshop Proceedings have always been included in the list of Q1 journals. The ACM International Conference Proceedings Series was continuously on the Q1 list from 2003 to 2022, while The Communication in Computer and Information Science and The ACM Transaction on Internet Technology has been there since 2008-2009.

The IEEE Transaction on Big Data journal is still on the Q1-Q2 list. Meanwhile The IEEE Transaction on Knowledge and Data Engineering as the main source of publication with a focus on DataOps is still on the list of Q2-Q3 journals.
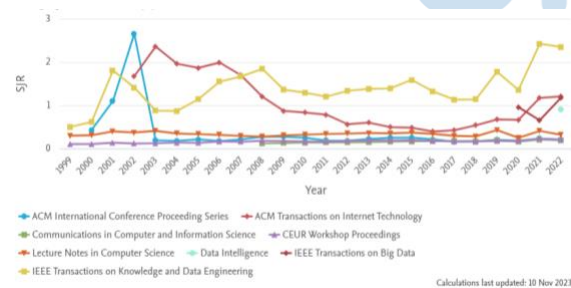
Fig. 7.   SCImago journal rank by year of the source

Research productivity of an organization or university research reflects the relative position of the institution among others regarding a specific research interest and affects its ability to raise funds. Therefore, generally many organizations and institutions compete to produce research that will attract public attention. Although DataOps can be applied in various sectors, it is still relatively new.

Research related to DataOps is mostly carried out by universities and a small number of companies. Most publications are affiliated with universities, but the top affiliation comes from companies, namely with Microsoft Research as many as 7 documents, and Ubitech Limited as many as 6 documents.
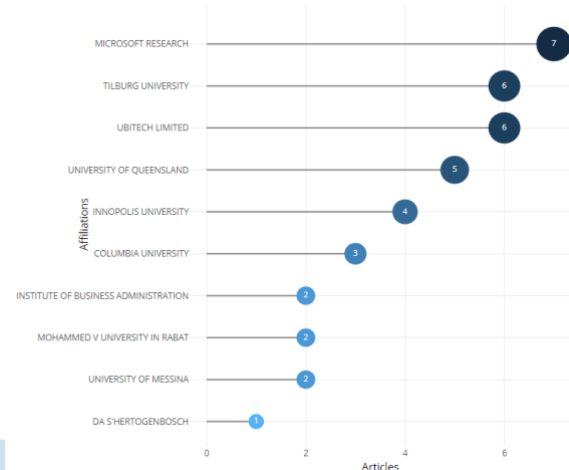
Fig. 8.   Most relevant affiliations

Tilburg University has the highest number of author affiliations with 6, followed by the University of Queensland with 5 and Innopolis University with 4. Additional affiliates originate from universities in the Americas, Europe, and Africa.

B. Publication Distribution Across Countries

Academic publications are thought to be indicative of a country's scientific prosperity, both in terms of quantity and influence. The Netherlands and the United States are the primary countries that publish documents on DataOps, based on the document's country of origin. Each country released 7 documents. Following that is Germany and Spain, both released 3 documents. Australia, along with Italy, Norway, the Russian Federation, and Sweden, each published a total of 2 documents. Austria is represented by 1 document.
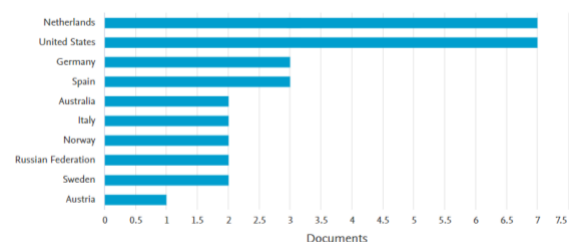
Fig. 9.   Documents by country or territory

C. Top Authors in The Research Term DataOps

Tamburi, D.A. is the most prolific author in DataOps-related research, with subsequent active authors producing only half of what Thamburi produces.
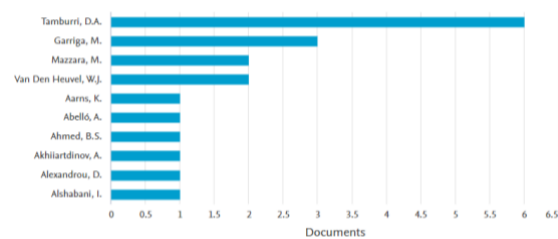
Fig. 10. Documents by author

Fig. 11.   Thamburi released a total of 6 documents. The following authors have the highest number of active documents: Garriga (3), Mazzara (2), and Van Den Heuvel (2). Additional authors who have each published one document include Aarns, Abello, Ahmed, Akhilarddinov, Alexandrou, and Alshabani. Figure 11 shows that Thamburi D.A., as a sole author, receives the highest number of citations in comparison to other writers. The article titled Sustainable MLOPs: Trends and Challenges garnered 51 citations. In addition, Thamburi's collaborative work with Heuvel and Garriga has garnered 12 citations.

Fig. 12.   The subsequent item that garnered significant interest was a publication authored by Munappy, Mattos, Bosch, Olsson, and Dakkak titled "From Ad-Hoc Data Analysis to DataOps," which amassed 23 citations. Ereth's work titled "DataOps: Towards Definition" got third place with a total of 16 citations. As of November 2023, documents authored by either a single individual or numerous authors receive fewer than 10 citations.


Fig. 13. Documents cited per author

D. Publication Pattern

The researchers used several keywords to describe their publications as we can see in figure 12, in DataOps related publications, the most popular keyword used is DataOps itself (9), followed by Data Analytics (6), information management (5), Life cycle (5), decision making (4), develops (4), machine learning (4). The rest use big data keywords (3), codes (3) and data handling (3).
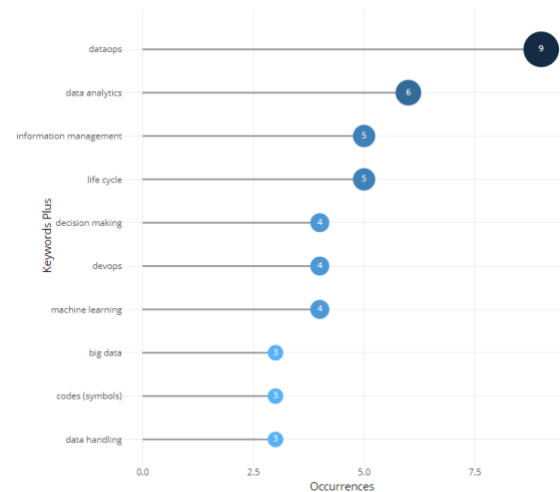
Fig. 14. Most frequent words
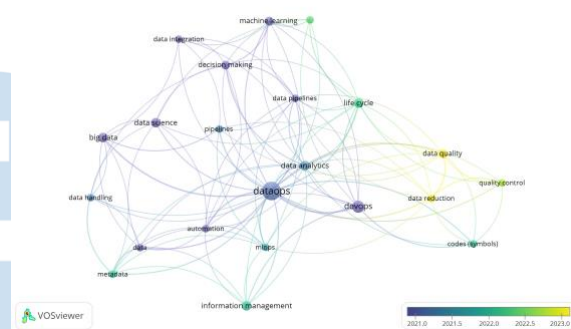
Fig. 15. Overlay Visualization

The topic of publication related to DataOps is also likely to shift from 2021 to 2023 as we can see in the visualization of the words in figure 13. In 2021, many publications discuss keywords related to defining DataOps, which include data, automation, integration, data science, big data, data pipelines, decision-making, and machine learning. In 2022, topics discussed include metadata, information management, mlops, codes, and life cycle. Shifting in 2023, more is discussed related to quality, data reduction, and quality control. We also able to see the trends of the word showed in figure 14 density visualization, DataOps and DevOps are one of the word mentioned a lot in the articles.
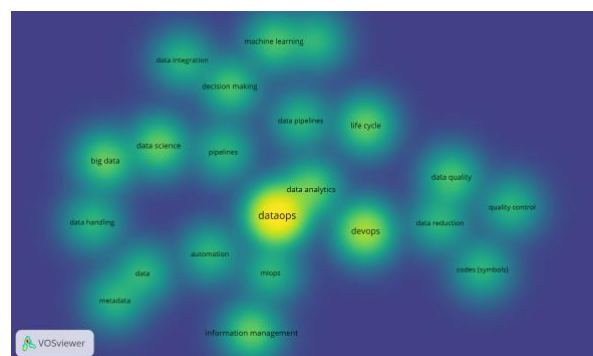
Fig. 16. Density visualization

E. Theme Cluster Visual Analysis

Bibliometrix can display the mentioned word in the articles by displaying as wordcloud as in figure 15, so we can observe that words like data analytics, information management, devops, etc are following the trends of the term DataOps. While we can use Vosviewer to see the cluster network visualization shown in figure 16 Researchers from around the world generated four main clusters, shown by the colours yellow, red, green, and blue, according to the Scopus database. The initial cluster, shown by its yellow colour, is formed based on phrases such as bigdata, pipelines, and data integration, which ultimately leads to the subject of DataOps. The second cluster, represented by the colour green, is formed based on terms such as devops, lifecycle, decision making, and machine learning. This cluster primarily focuses on the topic of DevOps, which is closely related to DataOps articles. The third cluster, represented by the colour blue, is formed based on terms related to data analytics, data quality, data reduction, and quality control. This cluster revolves on the issue of data analytics, which is an integral part of dataops. The final cluster (red) is categorised based on keywords such as data science, data handling, metadata, automation, MLOps, and information management, which signify the management of data operations.
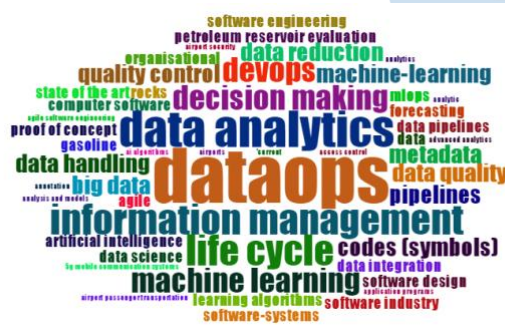
Fig. 17. DataOps terms wordcloud
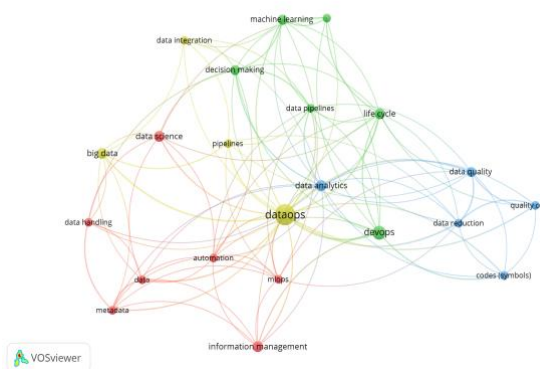
Fig. 18. Cluster Network Visualization

Now, we review the bibliometric result from bibliometrix in figure 17 and 18. It is found that a wide variety of topics are covered in the journal during the study period. All the research themes are classified in order from highest amount of coverage to least to find out most preferred areas.

Fig. 19. DataOps terms treemap
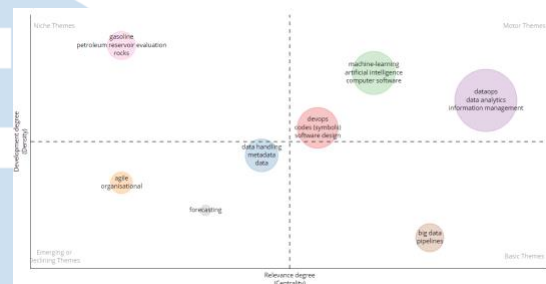
Fig. 20. Thematic map

The most frequently discussed topics in research related to DataOps include DataOps itself 98%, data analytics 65%, information management 54%, and life cycle 54%. These topics are related to the next sub-topic which is also often discussed including: decision making 43%, data handling 33%, data quality 33%, Data reduction 33%, machine learning 33% and so on. A very fewer numbers of research paper focused on codes 3%, computer software 3%, organization 2%, and others which account less than 2% of the total topic categories.

F. Limitations and Future Research Agenda

Currently, the process of devising and assessing research is of utmost importance for researchers. Utilising the references provided in article metadata from the Scopus database can be considered a highly reliable method for identifying taxonomies of research fields. The correctness of topic-level taxonomies can be evaluated by comparing document grouping methods such as direct citations, bibliographic coupling, and co-citation. Efforts of investigation should focus on the disparities in value across consistent taxonomic subjects and integrate historical records with fields of study that are prone to rapid changes. When employing more precise techniques to identify subjects, it is imperative for research papers, researchers,

organisations, and governments to enhance the accuracy of their innovation. Utilising direct citations results in a highly precise taxonomy, which is advised as a suitable foundation for decision-making.We exclusively utilised the bibliometric analysis technique on published documents alone from the Scopus database, without incorporating any additional databases. In addition, the study exclusively concentrated on the evaluation of digital collections, digital resources, and e-books. This evaluation was conducted using the bibliometric analysis method, which involved analysing published documents indexed in Scopus from 2018 to 2023.

IV. CONCLUSION

The term DataOps has gained prominence and has made substantial contributions to its definition and practical uses. DataOps enthusiasts work to provide a standardised approach for consistently implementing the technique across different data operation contexts. Despite the extensive efforts made, the diverse nature of the data analysis process gives rise to numerous uncertainties regarding the use of DataOps. Data analysis is a vast field with different techniques, approaches, and technologies that might produce the same results. DataOps, on the other hand, provides a solution by combining a comprehensive and process-focused approach to data with automation and methodologies from agile software engineering and DevOps. This approach aims to enhance quality, velocity, and cooperation, while also promoting a culture of continuous development. DataOps will continue to evolve into an effective and reliable data management system.

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Enhance the User Interface Design of the booking application at Rana Photo Studio by applying the User-Centered Design (UCD) method

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Abstract— **In the era of advancements in information technology within the business sector, it is expected that business professionals adapt their product marketing strategies to meet customer expectations. For instance, photo studio booking applications have transformed the way customers interact with the service, making the booking process more efficient and allowing customers to make reservations from anywhere and at any time.**

Through these applications, customers can place orders without the necessity of visiting the studio physically, accessing services via the company's provided website. Before the prevalence of online ordering, users typically placed orders via electronic mail or social media platforms like WhatsApp and Instagram, often with less detailed information. Therefore, the importance of developing more sophisticated ordering methods becomes imperative.

Good UI design is not only aesthetically appealing but also stimulates customer interest to explore more about the company. Likewise, a positive user experience fosters customer loyalty, creating a favorable impact on the business. By implementing the User-Centered Design (UCD) method, photo studio booking applications can gain a deeper understanding of their customers' needs and preferences, ultimately leading to increased customer satisfaction and effective resolution of potential user problems on the website. The adoption of online booking systems has completely revolutionized the way the creative industry operates, resulting in significant changes in discovering, booking, and managing photo studios.

Keywords: *Information System; UI/U; User-Centered Design (UCD; Online Booking;User Interface Design.*

I. INTRODUCTION

As information technology continues to advance, businesses must adapt their marketing strategies to reach their clients. For instance, a photo studio booking application allows clients to access the company's website instead of physically visiting the studio. This means that clients can now place their orders and make purchases online. The photo studio booking application is a service-based business that provides photography and videography services for couples, pre-wedding shoots, candid shots, school photos, and family albums. Previously, clients would have to make orders for photo and portfolio services through email or social media platforms such as WhatsApp and Instagram, where the information provided was often incomplete.[1]

Online ordering is a convenient system that allows customers to make reservations quickly and easily from anywhere, at any time. This system overcomes the problem of difficulties in ordering by providing a precise and accurate information system, which can be accessed directly by users. UI/UX is the acronym for User Interface and User Experience. It refers to the visual display and digital marketing tool of mobile applications or websites. UI or User Interface is the process of designing a website or application, which includes buttons, text, images, input fields, and other elements that are directly related to users. UX or User Experience, on the other hand, is the person responsible for creating the product and visualizing the user flow into a product whose suitability has been tested. [2]

The importance of user interface (UI) design in capturing customer interest in company information is emphasized. Good UI design encompasses the aesthetic value of product displays, motivating customers to explore more about the company. Through an appealing interface design, the photo studio booking application can instill new habits in users, facilitating a clearer understanding of the ordering process through to payment. Similarly, with UX, which aims to increase business value and profits.

A positive user experience will foster customer loyalty, yielding a positive impact on the business. In conclusion, designing the UI interface and UX user experience in the photo studio booking application is crucial to ensure service quality and meet customer needs. [3]

Adopting the User-Centered Design (UCD) method can help photo studio bookings better understand their customers' needs and preferences. This understanding can lead to the creation of products that align with customer expectations, ultimately increasing client satisfaction. The use of the User-Centered Design (UCD) approach can significantly impact UI/UX design. By adopting this method for the UI/UX design process of booking shutter photo studios, it becomes possible to address the needs and resolve user issues that were previously identified on the website. This approach will ensure that the website is easy to use and navigate, providing clear instructions to users for seamless operation.[4]

Website-based applications have revolutionized the way we interact with various services, especially in the entertainment and creative industries. These applications offer user-friendly interfaces that make it easy for users to access different menus. One of the most notable developments in this field is the emergence of website-based photo studio booking applications. This app has brought significant changes to the way recording studios, photography studios, and other creative venues are discovered, booked, and managed. This literature review will highlight the crucial role of website-based applications in facilitating the studio booking process. It will explore the key benefits offered by such applications, discuss the latest industry developments, and explain the challenges associated with their use.[5]

Online booking is a convenient system that allows customers to make reservations quickly and easily from anywhere, at any time. This system eliminates the problem of booking difficulties by providing a precise and accurate information system that can be accessed directly by users. The User Interface (UI) refers to the design and layout of a website or application. It encompasses all the visual components that users interact with, including the arrangement of display elements, color schemes, buttons, and fonts. A well-designed UI can significantly enhance user engagement and interest in the website or application.[6]

Borrys Hasian defines user experience as a range of different aspects. Out of these, UX is a team of professionals that work on user flow in applications and on the web to cater to the user's needs and make their experience smoother. UX designers possess the knowledge of how users interact with websites or applications, and they should know how to create wireframe or mockup designs, which is one of the basic requirements for UX work.[7]

UCD is a system development method that prioritizes the role of the user in each stage of the development process, with a focus on user experience. This approach involves developing the system in a way that aligns with the user's experience and outcomes. Another way to describe UCD is as a process of creating a system by incorporating the user's perspective into the development process to ensure the system functions and interacts in a way that is intuitive to the user. [8]

Using the User-Centered Design (UCD) method can assist photo studios in understanding customer needs and enhancing customer satisfaction. By incorporating UCD into the UI/UX design process for the photo studio booking application, we can address previously identified user issues on the website. This ensures that the website is user-friendly, provides clear instructions, and offers a seamless ordering experience.[9]

The photo studio booking application enables customers to place orders without visiting the studio in person. Previously, photo service orders were placed through electronic mail or social media, often with limited details. This challenge emphasizes the necessity for improved user interface (UI) design in photo studio booking applications.[10]

The implementation of online booking systems has revolutionized the way studio services are accessed, particularly in the creative industry. Website-based applications for photo studio bookings bring about significant changes in discovering, booking, and managing creative studios. In this literature, we will underscore the crucial role of website-based applications in facilitating the studio booking process, elucidate the key benefits they provide, discuss recent industry developments, and elaborate on the challenges associated with their utilization.[11]

II. METHOD

The first stage of a design project is planning. This involves user involvement in requirements elicitation, design evaluation, and addressing technical aspects. The visual aesthetics of the online booking process, a crucial element on the website, have a significant impact on user habits. The goal is to create a realistic appearance, enabling users to adapt easily and providing flexible features based on user needs.
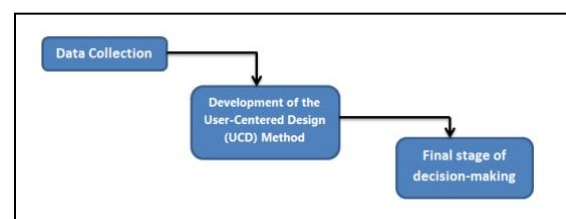
Fig. 1. Research Framework

A. Data collection

Observations are made to collect data for system upgrades and adjustments.

