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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 December 2021 edition, IJNMT enters the 2nd Edition of Volume 12. In this edition there are five scientific papers from researchers, academics and practitioners in the fields covered by Ultima Infosys. Some of the topics raised in this journal are: K-Nearest Neighbors Algorithm to Student Opinion of the Online Learning Method at Wira Wacana Sumba Christian University, The Role of COBIT5 as a Reference for Quality Service Quality Improvement, Toward National One Health Data: Reconfiguring Local Health Information Systems through Enterprise Architecture, COBIT 5: How Capable PT GTI Governing Innovation, Human Resource, and Knowledge Aspect?, and Analysis and Design of Web-Based Information System for Church Congregations Case Study: Church BNKP Pewarta.

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 December 2021 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.

December 2021,

Suryasari, S.Kom., M.T.
Editor-in-Chief

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K-Nearest Neighbors Algorithm to Student Opinion of the Online Learning Method at Wira Wacana Sumba Christian University

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***Abstract*— The education sector is one of the areas that has felt the major impact of the Covid-19 pandemic. The impact that arises is the teaching and learning process must be carried out from home using the online learning method. This teaching and learning method raises a variety of responses from students. This is what makes researchers analyze these views, both in the form of positive opinions or negative opinions. The analysis process is carried out by applying sentiment analysis or opinion mining from the comment on Facebook, text mining is processed using the preprocessing method, labeled it to positive and negative. Based on the available data, a classification process is carried out using the K-Nearest Neighbors algorithm. Rapid Miner is used to experiment text data with the KNN algorithm in order to find the value of accuracy, precision and recall. From the results of research, it was obtained a value of 87.00% for accuracy and 0.916 for the AUC value. The values are high enough for the classification of student opinion against this pandemic so that this research is classified as Excellent Classification.**

***Index Terms*— Covid-19; Online Learning Mode;, K-Nearest Neighbors; Sentiment Analysis; RapidMiner**

I. PRELIMINARY

The outbreak of the Corona Disease Virus 2019 or also known as Covid19 has had a huge impact on the teaching and learning process at all levels of education in all parts of the world. Specifically in Indonesia, the teaching and learning system is carried out from home, this is based on government regulations and recommendationsthrough the Indonesian Minister of Education and Culture (Mendikbud) for all students to study from home (BDR) and even the 2020 national exam was cancelled. The study from home policy is implemented with the aim of limiting and reducing physical contact as an effort to prevent virus transmission [1].

Wira Wacana Christian University Sumba is one of the universities affected by the Covid 19 outbreak so that all student activities are "homed", learning to teach from home using online or online learning models. As of March 2020 where the government's recommendation regarding Social Distancing during the Covid 19 pandemic was issued by Unkriswina through the Chancellor's Circular Number 019/EDR-R/2020 explaining that it is necessary to pay attention to measures to prevent the spread of Covid 19 in the campus environment so that lectures are carried out online. or online(Unkriswina, 2020)..The education system is carried out using an online method where every learning activity is carried out virtually through the media presented on the internet. Of course there is an impact, whether it supports or even harms the students. The positive impacts obtained are being safe from the Covid 19 outbreak, learning is more practical and flexible, saving time and energy, as well as a more personal learning approach(Pakpahan, R., & Fitriani, 2020). However, there are several problems that arise as a result of the application of the learning method from home using online media as an example of an unstable and adequate network to be accessed properly considering that Indonesia is an archipelagic country whose internet infrastructure development is uneven. There are obstacles for students and students with low economics considering that it takes money to access the internet. The effectiveness of online learning also depends on the maturity and readiness of the school, in this case the teaching teacher. There are many teachers who are not able to convey material effectively through online learning systems [2].

Based on the existing impacts, the focus to be studied is students using the Sentiment Analysis method which is a process to find out a person's views or opinions on events that occur, whether it is a positive or negative view. Opinions and views of students can be in written or oral form. K-Nearesr Neighbors is an algorithm used to perform the opinion classification process resulting from sentiment analysis.The advantage of the K-Nearest Neighbor algorithm is the high accuracy value in calculations that have been

proven and have been applied in applications [3].The aim is to classify student opinions in the form of positive and negative opinions and the accuracy value will be calculated using the K-NN algorithm approach. The results can be used as evaluation material regarding online learning models during the pandemic.

Previous research related to the classification of sentiment analysis is classification of wikipedia articles by Hardiyanto and Rahutomo (2016). The Indonesian Wikipedia article classification is intended for the classification of articles on the Indonesian Wikipedia website in text form by using a text pre-processing model and then forwarded by TF-IDF weighting. Based on this weighting, the articles in the Indonesian Wikipedia are classified using the K-Nearest Neighbor Algorithm. The results of the manual test show the accuracy of the truth with a value of 60% [4]. Comparison with this research is the classification process which is carried out manually without the help of classification tools or tools.

The research of Siti Ernawati and Risa Wati in 2018, The application of the K-Nearest Neighbors algorithm in the sentiment analysis of travel agent reviews shows the following: processing 100 positive and negative review data with the K-Nearest Neighbor (K-NN) algorithm related to sentiment. Experiments and results show that by using the K-Nearest Neighbor (K-NN) algorithm, it achieves high accuracy results and is classified as the best accuracy value of 87.00% and the AUC point of 0.916[5]. There are several things that are lacking from this research, namely the KNN algorithm is applied theoretically while the formulation or algorithm equation in finding distance or proximity data as a classification process is not applied.

Research related to the use of online learning models conducted by Toni Limbong (2020) shows the following: as an effort to support the Government's decision regarding the spread of the Corona Virus, the Catholic University of Santo Thomas Medan applies an online or online-based learning model. The researcher applied the Multi Attribute Utility Theory Method to a case study of the effectiveness of online learning using the Zoom and Edmodo applications at the Faculty of Computer Science, Santo Thomas Catholic University, Medan and obtained objective results with the assessment of Theory (0.88) as the highest assessment, followed by Theory and Practicum courses (0.70) , Practicum courses (0.42) and Field courses (0.20). The conclusion that the researcher obtained and became a reference for the decision if the university leadership would make an online or online exam policy, then the form of questions and the nature of the exam were in the form of theory, such as: multiple choice, essay and also analysis [6]. This study uses pseudocode and a combination of opinions so that the conclusions generated are solely the views of the researchers.

Some of the basic things that will be used in this research are the application of sentiment analysis and the K-Nearest Neighbors algorithm as a method for classifying Unkriswina students' views on the use of online learning during the Lock Down period due to the Corona Virus outbreak. The application of pseudocode or distance and proximity calculation algorithms as part of the classification process will be applied. Of course, the main target is how to find out the views of students while participating in online learning, which of course their views vary so that they need to be classified and separated positive opinions and negative opinions.

II. Research Materials And Methods

A. *Sentiment Analysis*

Sentiment analysis or also called opinion mining is a computational or computational study in finding and identifying opinions, attitudes, emotions, sentiments, evaluations, subjectivity, judgments contained in a text. Sentiment analysis is intended to find the percentage value of positive labeled sentiment and negative labeled sentiment towards a person, object or in a certain condition. Sentiment analysis has 3 values that are generally used, namely: positive sentiment, negative sentiment and neutral sentiment [7].

The steps of sentiment classification analysis of text-mining data or text data are as follows: 1). Initial stage: Collecting datasets such as public opinion, ratings of restaurants or products and others. 2). Pre-processing: stages in text-mining to convert raw data into important information where the stages include: Tokenization, Stopwords Removal, and Stemming. 3). Transformation: Weighted text data. 4). Feature Selection: The stage of limiting and reducing data that is not needed. 5). Classification: Classification stages such as: Naive Bayes, K-Nearest Neighbor, Support Vector Machine and others. 6). Interpretation/Evaluation: The evaluation stage is to calculate the accuracy value and the Area Under the Curve value[8].

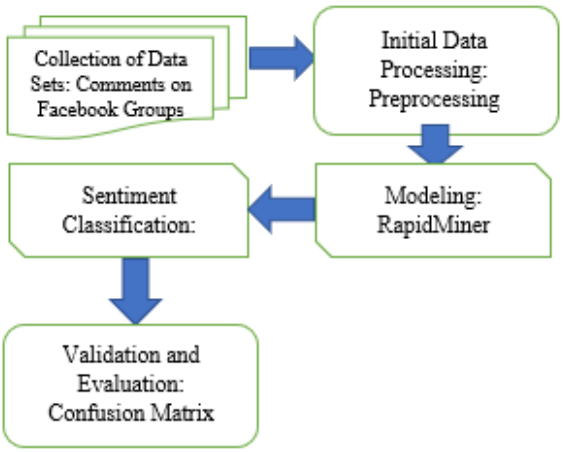
B. *K-Nearest Neighbors*

In the book Data Mining Algorithm, Kusrini explains that the K-Nearest Neighbors Algorithm is an approach to finding cases by calculating the proximity between a new case and an old case through a weight matching process from a number of available features [9]. In another view, it is stated that K-Nearest Neighbors is an algorithm for classifying objects based on the data that is closest to the object. Data is illustrated in many dimensional spaces, where each dimension reflects a feature of the object. Accurate k values for this algorithm depend on data with high k values [10].