1) *Identifying problems*

Conduct observations to identify problems and needs related to the booking system created by Rana Studio. Only a maximum of 5 people should be involved in this process. Data will be collected by conducting interviews to determine the issues and requirements related to the user's experience while using the application.

Below is a list of interview questions that will focus on the booking display wireframe design. :

a) Are the features in the booking display understandable for users?

b) Is there anything that might make it difficult to place an order during the booking process?

c) Are there any areas of the booking process that could use improvement or addition?

d) Do the ordering instructions meet your requirements?

e) Do you comprehend the functionalities presented in the dashboard and booking section?

List of interview questions" (Testimonial display wireframe design) :

a) Could users comprehend the features that have been offered?

b) Could you please inform me whether the user faces any issues while entering the data?

c) Could you confirm if the feature is easy for users to comprehend?

List of interview questions (Dashboard display wireframe design) :

a) Is the information displayed on the dashboard easy to understand and communicate?

b) Could you confirm if the dashboard display l ooks visually appealing?

c) Is it easy for users to learn and utilize the provided features?

2) The study of literature

Literature review is a crucial stage in understanding the User Centered Design (UCD) method, which supports each process and involves researching previous studies related to UCD.

B. UCD Method Development

Research at this development stage uses the User Centered Design (UCD) method. The processing time used in this research is as long as the Scientific Research Methods course takes place.

1) Understand the stage of the User-Centered Design (UCD) Method.

The next step involves identifying the user context, which includes conducting interviews to determine who is directly involved in the system.

The following are the results of the identification carried out:

a) This application is for adults who want to order a photo studio

b) The interview was conducted, reflecting the characteristics of the source like this:

i. The number of speakers was 5 people.

ii. Age : 19-30 years.

iii. Gender: 2 women, 3 men.

2) Specify user requirements stage.

Based on several questions asked during interviews with various sources, conclusions were drawn regarding user needs concerning the features found in several Rana Banyuwangi studio booking applications as follows:

Requirements Before Evaluation	Requirements After Evaluation
a. The features used are challenging for users to comprehend.	a. The features used are easy for users to understand.
b. Finding information regarding bookings is too difficult.	b. Finding information regarding bookings is not too difficult.
c. The appearance tends to be monotonous	c. The appearance that attracts users.

C. The Design Solution Stage.

In this process, a design is executed, starting from sketching each page or section of the application in the form of a low-fidelity wireframe. The final result of this interface design is a design prototype in the form of a high-fidelity wireframe.
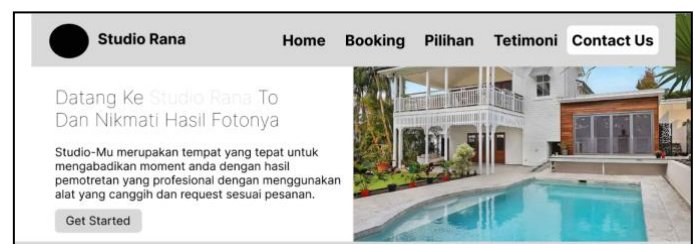
Fig. 2. Dashboard Display Wireframe Design

In Figure 2, the initial display menu is presented, providing information to facilitate customers in accessing the presented information. The display includes a navbar, offering various menu options for customers, such as Home, Booking, Testimonial, and Contact Us. We designed the application to ensure ease of understanding for customers.

Fig. 3. Booking Display Wireframe Design

In Figure 3, the Booking display is shown. On this page, there are input fields for name, address, cellphone number, and description. Customers are required to fill in this information for the package they will choose later. Once the input has been filled in, customers can click on "Booking," and the data will be sent.

Fig. 4. Testimonial Display Wireframe Design

Pada Gambar 4 adalah tampilan dari Testimoni. Dimana testimoni ini merupakan komentar yang harus diisi oleh customers untuk meningkatkan ratting aplikasi kami. Pada halaman testimoni ini juga terdapat inputan berupa nama, judul dan isi.

D. Evaluation Againts Requirements

The evaluation process is conducted to ascertain the suitability of the user interface design of this application for the users' needs and preferences. It also determines whether to proceed to the next stage (final stage) or to revisit the processes at the previous stage in case of any misalignment with the user's requirements. The evaluation process may be repeated multiple times if the initial evaluation leads to a decision to revisit the preceding stages. It involves conducting prototype trials, actively engaging users of the Photo Studio Booking application at Rana Studio.

III. RESULT AND DISCUSSION

A. Data collection

The data collection process through interviews with five users involved direct interaction to obtain rich and contextual information. Through structured questions, we gained in-depth insights into each individual's unique experiences and perspectives on the product or service under investigation. The following are the answers from interviews the author conducted with five users.

TABLE I. BOOKING

No	Questions	Yes	No
1	Is it possible for users to understand the features in the booking display?	3	2
2	Do users encounter issues when inputting data?	0	5
3	Is there a need to improve or add any processes to the booking procedure??	1	4
4	Do the ordering steps suit your needs?	4	1
5	Do you understand the features in the dashboard and booking section?	5	0
	Total Number	13	12

Thirteen answers indicated "yes" out of five questions. On average, users found it easy to understand the provided booking features and encountered no issues when adding data. Users expressed that there was no need for improvement in the booking process, and they believed all features met their needs.

List of answers to interview questions (Booking display wireframe design):
a) On average, three out of five users think that understanding the booking features presented in the booking display is easy.
b) On average, five users found no problems and felt the booking process was made easy.
c) On average, 4 out of 5 users feel that updates in development or features are sufficient, and there is no need for further changes and updates.

d) Four out of five users in the booking process steps found it very helpful in entering data and adapting to customer needs.

e) Five users felt that it was easy to find information about bookings, and it was also easy to find information on the dashboard.

Fig. 5. Booking Final Display Design

In Figure 5, the Booking display is presented. On this page, there are input fields for name, address, cellphone number, and description. Customers are required to fill in this information for the package they will choose later. Once the input has been filled out, customers can click on "Booking," and the data will be sent.

TABLE II. TESTIMONIAL

No	Questions	Yes	No
1	Do users of the testimonial table feel that it is possible and easy?	5	0
2	Are there any problems in filling in the data in the testimonial table?	0	5
3	Is there any change to the testimonial filling feature?	5	0
	Total Number	10	5

Ten affirmative answers out of three questions indicate that users find it easy, encounter no obstacles in ordering, and appreciate all the testimonial features.

List of interview questions (Testimonial display wireframe design):

a) Five users experienced ease when filling out testimonials.

b) Five users felt that, on average, there were no problems when inputting data.

c) On average, five users in the testimonial filling feature section want the title to be removed as they consider it not too important to include.

Fig. 6. Testimonial Final Appearance Design

In Figure 6, there is a display of the Testimonial. These testimonials are comments that customers must fill in to enhance the rating of our application. On this testimonial page, there is also input in the form of name, title, and content.

TABLE III. DASHBOARD

No	Questions	Yes	No
1	Do users understand the features that have been provided?	4	1
2	Is the dashboard display attractive to look at?	4	1
3	Do users easily learn the features provided?	3	2
	Total Number	11	4

11 answers to 3 questions: users feel they understand and can learn the dashboard features provided.

List of interview questions (Dashboard display wireframe design):

a) Four out of five users find it easy to comprehend the conveyed information.

b) Four out of five users feel that it is better for the image to be on the left because it is more comfortable for the user to look at and easier to

understand.

c) On average, three out of five users feel that it is easy to learn the features on the dashboard display.

Fig. 7. Dashboard Final Appearance Design

In Figure 7, the initial display menu is presented, providing information to facilitate customers in accessing the presented information. In this display, there is a navbar with several menu options that

customers can utilize. The menus include Home, Booking, Testimonial, Options, and Contact Us. We designed the application to ensure ease of understanding for customers.

IV. CONCLUSION

Based on the results of the above data collection, it is concluded that the UI/UX display designed by the team is well-received by users. The average user comprehends the features presented by the author. By considering these aspects, the UI/UX design for the photo studio booking application can provide a satisfying user experience. The UCD method has been applied in implementing the UI/UX of this website-based shutter photo studio booking application, aiding customers in obtaining information about studio photos and the booking process, as indicated by the research results.

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Evaluating IT Capabilities in The Success of Pipe Manufacturing Company

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Abstract—Information technology (IT) management is a process that a corporation or organization must carry out, particularly in terms of data management. The research employs a case study of a pipe manufacturer that has implemented a human resources system to manage employee information. To avoid problems in the data management process that can impede company performance, the company must have good information technology governance capabilities in the data management process. This research will focus on measuring and evaluating the capability of information technology governance at the company, as well as making recommendations to improve the company's existing IT governance. The COBIT 2019 framework will be used to assess the company's IT governance capabilities using qualitative data collected from collaborative interviews with the company and supported by previous research literature. The measurement focus will be on IT infrastructure for data management and operations management to support the data management process. APO01 - Managed I&T Management Framework, APO14 - Managed Data, and DSS01 - Managed Operations are the COBIT 2019 processes to be monitored. The study's findings include the realization of IT governance capabilities in the APO01 domain and a lack of IT governance capabilities in the other two domains, namely APO14 and DSS01. The capability level is stopped at level 2 for the APO14 and DSS01 domains, which is one level below the declared aim of level 3. The recommendations will center on enhancing the IT governance skills of the two domains that fail to meet the company's capability targets.

Index Terms—cobit 2019; data management; IT capabilities; IT governance; recommendation.

I. INTRODUCTION

In today's technology-driven world, the importance of IT governance, particularly in the areas of data science and data governance, cannot be overstated. It ensures that a company's business processes are not disrupted due to data-related issues or ineffective data management. Implementing IT governance, such as the COBIT (Control Objectives for Information and Related Technologies) framework, is crucial for both private and government organizations (including state-owned enterprises) [1]. COBIT provides a comprehensive framework for managing IT effectively, optimizing technology usage, and enhancing overall company performance [2].

This research focus on the evaluation and measurement of a pipe manufacturing company known as PT. XV. The research process will evaluate the IT infrastructure readiness in data management and operational data handling within the company. The chosen domain from COBIT 2019 framework namely APO01 – Managed IT Management Framework, APO14 – Managed Data, and DSS01 – Managed Operations, serve as guidelines to assess and provide recommendations for IT governance. PT. XV with its implementation of Human Resource Information System (HRIS) as part of Human Resource Management System (HRMS), makes it an ideal subject for this research. The HRMS aligns with the selected domains, as it plays a crucial role in collecting, storing, managing, delivering, retrieving, and manipulating data for effective HR management [3].

The goal of this research is to enhance the efficiency and effectiveness of data management at PT. XV and optimize the utilization of IT to gain a competitive advantage. By implementing robust IT governance practices, the company can mitigate operational disruptions caused by data issues and improve overall performance.

II. THEORETICAL BASIS

A. Literature Review

The literature review will use descriptive analysis methodology to support the qualitative methodology approach which is conducted primarily in the form of interviews. It will analyze the electronic book "COBIT 2019 Framework: Governance and Management Objectives" published by ISACA and IT Governance Institute, along with relevant journal articles related to the research topic.

Control Objectives for Information and Related Technology (COBIT) is a framework or reference developed by ISACA (Information System Audit and Control Association) and ITG (IT Governance Institute) with the primary objective of enhancing information technology governance. It aims to assess the capability level of IT governance and provides

comprehensive guidance for enterprises and institutions to align their business objectives with those of information technology [4].

COBIT 2019 represents the latest iteration of the COBIT framework that is more flexible and adaptable for use by institutions or organizations of any size, be it large or small. It focuses on the implementation of Enterprise Governance of Information and Technology (EGIT) which contributes to the framework's adaptability and flexibility traits.

It comprises six fundamental principles that form an integral part of the governance system for a company or institution, which include [5]: provide stakeholder value; holistic approach; dynamic governance system; governance distinct from management; end-to-end governance system.

Furthermore, it introduces three new domains (measurement) in COBIT 2019, namely APO14 - "Managed Data", BAI11 - "Managed Projects", and MEA04 - "Managed Assurance" [6].

Capability level is a way to measure performance and is an integral part of the COBIT 2019 framework. It helps evaluate how well a company or institution implements IT governance systems and aligns them with their business processes. The capability level is closely linked to predefined Process Reference Models or Domains within COBIT. For Indonesian state-owned enterprises (BUMN), the government has set a benchmark (target) capability level of 3 [7]. This serves as a guideline for this research, enabling the assessed company that have implemented information technology to aim for a specific level of capability. In COBIT 2019, there are six defined levels that provide a comprehensive assessment of capability levels [4].

This level correlates with the level of maturity that can be assessed. While capability level refers to how well a company able to perform specific IT processes effectively, maturity level assess the company overall capability to manage and govern the related IT processes [8]. Therefore, maturity level will be used as the basis of measurement for assessing the capability of IT processes on PT. XV.

The Responsibility Assignment Matrix, also known as the RACI Chart, is a COBIT 2019 tool that provides a clear overview of the roles and responsibilities of individuals involved in activities or projects within a company or institution. RACI represents four key roles or responsibilities that can arise in a project or activity [2][4].

B. Previous Research

This research is based on several previous research related to evaluating IT governance in companies using COBIT framework. Table 1 details 4 previous research used as referenced.

Table 1 Previous Research

No.	Journal Article	Point of View
1	The Measurement of maturity Level of Information Technology Service Based on COBIT 5 Framework [9] *Author:* Lanto Ningrayati Amali, Muhammad Rifai Katili, Sitti Suhada, Lillyan Hadjaratie Published at TELKOMNIKA, Telecommunication, Computing, Electronics and Control Vol. 18, No. 1, February 2020, pp. 133-139	Problem statement: Measurement of Maturity Level of IT System at Universitas Negeri Gorontalo Method used: Quantitative method using questionnaires based on COBIT 5 Result: The institution has obtained a fairly good capability level as well as maturity level and there are indications that the IT service process has been well implemented and documented.
2	Evaluation Of IT Project Management Governance Using Cobit 5 Framework In Financing Company [10] Author: Rahmigina Rooswati, Nilo Legowo Published at 2018 International Conference on Information Management and Technology (ICIMTech)	Problem statement: It is necessary to measure maturity levels in the company's project management environment Method used: Quantitative method by interviews and observations using the COBIT 5 framework as a reference Result: There is still a gap in the minimum maturity level standard in the company which at that time was at maturity level 1 while the minimum standard required was level 3.
3	COBIT 5.0: Capability Level of Information Technology Directorate General of Treasury [2] Author: Dian Utami Setya, Wella Published at IJNMT, Vol. V, No. 1	June 2018	Problem statement: It is necessary to measure capability level at the Directorate General of Treasury, Ministry of Finance of The Republic of Indonesia Method used: Qualitative method by interviews and observations as well as quantitative method by questionnaires using COBIT 5 framework as a reference Result: The domain that is focus of measurement has exceeded capability level 3 but has not been

No.	Journal Article	Point of View
		able to rise to level 5 due to deficiencies in supervision restriction related to the performance of the setting and maintenance process
4	Measurement of Capability Level Using COBIT 5 Framework (Case Study: PT. Andalan Bunda Bijak) [11] Author: Dicky Sanjaya, Melissa Indah Fianty Publihed at Ultima Infosys, Vol 13, No. 2, December 2022	Problem statement: The company needs to conduct an audit of the IT governance that exists in the company using the assistance from the COBIT 5 framework to prepare the business strategy of the company. Method used: Quantitative method is implemented in this research using the audit stages of Gallegos (Planning, Field work, Reporting, Follow up). Result: There are 4 IT processes selected from COBIT 5 framework namely EDM03, APO12, APO13, and DSS05. There are 28 recommendations given to the company.

III. RESEARCH METHODOLOGY

A. Research Phases

The research that are conducted will refer to 7 phases as seen at figure 1, that has been determined and are made to support the current scope of this research.
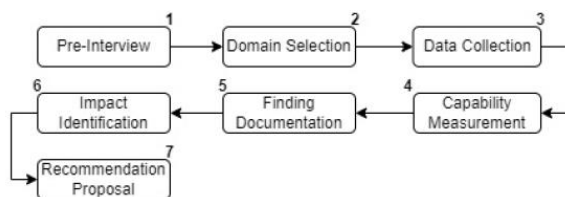

Fig. 1. Phases of Research Conducted

The first phase (pre-interview) aims to identify the company's issues related to the governance of information technology (IT) as well as to gather more in-depth information that will be used to determine the domains to be measured in the study. There will be three domains that will be selected and measured. Data collection will involve an interview with an employee that acts as a super-user of the HRIS application. Measurement will focus on finding the capability level of each domain's activity, which can then be used to measure the maturity level of said domain and finding the gap between the desired level and the level that has been attained based on the measurement conducted. Identification of possible impacts based on the findings from the previous phases will be conducted with the goal of giving recommendations to the company to help

them align their business objectives with those of information technology.

B. Data Collection

Interviews will be used as a method to collect the necessary data for reviewing and assessing the information technology infrastructure capabilities of the company, specifically in data management. This method will involve interviewing a senior member of the Human Resources and Development department at PT. XV who serves as a superuser and stakeholder of the HRIS application used by the company for data management.

The interviews will be conducted within predefined domains, namely APO01 - Managed I&T Management Framework, APO14 - Managed Data, and DSS01 - Managed Operations, to obtain the required data for the research.

IV. RESULT AND DISCUSSION

A. Pre-Interview Phase

The research starts with a pre-interview phase to identify existing IT governance issues in the company. The HRD Manager will be involved as the main source to review the company's challenges. The results of the pre-interview indicate that the company has not been able to identify problems related to enterprise goals (EG) based on the COBIT 2019 Framework used in this research, hindering the determination of specific domains to be measured based on enterprise goals. However, issues were discovered in the HRD division concerning the HRIS application used for employee data processing, including payroll and taxation.

To address these issues, the research will focus on domains related to data management, infrastructure, and operational management that support data governance. The objective is to identify the company's priority enterprise goals and measure its IT governance capabilities in the specified domains.

B. Domain Selection

The chosen measurement domains align with predefined The chosen measurement domains align with predefined Alignment Goals (AG) and Enterprise Goals (EG) in COBIT 2019. However, the company's limited awareness of potential challenges within their enterprise goals hinders the conventional approach to measuring IT capability in PT. XV. Reverse-mapping the enterprise goals through predetermined domains offers a solution. This assessment focuses solely on primary objectives within the evaluated alignment goals and enterprise goals to unveil undisclosed issues.

The domains, namely APO01 - Managed I&T Management Framework, APO14 - Managed Data, and DSS01 - Managed Operations, will be used in this research following the issues obtained during the pre-

interview phase to determine the enterprise goals that the company should prioritize.

For APO01, the alignment goals are AG03 - Realized benefits from I&T-enabled investments and services portfolio and AG11 - I&T compliance with internal policies. APO14 relates to AG10 - Quality of I&T management information, and DSS01 is connected to AG05 - Delivery of I&T services in line with business requirements. These mappings yield six enterprise goals as seen in Table 1.