The main purpose of this algorithm is to classify an object based on the attributes and training sample. The K-NN model applies a classification that refers to the

proximity of the points of existing objects as the approximate value of the new sample [11].

The method used is by observing the discussion and comment forms in the Facebook group which is then used as a dataset to be processed as research subjects. The stages of the research are as follows:



Source: (Mara, 2021)

Figure 1. Proposed Method

Figure 1, are the stages applied in this study with the following explanation.

C. *Collection of Data Sets*

The first stage is collecting data by creating a Facebook group account consisting of active Unkriswina students and providing space to answer questions related to online learning in the midst of the Covid 19 pandemic. The data in question are opinions or views from Wira Wacana Sumba Christian University students as targets. study. The data obtained is still in the form of a collection of opinions so that it must be processed first into a dataset.

D. *Initial Data Processing*

The data sample used for training is as much as 200 data. At the initial processing of data through pre-processing as follows:

i. *Case Folding*
Case Folding is the process of converting all letters of text data to lowercase.

ii. *Tokenization*
Tokenization is the stage of separating words, phrases, punctuation marks or symbols.

iii. *Stopword Removal*
Then next is the process of eliminating the stopword list which is a list of connecting words between sentences.

iv. *Stemming*
Stemming aims to change or replace tokens that have affixes into basic words. For example, the word remove is changed to replace [12].

E. *Modeling*

Experiments in processing text data in this study using RapidMiner 8.2. The training data used are opinions Unkriswina Sumba students obtained from Facebook Social Media and grouped into 2 parts, namely: positive opinions and negative opinions.

F. *Sentiment Classification*

K-Nearest Neighbors is a classification method used in this research. Equation 2 below is an equation to calculate the proximity between two cases:

$$\text{Similarity(T,S)} = \frac{\sum_{i=1}^{n} f(T,S) * w}{w} \quad (1)$$

Information:

T : New Object

S : Old Object

n : Number of Attributes On Each Object

i : Individual Attribute 1 Until N

f : Function Similar Attribute I between T and S

w : i-th Attribute Weight

Generally, Similarity is at a value between 0 to 1, a value of 0 is that the two objects are absolutely not similar, while a value of 1 indicates that the object is similar to absolute [13].

G. *Validation and Evaluation*

The validation stage is carried out by applying 10-fold-cross validation. The validation process has two sub-processes, namely: training set and testing set. The training data sub-process is intended to be used in RapidMiner modeling which will then be tested. The evaluation or testing of the results of the K-NN classification uses the Confusion Matrix.

TABLE 1. CONFUSION MATRIX

		PREDICTION	
		POSITIVE	NEGATIVE
CURRENT	POSITIVE	TP	FN
	NEGATIVE	FP	TN

Source: (Han, Kamber, & Pei, 2012)

i. TP (True Positive): The positive value obtained corresponds to the actual value.

ii. TN (True Negative): The negative value obtained corresponds to the actual value.

iii. FP (False Positive): Positive value but does not match the actual value.

iv. FN (False Negative): Negative value but does not match the actual value.

III. Result and Discussion

The data is obtained from the comments in the Facebook group discussion form: https://www.Facebook.com/groups/465615134612746 with more than 200 respondents and 291 comment data. The data were then given positive and negative labels so as to produce 200 comment data, these labeled data were used as research datasets. Rapidminer version 8.2 is used with the aim of obtaining a model that suits research needs.

A. Opinion Document Collection

The Opinion Document used is the result of collecting the opinions of Unkriswina students, as many as 200 opinion documents consisting of 26 positive opinions and 174 negative opinions. These 200 positive and negative opinion data are used as training documents and there are 50 testing documents.

TABLE 2. Opinion Documents

No.	Student Opinion	Training Opinion	Opinion Testing
1	Positive	25	-
2	Negative	175	-
3	Total	200	50

The Opinion Document in table 1 will be processed with the Prepoccessing approach and the application of opinion classification by prioritizing the data normalization stage.

TABLE 3. Opinion documents before pre-processing

No.	Opinion Document
1	Studying from home can be while playing with friends
2	Online learning is not at all good, I mostly don't understand
3	BASICALLY if this online learning model is implemented seriously by the lecturer and we are STUDENTS… I think everything will be fine 😊 and we also get SCIENCE with EFFECTIVE !!!
4	Online lectures are very inconvenient, costs a lot to buy packages, the network is so unstable here
5	I don't have a cellphone let alone a laptop, online lectures for me have to find more money to buy a cellphone
6	More of us are required to learn on our own actually
7	The lectures are ok but I don't know the lecturers and friends in class, I can only see they have photos
8	Online lectures but if there is no internet is the same as lying, it is difficult.
9	Most of the lecturers teach not clear, suddenly give assignments. Few materials are taught, a myriad of tasks are given
10	I don't concentrate when studying online, not to mention if the network has been disrupted, it's already bad

Table 3 is the initial opinion documents on training data that have not been preprocessed. The following is a preprocessing stage with a case folding, tokenizing, stopword removal approach in opinion documents in table 3.

B. Pre-processing Comment Data

Before the dataset is classified using the K-Nearest Neighbors method, as an initial stage, pre-processing will be carried out as follows:

TABLE 4. Preprocessing Student Opinions

No.	Student Opinion
1	study from home while playing with friends
2	online learning is not good I don't understand
3	the basic online learning model is applied seriously by lecturers and students, all will be good and get effective knowledge
4	online college is a hassle to buy an unstable network package
5	I don't have a laptop, I have to find money to buy a cellphone
6	we need to learn on our own
7	college is ok, don't know the lecturers, friends, see their photos foto
8	online college no internet is the same as a lie
9	The teaching lecturer is not clear, suddenly gives material assignments, a little teaching warehouse assignments
10	lack of concentration online lectures, network, severe interference

Next is the determination of the frequency term in the training data resulting from the preprocessing approach, as shown in table 5 below:

TABLE 5. Term Frequency of Training Data

No.	term	Id_document	Amount
1	studying	1	2
2	from	1	1
3	House	1	1
4	while	1	1
5	play	1	1
6	friend	1	1
7	study	2	1
8	on line	2	2
9	no	2	2
10	good	2	1
11	no	2	2
12	understand	2	1
13	studying	4	2
14	on line	4	2
15	Troubled	4	1
16	go out	4	1
17	cost	4	1
18	many	4	1
19	buy	4	1
20	package	4	1

The result of the term frequency of training data is in the form of word tokens which are then carried out in the classification stage, but first class labeling is carried

out on each opinion with the aim that the tools used can identify class documents from student opinions.

TABLE 6. LABELING OF TRAINING DATA

No.	Student Opinion	Class Sentiment
1	study from home while playing with friends	Positive
2	online learning is not good I don't understand	Negative
3	the basic online learning model is applied seriously by lecturers and students, all will be good and get effective knowledge	Positive
4	online college is a hassle to buy an unstable network package	Negative
5	I don't have a laptop, I have to find money to buy a cellphone	Negative
6	we need to learn on our own	Negative
7	college is ok, don't know the lecturers, friends, see their photos foto	Negative
8	online college no internet is the same as a lie	Negative
9	The teaching lecturer is not clear, suddenly gives material assignments, a little teaching warehouse assignments	Negative
10	lack of concentration online lectures, network, severe interference	Negative

Table 6 is the stage of labeling student opinion training data which will then be tested with the K-Nearest Neighbors algorithm.

C. *Classification Using the K-Nearest Neighbors Method*

Before the classification is carried out, first the calculation of the proximity of the distance is carried out using the existing equations, namely:

$$d = \sqrt{\sum_{i=1}^{n}(a_i - b_i)^2} \quad (2)$$

The comparison is on sample data and test data. Sample data used for example id_document = 1 with test data id_document = x. Then the application of the formula is as follows:

$$d_{1=}\sqrt{\sum_{i=1}^{p}(1)^2 + (-0{,}07175)^2 + (0{,}5)^2 + (1)^2 + (0{,}2222222)^2 + (1)^2}$$

$$d_{1=}1.83494708 \quad (3)$$

TABLE 7. DATA DISTANCE BETWEEN TEST DATA

Test Data	Sample Data	Distance
Id_document = x	Id_document = 1	1.83494708
	Id_document = 2	1.45308990
	Id_document = 3	1.17634227
	Id_document = 4	0.08900544
	Id_document = 5	1.07443387
	Id_document = 6	0.45009112
	Id_document = 7	1.09231099
	Id_document = 8	1.52096677
	Id_document = 9	1.69230019
	Id_document = 10	0.03670674

The distances in the test data as shown in table 7 can be sorted into the closest as follows:

TABLE 8. RESULTS OF NEAREST DISTANCE COUNT

Test Data	Sample Data	Distance
Id_document = x	Id_document = 10	0.03670674
	Id_document = 6	0.45009112
	Id_document = 4	0.08900544
	Id_document = 5	1.07443387
	Id_document = 7	1.09231099
	Id_document = 3	1.17634227
	Id_document = 2	1.45308990
	Id_document = 8	1.52096677
	Id_document = 9	1.69230019
	Id_document = 1	1.83494708

The following are the stages of data processing using RapidMiner tools from the results of pre-processing in the early stages.

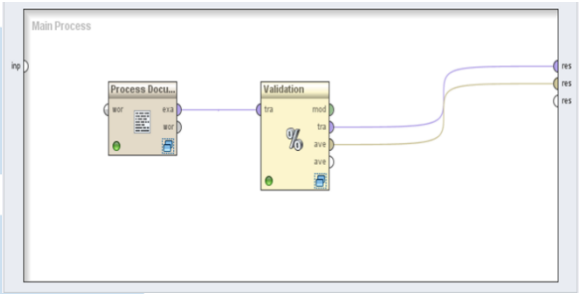


Figure 2. Input Validation (Mara,2021)

Figure 2, is the process of data validation into Rapidminer tools for later classification.

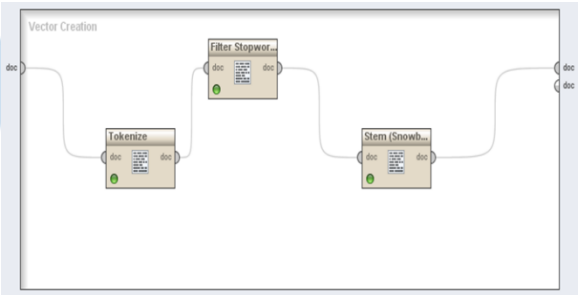


Figure 3. Pre-processing stage (Mara,2021)

Figure 3, is the pre-processing stage of the data set that has been determined, step by step is applied to obtain the expected final result.

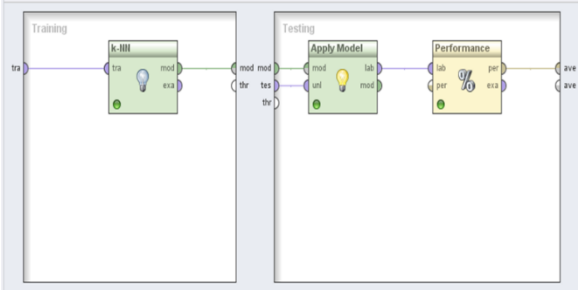


Figure 4. Application of K-Nearest Neighbors (Mara,2021)

Figure 4, is the data classification stage based on the data set that has been preprocessed.

TABLE 9. EVALUATION OF TRAINING DOCUMENTS WITH KNN

NO	CLASS SENTIMENT	WEIGHT | ACCURACY	PRECISION	RECALL
1	POSITIVE	26 | 13%	1.0	1.0
2	NEGATIVE	174 | 87%	1.0	1.0
	TOTAL/AVERA	GE100%	1.0	1.0

Table 9 is the result of the K-Nearest Neighbors sentiment training process with an accuracy value of 13% for positive sentiment and very large accuracy on negative sentiment reaching 87% of the total 100% accuracy. While the precision results in the positive sentiment class are worth 1 and the negative sentiment class is worth 1, thus the precision results are very accurate. Meanwhile, the recall results are the same as the precision results, with the results of positive and negative sentiment classes being worth 1. It means that the results of the training data sentiment are correct for all sentiment classifications.

D. *Change in k Value*

The following is an experimental process by changing the k value to determine the accuracy, precision, recall, and AUC values:

TABLE 10. EXPERIMENTAL CHANGES IN THE VALUE OF K

K. VALUE	*ACCURACY*	*PRECISION*	*RECALL*	*AUC*
1	80.05	77.58	84.00	0.500
2	83.50	89.88	74.00	0.833
3	81.50	78.48	85.00	0.854
4	82.00	84.47	79.00	0.814
5	82.50	76.77	85.00	0.857
6	83.50	88.59	78.00	0.918
7	84.00	86.54	83.00	0.911
8	**87.00**	**92.94**	**81.00**	0.916
9	85.00	85.05	84.00	0.926
10	84.50	87.42	81.00	0.919
11	86.50	87.16	86.00	0.912
12	85.50	88.51	81.00	0.914
13	86.00	87.70	84.00	0.912
14	85.00	89.90	79.00	0.911
15	83.50	85.08	81.00	0.912

Based on table 10, namely the change in the value of k, the highest accuracy results with a value of 87.00% and the AUC value of 0.916 is at the value of k=8.

E. *Validation and Evaluation*

Based on table 10, Accuracy with the KNN method produces a Negative class recall value of 93.00% and Positive of 81%, Negative Precision class values of 83.04% and Positive of 92.05%. Accuracy with the KNN method in table 10 is derived into the Confusion Matrix. The results are as follows:

$$\text{Accuracy} = \frac{(TN+TP)}{(TN+FN+TP+FP)}$$

$$\text{Accuracy} = \frac{(93+81)}{(93+7+81+19)} \quad (4)$$

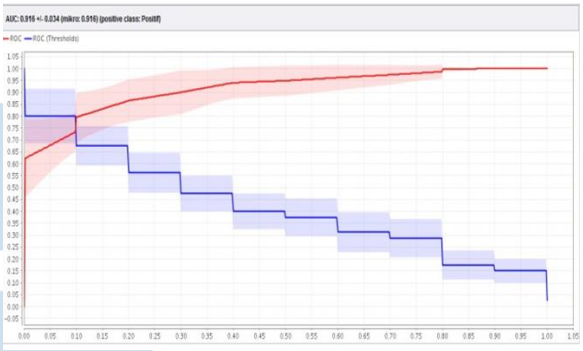


Figure 5. KNN on the AUC Graph (Mara, 2021)

Based on the accuracy value, an AUC graph can be made as shown above. Figure 5 shows the AUC graph with the application of the K-Nearest Neighbors method, resulting in the Area Under Curve (AUC) = 0.916. So from the values that have been obtained, it is concluded that the accuracy classification in this study is included in the Excellent Classification which can be seen in the guide to the accuracy of the AUC value as below:

i. 0.90 - 1.00: Excellent Classification,

ii. 0.80 - 0.90: Good Classification,

iii. 0.70 - 0.80: Fair Classification,

iv. 0.60 - 0.70: Poor Classification,

v. 0.50 - 0.60: Failure

Source: (Han et al., 2012)

IV. CONCLUSION

Research has been carried out by applying the classification of comment data from Facebook social media by taking into account the views of Wira Wacana Sumba Christian University students on the use of online or online learning models during the Covid-19 pandemic by utilizing the K-Nearest Neighbors method. The data of 26 positive reviews and 174 negative reviews were used as a dataset and then classified with the results of an accuracy value of

87.00% and an AUC value of 0.916 so that these results were used as a reference for classifying the classification group, namely Excellent Classification. Based on the results of the study obtained a very good accuracy value and obtained a fairly large AUC value. In relation to the online learning process, the value generated is in the form of a negative opinion presentation of 87. 00% indicates that most of the student population considers online learning that has been implemented so far to be ineffective. The presentation of the negative opinion is supported by an accuracy value based on the K-Nearest Neighbors algorithm of 87%, which means that the presentation has a very high validity value. So it can be concluded that there needs to be an evaluation of the online learning model at Unkriswina Sumba, both the competence of lecturers in teaching online, the handling of uneven internet networks for students, solutions for students who are economically limited and unable to study online. The presentation of the negative opinion is supported by an accuracy value based on the K-Nearest Neighbors algorithm of 87%, which means that the presentation has a very high validity value. So that it can be concluded that there needs to be an evaluation of the online learning model at Unkriswina Sumba, both the competence of lecturers in teaching online, the handling of the uneven internet network for students, solutions for students who are economically limited and unable to study online. The presentation of the negative opinion is supported by an accuracy value based on the K-Nearest Neighbors algorithm of 87%, which means that the presentation has a very high validity value. So it can be concluded that there needs to be an evaluation of the online learning model at Unkriswina Sumba, both the competence of lecturers in teaching online, the handling of uneven internet networks for students, solutions for students who are economically limited and unable to study online.

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The Role of COBIT5 as a Reference for Quality Service Quality Improvement

Case Study: Private Bank in Indonesia

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***Abstract*— PT. Bank Central Asia Tbk. is the largest private bank company in Indonesia, which is now owned by one of the largest cigarette group companies in the world, namely Djarum. PT. Bank Central Asia Tbk. make various efforts to improve the quality of service quality by setting a standard and policy. One of them is the determination of ITIL V3 standardization, which covers the entire IT Service process. ITIL V3 is a series of concepts and techniques for infrastructure management, development, and information technology operations. These efforts were made to meet the ISO 20000 standardization to obtain ISO 20000 certification in 2011. However, PT Bank Central Asia Tbk wants to continue to improve the quality of IT services for the better, therefore PT Bank Central Asia Tbk. choose to use the COBIT 5 framework as a method of measuring the quality of IT service quality, especially in the field of IT Service Management (ITSM) in the DSS02 (Manage Service requests and Incidents) and DSS03 (Manage Problems) processes. The result of this research is that the Capability Level of the DSS02 and DSS03 processes is known at PT Bank Central Asia Tbk. the current condition is level 3 (Established Process), while the target level to be achieved is level 4 (Predictable Process). So that to reach the next level, PT Bank Central Asia is expected to have followed the recommendations for improvement given.**

***Index Terms*— Capability Level, COBIT 5, IT Service Management (ITSM)**

I. INTRODUCTION

Information technology is becoming a must-have in the corporate sector, opening up a slew of new company and job prospects [1]. The output of a business process is heavily influenced by information technology, from everyday operational activities to the company's business processes, the majority of which are influenced by information technology implementation. Information technology management can serve as a guarantee for a company process' efficiency as well as an assessment tool for ongoing development and improvement [2].