TABLE 1. MAPPED ENTERPRISE GOALS

EG Reference	Goal Description
EG01	Portfolio of competitive products and services
EG03	Compliance with external laws and regulations
EG04	Quality of financial information
EG07	Quality of management information
EG11	Compliance with internal policies
EG12	Managed digital transformation programs

C. Data Collection

The data collection process involves classifying individuals based on their roles and responsibilities in specific domains through the interview conducted with the senior member of the Human Resources and Development department. In this research, there will be three created RACI tables, each for the APO01, APO14, and DSS01 domains. These tables will outline the activities from the COBIT 2019 framework and the corresponding individuals and their roles in those activities:

TABLE 2. RACI CHART APO01

Activities	HRD Head	HRD Manager	IT General Manager	IT Support System Head
APO01.01	R/C	I	A	R/C
APO01.02	A	R/I	R/C	I
APO01.03	R/I	I	A/C	R/I
APO01.04	R	I	A/C	I
APO01.05	A	R	C	I
APO01.06	C/I	C	A/I	R
APO01.07	C/I	I	R/A	R/I
APO01.08	A/C	R	I/C	I
APO01.09	A	R	C	I
APO01.10	I	C	R/C	R/A
APO01.11	C/I	I	A/C	R

Table 2, 3, and 4 detailed the result of RACI chart for each domain APO01, APO14, and DSS01.

TABLE 3. RACI CHART APO14

Activities	HRD Head	HRD Manager	IT General Manager	IT Support System Head
APO14.01	C/I	C/I	R/A	R
APO14.02	A/C	R	I	I
APO14.03	C	C	R/A	R
APO14.04	I	C	A	R
APO14.05	I	I	R/A	C
APO14.06	I	I	R/A	R/C
APO14.07	I	I	A/C	R
APO14.08	I	I	A	R/C
APO14.09	C/I	R	A	R
APO14.10	I	C/I	A	R

TABLE 4. RACI CHART DSS01

Activities	HRD Head	HRD Manager	IT General Manager	IT Support System Head
DSS01.01	C/I	C	R/A	R
DSS01.02	C	C	R/A	R
DSS01.03	C	C	R/A	R
DSS01.04	C	C/I	R/A	C/I
DSS01.05	I	I	R/A	C/I

D. Capability Measurement

The total scores for each domain's maturity level will be determined by initially calculating the scores for the sub-domains within that domain. Through this score, the capability level of each domain can be acquired, in which it will be used to acquire the maturity level of the measured domain. Equation (1) refers to the solution on acquiring the score of each activity in the measured domain.

$$Score = \frac{\sum Rating}{\sum Activities} \qquad (1)$$

Once the score of each sub-domain are acquired, the domain's Capability Level can be obtained by using Equation (2) as a reference, in which it divides the total score on those sub-domains and dividing it with the total quantity of sub-domains that existed in the measured domain. The values representing the capability level of the measured domain, derived from this equation, will be expressed as a percentage (%). These percentages can be categorized according to ISACA's level categorization standard, as mentioned earlier [12].

$$Capability = \frac{\sum Score}{\sum Sub-domain} \qquad (2)$$

Through analyzing the data acquired from interviews, applying the predefined equations, the

following assessment results for the capability levels of the measured domains are obtained.

TABLE 5. CAPABILITY LEVEL MEASUREMENT RESULTS

Sub-domain	Score (%)	Capability	Rating
APO01.01	92.50	3.56	Fully Achieved
APO01.02	76.25	2.93	Largely Achieved
APO01.03	61.67	2.37	Largely Achieved
APO01.04	93.75	3.61	Fully Achieved
APO01.05	95.00	3.65	Fully Achieved
APO01.06	95.00	3.65	Fully Achieved
APO01.07	88.33	3.40	Fully Achieved
APO01.08	95.00	3.65	Fully Achieved
APO01.09	88.33	3.40	Fully Achieved
APO01.10	85.00	3.27	Largely Achieved
APO01.11	91.67	3.53	Fully Achieved
APO14.01	41.78	1.61	Partially Achieved
APO14.02	61.50	2.37	Largely Achieved
APO14.03	14.00	0.54	Not Achieved
APO14.04	32.00	1.23	Partially Achieved
APO14.05	43.83	1.69	Partially Achieved
APO14.06	50.00	1.92	Partially Achieved
APO14.07	85.00	3.27	Largely Achieved
APO14.08	73.33	2.82	Largely Achieved
APO14.09	58.75	2.26	Largely Achieved
APO14.10	61.67	2.37	Largely Achieved
DSS01.01	82.00	3.15	Largely Achieved
DSS01.02	78.75	3.03	Largely Achieved
DSS01.03	75.00	2.88	Largely Achieved
DSS01.04	61.29	2.36	Largely Achieved
DSS01.05	49.73	1.91	Partially Achieved

Following the result of calculation on the domains Capability Level, the overall capability to govern and manage the predetermined domains or Maturity Level can be calculated using Equation (3) below:

$$Score = \frac{\sum capability}{\sum Sn} \qquad (3)$$

In Equation (3), Sn refers to the total number of sub-domains within the measured domain. Through this equation, the following assessment result can be used to determine the overall capability of PT. XV on executing the activities within the measured domain in this research.

TABLE 6. MATURITY LEVEL MEASUREMENT RESULTS

Domain	Level	Indicator
APO01	3.37	Defined
APO14	2.01	Managed
DSS01	2.67	Managed

E. Impact Identification

The result of previously conducted calculations to measure the maturity level of domains APO01, APO14, and DSS01 enables the execution of gap analysis, which involves comparing the desired level with the currently acquired level.

TABLE 7. MATURITY LEVEL MEASUREMENT RESULTS

Domain	Current Level	Target Level	GAP
APO01 – Managed IT Management Framework	3	3	0
APO14 – Managed Data	2	3	1
DSS01 – Managed Operations	2	3	1

Current results indicate that 2 out of 3 domains that were measured are unable to achieve the desired target level. Based on data collected and conducted calculations, domains APO14 and DSS01 lacks the necessary capability to accomplish activities predetermined by the COBIT 2019 Framework. Several key impacts based on the key findings acquired during the data collection phase can be identified, which can be referred to in the following tables.

TABLE 8. APO14 FINDINGS IMPACT IDENTIFICATION

Findings	
Code	Details
A14.1A	Lack of clear data management strategy and communication gaps between the IT Support System Head and the IT General Manager, resulting in a lack of user feedback and decision-making solely in the hands of the IT General Manager.
A14.4A	Occurrence of incidents where the salary calculation formula for head office employees can inadvertently change to match the formula used for factory workers, or vice versa. This issue is identified by the HRD Manager, who notices discrepancies between the data generated by the HRIS application and the expected results based on the appropriate calculation formulas.
Impact	
Code	Details
A14.1A	Potential data management errors, data misalignment, and recurring issues faced by users of the HRIS. This can hinder efficient data utilization and decision-making within the company.
A14.4A	HRIS users, such as the HRD Manager (as the source), needing to perform manual calculations and create manual salary reports to adjust salary calculations according to the latest tax formulas. This process hampers the monthly payroll process, adding complexity and increasing the workload for HRIS users. Moreover, it can lead to delays in payroll processing and potential errors, impeding the overall efficiency of the payroll workflow.

TABLE 9. DSS01 KEY FINDINGS IMPACT IDENTIFICATON

Findings	
Code	Details
D01.15A	Focus on comprehensive management of IT facilities, particularly cabling, is still lacking. However, there has been a notable emphasis on data storage facilities, such as server rooms
D01.5B	The company has yet to prioritize regular testing of power supply mechanisms to ensure uninterrupted power availability.
Impact	

Code	Details
D01.5A	Problems may arise when one of the cables used in the company encounters issues, and accessing that particular cable becomes challenging. This can result in obstacles to employees' performance when such situations occur.
D01.5A	Prolonged power limitations can disrupt company activities and lead to unexpected losses if the issue persists beyond a week as a result of natural disaster (floods, earthquake, etc.), it will require additional uncalculated resources expenses from the company..

F. Recommendation Proposal

Recommendations will be provided for domains APO14 and DSS01, based on the attached findings. In contrast, recommendations for APO01 are not required at present, as the desired level has been achieved in this study. However, for future measurements of the APO01 domain at PT. XV, if the desired level cannot be attained, a recommendation should be made. It is important to note that the future target level should exceed the current desired level (level 3), aiming for level 4 or higher for the APO01 domain.

The following are the assessed recommendations for domains APO14 and DSS01 and will be based primarily for the sub-domains with capability scores of below 2.00 as shown on Table (5). Improvement can be achieved by PT. XV by referring to these recommendations in order to achieve a higher capability and maturity level on both domains:

TABLE 10. RECOMMENDATIONS

Recommendations for APO14	
#	Recommendations
1	Implementing a strategy to manage data and enhance communication between the IT Support team and the IT General Manager.
2	Providing guidance on metadata and its impact on data quality. It is necessary to allocate responsibilities for the HRIS application within the IT division to avoid conflicting priorities in application development.
3	Consulting the vendor regarding the issue at hand, although it has been done by most employees using the HRIS, a permanent solution from the vendor is yet to be provided.
4	A review of the HRMS application vendor should be conducted to proactively prevent encountering similar issues in the future.
5	Implementing a focused data quality supervision on the HRIS application by the IT department while establishing a dedicated division responsible for data stewardship and evaluation is essential. This will effectively alleviate the workload of the IT General Manager and mitigate conflicting priorities between the JDE application and the HRIS application.
Recommendations for DSS01	
1	Conduct documentation and inspection of cabling within the company while ensuring that cables used in work areas are properly placed to minimize the potential for damage due to human error.
2	Conduct regular (weekly/monthly) testing and evaluation of the power supply mechanism, ensuring the backup power supply remains intact.

V. CONCLUSION

Referring to the results of measurements and analysis of the previous discussion, several conclusions can be drawn for this research:

- The conducted research has resulted in solutions to the problem formulation outlined in the initial stages of the study. Based on measurements using the COBIT 2019 framework, PT. XV's IT governance evaluation yielded Level 3 for APO01 and Level 2 for APO14 and DSS01 domains. Recommendations are needed to improve the Level 2 domains (APO14 and DSS01) based on observations and data collection, considering PT. XV's current situation.

- To achieve the desired level of capability, recommendations have been made for the company in order to improve their capabilities in the assessed domain.

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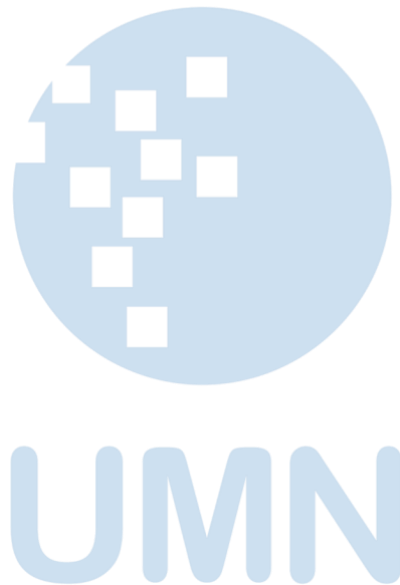
Stakeholder Analysis Using The Enhanced Salience, Power-Interest, and Stakeholder Cube Diagrams

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Abstract— **Parties impacted by a project, both positively and negatively, are considered stakeholders. These stakeholders' expectations must be appropriately handled during a project, and a project manager is crucial in ensuring that their interests are met and balanced. Stakeholder analysis must be conducted in detail. To uncover fresh insights that might have been obscured by the stakeholder data, it also needs to be backed by the appropriate resources. The existing stakeholder analysis methods are predominantly qualitative, raising concerns about their ability to uncover all relevant insights effectively. Consequently, there's a risk of overlooking crucial stakeholder expectations and interests. To address this issue, two key enhancements are proposed. Firstly, salience diagrams are enhanced through the application of vectorization techniques, aimed at providing a clearer and more accurate visual representation of stakeholders' significance. Secondly, power grid diagrams benefit from the integration of Gartner's magic quadrant concept, facilitating a more precise evaluation of stakeholders' relative power and interest. These improvements enable the project team to make better-informed decisions and tailor strategies more effectively to interact with stakeholders. Ultimately, they lead to a deeper understanding of stakeholders' impact on the project and ensure that project outcomes are optimized for the benefit of all involved parties. In the end, these enhancements will provide the project team with the ability to decide and adjust their strategy to interact with each stakeholder efficiently.**

Index Terms—**Project management; stakeholder management; salience diagram; power grid.**

I. INTRODUCTION

Stakeholder analysis has been included in the Project Management Body of Knowledge (PMBOK) handbook since its fifth version, published in 2013 [1]. This means that the world project manager community views understanding stakeholders as one of the keys to the success of a project.

The stakeholder analysis included in PMBOK adopts three tools that assist the project manager and his team in carrying out the analysis process. The three tools are the power-interest grid, the stakeholder cube, and the salience model [2]. So far, these tools have been quite helpful in the qualitative analysis of stakeholder positions, the results of which can be used as a reference in determining appropriate action plans as part of a stakeholder management strategy to be implemented in a project.

But even so, the methods of using these three tools can still be improved so that they involve numbers that indicate the degree of measurement in the units or metrics they use, and these numbers can then be mapped more clearly so that they can show the position of stakeholders in their quadrants. more precisely.

In this study, improvements were made to these tools to be more effective when used in project management. The results of improving these analytical tools are expected to be able to better support decision-making related to stakeholder management strategies.

Stakeholders have various definitions, ranging from narrow to broad. However, the most appropriate definition is "all those who impact and are affected by an organization's strategic policies" [3][4].

The Project Management Institute, an international project manager organization then formulates it as "all parties who are affected positively and negatively by a project initiative" [1]. This is included in the fifth version of the standard book and project management guide (PMBOK guide).

Stakeholder management, especially management of expectations, plays an important role in a project. In some cases, stakeholders from the client or user side may have unexpected and different wishes from what the project manager had in mind. Even under certain conditions, it is possible that a project that fails to meet the process performance success criteria can be declared successful because it meets the product performance success criteria according to its stakeholders [5].

In the organizational hierarchical structure, stakeholders have levels that indicate the size of the power and influence. Intensive communication in projects is important, especially for stakeholders closest to the project manager and with the greatest

potential for support, one of which is project sponsors [6].

Stakeholder analysis has an essential function especially when project leaders must implement the management strategy appropriately [1]. The tools used in the analysis process, such as the power-interest grid, stakeholder cube, and salience diagram provide the project team with the correct picture and measurement. The direction in which desires and interests are moving can be identified and indicate the direction that project leaders must take to support the smooth running of the project [7].

The principal aim of this study is to improve the efficacy of stakeholder analysis instruments frequently employed in project management, namely those specified in the PMBOK manual [1]. Even while methods like the salience model, stakeholder cube, and power-interest grid are useful in qualitative analysis, there is still room for development. The goal is to give project managers better insights into stakeholder positions and enable more informed decision-making on stakeholder management methods by adding numerical metrics to these tools and improving their mapping procedures [7]. In the end, the goal of the research is to enable project teams to better comprehend and cater to stakeholders' expectations and interests, which would improve project outcomes.

II. METHOD

The method used here is according to the stakeholder management method listed in PMBOK version 7. The following is the flow of the method used (Fig. 1).
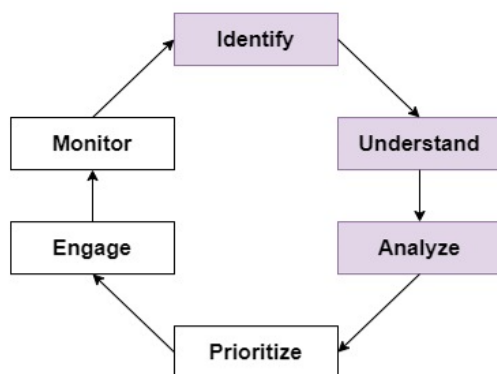

Fig. 1. Stakeholder management method [2].

Three crucial phases make up the process of conducting a stakeholder analysis: identification, understanding, and analysis. The identification phase, which comes first, is like putting out a wide net to catch every possible recipient or influencer for the initiative. It entails identifying peripheral stakeholders whose interests might overlap with the project's scope in addition to those directly involved. This is a foundational phase since failure to include important stakeholders could result in major oversights or

misalignments in the planning and execution of the project.

The understanding phase dives deeper into the complex nature of stakeholders after identification. At this point, the emphasis switches to obtaining thorough insights into the traits, drives, and relationships of the stakeholders. This calls for a careful analysis of several variables, including their degrees of authority and influence within the project ecosystem, the kind and extent of their influence, their inclinations as individuals, and the underlying goals and interests that motivate their participation. This stage plays a crucial role in shedding light on the many viewpoints and possible motivators influencing stakeholder interactions and expectations.

The analysis phase then takes all the data gathered in the identification and understanding phases and combines it to create insights that can be used. Here, systematic procedures and analytical tools are used to examine the characteristics and dynamics of stakeholders. This entails evaluating prospective roles and contributions from stakeholders as well as mapping their locations, relationships, and relative value within the project landscape. The analysis phase provides project teams with the clarity and foresight required to build targeted plans and successfully minimize any risks or disputes by condensing complicated stakeholder data into actionable insight.

All those three phases are usually done qualitatively. This study focuses on how to enhance the tools used to gain more detailed results in a semi-quantitative way.

III. RESULT AND DISCUSSION

To identify, we can use the stakeholder register form which contains the following elements:

TABLE I.   ELEMENTS ON THE STAKEHOLDER LIST FORM [8].

No	Element
1	Name
2	Position / Role
3	Contact Information
4	Requirements
5	Expectations
6	Impact (High, Medium, Low)
7	Interest, scale: (1-5)
8	Power, scale: (1-5)
9	Attitude, scale: (1-5)
10	Legitimacy, scale: (1-5)
11	Urgency, scale: (1-5)

The attributes explanation is described below:

1. Name: name of the stakeholder.
2. Position/Role: position in the organization.
3. Contact Information: email address or phone number of related stakeholders.
4. Requirements: requirement from related stakeholders that needs to be implemented in the project.

5. Expectations: what the stakeholders want from the project outcome.
6. Impact: stakeholders' impact on the project.
7. Interest: the level of concern or stake that a stakeholder has in the project's outcomes.
8. Power: the extent of influence or control that a stakeholder holds over the project.
9. Attitude: the disposition or perspective towards the project.
10. Legitimacy: the perceived appropriateness or validity of stakeholders' claims, interests, or involvement in the project.
11. Urgency: immediacy with which stakeholders' needs, concerns, or expectations must be addressed.

The stakeholder's factors (no. 7-11) are measured on a 1-5 scale, where 1 represents lowest or least significant and 5 represents highest or most significant.

After we get the data related to the stakeholders in a table with the elements above, we can proceed to the analysis stage. The tools raised in this research have often been used in the stakeholder management activities of a project. These tools support qualitative analysis to map the positions of stakeholders, where knowledge of these positions can assist project leaders in determining and implementing appropriate strategies in approaching stakeholders (stakeholder engagement).

The effectiveness of these tools can still be increased, this is what will be reviewed in this section.

A. Enhanced Power-Interest Grid

This analytical tool maps two elements of the characteristics of a stakeholder, in this case, the level of power and the level of interest. From the data obtained, the following is the mapping performed on the initial version of the power-interest grid.

The following is an example of data used in mapping on power-interest diagrams and stakeholder cubes (Table 2). Parameter assessment (P, I, and A) uses a scale of 1-5 (Table 3). This data is synthetic data, which has already been coded and given the values of P, I, and A. This data has been made to be as representative as possible of the project data used in the actual project environment.

In Fig. 2 we map the stakeholder groups listed in Table 2 onto the original power-interest grid diagram. The power-interest grid has two axes, where the Y axis represents the power factor, and the X axis represents the interest factor. From the left to the right, the interest factor spans from lowest (1) to highest (5), while from bottom to top, the power factor spans from lowest (1) to highest (5).