PT. Bank Central Asia Tbk. is one of Indonesia's largest private banking firms, with shares worth $47.64 million (67 trillion rupiahs) as of September 23, 2019 [3]; it is now owned by Djarum, one of the world's largest tobacco companies. The service procedure was carried out with sufficient information technology, making it easy for PT. Bank Central Asia Tbk. to serve clients. PT. Bank Central Asia Tbk. is always innovating in financial and information technologies to ensure that its clients are satisfied [4].

PT. Bank Central Asia Tbk. makes various efforts in the IT field, especially IT Service Management, to continuously improve the quality of service by setting a standard and policy, one of which is the establishment of ITIL V3 standardization, which covers the entire IT Service process, where ITIL V3 is a series of concepts and techniques for infrastructure management, development, and information technology (IT) operations [5]-[7].

PT Bank Central Asia Tbk. has the goal of continuously improving service quality from various angles, according to the results of field interviews conducted with one of the leaders of the ITSM (Information Technology Service Management) work unit of the GSIT (Group Strategic Information Technology) division. They aim to employ COBIT 5 as a measurement tool for assessing the quality of service quality, which is unique and has never been tried before. As a result, by executing an assessment process in the ITSM work unit, COBIT 5 will be used as a measuring framework to improve service quality.

PT Bank Central Asia Tbk. currently requires improved service quality in the areas of problem management and service requests, so the DSS (Deliver, Service, and Support) domain in the DSS02 process code, namely Manage Service Requests and Incidents, and DSS03, Manage Problems, will be focused on based on the COBIT 5 framework process domain.

II. METHOD

A. COBIT (Control Objectives For Information & Related Technology)

COBIT 5 is the most recent set of ISACA IT governance and management guidelines. COBIT 5 was developed by ISACA based on the experiences of

of organizations that had been using earlier versions of COBIT for over 15 years [8].

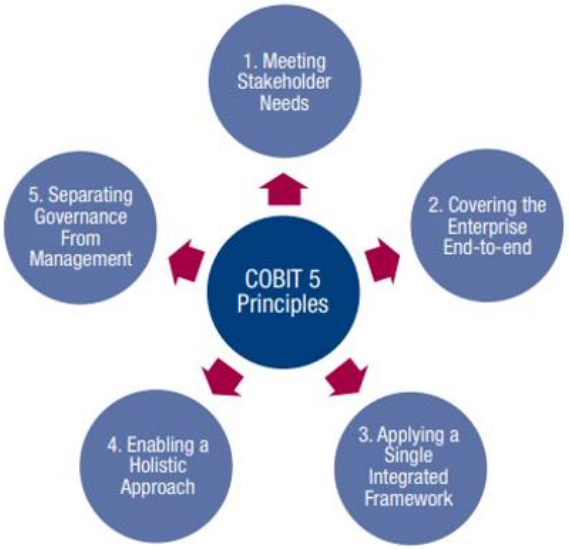

Figure 1. Five fundamental principles of COBIT 5

The five fundamental principles of COBIT 5 for IT governance and management are [8]:

1) Assisting stakeholders in meeting their demands.

2) COBIT 5 integrates IT governance with corporate governance, protecting end-to-end business completely and responsibly.

3) Implementing an integrated framework.

4) COBIT 5 is consistent with other related standards and other high-level frameworks.

5) Separating governance and management.

B. Capability Level

COBIT 5 introduces a functional process model. This series contains an internationally recognized evaluation standard, a process capability model based on the ISO / IEC 15504 software engineering process. This model achieves the same goal of supporting process evaluation and process improvement. Functional models provide a means of measuring the performance of governance processes (EDMs) or management processes (PBRMs) and identifying areas that need improvement [9]. The process evaluation ability aspect consists of six skill levels. There are PAs (process attributes) within 6 skill levels. Level 0 means that the process failed and was not implemented, or the process was only partially successful. Evaluation activities are conducted to distinguish between level 1 and higher level evaluations. If you are 100% successful in the previous level, you can reach the next level. Each level of assessment by ISACA falls into four categories [8]:

1). N (Not Achieved)

In this category, there is little evidence of the achievement of the attributes of the process. The range of scores achieved in this category ranges from 0-15%.

2) P (Partially achieved)
Within this category, there is some evidence of the approach and some of the achievement attributes of the process. The range of scores achieved in this category ranges from 16-50%

3) L (Largely Achieved)
There is evidence of a systematic approach within this category, and significant achievements over the process, although there may still be few weaknesses. The range of scores achieved in this category ranges from 51-84%.

4) F (Fully achieved)
Within this category, there is evidence of a comprehensive and systematic approach and full achievement of the attributes of the process. There are no weaknesses related to the attributes of the process. The range of scores achieved in this category ranges from 85%-100%.

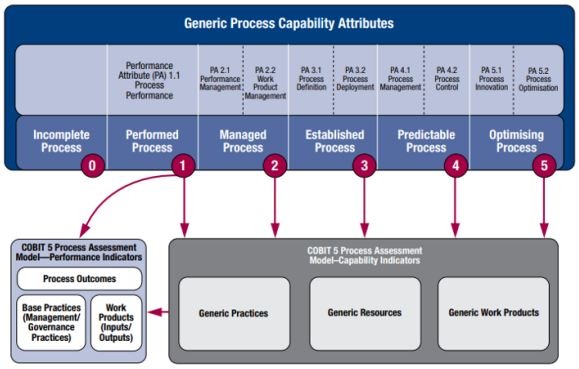

Figure 2. COBIT 5 Capability Model

The Largely achieved (L) or fully achieved (F) category must be achieved to state that the process has achieved a level of capability. Still, a fully achieved (F) category must be a process to continue the assessment to the next level. For example, a process must reach the Fully achieved (F) category at levels 1 and 2. Then it can proceed to level 3. The six capability processes are as follows [8], [10]:

1). Level 0 – Incomplete Process
The process is not implemented or has failed in achieving its process objectives. At this level, there is little or no evidence of any systematic achievement of a process.

2) Level 1 – Process has done (Performed Process)
The implemented process achieves its process objectives. The PA (Process Attribute) provisions at this level are as follows:

- PA 1.1 Process Performance
  Measurements related to the goals that

have been achieved to what extent. The achievement of goals marks full achievement.

3) Level 2 – Managed Process

The processes that have been implemented have been successfully planned, monitored, and adjusted. Appropriate work products have been appropriately applied, controlled, and maintained. The PA (Process Attribute) provisions at this level are:

- PA 2.1 Performance Management
  Measuring the performance of the managed processes to what extent.
- PA 2.2 Work Product Management
  Measures the extent to which the work produced by the process is managed. The results of the work referred to in this case are the results of the process.

4) Level 3 – Defined Process (Established Process)
Managed processes are now implemented using defined processes capable of achieving their process outcomes. The process attribute requirements at level 3 are as follows:

- PA. 3.1 Process Definition
  Measuring the extent to which standard processes are managed to support the execution of the described processes.
- PA. 3.2 Process Deployment
  Measuring how to process standards have been effectively implemented as defined processes to achieve the process results.

5) Level 4 – Predictable Process
The current process operates within defined limits to achieve its process results. The process attribute requirements at level 4 are as follows:

- PA 4.1 Process Measurement
  Measurements related to the extent to which measurement results have been achieved help confirm that process performance supports company goals.
- PA 4.2 Process Control
  A related measurement of the extent to which the stability and capability of the process can be quantitatively and predictably within certain limits.

6) Level 5 – Optimizing Process

Due processes are continuously improved to meet current relevant business objectives. The process attribute requirements at level 5 are as follows:

- PA 5.1 Process Innovation
  Changes to the process are identified and measured. Analyze common causes of variation in performance. There is a need to investigate innovative approaches to defining and implementing processes.
- PA 5.2 Process optimization
  Measures the extent to which changes to the definition, management, and performance of effective process outcomes impact relevant process improvement objectives.

C. *RACI Chart*

COBIT 5 provides a RACI Chart, a matrix of all activities or decision-making powers carried out in an organization for all people or roles for each process [8], [10], [11].

1) Responsible: People who do an activity or do work.

2) Accountable: The person who is responsible and has the authority to decide a case.

3) Consulted: People who need feedback or suggestions and contribute to the activity.

4) Informed: People who need to know the outcome of a decision or action.

D. *Audit Procedures*

ISACA developed a guide on performing audit procedures step-by-step, entitled; Information Systems Auditing: Tools and Techniques Creating Audit Programs. There are three main processes in carrying out an audit in the guide: planning, fieldwork/documentation, and reporting/follow-up.

Figure 3. Three phases of the audit process [8]

At each stage, there is a step-by-step process that researchers can develop independently. The planning phase typically consists of planning the pre-audit process, determining the scope, defining what to audit, and describing the steps that are performed during the audit process. In the second stage, fieldwork / documentation is the stage in which the audit process takes place, where data acquisition, test control, problem identification and validation, and document analysis results are performed. The final phase is the reporting / follow-up phase. This phase occurs after the audit process is complete and all data conclusions / collections have been received. This process involves collecting report requirements, creating reports, creating and completing reports, and tracking the parties involved in the audit.

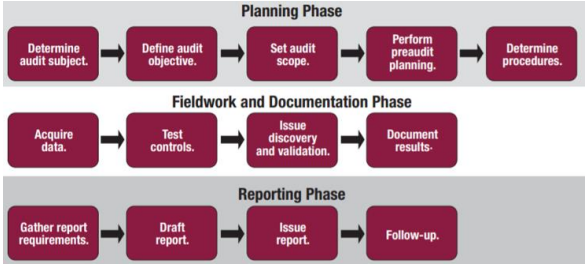

Figure 4. Step-by-step audit process [8]

The following are data collection methods related to the assessment process carried out in this study [12]-[15]:

E. Observation

Observations made at PT Bank Central Asia Tbk Head Office aim to identify and seek some information that can be collected. Observations began in June 2019 until August 2019. Through observations, data collection was carried out by observing firsthand how the system and services were provided by the ITSM work unit in the GSIT division.

F. Interview

This interview was conducted by discussing with several managers and staff from the ITSM work unit. The Manager consists of 2 Service requests & Incidents Management Managers, four other staff, one problem management manager, and three staff. This interview is helpful to obtain the data needed in the analysis of the business processes currently running in the company, especially those related to service management applications. This interview refers to a questionnaire based on key activity levels 1-5 in the COBIT 5 framework, DSS02, and DSS03 processes process.

G. Literature review and document study

The literature review is done by collecting data in descriptions or explanations related to what is being studied. Data collection was carried out by reviewing several journals and books related to the research carried out and reviewing and studying the procedures carried out by the ITSM work unit by observing and analyzing existing procedure documents.

III. Result and Discussion

A. Data Gathering

In the data-gathering phase, before the assessment process begins, this phase consists of 3 parts: the collection of pre-assessment information, Requirements Gathering, and Identification of the target sources.

1). Collection of pre-assessment information
At this stage, the activities carried out are to identify field conditions directly by conducting a work environment survey, followed by identifying the hierarchical structure of the work unit, and asking what needs an assessment is needed regarding the work process in consultation with the relevant managers.

2). Requirements Gathering
The Requirements Gathering activity is to determine what needs are needed for conduct an assessment, including determining a list of documents based on COBIT 5 and the target sources who want to be interviewed. Document requirements, or so-called work products from each process are as follows:

TABLE 1. DSS02 Work products

DSS02 *Work products*	
Inputs	
Number	**Description**
APO12-WP16	*Risk-related root causes*
DSS02-WP3	*Criteria for problem registration*
DSS02-WP9	*Problem log - Application service management*
DSS02-WP10	*Incident resolutions*
DSS02-WP11	*Closed service requests and incidents*
Outputs	
Number	**Description**
DSS02-WP1	*Operational schedule Incidents and service request classification schemes and models*
DSS02-WP2	*Rules for incident escalation*
DSS02-WP3	*Criteria for Problem registration*
DSS02-WP4	*Incident and service request log*
DSS02-WP5	*Classified and prioritized incidents and service requests*
DSS02-WP6	*Approved service request*
DSS02-WP7	*Fulfilled service request*
DSS02-WP8	*Incident symptoms*
DSS02-WP9	*Problem log*
DSS02-WP10	*Incident resolution*
DSS02-WP11	*Closed service requests and incidents*
DSS02-WP12	*User confirmation of satisfactory fulfillment or resolution*
DSS02-WP13	*Incident status and trends report*
DSS02-WP14	*Request fulfillment status and trends report*

TABLE 2. DSS03 Work products

DSS03 *Work products*	
Inputs	
Number	**Description**
APO12-WP16	*Risk-related root causes*
DSS02-WP3	*Criteria for problem registration*
DSS02-WP9	*Problem log - Application service management*
DSS02-WP10	*Incident resolutions*
DSS02-WP11	*Closed service requests and incidents*
Outputs	

DSS03 *Work products*	
Number	**Description**
DSS03-WP1	*Problem classification scheme*
DSS03-WP2	*Problem status reports*
DSS03-WP3	*Problem register*
DSS03-WP4	*Root causes of problems*
DSS03-WP5	*Problem resolution reports*
DSS03-WP6	*Known-error records*
DSS03-WP7	*Proposed solutions to known errors*
DSS03-WP8	*Closed problem records*
DSS03-WP9	*Communication of knowledge learned*
DSS03-WP10	*Problem resolution monitoring reports*
DSS03-WP11	*Identified sustainable solutions*

B. Identification of Target Sources

The identification of the sources was determined based on the RACI Chart COBIT 5 in the DSS02 and DSS03 processes. A total of 10 resource persons were appointed. The Manager consisted of 2 Service Request & Incidents Management Managers, four other staff, one problem management manager, along with three staff.

C. Observation

At this stage, field observations were carried out after a literature study of related documents and SOPs was carried out, field observations were carried out within the ITSM work unit work environment to match work procedures with the SOP documents that had been studied.

The DSS02 and DSS03 assessment processes are carried out by identifying the subprocesses listed in COBIT 5 and then matching them to the work process being carried out. Field observations focused on level 1 assessment activities on the DSS02 and DSS03 processes. After conducting a comparative study of SOPs with work processes, it can be concluded that the DSS02 process has no findings, all activity processes have been well documented, but for DSS03, there are two findings related to service management applications that are not fully integrated, and also related to cost monitoring.

D. Interview

The interview process focuses on the assessment process level 2 to 5, where direct interviews are carried out with resource persons who have been identified on the RACI chart. After the interview, the DSS02 and DSS03 processes achieved capability level 3 (Established Process). There are still shortcomings in the determination of process standards, especially in the field of SOP documentation standard-setting; this causes the two processes not to achieve capability level 4 (Predictable Process).

TABLE 3. ASSESSMENT RESULTS DSS02

DSS02 Manage Service requests & Incidents		
Capability Level	Avg. Score	Level Conversion
Level 1 - Performed	95	1.00
Level 2 - Managed	95	1,00
Level 3 - Established	88,1	1,00
Level 4 - Predictable	79,54	0,94
Capability level Reached:	3,94	
Current Capability level:	Level 3 - Established	

TABLE 4. ASSESSMENT RESULTS DSS03

DSS03 Manage Problems		
Capability Level	Avg. Score	Level Conversion
Level 1 - Performed	93	1.00
Level 2 - Managed	95	1,00
Level 3 - Established	86,8	1,00
Level 4 - Predictable	82,7	0,94
Capability level Reached:	3,97	
Current Capability level:	Level 3 - Established	

TABLE 5. ASSESSMENT SUMMARY

Process Name	**Process *Capability level***					**Target *level***
	1	**2**	**3**	**4**	**5**	
DSS02 Manage *Service Requests* and Incidents	**F**	**F**	**F**	**L**	**-**	**4**
DSS03 Manage *Problems*	**F**	**F**	**F**	**L**	**-**	**4**
Ratings: **N: Not Achieved (0-15%)** **P: Partially Achieved (15%-50%)** **L: Largely Achieved (50-85%)** **F: Fully Achieved (85%-100%)**						

Judging from the table above, based on the assessment process carried out, it can be concluded that the DSS02 and DSS03 processes meet the Fully Achieved value at levels 1 to 3. However, for level 4, it is still included in the Largely Achieved because there are still incomplete documents and standard procedures that have not been completed.