The group that is mapped is the top management group. Here we can see that the dominance of this group is in the upper right quadrant which can be interpreted that this group possesses high power and high interest in the project's success. The suggestions for action that need to be taken (Fig. 3) are strict management of both information and the wishes of the stakeholder group [9].

In Fig. 4 we apply one improvement to the original diagram, namely by adding the average line. The dotted red line shows clearly which way the weights of the combined power and interest levels move. From Fig. 4 it can be observed that the direction of the weight of the power-of-interest level of the stakeholder group is to the upper right quadrant. The quadrant formed from the average line is somewhat different from the original quadrant. From this composition, we can re-prioritize the ranking of stakeholders within a group.
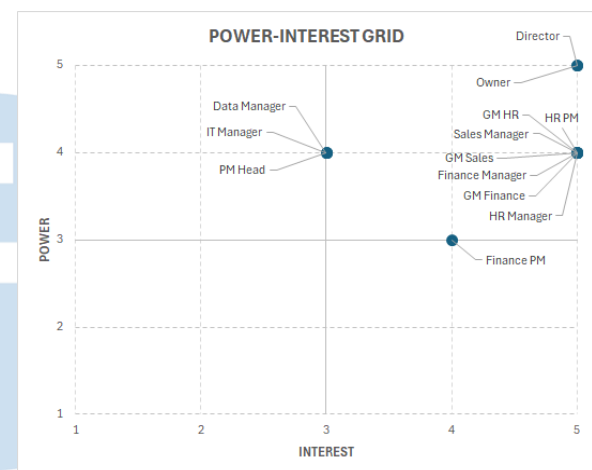
Fig. 2. Mapping part of the stakeholders on the original power-interest grid.

TABLE II.   THE DATA USED IN THIS STUDY.

No	Code	Role	Power (P)	Interest (I)	Attitude (A)
1	OWN	Owner	5	5	3
2	DR	Director	5	5	4
3	ITM	IT Manager	4	3	1
4	GMF	GM Finance	4	5	4
5	GMH	GM HR	4	5	5
6	GMS	GM Sales	4	5	3
7	MF	Finance Manager	4	5	5
8	MH	HR Manager	4	5	5
9	MS	Sales Manager	4	5	3
10	PM1	PM Head	4	3	1
11	PMF	Finance PM	3	4	4
12	PMH	HR PM	4	5	5
13	MD	Data Manager	4	3	3
		Average	4.08	4.46	3.54

Fig. 3. Suggested approaches from the original power-interest grid model.

In the Fig. 4 diagram, the roles of Data managers, IT managers, PM heads, and PM finance can be given lower priority weights than Owners and directors in the first group. Also, relatively lower than GM Sales, HR and Finance, HR and Finance Managers, and PM HR in the second group.
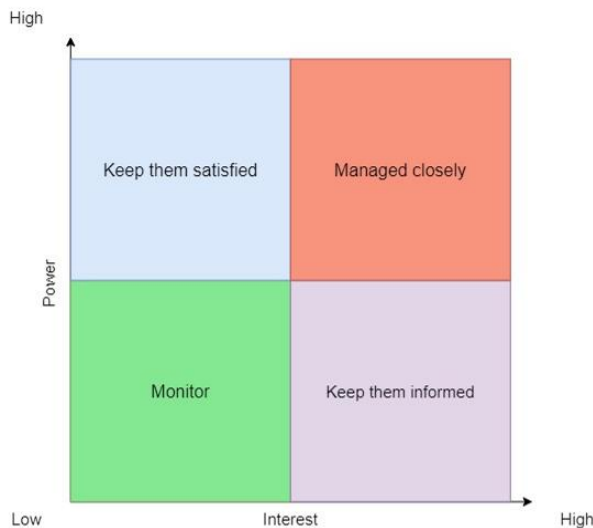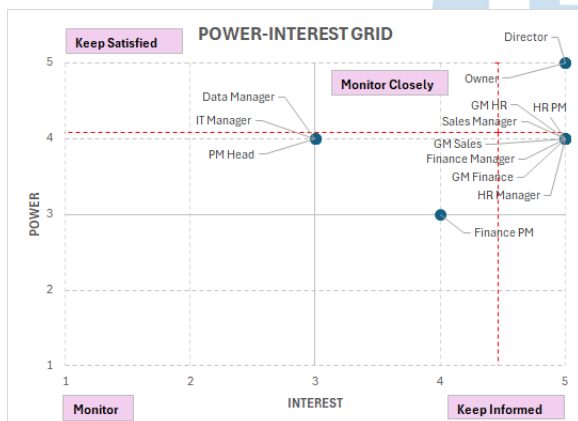

Fig. 4. The same mapping *was* implemented on *an* enhanced power-interest grid.

The addition of the dotted red average line in the power-interest grid adds certainty to the trend direction which will greatly assist us in determining the right general action in engaging and managing the stakeholders. The average value of the parameters P and I can be seen in Table 2. In the analysis stage of stakeholder management, this average line helps to visualize the weight of the overall stakeholder's power and interest, thus this will allow the team to decide which stakeholder engagement strategy to focus on the project and on which group of stakeholders the strategy should be targeted.

B. Enhanced Stakeholder Cube

The stakeholder cube is a multidimensional tool utilized in stakeholder analysis to comprehensively evaluate stakeholders' attributes and dynamics. It involves three key dimensions: interest (x), influence (y), and power (z). The interest axis denotes stakeholders' level of concern or vested interest in the project's success. The influence axis indicates stakeholders' capacity to impact project processes and outcomes. The power axis represents stakeholders' ability to influence project decisions and outcomes. Each stakeholder is positioned within the cube based on their level of power over the project, their level of interest in the project's outcomes, and their influence on project decisions.

In this tool, the improvements made are the same as in the power-interest diagram, namely the addition of an average line, but it is applied to a three-dimensional plane. The following is an example of a typical stakeholder cube diagram that maps out the same group of stakeholders (Fig. 5). The stakeholder cube in principle is a power-interest grid with one more axis added, namely the level of behavior (attitude) so that it becomes a three-dimensional power-interest-attitude mapping. The data used in this mapping is the data in Table 2.

The addition of the average plane, where the point of intersection is represented by a blue dot, shows the direction of the trend of the position of the stakeholders. From this position, we can conclude that the stakeholder group that we mapped has a high level of power and interest, but behavior that is only slightly above neutral.
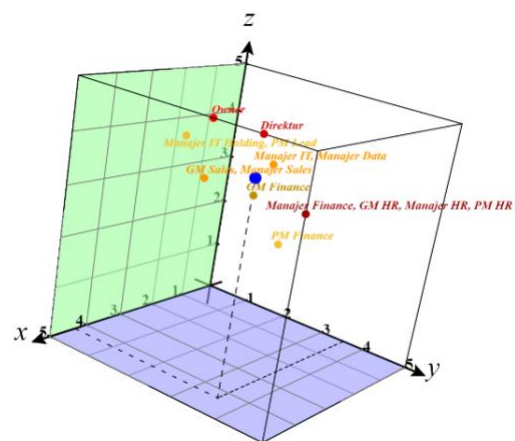
Fig. 5. Enhanced stakeholder cube, mapping the interest (x), attitude (y), and power (z).

This means that in carrying out the stakeholder engagement and management strategy, we need to prioritize increasing the level of behavior, where some stakeholders whose behavior values are below neutral (3) become above neutral (> 3) so that the blue dot becomes closer to the top corner (x= 5, y=5, z=5).

C. Vectorized Salience Diagram

The salience diagram was known to be able to map stakeholders into eight characteristics (Table 3).

From these characteristics, we can determine the approach strategy for each party.

Most of the articles and blogs that discuss the use of the salience diagram only describe descriptively the mapping of stakeholders, so it seems there are no definite measurements. There is only one template obtained from a search on the internet regarding the application of the salience diagram which sufficiently involves a semi-quantitative assessment, although the range of values given is only 0 to 1 for each parameter of power, legitimacy, and urgency. We also use this as a basis for classifying stakeholders, but the range of values is widened to a scale of 1 to 5 (Table 3).

TABLE III.   EIGHT CHARACTERISTICS OF STAKEHOLDERS IN THE SALIENCE DIAGRAM [10].

| No. | Characteristics | | | Classification | Action |
	P	L	U		
1	1	0	0	Latent/Dormant	Monitor
2	0	1	0	Discretionary	Monitor
3	0	0	1	Demanding	Keep them informed
4	1	1	0	Dominant	Keep them informed
5	1	0	1	Dangerous	Keep them satisfied
6	0	1	1	Dependent	Managed closely
7	1	1	1	Core/Definitive	Managed closely
8	0	0	0	Non-Stakeholder	Don't manage

The parameters of power, legitimacy, and urgency are explained as follows:

1. Power – Related to how much influence and impact a stakeholder can have on the results of a project [10]. It can also be defined as a person's position to others in an organization, where the higher the position the person has the greater the power to make other people do what they are told [4].

2. Legitimacy (Legitimacy) – Related to how much authority the stakeholders have [10]. Or in another perspective, the level of acceptance of the actions taken by a party within an organization, where the higher the level of acceptance from all parties, it can be said that the party acting has high legitimacy [4].

3. Urgency (Urgency) - Related to how much sensitivity to time and the level of criticality of project work. A stakeholder who always emphasizes the speed of response, and timeliness and considers the project critical can be said to have a high level of urgency [4].

In practice, each project may have different characteristics that affect these three parameters. In some regions or countries, maybe the power parameter dominates more, and company culture also influences the dominance weight of each parameter [11].

The salience diagram pattern used in the project has the shape shown in Fig. 6.
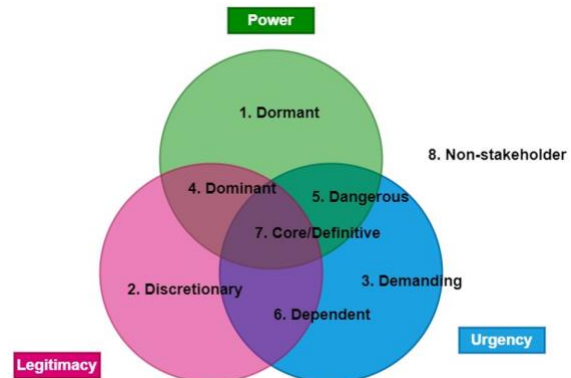

Fig. 6. Mapping parameters of power, legitimacy, and urgency along with their intersections [4].

Mitchell [4], only explained that the above diagram is qualitative, which then describes a detailed review of the characteristics of each stakeholder category (numbers 1-8). In this research, we proposed a vectorized salience diagram. It is an enhanced salience diagram that is added with an element of scale to measure the level of power, legitimacy, and urgency of each stakeholder in a more detailed manner, and a sense of direction that comes along with the vector characteristics.

The implementation of the vector to the salience diagram adds a visual indicator of how strong the classified characteristics go and the direction in which characteristics go along. Finally, we could also do a vector operation on the model and get the resultant which shows the combined characteristics and its magnitude.

The functions of adding the scale and direction include:

1. Provide a graded quantitative reference, by which the analyst can determine the position of stakeholders within a representative spectrum.

2. Clarify measurement metrics. Of course, a scale of 1-5 will provide a broader perspective than just 0-1.

3. Incorporating vector operation in the parameter mapping of each stakeholder, where the resultant vector will show the direction of the relevant stakeholder category, complete with instructions on the magnitude of the trend [12].

The following is an example of mapping the parameters of levels of power, legitimacy, and urgency using the vectorized salience model (Fig. 7 and Fig. 8).
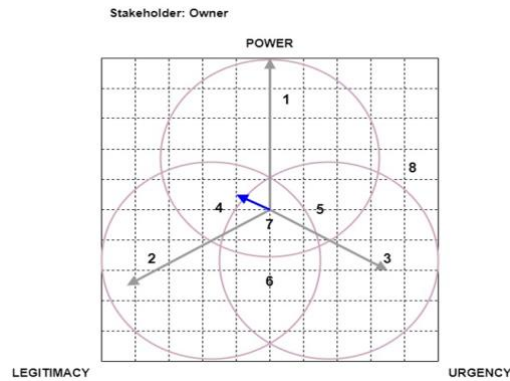
Fig. 7. Vectorized salience diagram of stakeholder with owner role.

In Fig. 7, the stakeholder whose parameters are mapped is the owner, who has parameter values as shown in the following table (Table 4). It shows the value of each factor (power, legitimacy, and urgency) along with their coordinates (X, Y) in the 2D plane as shown in Fig. 7. The coordinates value for legitimacy and urgency is calculated with formulas (1) through (4).

The resultant vector shows two competing strong factors of the Owner, which are power and legitimacy. While the short magnitude of the resultant shows significant strength on the urgency factor. Stakeholders with this kind of characteristic can be considered a high priority to be managed. The action to be taken from Table 3 should be "managed closely".

TABLE IV. PARAMETER MAPPING FOR THE OWNER ROLE.

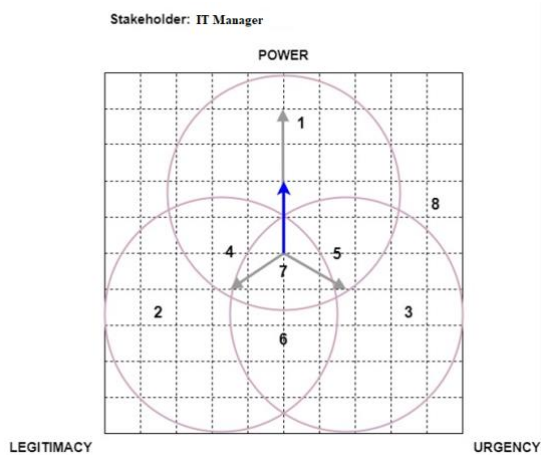|	Stakeholder: *Owner*		
	Value	**X**	**Y**
Power	5	0	5
Legitimacy	5	-4,33	-2,5
Urgency	4	3,46	-2
Resultant		-0,87	0,5

Fig. 8. Vectorized salience diagram of stakeholders with the role of Holdings IT Manager.

The owner gets the results of a row of 5, 5, and 4, for power, legitimacy, and urgency. The X and Y

values are their vector mappings to cartesian coordinates. The power vector $(\vec{p})$ is aligned along the Y axis, which means that the value of X = 0, and the value of Y ranges from 1-5. The legitimacy vector $(\vec{l})$, will point 120° counterclockwise, where the X and Y values follow the following formula:

$$X = - (legitimacy \times \cos(-30°)) \quad (1)$$

$$Y = legitimacy \times \sin(-30°) \quad (2)$$

The urgency vector $(\vec{u})$, will point 120° clockwise, where the X and Y values are calculated using the following formula:

$$X = urgency \times \cos(-30°) \quad (3)$$

$$Y = urgency \times \sin(-30°) \quad (4)$$
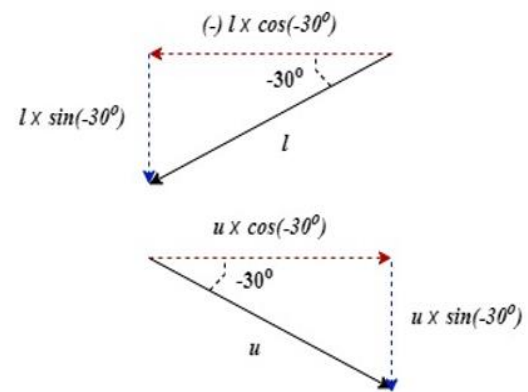
Fig. 9. Illustration of vectors $(\vec{l})$ dan $(\vec{u})$ along with their x and y components.

TABLE V. PARAMETER MAPPING FOR THE IT MANAGER ROLE.

	Stakeholder: *IT Manager*		
	Value	**X**	**Y**
Power	4	0	4
Legitimacy	2	-1,73	-1
Urgency	2	1,73	-1
Resultant		0	2

The second example is shown in Fig. 8 which plots the IT Manager factors into the coordinates. The resultant vector which is colored in blue keeps pointing upward towards the power factor but with a slightly lower magnitude than the power vector. Its factors value and their coordinates are shown in Table 5. It shows that the most dominant is the power factor.

Vectors have advantages in their characteristics, namely being able to show magnitude and direction. Vectorization of stakeholder identification data related to the parameters of power, legitimacy, and urgency allows us to obtain an accurate indication of the direction of the stakeholder category along with the magnitude of the trend. Directions give us greater certainty about the positions of relevant stakeholders

and which factors are dominant in the related stakeholders.

The use of a scale of 1-5 makes the level of granularity more precise. If with a scale of 0 and 1, we will only get direction vectors that are fixed in certain directions, and with a certain magnitude, then with a scale of 1-5, our vectors have a more varied range of directions and magnitudes and can reach to 360° from the center point, or in other words in all directions. This combination of direction and magnitude can help to show more precisely, because in practice each stakeholder has a certain level of each parameter, and the combined values of these levels would form the final characteristic value. We can see this from Fig. 7, for example where the resultant vector ($\vec{R}$) which is blue leads to the dominant classification (4) but is not too strong, in fact, it almost enters the core/definitive classification (7).

From Fig. 8, it can also be seen that the resultant vector ($\vec{R}$) points perpendicularly upward and makes the stakeholder with the position of IT holding manager dominant in the power factor. If we use the previous version of the salience diagram, certainly this kind of stakeholder will fall into the latent/dormant classification (Table 3). However, from the value of the resultant magnitude, it can be seen that its other two factors are still quite strong because the resultant magnitude value shows closeness to the core/definitive classification area which proposes the action of "manage closely".

IV. CONCLUSION

The following are the things that can be drawn as a conclusion from this research:

1. The application of calculations and mapping of the average value of each element in the power-interest grid and stakeholder cube add clarity to the tool and can assist project managers in seeing the direction of trends that dominate the stakeholder population of a project. However, for the stakeholder cube, the visualization is a little bit complicated because of the mapping effect of 3D coordinates to 2D canvas. Users need more effort to spot each of the points plotted on the three-dimensional coordinates.

2. The application of vectorization to the salience diagram also adds clarity to the tool. It makes the diagram more detailed in determining the position of stakeholder classification in the trigram quadrant. The resultant vector from the sum of the three vectors of the power, legitimacy, and urgency parameters has wide variations and can point to 360° directions in the quadrant trigram salience diagram. Besides that, it is also able to show the value of the quantity that represents the level of each parameter. This causes the mapping to be more accurate in showing the stakeholder classification. However, this enhancement also brought additional effort in drawing the vectors. It is very easy to draw the vectors manually on paper

using a ruler and protractor, but it will be quite difficult to draw them on Microsoft Excel or graphics tools such as *draw.io.*

Overall, the enhancement of those three tools brought positive effects such as more clarity, quantification, and more detail added to the existing method.

The enhanced tools in this study can be applied to project management information systems for further research, especially to the stakeholder management module as a component of the analysis dashboard visualizing the data with these enhanced tools.

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Utilization of Game Techniques as a Test Tool to Measure Persistence of Applicants

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Abstract—**This research was conducted at PT. XYZ, which utilizes the game elements in the process of psychological test. This game-based test is intended to measure the persistence of applicants (management-trainee position) and to replace Pauli Test, which is administered through a paper and pencil test method. Results of the game-based persistence test are proven to have a positive correlation with the measurement of persistence in the measurement of persistence on the Pauli Test (p-value <.05, koef. Correlation (+)). This project was developed using iOS platform from Apple, which automates the process of psychological test by applying Computer Based Test (CBT) which uses iPad media.**

Index Terms—**Computer Based Test; Game; Persistence; Psychological Test**

I. INTRODUCTION

The development of technology that is accompanied by the increase of business competition has pushed almost every organization to innovate and provide added value in supporting the daily business processes, including the recruitment process of human resources (HR). By viewing the needs of growing business, PT. XYZ is constantly trying to get superior human resources and qualified (high quality talent). Superior human resources and qualified can be seen from the beginning of the recruitment process through a series of tests given in the selection process such as: ability test, personality test, and persistence test.

The main issue often faced by HR recruitment section is the process of recruiting candidates, which is long and complicated. The selection process in the form of Pauli Test is to measure the persistence of candidates. It is still paper-based because Pauli Test or also known as paper test is using a similar answer sheet to paper size. Psychological test results on the answer sheets are then checked manually which of course require quite long and complicated administrative work. Besides, the accuracy of test results is potentially inaccurate due to human error and fatigue in conducting examination manually.

To innovate in the process of persistence test, then it is required a new breakthrough in providing new test instrument using computer technology. [1] Shows the relationship between Video Game and the measurement of persistence performance. Persistence can be measured by recording the time spent for the unsolved game. [2] States that the use of media such as paper or the use of technology do not give any effect to the validity of test results. Therefore, the implementation of game-based test by including elements contained in the game is expected to be used as a substitute for Pauli Test, so that it can shorten the selection process of prospective employees at PT. XYZ. Besides, this instrument of game-based test can measure the persistence of applicants and have a positive correlation with the measurement of persistence in the Pauli Test (p-value <.05, koef. Correlation (+)).

The game genre used as a test in this research is the puzzle game. Puzzle games are games that require the player to find a solution to a problem while still adhering to a set of game rules. Usually, puzzle games rely heavily on logic which involves a timing element and requires quick thinking. Therefore, this puzzle game genre is used to replace the Pauli test, where the Pauli test is intended to determine a candidate's level of persistence, accuracy and speed when facing a problem.

II. LITERATURE REVIEW

A research of [3] states that the game can be used as a test instrument to determine a person's level of persistence. In the study, the measurement of persistence was using Anagrams and Riddles. Games consist of two levels of difficulty namely easy and hard. The time needed to complete each game is 120 seconds. The failure in every game is due to unsuccessfully complete within 120 seconds at a particular level. The game at that level is still possible to be repeated in 120 seconds. The persistence assessment is only done on a game that fails to be solved (unsolved) generally occurring in the game with a level of difficulty (hard). The assessment is based on the length of time in which someone plays the game before doing repetitions or finally timed out.

The time spent by participants to work on unsolved game increasingly decreases in the overall game. It occurs due to fatigue or participants choose 'skip' on the game level that is deemed difficult to resolve. Persistence is measured by recording the time spent on unsolved anagrams and riddles. The time spent on unresolved issues correlates with the standard of persistence.

The test used [1] as a measure of performance-based persistence is through Anagram Riddle Task (ART), which measures how long participants spend the time in completing difficult tasks. ART is provided online via internet and the anagram is presented with a level of difficulty (hard) and (easy) and accompanied by a series of puzzles test that must be answered one by one.

The tasks performed by the participants are among others to type their response for anagram or riddle into a text-box and then press the "guest" button. If the answer is wrong, the screen displays "incorrect" and the individual can try again until the time limit of 120 seconds is reached.

Any time, the individual can also choose to press the "skip" button if he wants to leave the task level and go to the next level. If the individual can guess correctly, then it will be is presented with a new task level. A trial is classified as "solved" if someone accurately solves a given task. The trial is classified as "unsolved" if someone skips to the next level or past the deadline after 120 seconds. The reason why allows participants to "skip" when he gets a difficult task is to see the extent to which a person survives on difficult issues when he is given the option for not survive.

The research method of [4] was conducted to 102 students enrolled in the program of educational psychology at Florida State University to participate in this study. The majority (81%) of the sample were female (n = 83). Students followed all assessments and Anagram Riddle Task (ART) via online according to the time of the students themselves. The instruction given to participants is that they must solve as many as possible anagrams and riddles provided. Participants were also told that some of the anagrams and riddles will have a hard difficulty level and if they cannot solve the anagram, they have the option to "skip" to the next level. Participants are not timed, but there is a limit of 2 minutes on each level. If the limit of 2 minutes is passed, then the participants will be presented with the next level.

In this study, the students were asked to complete ART consisting of 28 anagrams and 20 riddles. Anagram is a series of letters that can be rearranged to form a word. For example, the switched letters of YBO can be rearranged to be BOY, so that they have other meanings. The student task is to rearrange the letters into a word. Some words have a level of difficulty that is difficult and should be tried to do our best in order to form a word from the anagram. All of the anagrams are made by ourselves so that they will not find the answers via online. Among the anagrams,

there are 12 anagrams with hard levels and 16 easy levels, where the level of difficulty is determined by the pilot work. Anagram of hard level is derived from the words that are rarely obtained from the dictionary. Since the anagram is only in the form of character (string), then the answer cannot be found on the web via online.

Students were also asked to answer 20 riddles. All riddles are also made by ourselves, so the answer cannot found via online. Among the riddles, there are 12 hard levels and 8 easy levels. All of the riddles are also made by ourselves to ensure that participants will not get the answer on the web.

If students have any difficulty to solve the anagrams or riddles, they are allowed to pass the level by pressing the "skip" button. The combination between anagrams and puzzles with hard and easy difficulty levels is intended to ensure that participants do not get too frustrated which can disrupt the persistence aspect. In addition, for hard level, it does not mean that it cannot be solved at all, but it is truly able to be solved. The selection on the sequence of hard and easy level is done by ensuring not too many hard levels consecutively and Anagram Riddle Task is presented in four blocks.

For the results of report with a high variability in the testing process of ART, then it is made a log that calculates all the time data during the testing. In addition, it is also conducted a recording on the number of trials that are successfully solved for the anagrams and riddles. The total of anagrams successfully completed is more significant than the riddles that are successfully completed. Moreover, the time of unsolved anagrams is not significantly different from the time of unsolved riddles, but the completion time of solved anagrams is shorter than the completion time of riddles solved. During sampling, the hard difficulty level was successfully completed by 24%, while the easy level was solved amounting to 95%.

The result obtained from this study is unsolved ART that significantly correlates with the standard of persistence. Therefore, the length of time a person spends time on a difficult problem to be solved, and then the higher level of persistence is reported.

The results of this study have shown that playing the game can make a person more "resilient". [5] Writes in the Harvard Business Review about the people who regularly play games that can be better problem solvers, more collaborative, and unlikely to give up easily. In other words, the game can make people more resilient.

Playing digital games has been shown to be positively related to a variety of cognitive skills [3] [6] attention [7], personality traits [4] [8] [9], persistence [1], academic performance [3] [10], and civic engagement [11].

According to [12], games provide a potentially valuable tool because they provide opportunities for

cognitive and metacognitive engagement and are typically highly motivating. [13] show strategic video games promote self-reported problem-solving skills. And [14] provides empirical evidence of a highly specific use of games in education¬ the assessment of the learner. Linear regressions were used to examine the predictive and convergent validity of a math game as assessment of mathematical understanding.

[15] builds an evidence model for the assessment of persistence from Poptropica, a popular commercial game for children. Task persistence is an important skill related to successful school and work outcomes, particularly given new, complex tasks requiring sustained application of effort. Evidence extracted from log files of the game was used to identify players with a particular goal and then create a measure of persistence toward that goal. Task persistence is defined as continuing with a task despite obstacles or difficulty.

According to [16], persistence can play an important role in learning in a video game due to the design principle of challenge in well-designed games. [17] showed that trying to complete difficult tasks can improve persistence. Participants were randomly assigned to solve impossible, hard, or easy anagrams and then take the perceptual comparison task where they were asked to detect as many differences as possible between two pictures.

Research from [18] states that challenge in video games has some association with positive reactions to failure. [19] states that digital games can be used as vehicles for measuring and enhancing persistence. Study from [20] states that game failure facilitates persistence when players can identify a purpose. [21] states that gaming and interactivity have been suggested as essential features in increasing persistence in online learning. Experiment from [22] shows that participants who experience setbacks and defeat multiple times still show interest towards playing a game that has challenging gameplay.

III. RESEARCH METHODOLOGY

In this study, the writer analyzed the application of Game Based Test as a replacement for Pauli Test because based on the findings, the implementation of Pauli Test takes a fairly long time. The test process lasts for 60 minutes and the examination of Pauli Test results takes 5 minutes per answer sheet. In fact, one of the essential elements in the recruitment process of HR is the speed of announcement on the test results in order that candidates can immediately know whether they pass the test or not.

As shown in figure 1, the framework for this research begins with identifying problems that occur in the process of implementing the Pauli test, collecting data which is summarized for analysis using qualitative data analysis through several interview questions, analysis of test results, and recommendations.

In the development of Game Based Test, is required stages starting from an idea into a game that can be played. In this study, there are four stages should be passed for designing a game, namely: (1) Game Concept. The earliest stage in the creation of a game is to determine the purpose and theme of the game that will be made (adventure, puzzle, simulation, or others). This stage begins with conducting a research and preparation of basic concepts. Before starting to make games, then it is determined what kind of game concepts will be created, the number of players, how to play and what will make people happy to play this game. The main point at this stage is also formulated the patterns, rules or mechanisms of how the interaction process of players with the game that will be created. (2) Pre-production. This stage begins with the preparation of various technical matters relating to the game that will be created, for example, what media (platform) will be used, the programming language, determining the level of design or classification of difficulty level as well as various appropriate assets at each level in order that the game can bring an optimal gaming experience. This stage includes determining all of characters as well as the assets needed such as characters, sound/music, the kind of graphics will be used (cartoons, semi-real or real), to increase the interest of players towards the game created. Besides characters, at this stage is also created a game scenario using the characters determined before. Scenario in a game is very important in order that people playing games (player) will be directed in accordance with the scenario that has been made and to ensure that players do not get bored. If the game is too difficult, the player is likely to be lazy on the contrary if it is too easy, the player will become bored and less challenged, so that it requires a dynamic scenario and can adjust to the player's ability and the emergence can be random. At this stage, a prototype/dummy is presented to test the gameplay as well as various concepts that have been arranged, both in each level and overall, as well as perform various improvements required. This stage also serves to provide a complete overview so that it can facilitate the process of further development. (3) Production. Production stage is the stage where the game is developed into a product that is ready to use. In this stage, a lot of work is done, among others, the creation of all game assets, to implement all of assets into the game and including to conduct trials in the game. The main points in this stage are the entire concepts (characters and assets) that previously had been arranged, are started to be fully developed, the game engines are started to be developed and all the elements are started to be integrated. (4) Post-production. Post-production stage is the last stage in the process of game development. At this stage, it should be ensured that all major components of the game have been able to provide user experience as expected, as well as to detect any technical problems that have not been detected at the previous stages. If all are finished, the production of this game is ready to be implemented to users.
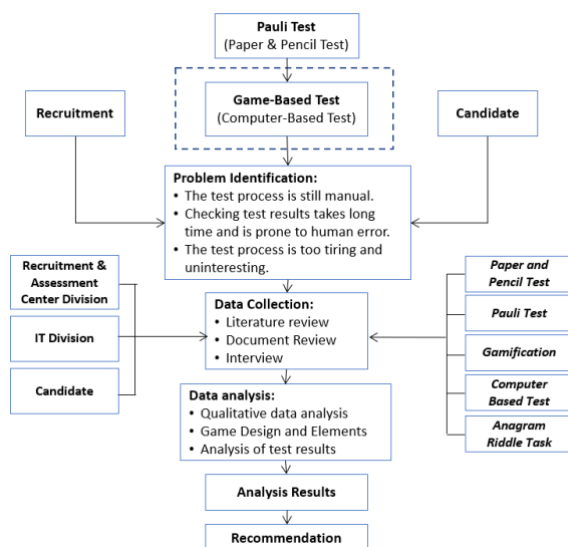
Fig. 1. Conceptual Framework

To conduct an evaluation on the Game Based Test, it will be used the type of puzzle game where the number of questions consist of 30 levels with 3 levels of difficulty, they are: 12 questions of easy level, 8 questions of medium level and 10 questions of hard level. The level cycle is not presented increasingly difficult (incremental), but it is combined between easy-medium-hard to rebuild the spirit of the participants in doing the puzzle test, because the goal of this game is to assess persistence as seen from the efforts to complete the task successfully. Although there are many obstacles, but they keep trying to complete the task. However, they are still allowed to skip levels if they do not want to continue their efforts.

Level with hard difficulty level is not intentionally made into a level that cannot be solved (impossible) but it is made into extremely hard level to ensure that all levels can be solved by the participants. This game application has already been developed with tools XCode 5, programming language Objective C, storage Core Data and library/engine Cocos2D-iPhone 2.1. The development of this application has been done using the native language of iOS namely Objective-C. While for the storage of test result data is on Core Data because Core Data is a native and standard feature from iOS for data storage. The selection of Cocos2D-iphone as a game engine used in the development of this game is because Cocos2D-iPhone using pure Objective-C so that it will fully compatible to be integrated with the existing iOS application.

Evaluation method used on the Game Based Test method is measured based on the performance of participants in the test items with hard difficulty level. The measurement is performed on the first hard question that is done (either successfully completed or not successfully completed). The scoring system specified is the calculation of duration needed by participants to solve the first hard question (in seconds). Furthermore, to know that the persistence test (Game Based Test), which is measured by the duration in answering the first hard question is valid in measuring the persistence, then it will be proven through correlation test with the measurement of Pauli Test. The results of correlation test between Game Based Test and Pauli Test will use a software named Statistical Packages for Social Science (SPSS), which has been used by the Recruitment & Assessment Center Division as a program for statistical analysis.

IV. RESULTS AND DISCUSSION

To provide innovation in the recruitment process in PT. XYZ is required a new breakthrough in providing new test instrument by utilizing computer technology. The innovation of software developed for the needs of recruitment at PT. XYZ in conducting an analysis on the persistence level of test participants is in the form of Game Based Test. The development of this game is using the concept of gamification, namely the utilization of game elements in a non-game context.

The activities performed by the user will be recorded during the game and then sent to the server at the end of each session to be analyzed. The selection of game in the form of puzzle with a target of young adult players (all gender), played by a single player in the iOS platform. In this game, there are 30 levels divided into 3 levels of difficulty, they are easy, medium and hard. This game is made to be implemented on the device Apple iPad 2 screen resolution of 1024x768 and 2048x1536 (retina display) with the operating system iOS version 8.

As shown in figure 2, workflow of the game in outline is started from the home page (cover). Then from the home page, the user will go to the story line page, in which there will be described briefly about the purpose of the game played. After that, the user will go to tutorial page, which will be explained interactively about the basic of mechanism of this game. This tutorial page will visually be similar to the game level page, but the user will be guided step by step.

On the game level page, besides playing a puzzle game if the user cannot solve the existing puzzle, there will be popup skip level, where the user is given an option to skip the level and go to the next level or the user may choose to stay at that level. Every a level is completed, there will be an animation as a visualization that the level is successfully completed. After a certain time (default: 30 minutes), the time will be over and is marked with popup that the time is over and the user will go to the ending page.
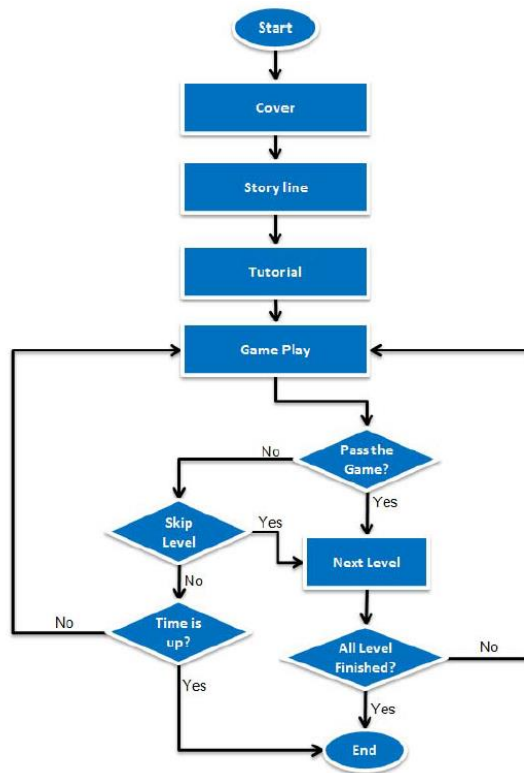
Fig. 2. Game Flow

User must perform authentication in advance before play the game. As shown in figure 3, authentication of game application is done using Face Recognition Authentication system so that this application will get user data based on the results of authentication. During played by the user, the game will store the data of analytical results in the internal database for each session, and then at the end of session, the data will be sent to the server by sending JSON data to API web service that has been provided by the server.

The database in Figure 4 has been called since the authentication process used face recognition to be able to enter the cover page as in Figure 2.
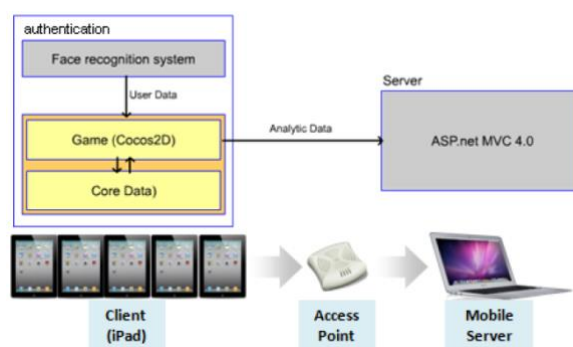

Fig. 3. Architecture Chart of the Game

As shown in figure 4, the data stored in the form of "raw", in the sense of truly activity data and its timestamp. So that, to obtain the data such as number of taps per level, whether the idle and others still require further data processing by an analyst team. Activities conducted will be carried out with key-value format so that it can be flexible and if there is another activity that want to be recorded, do not need to change the database scheme.
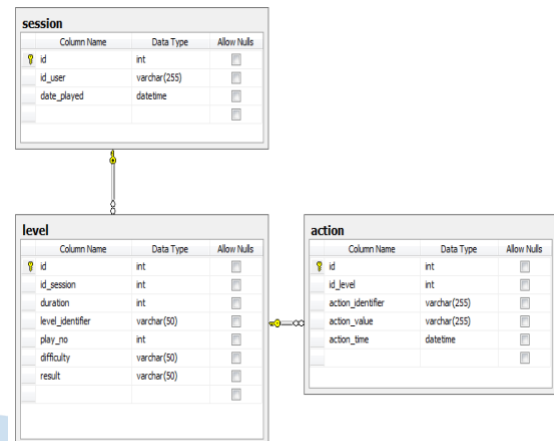

Fig. 4. Database Chart

A. Presentation Design

As shown in figure 5, the display page of this game broadly includes game elements as follows: (1) Avatar: a character that is made to make the players feel involved in the missions of this game. This character is named Professor Astro. (2) Instructions: a page that explains the purpose of the game and how to play it. (3) Level: a facility to show the progress of a player in this game. Level is indicated in the form of a label containing numbers where the player is located. The label itself is located in the middle upper part of the screen in every page of the game. (4) Progress: a facility to show the development of the game of a player in a certain level. The progress indicates the percentage of area that is already filled. This pointer is located in the same label with Level. (5) Help button: a facility for players to return to the instruction page. This button is located on the top left of the screen in every page of the game. (6) Left Arrow key: a facility for players to shift the bar that contains the pieces of puzzle to the left side. The key itself is located on the bottom left of the screen in every page of the game. (7) Right Arrow key: a facility for players to shift the bar that contains the pieces of puzzle to the right side. The key itself is located on the bottom right of the screen in every page of the game. (8) Serrated left arrow button: a facility for players to stay at the level that is being played when the time of 3 minutes is exceeded. (9) Skip button: a facility for players to pass through the level that is being played and advance to the next level. (10) Puzzle: a facility for players to fill the puzzle area in the game. These pieces of puzzle are likened as a piece of machinery that will be reassembled into a large machine, which is the goal of this game. (11) Puzzle area: an empty area that must be filled by players with the pieces of puzzle to

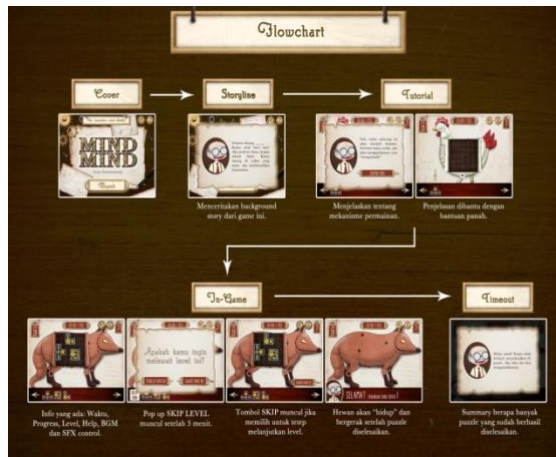complete a level. The size and shape of this area is different at every level.