The following are recommendations for improvements that can be made by PT Bank Central Asia TBK. to achieve a higher capability score:

TABLE 6. RECOMMENDATIONS

Recommendations of DSS02	
#	**Recommendations**
1	Identifying infrastructure and work environment needs based on business process objectives, and documenting them into service request & incident management procedures as a standard process, this is done to assist as a guideline in smooth process activities to achieve business goals.
2	Referring to the procedure for managing the service request process based on the standard that is used as a reference if further review and review is needed.
3	Establish a maintenance documentation process for infrastructure and work environment as a reference for process improvement.
4	Plan and determine the goals to be achieved from the evaluation process of improving the performance of the service request & incident management process, as well as the actions that need to be taken to improve the performance of the processes that have been carried out so that the process is more effective and efficient.
5	Determine control limits & normal parameters in the service request & incident management process such as CPU threshold, server load, etc. and document it as part of the standard process.
6	Identify control techniques in the form of actions taken to maintain process normalization so as not to exceed the threshold limit in accordance with the normal parameters of the specified service request & incident management process, and document it as a standard process.
7	Determination of a change in control procedures in the form of documentation of change actions taken if needed during the improvement process, and making it a process standard.
Recommendations of DSS03	
#	**Recommendations**
1	Connecting Configuration Items (CI) to known error/established, so that the fundamental structure of the problem management system is more integrated.
2	Monitor costs related to resources used in order to maintain transparency to process stakeholders.
3	Identify infrastructure and work environment needs, and document them into problem management procedures as a standard process.
4	Establish documentation procedures in the maintenance of infrastructure and work environment as a reference for process improvement, and make it a standard process.
5	Plan and determine the goals to be achieved from the evaluation process of improving the performance of the problem management process, as well as the actions that need to be taken to improve the performance of the processes that have been carried out so that the process is more effective and efficient.
6	Define normal control limits & parameters on the performed process and document it as part of the process standard. This can help in the running of the process so as not to go outside the specified normal limits.
7	Establish a data measurement analysis method for the special causes of a variety of events, so that the results of the data analysis can be used as a reference in carrying out follow-up on the variation in the occurrence of these events.

IV. CONCLUSION

Based on the results of the analysis and description of the discussion of the previous chapter, the following conclusions can be drawn:

1). The evaluation results using the COBIT 5 capability level for the Manage Service requests and Incidents (DSS02) process the current capability level is at level 3. For the Manage Problems (DSS03) process, the current capability level is at level 3. Both processes are at level 3 (Established Process), which means the process has been identified and carried out with formal standard procedures and is mostly well documented. Due to the target level to be achieved by PT Bank Central Asia Tbk. is level 4, the process still needs improvement to reach that level. However, overall, the processes that have been implemented so far are pretty good, and most have followed general standards.

2). To achieve the target level to be achieved, namely level 4 (Predictable Process), the results of this study have resulted in recommendations for improvements that need to be made to achieve the target level of process capability

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Toward National One Health Data: Reconfiguring Local Health Information Systems through Enterprise Architecture

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***Abstract*— Indonesian government is currently on the course of nationwide digital transformation, manifested through its 'One-Data Policy' recently introduced by top-level government. The initiative also includes the country's health information systems (HIS) for which various technological choices are under consideration to be implemented. However, such a sound and ambitious initiative often overlook the configurational outlook of local systems where the data is created and aggregated to the national system. This study addresses this concern by exploring the issues pertaining to local HIS and developing its enterprise architecture proposed to reconfigure the existing arrangement of the systems. Using a case study of Palangka Raya municipal health government, this study contributes to this current important agenda by delineating the complexity that occurs at local HIS and proposing a set of enterprise architecture artifacts required toward Indonesian one health data.**

***Index Terms*— Health Information Systems; Enterprise Architecture; TOGAF; Indonesia**

I. INTRODUCTION

According to the Law of the Ministry of Health, Republic of Indonesia, Number 92 of 2014, Health Information Systems (HIS) is defined as a set of myriad components that includes data, information, indicators, procedures, devices, technology, and human resources. These components are interrelated and need to be managed in an integrated manner to direct actions or decisions making to support the health system [1]. That being said, Indonesian HIS is not a standalone entity but rather a functional component within the framework of a comprehensive health system. Effective HIS provides supporting information to the decision-making process at all levels of government entities, which WHO regards as effective management tools in healthcare [2].

Following the mandate to implement One-Data Policy in national government practices, the Indonesian health government is currently on the course to enact similar undertaken through One Health Data Policy in HIS. The Ministry of Health develops the policy through 3 main areas: interoperability (data sharing), standardization (improvement of data collection processes), and accountability (data utilization that drives decision making). The enactment of these areas heavily relies on the strategies and programs in strengthening the HIS, particularly restructuring transaction data at health facilities, optimizing data flow and integration, and increasing the use of data and information [3]. As such, the successful actions toward One Health Data are contingent on the conditions of the current local HIS [4].

This study addresses this issue by investigating the complexity of the conditions of local HIS through a case study in the city of Palangka Raya, Central Kalimantan, Indonesia. We then propose an enterprise architecture for municipal health government as a way to redesign integrated business and information systems architecture of local HIS at the municipal level. As such, this study offers two contributions. First, this study reports the complexity that occurs at local HIS emanated from various applications and tools implemented and deployed at municipal and community health centers (CHC) [4], [5]. Second, this study offers a set of a reference architecture that can be used in future practice related to HIS implementation [3].

This paper is organized as follows. Section 2 describes our research methods, which consists of our framework in developing the enterprise architecture as well as our research design. We present the results in Section 3, structured along the line of the TOGAF framework on architecture development method (ADM). Section 4 concludes the paper.

II. METHODS

A. Framework

To pursue our research objectives, we used the conceptual foundations of Enterprise Architecture (EA) and subsequently its most well-received framework, that is, TOGAF®. In essence, EA relates to how an organization starts and produces a well-defined arrangement and alignment of business, information systems, and technology architecture [6], [7]. EA

supports an organization's actions in managing complex information technology to achieve business goals and objectives and to increase operational efficiency and effectiveness through integration and interoperability [8], [9]. EA can influence organizational management and technology in an organization to develop an information systems blueprint and roadmap [10], [11].

In brief, TOGAF® is a consortia-based EA framework developed by The Open Group, which is widely used to develop a step-by-step organizational EA [12]. TOGAF® contains a set of methodological guidelines in developing EA [13], [14] through Architecture Development Method (ADM), consisting of eight main phases. ADM forms an iterative cycle for the entire process, between phases, and each phase where each iteration a new decision must be made. This is done to determine the scope of the enterprise, the level, target time, and the architecture that will be used in the enterprise continuum.

B. *Research design*

We conducted a case study [15] in Palangka Raya Municipal Health Office as well as Menteng Community Health Centre (CHC). The primary data was interviews with related parties at municipal government (officials) and CHC (official and healthcare staff), which was aided with direct observations in the field. A total of fourteen participants was interviewed. The interviews were audio-recorded for subsequent data analysis through the permission of the participants. Meanwhile, the secondary data was documents obtained at municipal government and CHC such as reports and other documentation. The field study was conducted over a period of seven months from November 2020 to May 2021. The data that had been obtained was processed and analyzed for the identification of existing architecture, targets and expectations, all of which were used for the development of EA artifacts. In addition, we identified the gap of HIS at the Palangka Raya City Health Office and Menteng CHC to develop a blueprint and identify work projects.

III. RESULT

This section now presents a general overview of the conditions of local HIS in Palangka Raya and the proposed enterprise architecture of local HIS. The architecture is structured based on TOGAF ADM which consists of the preliminary phase, business architecture, data architecture, application architecture, and opportunities and solutions.

A. *General* overview of Palangka Raya HIS

Currently, no prevalent integrated systems that exist related to the HIS in Palangka Raya Municipal Health Office and its CHCs. All related applications are operating separately for each different program and agency. Also, some reporting is still performed manually. This causes several issues in the reporting and recording process, such as data redundancy, inadequate technical capacity, and frequent submission delays. In addition, the main purpose of current applications is solely to collect as much data as possible. This causes the workers at CHC as a data source to feel overloaded.

B. *Preliminary phase*

The preliminary phase is the initial preparation phase in enterprise architecture design needed in preparation for HIS activities to support business needs. In this phase, the architectural principles are identified, consisting of business, data, and application architectures are carried out according to needs, as presented in Table I.

TABLE 1. PRINCIPLE CATALOG OF PALANGKA RAYA HIS EA

Architecture	Principle	Description
Business Architecture	Legal Compliance	Activities at the Palangka Raya City Health Office and Menteng Health Center must comply with the provisions of the Ministry of Health Regulation Number 92 of 2014 and Number 75 of 2014
	Health services	Community health service activities at the Menteng Health Center and its network and the Health Office as a regulator of the health system, as well as health service operators
	Public health	Health socialization activities to the community by the Palangka Raya Municipal Health Office and Menteng CNCto improve the health status of the community.
	Good documentation	Data and information storage activities from all stakeholders
	Sustainable Business Development	All organizations in the Palangka Raya City Health Office and Menteng Health Center are responsible for carrying out operational activities.
Data Architecture	Data Transparency	Dissemination of information transparently to stakeholders
	Data Assets	Data is an organizational asset that must be managed
	Sharing Data	Data can be obtained from users who have predefined access rights
	Data Integration	Data on the company can be connected with users who need it for business support
Application Architecture	Ease of Application	The application can be used easily by all users
	Integration	Applications are interconnected
	Usage permissions of applications	Assign access rights for users according to their respective positions and responsibilities

C. *Architecture Vision*

The architecture vision phase is a description of the initial phase of the TOGAF ADM cycle. In this phase, the importance of top-level management of the Palangka Raya City Health Office and Menteng CHC is presented to the business value that exists in Palangka Raya. In Table II, the Requirements catalog describes the mapping of the requirements used to meet the objectives. This catalog is needed to provide an objective description of the strategic plans of the Palangka Raya City Health Office and Menteng CHC when changes occur in the business environment.