Fig. 5.   UI Chart of Game Puzzle Design

B.   Testing of Game Based Test

Testing of Game Based Test is performed to analyze the gaming system that is designed to be implemented by Recruitment and Assessment Center Division at PT. XYZ. [23] suggested that a sample size greater than 30 and less than 500 is suitable for most behavioral studies. From the criteria mentioned, then the number of participants used for the testing of Games Based Test as many as 37 candidates. The measurement of Game Based Test is based on the performance of participants on the test items with hard difficulty level. The measurement is performed on the first hard question that is done (either successfully completed or not successfully completed). The scoring system specified is the calculation of duration needed by participants to solve the first hard question (in seconds).

To get the value, then the scores from the test results which is essentially still in the form of a time duration (in seconds), need to be processed in advance so that it should be converted into standard scores, with the formula as seen in figures 6 and 7. One of the ways to convert raw score into standard value is by using STEN norm (standard ten). [24] states standardization is the requirement that a test's results are comparable to some baseline or norm and are therefore interpretable. According to Canfield, A. A. (1951), the STEN norm ranges from 1 to 10, has a mean of 5,5 and a standard deviation of 2. The conversion technique of STEN norm is changing the raw scores into standard scores in scale of ten (in the range of 1 to 10).
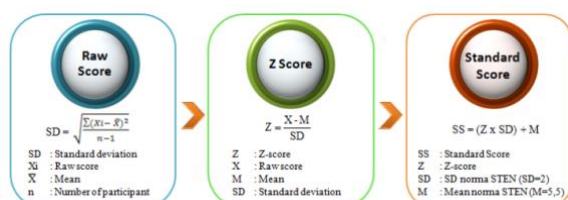

Fig. 6.   Formula Raw Score, Z-Score, Standard Score

Based on the scoring standards (norms) from the calculation of test results to 37 candidates, then its is known that the mean of duration in answering the first hard question is 381 seconds. By calculating the mean and standard deviation, it can be obtained the following norm table 1:

TABLE I.   CONVERSION OF RAW SCORES INTO STANDARD SCORES

RS *(Raw Score)*	SS *(Standard Score)*
-	1
-	2
0-183	3
184-380	4
381-577	**5**
578-775	6
776-972	7
973-1169	8
1170-1367	9
>1368	10

Thus, it can be concluded that the minimum duration limit in answering the first hard question on Game Based Test is 381 seconds. Participants who pass the duration limit can be declared passing the persistence test.
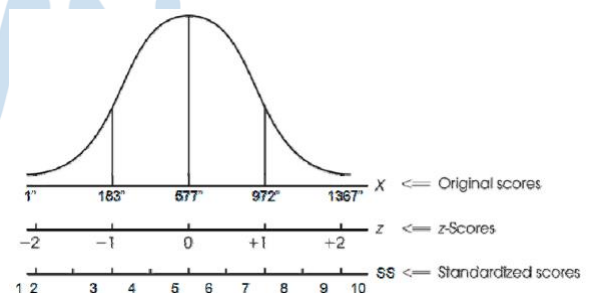
Fig. 7.   Comparison of Raw Score, Z-Score, Standard Score

C.   Validity Results of Game Based Test

The results of correlation test between the persistence test using Game Based Test and Pauli Test showed a significant positive correlation (N=37, p-value < .05) as shown in table 2. Thus, it can be concluded that the persistence test using Game Based Test measured by the duration in answering the first hard question is valid to measure the persistence, as evidenced through positive and significant correlation test with the measurement of Pauli Test.

TABLE II. THE CORRELATION CALCULATIONS BASED ON A SOFTWARE OF STATISTICAL PACKAGES OF SOCIAL SCIENCE

Correlations		
	Persistence (Pauli Test)	Duration (Game Test)
Persistence Pearson Correlation (Pauli Test)	1	.277*
Sig. (1-tailed)		.048
N	37	37
Duration Pearson Correlation (Game Test)	.277*	1
Sig. (1-tailed)	.048	
N	37	37
*Correlation is significant at the 0.05 level (1-tailed)		

V. CONCLUSION

Based on the implementation results of Game Based Test as one of the methods to measure persistence of candidates, it can be concluded that: (1) the utilization of Game Based Test shortens the time used to carry out the recruitment process because it automates the conventional process of psychological test. The duration given for the Pauli test and Game Based Test is both 30 minutes but the test result scores can be generated in 30 seconds after the test process is complete, rather than manually checking the Pauli test sheet which takes 5 minutes per sheet. (2) The results of persistence test are obtained faster than using examination (scoring) of Pauli Test, because the scoring process of Game Based Test and the preparation of reports are already automated. The use of Game Based Tests and test reports that can be produced more quickly within 30 seconds certainly provides benefits for companies such as speeding up the candidate recruitment process (reducing recruitment lead time), reducing human error in correcting Pauli sheets (more accurate with automatic assessment calculations), reducing use of Pauli sheets (paperless), using impressive test tools to attract candidates (create company branding). (3) From the test results of Games Based Test to candidates, most of candidates understand to use this application after reading the tutorial (user guide) that is already available in the application. It can be seen from the timestamp when the candidate is on the tutorial page with an average duration of 163 seconds. (4) By applying the game elements in the recruitment activities, a test process that formerly seems boring, but now it becomes more attractive although it still need to concentrate when taking the test. This response was obtained from 6 recruiters' feedback regarding game experiences when testing the game based test (5) Game that is measured through the duration in answering the first hard question is valid to measure persistence, as evidenced through positive and significant correlation with the measurement of Pauli Test.

The contribution from this research can be used as a reference for companies to speed up the process of recruiting candidates through the implementation of Game Based Test with automated scoring and reporting.

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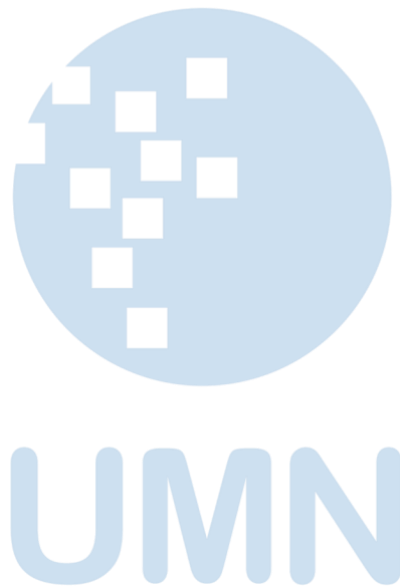
Usability Evaluation of Ticket Purchasing Applications, Case Study Public Railways in Indonesia

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Abstract— **This study is an experimental research aimed at evaluating the usability of a mobile-based application used to facilitate passengers in purchasing train tickets. Currently, the ratings and comments on the Play Store indicate that users are experiencing a poor user experience with the ticket purchasing application. As an application widely used by the public, the usability evaluation is essential. The evaluation was conducted in a laboratory setting by measuring usability in three aspects: effectiveness, efficiency, and user satisfaction. The level of effectiveness and efficiency was measured using task analysis, analyzing the final results of each respondent after performing five predetermined tasks. The system usability scale method was used to determine the user satisfaction level. The measurement involved 10 respondents who actively use the application. The results show that the effectiveness and efficiency of the application are good. However, the measurement of user satisfaction aspect indicates less favorable results. This obviously results in poor user experience (UX) for users. Therefore, the practical implication of this study is the need for improvements to the application, both in the user interface (UI) and existing business processes, to enhance the user experience.**

Index Terms—ticket; system usability scale; testing; usability

I. INTRODUCTION

Transportation is an essential means in daily life, facilitating people to travel anywhere. One of the public transportation options is the train. According to [1], transportation is an effort to move goods and/or passengers from one origin location to a destination location. One of the transportation modes in Indonesia is the train. The government provides train transportation services managed by Badan Usaha Milik Negara (BUMN), namely PT Kereta Api Indonesia (Persero). The Badan Pusat Statistik (BPS) reported that in September 2023, there were approximately 31.5 million train passengers in Indonesia [2]. Meanwhile, if calculated from January to September 2023, the number had reached 270 million train passengers. Compared to the data for the same period in 2022, this figure represents a 40% increase [2].

Currently, train tickets can be purchased at various locations such as train station counters, Alfamart, and Indomaret. Additionally, there are several applications available for purchasing train tickets online, including Traveloka, Shopee, and several other similar applications. Therefore, to facilitate passengers in purchasing train tickets, PT Kereta Api Indonesia officially released a mobile-based application. This application was first launched on September 10, 2023. Data from kai.id website shows that the number of users using the ticket purchasing application is approximately 12.4 million registered users [3]. Among these application users, there are approximately 6.1 million active users, including premium members. The data indicates that during the period from January to June 2023, there were 9.2 million (62%) train ticket bookings made through the application.

Furthermore, data from the Play Store indicates that more than ten million users have downloaded the ticket purchasing application. The application is expected to be a modern solution for train users to facilitate train travel with innovative features. Additionally, this application is a digital-based innovation from KAI equipped with reliable technology, a fun and youthful user interface, as well as various feature enhancements and seamless services. All of these are expected to enhance the user experience.

The success of an application depends not only on its advanced features but also on how easy it is to use [4][5]. Users should be able to interact with the application quickly and effectively. A usable application can reduce user frustration, increase efficiency, and reduce the time required to learn how to use it [6]. Usability heavily relies on easy-to-understand design, clear navigation, and consistent layout and icons [7]. An application must have good usability to attract users, increase retention, and provide a positive user experience (UX) [8].

However, data from the Play Store indicates that the ticket purchasing application has received a rating of 2.3 out of 5. Several user reviews suggest that the app's UI and UX are problematic. Specific issues reported by

users include a complicated payment system, the absence of an option to view seat orientation (front or back), and the lack of a feature to display travel history. These reviews suggest that users currently have poor user experience with the application.

Therefore, this research proposes the following research question: R1 Does the ticket purchasing application offer users an effective and efficient process?; R2. How satisfied are users with their experience using the ticket purchasing application? The results obtained will indicate whether users have a good user experience (UX) when using the application. Usability testing is crucial because the ticket purchasing application is widely used by train users for public transportation in Indonesia. In addition to testing the effectiveness and efficiency of the application, this research will also measure user satisfaction levels using the system usability scale method. The method has been widely used by researchers to measure usability scales in various applications, including Microsoft Teams [9], mobile-based learning applications [10], and augmented reality-based learning applications [11].

II. LITERATURE REVIEW

Usability is an important characteristic of any application, as it directly affects the application's overall quality. Consequently, numerous studies have focused on usability, though they remain relatively limited. An experiment conducted by [12] assessed the usability of a web-based application by examining three key aspects: effectiveness, efficiency, and satisfaction. Similarly, a study by [13] tested the usability of a mobile-based learning application using both undergraduate and postgraduate students as the respondents. Moreover, usability testing has been shown to enhance the quality of electronic health (eHealth) applications, making them more easily adopted by users [14][15].

More specific usability research has explored user satisfaction by utilizing a system usability scale. Researchers [16] compared scores of system usability scale among various mobile-based social media applications. Additionally, a systematic review summarized the use of system usability scale to measure usability in different educational applications [5]. The system usability scale method has also been adopted to evaluate the usability of mobile-based health applications [17][19]. During the Covid-19 pandemic, system usability scale was also employed to measure the usability of the Microsoft Teams application [9].

III. METHODOLOGY

This study is an experimental research aimed at examining user experience through usability testing carried out in a laboratory setting. The measurement will be based on three aspects including Effectiveness, Efficiency, and User Satisfaction [12][18]. Testing of all these aspects is carried out using the task analysis

method, which involves inviting respondents who are the target users of the ticket purchasing application to perform a series of tasks. The respondents involved are users of train transportation services who are accustomed to purchasing train tickets directly at the counter or through other applications but have never used the ticket purchasing application before.

Next, in conducting task analysis, a task list is created to serve as a tool for measuring the Effectiveness and Efficiency aspects of the ticket purchasing application. There are five tasks that each respondent must complete. These five tasks involve using the main features of the application that users will utilize when purchasing train tickets. The details of these five tasks are as follows:

A. Task 1

Viewing train schedules is a crucial step before purchasing tickets. Viewing schedules on the ticket purchasing application is used to check availability, select suitable times, and make better travel plans. In Task 1, respondents are expected to view the train schedule from Gubeng Surabaya Station to Jember Station, with the date set to one day after the task is performed. The expected steps for each respondent to complete Task 1 are shown in Figure 1.
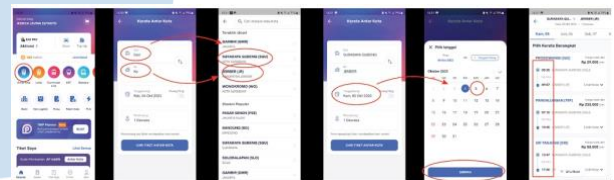
Fig. 1. Steps of Task 1

B. Task 2

Booking train tickets is a primary feature of this application. This feature provides information about ticket availability, various class options, as well as seat and meal selection. In Task 2, respondents have to book train tickets. Task 2 is a continuation of Task 1. Respondents are required to view the train schedule, choose one of the schedules, and proceed to the payment stage. Respondents do not need to pay for the ticket but only to complete the ticket booking. The steps for Task 2 can be seen in Figure 2.

Fig. 2. Steps of Task 2

C. Task 3

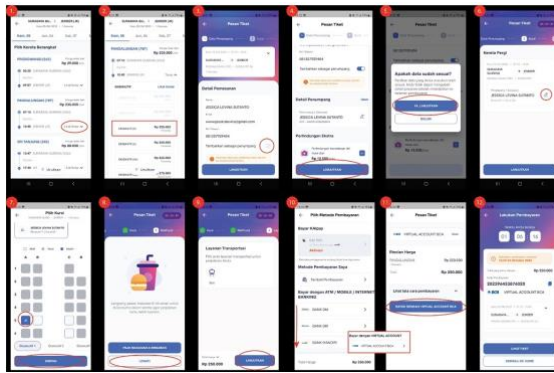The feature to view booked tickets is included as one of the most important features of this application. Users are required to show proof of booking in the form of an e-boarding pass to the inspector when boarding. Therefore, in Task 3, respondents are asked to view the tickets that have been booked in the previous Task 2. The steps for Task 3 can be seen in Figure 3.
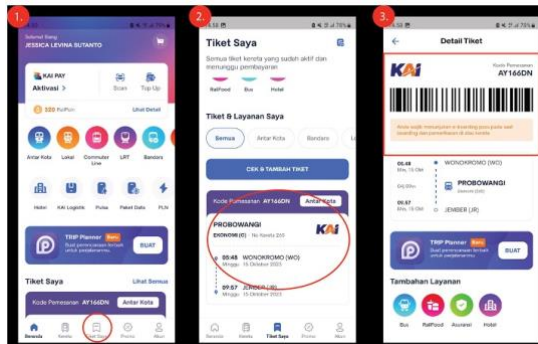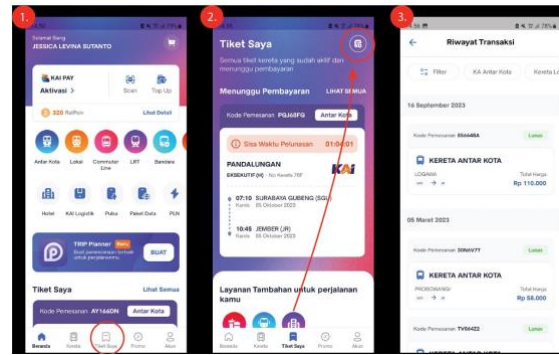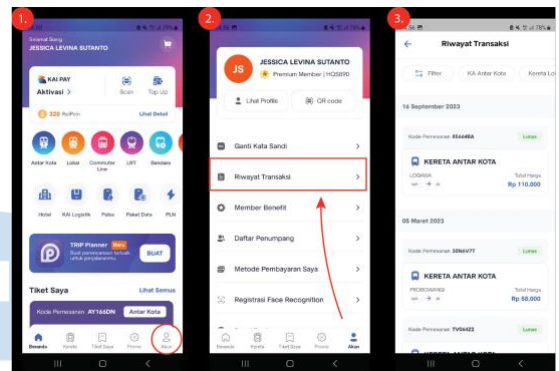

Fig. 3. Steps of Task 3

D. Task 4

For users, viewing booking history is a useful tool for future reference, serves as confirmation and evidence of previous travel details, and tracks expenses and personal preferences. In Task 4, respondents are expected to view the booking history of tickets that have been previously purchased. There are 2 ways to complete this task. The first scenario for completing Task 4 can be seen in Figure 4. Meanwhile, the second scenario can be observed in Figure 5.

Fig. 4. Steps of Task 4 (1st scenario)

Fig. 5. Steps of Task 4 (2nd scenario)

E. Task 5

The profile feature allows users to access and manage their personal information easily, enabling users to validate their identity. In Task 5, respondents need to view their profile on the application. Respondents are advised to log in or create an account before starting Task 5. The steps for Task 5 can be seen in Figure 6.
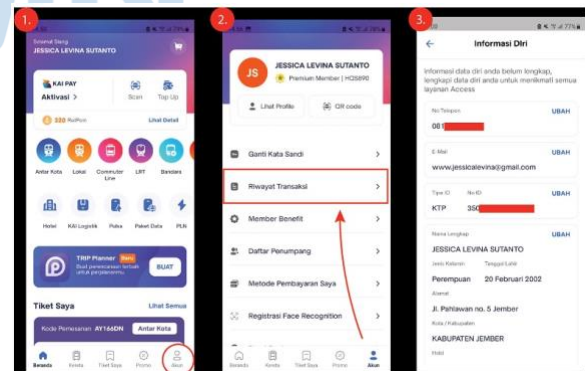

Fig. 6. Steps of Task 5

Furthermore, to measure the level of user satisfaction, the system usability scale measurement instrument is used. Respondents have to indicate whether they agree or disagree with 10 provided statements [19]. The system usability scale score results will determine the level of user satisfaction with the application.