TABLE 2. REQUIREMENT CATALOG OF PALANGKA RAYA HIS EA

Capability	Objective	Requirements
Improving Public Health Efforts	Health Information System	Improving the quality of health data and information
		Develop the provision of information on IT applications/systems to the public
		Develop an effective and efficient delivery of health information
Improving the quality of health services		The health service process runs effectively and efficiently to improve quality
		Developing equitable health service coverage
		Develop an easy health service process
		Developing health standards

On the other hand, the solution concept diagram illustrates the overall overview of the proposed architectural solution to be implemented based on the analysis of the target needs of the Palangka Raya City Health Office and Menteng CHC, which are presented in Figures 1 and 2 respectively.

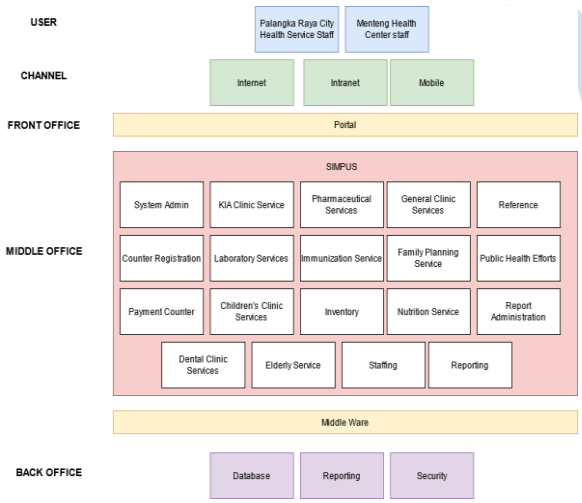

Figure 1. Solution Concept Diagram for CHC

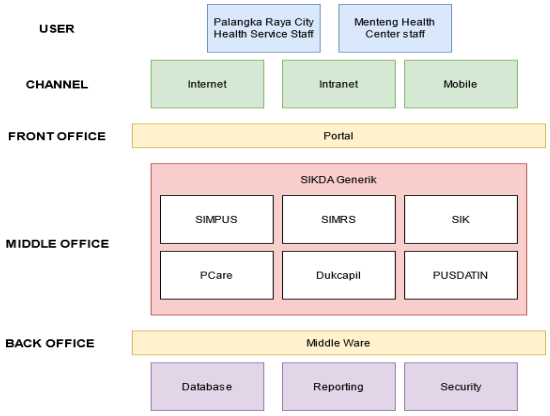

Figure 2. Solution Concept Diagram for Municipal Health Government

D. *Business Architecture*

The business architecture is a phase that delineates the organization's needs in carrying out its business functions to achieve the desired target. This phase describes how the target businesses interact with each other. This goal/objective/requirement catalog, as shown in Table III, presents the relationship between goals, objectives, and requirements. This catalog serves to fulfill the function objectives and identify the need to achieve the objectives of the Palangka Raya Municipal Health Office and Menteng CHC to improve their business processes.

TABLE 3. GOAL/OBJECTIVE/REQUIREMENT CATALOG OF PALANGKA RAYA HIS EA

Goal	Objective	Requirement
Improving Public Health Efforts	Improving nutritional status, maternal and child health	Improving nutrition and health of mothers and children in the community
	Prevention and Control of Communicable and Non-Communicable Diseases	Improving prevention programs for communicable and non-communicable diseases
	Health quality improvement	Reducing health problems related to people's behavior
	Increase community independence in health	Increase public awareness of health
Improving Health Services	Implementing health sector standards	Implementing good health standards in health services
	Improving public access to health services	Improving access to health services and information evenly throughout the community in all regions

Table IV, on the other hand, presents the service catalog which maps the requisite service that exists in the function according to the needs or requirements of that function. This service catalog outlines the key public health service enacted by local health facilities to population related to particularly in health data management and reporting.

TABLE 4. SERVICE CATALOG OF PALANGKA RAYA HIS EA

Service	Requirement
Improvement of Public Health Status	Improving public health status by optimizing health information systems
Health Service Operations	Improving the quality of public services by optimizing the health information system
Application/IT System Development	Development of IT applications/systems to improve the quality of integrated health information systems at the Palangka Raya City Health Office and Menteng Health Center

E. Data Architecture

The data architecture describes the data types and data sources needed in the development of the enterprise architecture to meet the needs identified in the business architecture phase. In this phase, the data entities relevant to the organization are determined. As shown in Table V, the data architecture requirements identify the data needs of the Palangka Raya Municipal Health Office and Menteng CHC.

The conceptual data diagram, as presented in Fig. 3, describes the relationship between data entities. This artifact presents the target conditions in the data architecture of the Palangka Raya Municipal Health Office and Menteng CHC, in which it proposes an integrated data flow between CHC and Municipal Health Office. The flow of data in an integrated fashion makes it easier for the Municipal Health Office as the superordinate of CHC to carry out monitoring and evaluation more efficiently and effectively. The integration specifically includes the Generic Regional Health Information System (SIKDA) and CHC Information Systems (SIMPUS).

TABLE 5. DATA ARCHITECTURE REQUIREMENT OF PALANGKA RAYA HIS EA

Capability	Objective	Requirements
Improving Public Health Efforts	Health Information System	Improving the quality of health data and information
		Improve integrated data management
Improving the quality of health services		The data can be used by users who have the authority that has been set
		Improve the process of sending data to the top level more quickly and effectively
		No data duplication
		Eliminate manual reporting and recording

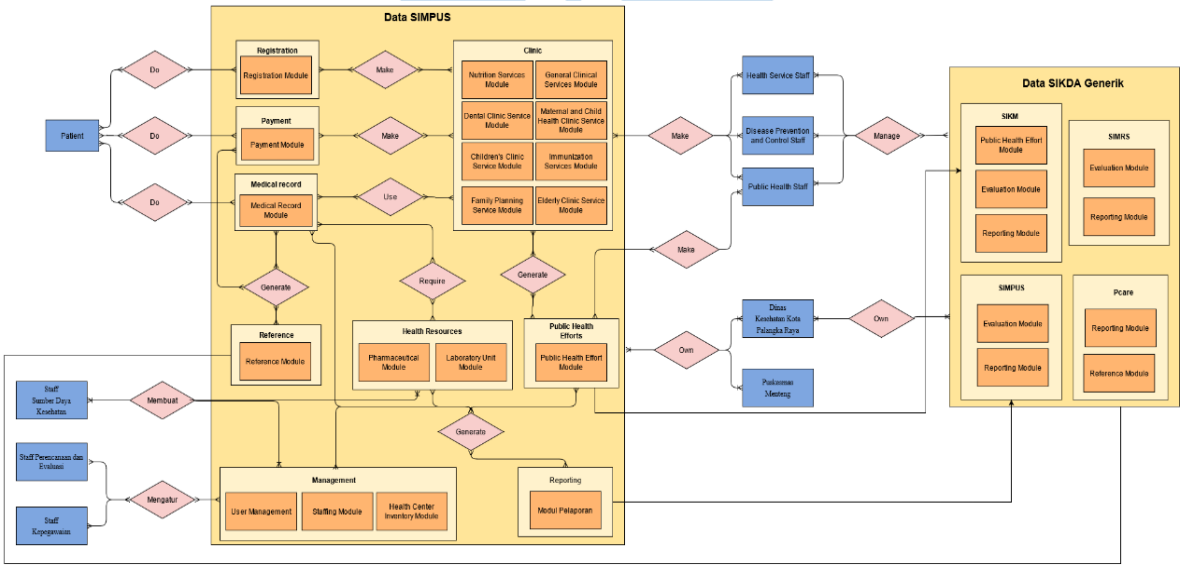

Figure 3. Proposed Conceptual Data Diagram

F. Application Architecture

Application architecture depicts the application systems needed to process data and support businesses. This phase aims to define the type of application and the integration between these types to support the business processes of the Palangka Raya Municipal Health Office and Menteng CHC. Application Architecture Requirements, presented in Table VI, identifies the requirements for the HIS applications.

TABLE 6. REQUIREMENT CATALOG OF PALANGKA RAYA HIS APPLICATIONS

Capability	Objective	Requirement
Improving Public Health Efforts	Health Information System	Applications can provide real-time reporting recaps.
		Applications can manage and validate data in real-time
Improving the quality of health services		The application is able to facilitate the duties/work of employees in carrying out health service activities.
		All applications used are interrelated and connected both at the Palangka Raya City Health

Capability	Objective	Requirement
		Office and Menteng Health Center
		Assign access rights according to the level of authority according to the position and responsibility for each user.
		Applications ease of use

Currently, there are 18 applications used by the Health Office and HIS in recording and reporting. The existing, SIMPUS application has not been fully implemented. It is only used for reporting and recording employees' data, which is integrated with other applications namely SIMPEG (HR IS), SISKA (Performance Monitoring IS), SIMSKP (MIS), and Renbut SDK applications (Health Resources IS). Other interconnected applications are SIGIZI and E-PPGBM (reporting for nutrition). These existing applications are operated separately and not integrated. Therefore, an interconnected system is proposed as presented in the application communication diagram in Figure 4.