IV. RESULT AND DISCUSSION

A. Respondent Profile

This study involves 10 respondents following the guidelines from [20]. The characteristics of these 10 respondents are that there are six (60%) females and four (40%) males. Figure 7 shows the profile of respondents based on gender.
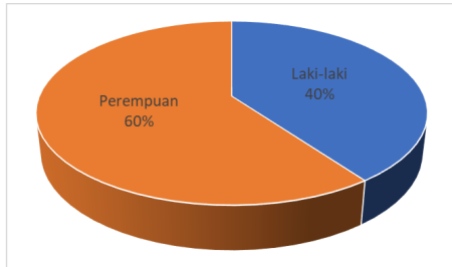

Fig. 7. Respondent profile based on gender

Based on age, there are 7 respondents aged between 21 to 30 years old (70%), while 3 respondents are over thirty years old (30%). The percentage breakdown of both age groups can be seen in Figure 8.
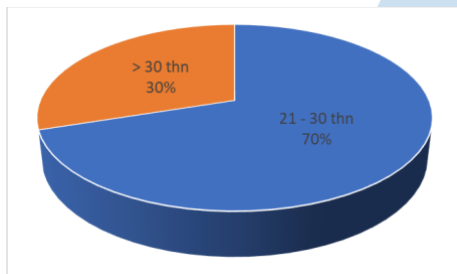

Fig. 8. Respondent profile based on age

B. Task Analysis Results

This section provides a detailed explanation of the results obtained after all respondents completed all the specified tasks. The final score is obtained from the calculation of the average completion time of tasks by all respondents. Each task has a maximum completion limit depending on the difficulty of the given task. The completion results of each task by the 10 respondents will be explained as follows:

1. Task 1: The completion time limit for this task is 60 seconds. The final score indicates that the average time taken by respondents to complete Task 1 is 28.82 seconds. One respondent failed to complete this task.

2. Task 2: The completion time limit for the task given to respondents is 90 seconds. The final score indicates that the average time taken by respondents to complete Task 2 is 55.91 seconds. One respondent failed to complete this task.

3. Task 3: Respondents were given a maximum of 10 seconds to complete this task. The final score indicates that the average time taken by respondents to complete Task 3 is 6 seconds. Three respondents failed to complete this task.

4. Task 4: The time limit given to respondents to complete this task is 30 seconds. The final score indicates that the average time taken by respondents to complete Task 4 is 20.45 seconds. Four respondents failed to complete this task.

5. Task 5: The completion time limit for this task is 10 seconds. The final score indicates that the average time taken by respondents to complete Task 5 is 5 seconds. One respondent failed to complete this task.

C. Effectiveness Measurement

Effectiveness is the accuracy of users in achieving the specified goals. To calculate the effectiveness, this study uses the formula proposed by [21] as follows:

$$Effectiveness = \frac{\text{Number of tasks completed successfully}}{\text{Total number of tasks undertaken}} \times 100\% \quad (1)$$

Based on the task completion results and the formula above, the effectiveness results for each task are quite good, as shown in Table I. All tasks have effectiveness values above 60%, with an average value of 80%. This indicates that the effectiveness of the ticket purchasing application is high [22].

TABLE I. EFFECTIVENESS RESULTS

No Task	Percentage
Task 1	9/10 * 100% = 90%
Task 2	9/10 * 100% = 90%
Task 3	7/10 * 100% = 70%
Task 4	6/10 * 100% = 60%
Task 5	9/10 * 100% = 90%

D. Time Based Efficiency Measurement

Time Based Efficiency measures the time used in an activity or process that can be optimally utilized to achieve the desired results. Time Based Efficiency is obtained using the following formula:

$$Time\ Based\ Efficiency = \frac{\sum_{j=1}^{R} \sum_{i=1}^{N} \frac{n_{ij}}{t_{ij}}}{NR} \quad (2)$$

N (total tasks) = 5
R (total respondents) = 10
Nij: The result of task i by user j; Nij = 1 if the user completes the task, otherwise Nij = 0

Tij: The time needed by user j to complete task i. If the respondent can not complete the task, then Tij = time the respondent quits the task

By using the formula above, we obtained a quite good result with a value of 1.320 goals/sec. This result shows that the ticket purchasing application is efficient.

E. User Satisfaction Measurement

User satisfaction level is measured using the system usability scale. The measurement consists of 10 questions that respondents must answer by ranking from 1 to 5 based on how much they agree with the given questions [23]. The details of the system usability scale questions are listed in Table II.

TABLE II.   SYSTEM USABILITY SCALE QUESTION

No.	Question
1.	I will frequently use this application
2.	I feel this application is unnecessarily complex
3.	I find this application easy to use
4.	I need technical assistance to use this application
5.	I find a variety of features integrated well in this application
6.	I find many inconsistencies in this application
7.	I believe many users would be able to learn this application quickly
8.	I find this application very impractical to use
9.	I am very confident in using this application
10.	I need to learn a lot of things first to be able to use this application

Based on the provided guidelines, here is the calculation of the system usability scale score for the ticket purchasing application:

- For each of the odd-numbered questions, subtract 1 from the score.

- For each of the even-numbered questions, subtract their value from 5.

- All scores are then summed up, and the result is multiplied by 2.5 to obtain the system usability scale score.

After calculation, the value indicates that the system usability scale score for the ticket purchasing application is 65. Based on the guidelines from [24] as seen in Table III, a score of 65 can be interpreted as the user satisfaction level for the application is still low, as the application falls within the "poor" category. This will undoubtedly result in a subpar user experience. Therefore, improvements to the user interface of the application are necessary to enhance the user experience.

TABLE III.   SYSTEM USABILITY SCALE INTERPRETATION

Score	Grade	Interpretation
> 80.3	A	Very Good
68 – 80.3	B	Good
68	C	Average
51 – 68	D	Poor
< 51	E	Very Poor

V.   CONCLUSION

The objective of this study is to assess the usability of the ticket purchasing application, a mobile-based platform designed to assist passengers in purchasing train tickets. The assessment was conducted in three aspects: effectiveness, efficiency, and user satisfaction. The measurement results indicate that the effectiveness of the application is good with an average score of 80%. Additionally, the efficiency of the application is also quite good, as evidenced by the Time Based Efficiency score of 1.320 goals/sec and the Overall Relative Efficiency score of 72.18%. However, based on the system usability scale score obtained, user satisfaction with the ticket purchasing application is still low at 65. This can potentially lead to a subpar user experience for users.

Furthermore, this research provides practical guidance for government decision-makers on improving ticket purchasing applications. This can be achieved by optimizing the user interface (UI) and refining business processes to enhance the user experience. However, there are some limitations to this study. The evaluation of usability in Indonesian ticket purchasing applications might produce different results if replicated in other countries. Moreover, the sample size in this study was relatively small, suggesting the need for further research with a larger group of respondents.

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Using the Scrum Method to Develop Population Information System

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Abstract—**The adoption of Population Information System is crucial to enhance work effectiveness and serves as a manifestation of transparency in population data management. The complexity from design to implementation of such a population information system poses its own challenges. There are at least three main issues in system design, namely time estimation, team management, and ensuring the quality of system being developed. These issues must be addressed early on to prevent potential team management problems during the design and development stages of the application. One suitable method that can be employed for the design of the population information system is the Scrum methodology. Scrum is a software development framework that emphasizes a collaborative and adaptive approach. It falls under the Agile methodology, aiming to produce products that are more responsive to changes and enabling teams to adapt quickly in a dynamic environment. While the Waterfall method tends to follow predefined in linear steps. The novelty of this research lies in the proactive approach to addressing the complexity of designing population information systems by implementing Agile methodologies such as Scrum. The use of the Scrum method in designing this system can elucidate the complexity in design from each task performed to the implementation stage compared to the use of the Waterfall method.**

Index Terms—**Population Information System; Scrum Method; System Design**

I. INTRODUCTION

The development of a Population Information System (PIS) using the Scrum method faces several challenges that need to be addressed. First, the complexity of user requirements is a critical factor that requires a deep understanding to integrate various needs from the government, private institutions, and the general public into a product backlog that can be managed within Scrum sprints. Effective priority management is also crucial to ensure the development of the most valuable features for users, yet determining priorities among various features and requirements of the PIS can be a significant challenge. Furthermore, the availability of consistent and accurate data is key in PIS development, requiring extra efforts to ensure that adequate and reliable data is available. Effective communication with stakeholders, including local governments, administrative officers, and the general public, is also necessary to ensure good collaboration and a clear understanding of the needs and expectations from various related parties. Lastly, the ability to adapt to changing requirements and regulations is an important aspect of PIS development with Scrum, requiring flexibility and adaptability from the entire development team. With careful management and effective collaboration, these challenges can be overcome to achieve success in PIS development using the Scrum method.

The rapid advancement of information systems demands every institution or organization to digitize their work. Information systems are organized ways to collect, input, process, and store data, as well as to manage, control, and report information in such a way that an organization can achieve its set goals [1]. In the modern era, with its rapid development, the handling of information has started to utilize sophisticated technological tools such as computers and other supporting devices, for example, the Population Administration Information System, which facilitates the handling of information used in government activities, one of which is the management of information throughout Indonesia. It is well-known that the birth rate is faster than the death rate.

The PIS is a collection of all data from all regions of Indonesia in a network that is interconnected between regions [2]. The PIS comprises population data from all regions of Indonesia in an integral network where all population data in various regions are interconnected [3]. The Population Administration Information System is a crucial foundation in managing population data, identification, administration, and various other related information.

The development of this system is a complex one that involves a development team and substantial financial support. Thorough planning for the design of

this application is crucial to prevent failures in the design and implementation of the system. One suitable method for designing this system is to use the Scrum method. This is because the flow present in Scrum can foster close collaboration between the team and users, ensuring that the resulting solution meets the requirements.

The Scrum method follows the Agile approach in software development. Scrum is defined as a framework of stages/processes applied to manage and execute the development of computer applications, whether simple or complex. Scrum is beneficial in producing a product with maximum value in a productive and creative manner and can be developed incrementally in information system development [4]. This is because Scrum provides a framework that is responsive to changes through repeated development cycles, allowing quick adjustments if there are changes in the environment or requirements. Scrum also promotes transparency in the development process, aiding in monitoring system progress and information accuracy. Compared to the commonly used Waterfall method, the Scrum approach offers greater flexibility in dealing with changes in requirements or needs that may arise during the development process.

Features that are most important or urgent for operations or policies can be given higher priority in development. Scrum encourages transparency throughout the development process. This is beneficial in managing the system as it allows better oversight of system progress, data changes, and information accuracy. The Scrum method can bring about real progress in the system and provide benefits to users earlier in the development process.

The use of the Scrum method offers several significant benefits. First, Scrum provides high flexibility and adaptability, allowing the team to quickly adjust to changing requirements or regulations, which is crucial in the context of PIS. This method also enhances collaboration and communication through daily meetings, sprint planning sessions, sprint reviews, and retrospectives, ensuring all parties are aligned and can provide valuable feedback continuously. Project transparency and visibility are also improved, as stakeholders can directly observe system progress and provide timely feedback. Priority management becomes more effective with an always-updated product backlog, enabling the team to focus on the highest value features first. Product quality is enhanced through testing at the end of each sprint, allowing early identification and correction of issues. Being responsive to user feedback is easier, as end users can provide input at each sprint review, ensuring the final product meets their expectations and needs. Additionally, Scrum allows for more efficient use of resources by focusing on important tasks in short sprint cycles, reducing wasted time and increasing productivity. Overall, implementing Scrum in the development of PIS provides a clear and adaptive structure, enabling the team to effectively address

complex challenges and produce a responsive, high-quality system that meets user needs.

II. METHODOLOGY AND IMPLEMENTATION

The method employed in designing this system is the Scrum method. The Scrum approach is one of the software engineering methods that utilizes the principles of the Agile approach [5]. The principles in the Scrum method must align with the agile manifesto, which serves as a guide for development activities within a process [6].
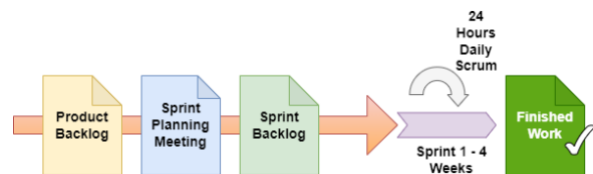

Fig 1. Phases of Scrum Method

A. Product Backlog

The Product Backlog consists of several backlog items designed/created based on user requirements [7]. These items are obtained through data collection (interviews, observations, and literature studies). The data collection stage in this research was obtained through two methods: interviews with end-users and observation [8]. The basic requirement of a product backlog is dynamic so that it can continually evolve as the development team receives input/changes/feedback from the user team during the evaluation and application demo processes [9]. In the product backlog, researchers prioritize the essential requirements for the development of this information system, as seen in Table 1.

TABLE I.   PRODUCT BACKLOG

Requirements	Priority Levels
Login page	High
Data Login	High
Village Information System	Moderate
Databases	High
Input data population	High
Administrative documents	Moderate

This priority level is based on essential tasks that must be completed and demonstrated to users. These levels also assist developers in prioritizing work that needs to be addressed first. Each level may not be interconnected with other requirements or menus.

B. Sprint Planning

This process accommodates the use of the Scrum method. Through this process, the system design team

is formed, budgeting is done, and planning for the work duration is carried out [10]. In this stage, the Scrum Master will form the development team that will later develop the PIS. Additionally, the Scrum Master will schedule each Product Backlog item to be worked on. These estimations are determined based on the difficulty level of each Product Backlog item to be worked on and the readiness of the data required by the development team from the end-users.

The Sprint Planning involves planning the execution of the product backlog during the sprint [11]. This stage includes designing the system, mapping functional requirements that have been analyzed into a diagram, and explaining the database design. The system design must adhere to user requirements and be easily usable by end-users [12]. Additionally, Sprint Planning estimates the time required for features in each sprint [13]. In this stage, the backlog will be broken down into several tasks that need to be completed for a backlog item within one sprint. An example of sprint planning for Input Data Population can be seen in Table 3.

TABLE III.   TIMELINE SPRINT BACKLOG OF INPUT DATA POPULATION

Requirements	Estimated (Days)
Family card registration data input	2
Marriage registration data input	1
Divorce registration data input	1
Birth registration data input	1
Death registration data input	1
Residential relocation data input	1

C. Sprint Backlog

This stage must be carried out each time a new sprint is executed. In this phase, it is necessary to organize the processes into sub-tasks that need to be completed during the initial period of the sprint. The Sprint Backlog is a product backlog divided into several parts to be worked on in the upcoming sprint phase. The duration of a sprint usually ranges from 1-4 weeks, depending on the agreement with the Scrum Team [14]. Daily stand-up meetings are conducted to review the previous work and discuss the upcoming tasks. The timeline for the sprint backlog can be seen in Table 2.

TABLE II.   PRODUCT BACKLOG

Requirements	Sprint Backlog	Estimated (Days)
Login page	1	2
Data Login	2	3
Village Information System	3	6
Databases	4	7
Input data population	5	7
Administrative documents	6	5

D. Sprint Review

A Sprint is a unit of work required to meet the defined needs in the backlog within a predetermined time-box [15] also in this stage each team member demonstrates tasks completed during the one-sprint period [16]. This stage will describe whether the implementation of the features has been completed or not. The demonstration of completed work is carried out to provide information to users about the software produced and to gather user feedback for evaluation. At the end of each sprint, a sprint review is conducted, attended by the Scrum team: Scrum Master, Product Owner, and the Development Team [17]. During the sprint review, the Scrum Master presents features that have been completed. If there are no issues with the features, the system can be handed over to the users.

TABLE IV.   SPRINT REVIEW OF INPUT DATA POPULATION

Requirements	Sprint Backlog	Status (Completed/Not Completed)	Feedback
Family card registration data input	5	Completed	-
Marriage registration data input	5	Completed	-
Divorce registration data input	5	Completed	-
Birth registration data input	5	Not Completed	This requirement needs to include the time of birth and the name of the assisting personnel involved in the birthing process
Death registration data input	5	Completed	-
Residential relocation data input	5	Completed	-

Table 4 simulates that there are 6 requirements being worked on. All of these requirements are included in the sprint backlog (Input Data Population) as stated in Table 2. Based on these requirements, one requirement remains incomplete, namely "Birth Registration Data." The user has provided feedback that this requirement has not yet recorded the time of birth and the personnel who assisted in the birthing process.

E. Sprint Retrospective

The next stage in the Scrum implementation is the sprint retrospective, conducted at the end of each sprint [18]. At this stage, all team members have the opportunity to express their opinions and evaluations regarding the performance during the implementation of the Scrum method. Table 5 displays a simulation of the Sprint Retrospective in the Population Information System.

TABLE V.   SPRINT RESTROSPECTIVE OF INPUT DATA POPULATION

Requirements	Challenges	Solutions
Birth registration data input	Difficult to integrating Family Head's National Identification Number (NIK)	The National Identification Number (NIK) table for family heads is created as the parent table and integrated with a table containing infant data.
Residential relocation data input	Difficult in transferring the NIK for the head of the family. The data was deleted or just changed status but the data is still available.	The data for family heads who relocate is not deleted but is assigned the status "Moved."

The challenges faced during the development of this population information system can be both technical and non-technical in nature. Both technical and non-technical challenges still require guidance from users.

III.   CONCLUSION

In the development of PIS, the use of the Scrum method has proven effective in improving efficiency and transparency in the development process. This method allows for the formation of a responsive and adaptive development team to changes in user requirements. The stages in Scrum, from planning, design, implementation, to testing, are collaboratively conducted between the development team and end-users. This enables rapid iterations and feedback to rectify errors or deficiencies early in the development process. However, the use of the Scrum method also requires effective communication among all parties involved, especially in ensuring user needs are met and addressing issues that arise during development. Thus, implementing the Scrum method in the development of Population Information Systems brings significant benefits in achieving the goals of effectiveness and transparency in system development.
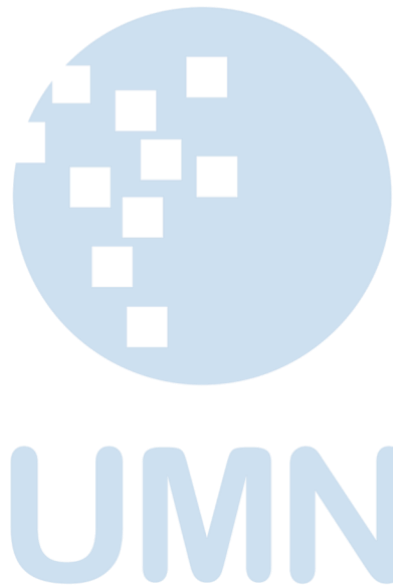
Furthermore, for future research, it is recommended to continue the analysis of effective development strategies to address the challenges faced in the development of PIS. This may include further research on the use of specific software development methodologies, such as Scrum, as well as exploration of key factors influencing the success or failure of PIS implementation. Thus, future research can provide deeper insights and more precise solutions in overcoming the challenges in PIS development.

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Enhancing Sales Strategies In Prime Market Retail Business Using Tuned Gradient Boosting

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Abstract— **In the retail sector, comprehending customer behavior and employing effective customer segmentation is pivotal for refining marketing strategies and augmenting profits. This study aims to use predictive modeling for customer segmentation at Prime Market, a prominent retail entity. We apply Gradient Boosting for customer classification. The research initially yields a classification error rate of 25.10%. However, this rate dramatically improves through meticulous parameter tuning, achieving an impressive accuracy of 91.4%. This refined model furnishes invaluable insights into Prime Market's customer segments, enabling the customization of marketing tactics and strategic business approaches. Armed with these insights, Prime Market can make data-driven decisions to enhance customer segmentation accuracy, better comprehend customer preferences, and pinpoint potential avenues for revenue growth. Leveraging advanced data analytics and predictive modeling empowers Prime Market to maintain a competitive edge and deliver its clientele a personalized, gratifying shopping experience.**

Index Terms— customer segmentation; data analytics; data mining; Gradient boosting; hyperparameter tunning

I. INTRODUCTION

In the fiercely competitive retail business industry, customer understanding and behavior analysis are fundamental for gaining a competitive edge and achieving success [1]. By delving deep into customer preferences, shopping habits, and needs, businesses can make well-informed, data-driven decisions that significantly impact their performance [2]. A primary advantage of comprehending customers is the ability to customize products and services to cater to their specific demands [3]. By analyzing customer data and identifying trends, companies can create products that resonate with their target audience, fostering customer satisfaction, loyalty, and repeat business. Additionally, customer behavior analysis empowers companies to develop effective marketing strategies [4]. Understanding the factors that drive customer purchases and their preferred shopping channels enables businesses to craft targeted and personalized

marketing campaigns. This level of personalization ensures that the right message reaches the right customers at the right time, maximizing the impact of marketing efforts and driving sales.

Moreover, customer behavior analysis offers valuable insights for enhancing customer service [5]. Understanding customer pain points and preferences allows companies to proactively address issues and provide personalized and satisfactory experiences [6]. Happy and contented customers are likelier to become brand advocates, spreading positive word-of-mouth and attracting new customers.

Data mining is the systematic process of extracting valuable knowledge and insights from an extensive database or dataset [7], [8]. Data mining is integral to data analytics, contributing to understanding and utilizing data effectively for decision-making and problem-solving [9]. Data analytics is often employed in retail businesses to analyze data and optimize sales strategies [10], with one popular tool being SAS (Statistical Analysis System). SAS is widely used by statisticians to analyze data more effectively [11], calculating probabilities and statistics for customer numbers [12]. Additionally, SAS enables the generation of relevant visualizations from the analysis results [13].

This study contributes a unique solution to enhance sales strategies in retail business by applying Gradient Boosting with parameter tuning. While several previous studies in this area applied machine learning-based daily retail demand forecasting to examine past data and the impact of special days, such as weekends and holidays [14], forecasting in multi-channel retail using random forests and long short-term memory networks [15], marketing behavior evaluation in multi-channel retail using random forests and term memory networks, with machine learning applied to customer meta-combination brand equity analysis [16].

Prime Market is a supermarket retailer offering a diverse range of products and services across several categories, including Health and Beauty, Electronic Accessories, Home and Lifestyle, Fashion

Accessories, Food and Beverages, and Sports and Travel. Their goal is to provide a pleasant shopping experience and offer quality products at affordable prices to meet the daily needs of consumers in the Bekasi, Depok, and Tangerang areas. This research uses SAS Visual Analytics technology to understand Prime Market's customers better and optimize sales strategies.

The findings from this data analysis and customer segmentation will offer valuable insights to the management team. They will better understand customer preferences and needs, identifying opportunities to boost sales. Moreover, this information can be utilized for product development tailored to customer preferences, more efficient inventory management, and targeted marketing strategies—this research aims to enhance sales performance significantly. The organization can optimize sales strategies, provide an improved shopping experience, and achieve higher customer satisfaction by harnessing the power of data analysis and customer segmentation using SAS Visual Analytics. With a deeper understanding of customer preferences, shopping habits, and needs, the company can focus on developing suitable products, implementing more targeted marketing strategies, and enhancing customer service.

II. METHOD

A. Data

Data is collected from an open-source website, Kaggle, specifically the Prime Market dataset containing 17 columns and 1000 rows. Subsequently, the data is organized using SAS Studio and SAS Data Studio. Some techniques, such as data cleaning, standardization, and parsing, are employed at the data preparation stage.

B. Model Building

At the data modeling stage, Gradient Boosting is applied in SAS Visual Analytics to gain valuable insights and evaluate the performance and accuracy of each model. Afterward, Visualization is used to identify factors influencing sales.

Gradient Boosting is a robust machine-learning algorithm widely used for various classification and regression tasks [17]. It is based on ensemble learning, where multiple weaker learners, typically decision trees, are combined to create a robust predictive model. As shown in Figure 1, the algorithm works iteratively, and in each iteration, it adds a new decision tree to the ensemble, gradually refining its predictions. The main idea behind Gradient Boosting is to leverage the strengths of individual decision trees while compensating for their weaknesses. Each new decision tree is trained to correct the errors made by the previous ones, thus reducing the overall prediction errors. This sequential learning process sets Gradient Boosting apart from other ensemble methods.

C. Model Tuning

Hyperparameters play a crucial role in optimizing the performance of the gradient-boosting model [18]. These hyperparameters control various aspects of the training process, such as the number of trees in the ensemble, the learning rate that determines the contribution of each tree to the final prediction, and the depth of the individual decision trees. One of the critical advantages of Gradient Boosting is its ability to handle large and complex datasets effectively [19]. It can capture intricate relationships and non-linearities in the data, making it well-suited for tasks with high accuracy. However, due to its iterative nature, Gradient Boosting may require more computational resources [20] and longer training times than other algorithms [21]. Decision Trees, as the base learners in Gradient Boosting, are chosen for their simplicity and interpretability. They can handle both numerical and categorical data, making them versatile for a wide range of applications. By combining multiple decision trees in a weighted manner, Gradient Boosting can deliver highly accurate predictions even in noisy and complex data. In summary, Gradient Boosting is a powerful and flexible machine-learning algorithm that leverages the strengths of decision trees to achieve optimal classification results. Its ability to handle large datasets and model complex relationships makes it a popular choice for real-world applications, from customer churn prediction to image recognition and natural language processing.
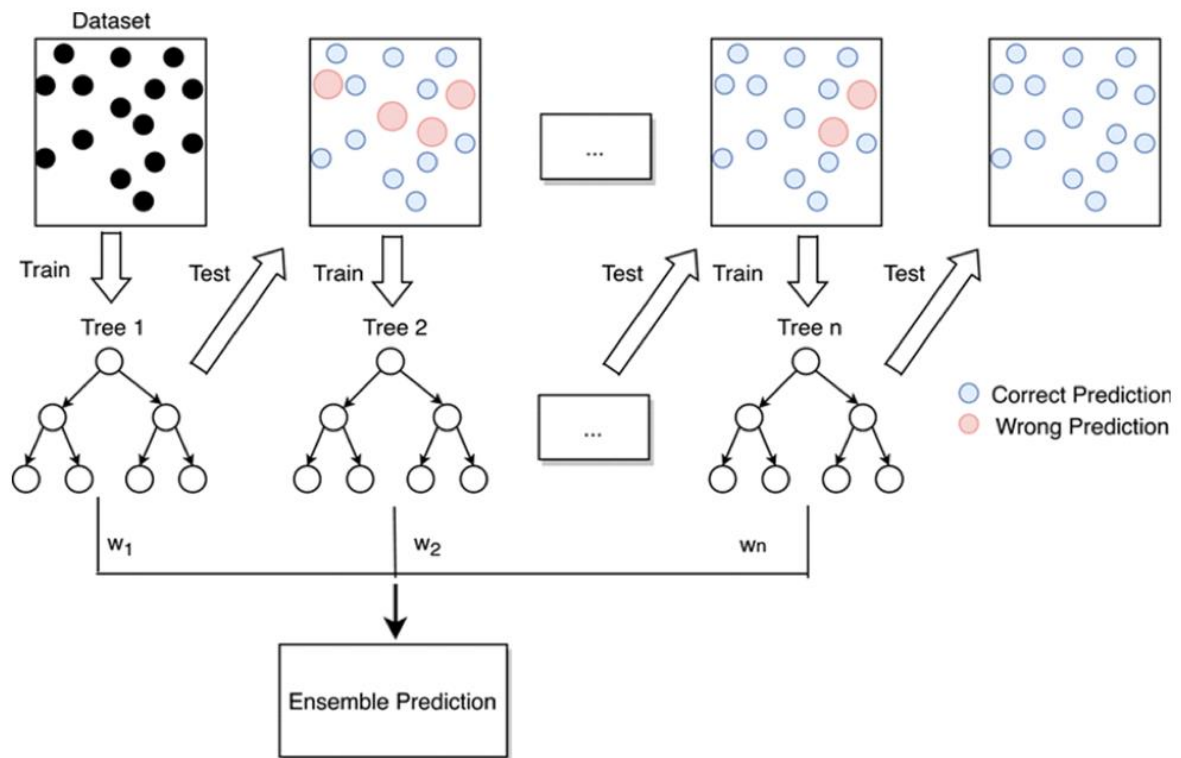
Fig. 1.   Gradiant Boosting [22]

D. Model Evaluation

A confusion matrix is a crucial tool for assessing classification model performance, like the Gradient Boosting model in your example, by comparing its predictions to actual dataset labels. This matrix is typically a table with rows and columns representing actual and predicted classes. True Positives (TP) are correct optimistic predictions (e.g., identifying customer segments accurately), True Negatives (TN) are correct pessimistic predictions, False Positives (FP) are incorrect optimistic predictions (false alarms), and False Negatives (FN) are incorrect pessimistic predictions. These metrics are used to derive performance measures such as accuracy (correct predictions overall), Precision (true positives among positive predictions, indicating false positive avoidance), Recall (true positives among actual positives, capturing all positives), and F1 Score (harmonic mean of Precision and Recall, balancing precision-recall trade-offs).

III.   RESULT AND DISCUSSION

Before the modeling process, the data was split into training and testing sets using a 70:30 partitioning ratio. This division was achieved through Simple Random Sampling, where the data was randomly partitioned into two predetermined subsets. This study compared five different models to analyze the Prime Market dataset. The model used is Gradient Boosting. This model is applied to predict the Response Customer Type based on predictors such as City, Gender, Payment, Quantity, Tax, Unit Price, COGS, and Rating. The modeling

process was carried out to evaluate the performance of each model on the Prime Market dataset. The dataset was divided into training and testing sets in preparation for the modeling phase. This partitioning was carried out using a 70:30 ratio, where 70% of the data was allocated for training purposes, while the remaining 30% was set aside for testing the models.

Based on the Gradient Boosting algorithm, the variable importance analysis revealed that the "unit price" feature significantly contributes to decision-making. Following closely in the second position is the "rating" feature, while "tax," "payment," "quantity," and "city" features rank next in descending order of importance. These insights provide valuable information about the factors influencing customer churn decisions within the Prime Market dataset, enabling businesses to focus on crucial areas when implementing targeted retention strategies. The confusion matrix further illustrates the model's performance on the dataset. It shows 379 True Positives, 122 False Positives, 129 False Negatives, and 370 True Negatives. So, the accuracy of this specific dataset is 74.9%.

TABLE I.   EXPERIMENT SETTING

Options	Minimum	Maximum	Optimal
Number of Trees	50	100	100
Learning rate	0.1	0.9	0.75
Subsample Rate	0.5	0.9	0.5
Lasso	0	0	0
Ridge	1	1	1

Table I offers a concise overview of the options and corresponding parameter values utilized during the tuning process of the Gradient Boosting algorithm. Tuning is crucial in optimizing the model's performance and achieving the best possible results for predicting customer churn. The "Number of Trees" refers to the number of individual decision trees forming the ensemble in the Gradient Boosting algorithm. During tuning, the values for the number of trees varied between 50 and 100. Eventually, it was observed that the best performance was attained with 100 trees, suggesting that a larger ensemble contributed to superior predictive accuracy. The "Learning Rate" is a crucial parameter determining the contribution of each tree to the final ensemble prediction. Different learning rates were examined during tuning, ranging from 0.1 to 0.9. The optimal learning rate was 0.75, as it struck a balance between accuracy and computational efficiency. The "Subsample Rate" represents the fraction of the training data randomly sampled to train each tree in the ensemble. Different subsample rates were tested between 0.5 and 0.9 during the tuning process. The best performance was achieved with a subsampling rate of 0.5, implying that using a smaller portion of the data for each tree led to improved model generalization and reduced overfitting. The "Lasso" and "Ridge" parameters are associated with L1 and L2 regularization, respectively. During model training, these regularization techniques introduce penalty terms to the loss function to control model complexity and prevent overfitting. Lasso and Ridge were employed in this tuning process, with Lasso having a value of 0 and Ridge having a value of 1. The parameter tuning process identified the most effective configuration for the Gradient Boosting algorithm. The optimal combination of hyperparameter values, including the number of trees, learning rate, subsample rate, and regularization, yielded an outstanding accuracy of 91.4% and a significantly reduced misclassification rate of 0.0860. These parameter choices indicate the model's ability to effectively capture intricate patterns and relationships in the Prime Market dataset, making it a powerful tool for customer churn prediction and sales optimization.

TABLE II.   CONFUSION MATRIX BEFORE AND AFTER TUNNING

Prediction	Before Tuning		After Tuning	
	Positive	Negative	Positive	Negative
Positive	379	122	459	42
Negative	129	370	44	455

As can be seen in Table II, Before tuning, the model's performance exhibited 379 true positive (TP) instances, indicating correct predictions of positive cases. However, there were 122 false positive (FP) instances where the model incorrectly classified negative cases as positive. Additionally, the model produced 129 false negative (FN) instances, indicating

incorrect predictions of negative cases as positive. Furthermore, there were 370 true negative (TN) instances, representing accurate predictions of negative cases. After tuning, significant improvements were observed in the model's performance. The number of true positive (TP) instances increased from 379 to 459, indicating a better ability to classify positive cases correctly. The false positive (FP) instances decreased from 122 to 42, suggesting a reduction in misclassifying negative cases as positive.

Moreover, the false negative (FN) instances decreased from 129 to 44, indicating an improvement in predicting negative cases as unfavorable. Additionally, the number of true negative (TN) instances increased from 370 to 455, signifying more accurate predictions of negative cases. The tuning process enhanced model accuracy, with more correctly classified positive and negative instances. The reduction in false positive and false negative predictions demonstrated improved precision and recall. Consequently, the tuned model better distinguished positive and negative instances, making it a more reliable data classification and prediction tool. The model's predictions were correct for approximately 91.4% of the cases, indicating a substantial enhancement in predictive performance.

Figure 2 shows some significant variable importance from Rating to cogs. Analyzing the Rating variables reveals valuable insights into Prime Market's customer perceptions and preferences for different product categories. Among these categories, the Food and Beverages products stand out with the highest Rating of 7.11, indicating a high level of satisfaction and positive feedback from customers. This favorable Rating suggests that Prime Market's Food and beverage offerings have been well-received and likely meet or exceed customers' expectations. Following closely, Fashion Accessories products received a commendable rating of 7.09. It suggests that customers are also delighted with the selection and quality of fashion accessories offered by Prime Market. The positive feedback for this category demonstrates the effectiveness of the products in meeting customer needs and preferences.

On the other hand, Electronic Accessories and Sports and Travel products obtained ratings below 7, with scores of 6.92 and 6.91, respectively. These ratings may indicate room for improvement in these categories to better align with customer expectations and enhance overall satisfaction. In the Health and Beauty category, products received a satisfactory rating of 7.00. While this score reflects a generally positive reception, there may still be opportunities further to enhance product offerings and customer experiences within this category. Lastly, Home and Lifestyle products obtained a rating of 6.83. While the Rating is decent, Prime Market may have the potential to explore ways to improve product assortment and customer engagement in this category, aiming for higher levels of customer satisfaction. The insights

from analyzing the Rating variables can guide Prime Market's strategic decision-making. By focusing on product categories that received lower ratings, the company can identify areas for improvement and invest in enhancing the quality and appeal of those offerings. On the other hand, products in highly rated categories can be emphasized and leveraged to

strengthen customer loyalty and attract new customers. Understanding customer perceptions through these ratings allows Prime Market to refine its product offerings continuously, tailor marketing strategies, and elevate the overall shopping experience to meet and exceed customer expectations.
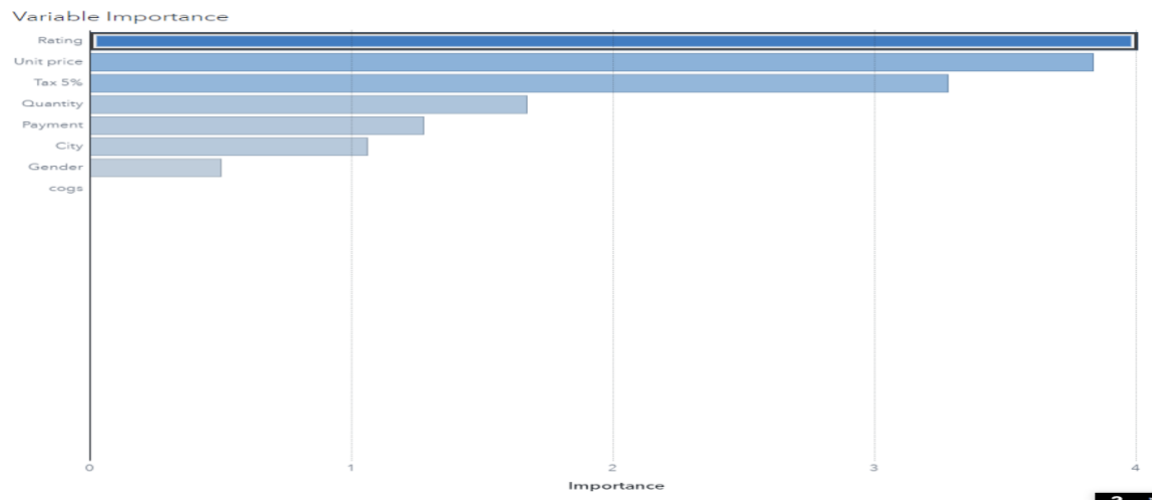

Fig. 2. Variable importance

IV. CONCLUSION

Tuning several parameters was conducted to maximize the model's accuracy, resulting in an impressive accuracy of 91.4% or a misclassification rate of 0.0860. These results demonstrate that the Gradient Boosting model performs excellently in accurately classifying customers in the Prime Market. Additionally, the research identified several features that significantly contribute to customer segmentation decisions. For customer segmentation in the Prime Market, the Gradient Boosting model can be effectively employed with appropriately tuned parameters to achieve high accuracy. Moreover, the most influential feature is Rating. Food and Beverages received the highest Rating of 7.11, indicating high customer satisfaction. Fashion Accessories followed closely with a rating of 7.09, demonstrating positive feedback. Electronic Accessories and Sports and Travel received ratings below 7, suggesting areas for improvement. Health and Beauty received a satisfactory rating of 7.00, while Home and Lifestyle scored 6.83. These insights can guide strategic decision-making, allowing Prime Market to enhance products and tailor marketing strategies for improved customer satisfaction and loyalty.

ACKNOWLEDGEMENT

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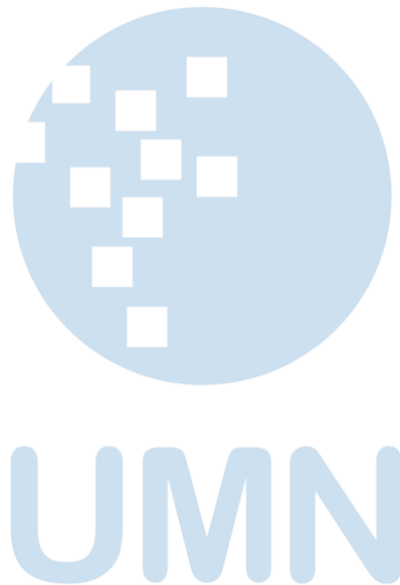
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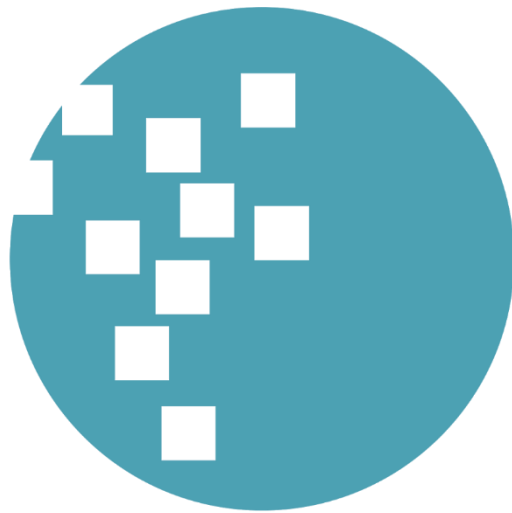
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