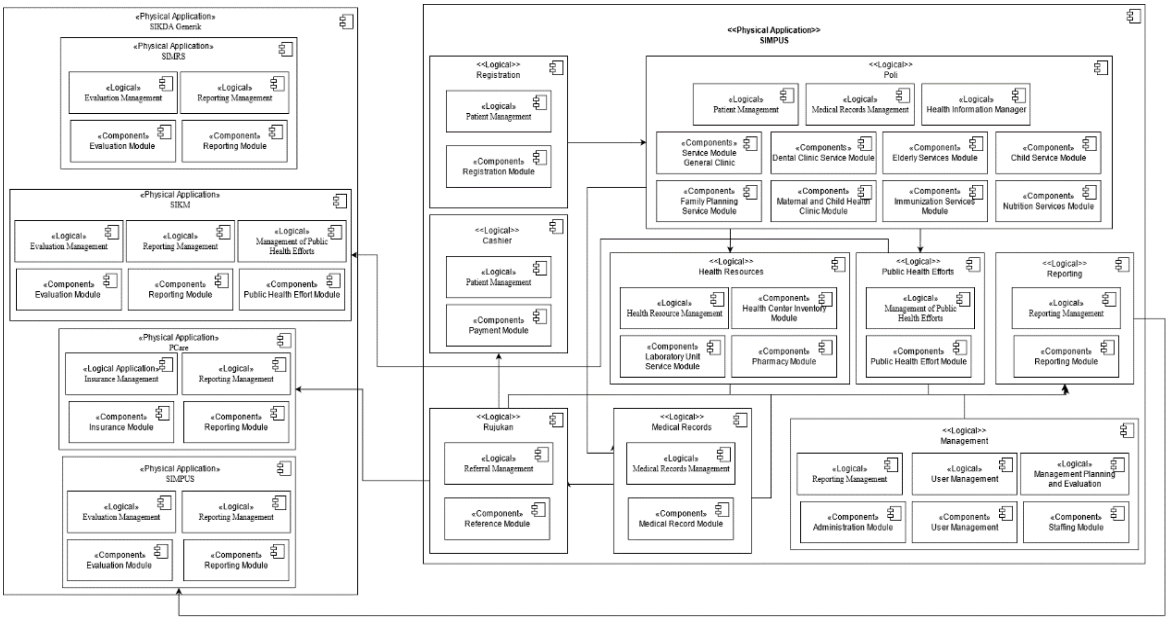

Figure 4. Proposed Application Communication Diagram

G. *Opportunities and Solution*

The proposed EA, in this study, proceeds to the phase of Opportunities and Solution. Opportunities and Solution is a phase that delineates the evaluation of the architectural design from previous phases which serves as the basis for preparing an implementation plan to achieve the architectural design objectives. Table VII identifies the required projects for the Palangka Raya Municipal Health Office and Menteng CHC along with the possible options for executing them according to the results of the identification of the gaps that have been carried out. The identified projects also serve as the basis for the roadmap of implementation of HIS EA.

TABLE 7. PROJECT CATALOG FOR PALANGKA RAYA HIS EA

Project	Sub-project	Service/Application
Integration of Municipal Health Information System	HIS for 'in-room' (e.g., doctors' room) and 'out-room' (e.g., field workers, cadres) of CHC	Sistem Informasi Manajemen Puskesmas (SIMPUS) and Sistem Informasi Kesehatan Daerah (SIKDA) Generik
	Integration of CHC and municipal government system	
	Information services that are publicly accessible	Health Open Government
Implementation of Management and Governance	Implementation of international standards of management and governance (e.g., ISO 20000)	N/A
	Implementation of information security management and governance (e.g., ISO 27000 series)	
Skills development	Capability development for officials and staffs	N/A

IV. DISCUSSION

This study aims to explore issues that emerge at local HIS with regard to Indonesian goal on nationwide one health data and to propose a set of enterprise architecture artifacts as a way to reconfigure such local HIS. Overall, we have attained the study's objectives through identifying the architectural principles and the subsequent artifacts using TOGAF as our methodological framework.

A. Research Implications

This paper offers key lessons to current literature and practices. First, in line with an early discussion [3], this study provides an empirical example of the multiple overlapping information systems in district health information systems, prompting the need to conduct an architectural analysis of such systems. Using the case of the municipal health system of Palangka Raya, our study presents an ongoing complexity of national monitoring and reporting systems in Indonesia in response to recent calls on better health data management in developing countries [1], [16].

Second, this paper shows how enterprise architecture can be used to decompose the complexity in the overlapped and dispersed HIS in the local setting and subsequently to provide a basis for policymakers in reconfiguring systems. Ultimately, the development of architectural artifacts ranging from business, data, application, to technology domains, offers a well-aligned approach so that the solutions, as identified in the opportunities and solutions phase, are in line with key objectives in health data management [11].

B. Practical Implications

This paper offers practical implications to those districts who now pursue healthcare digitalization and, further, integration. Specifically, the Opportunities and Solution phase of our study consolidates and proposes executable projects for stakeholders in the district health government. As presented in Table VII, nine sub-projects are proposed: 1) HIS for 'in-room' (e.g., doctors' room) and 'out-room' (e.g., field workers, cadres) of CHC, 2) Integration of CHC and municipal government system, 3) Information services that are publicly accessible, 4) Implementation of international standards of management and governance (e.g., ISO 20000), 5) Implementation of information security management and governance (e.g., ISO 27000 series), 6) Capability development for officials and staffs. Even though the relationships between the present paper with health government's objectives are beyond our study, the subsequent artifacts based on TOGAF's phases (e.g., benefits diagram) could extend the current architectural propositions.

V. CONCLUSION

In this study, we have conducted a study aimed to identify the conditions of local HIS of our case and to develop Health Information Systems Enterprise Architecture to prepare for Indonesian One Health Data. In business architecture, this study identifies several business processes that require reconfigurations to optimize the municipal process regarding public health status and health service operations. In the information system architecture phase, this study proposes the integration of substantial data and application integration encompassing the 18 applications that currently operate separately across Palangka Raya Municipal Health Office and Menteng CHC. This study concludes with the opportunities and solutions phase in which it identifies potential projects that can be used by related stakeholders in the respective local government toward achieving integrated local HIS.

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COBIT 5: How Capable PT GTI Governing Innovation, Human Resource, and Knowledge Aspect?

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***Abstract*— The performance of information technology governance by PT GTI has not been optimal and there has never been a measurement of information technology governance capability. Based on these problems, it is necessary to measure the capability of information technology governance and make an appropriate information technology management recommendation that can be used as a guide—the measurement of the COBIT 5.0 framework. The data collection method consisted of observation, questionnaires, and interviews. The data collection results will produce findings, impacts, and recommendations for PT GTI. Measuring the capability of information technology governance used includes Planning, Preparation, Implementation, and Measurement Reporting. The study focused on 3 IT processes and obtained the following capability level results: APO04 Manage Innovation got a score of 78.4% and stopped at level 3, APO07 Managed Human Resource with a score of 81.07% and stopped at level 1, and BAI08 Manage Knowledge got to score 61% and stop at level 2.**

***Index Terms*— Capability Level, COBIT 5.0, Frameworks, Information Technology, Performance**

I. BACKGROUND

In such a competitive and rapidly changing business environment, companies increasingly realize the potential benefits that Information Technology can bring. This makes the company's management expectations high on the outcomes and benefits of Information Technology [1]. The use of information technology has the potential to be a significant determinant of success or success that can provide opportunities to gain competitive advantage and offer tools to increase productivity, company performance and provide more benefits in the future [2]. Information technology governance is also an essential part of ensuring that the company's information and available technology can support business goals [3]. Various ways are used to achieve the company's business goals, measuring the capabilities of IT and information technology to evaluate the evidence to determine whether the related resources provide the information needed by management under the fulfillment of its business objectives [4].

PT GTI is a cloud computing provider for medium to large scale companies founded in 1996 and has successfully delivered business solutions for more than 12 years and more than 100 clients in more than 20 industries and 10 countries by designing, implementing, and managing technology solutions. Who helps their business from back office to front office. At this time, PT GTI is a company that has used information and communication technology in supporting every teaching and learning process. Therefore PT GTI requires good governance and management. PT GTI specializes in providing Automotive Industry Solutions, from distribution, Dealer Management systems (DMS) to Automotive CRM. PT GTI's flagship product is PT GTI DMS for Automotive OEMs and a network of distributors/dealers. Built as an integrated solution, PT GTI leverages the power of the Microsoft Dynamics CRM platform to offer the next generation of DMS product solutions and services to consumers and partners. PT GTI must be aware of information technology and related service trends, identify opportunities, innovations, and plan ways so that the system built by PT GTI can always support client needs. Innovation is critical at PT GTI because PT GTI makes a system continue to innovate to follow client needs, such as adding features needed by users. Human resources are essential; PT GTI must manage human resources to ensure optimal structures are made. Staff placement, decision rights, and human resource skills must be appropriate so that the resulting product can be quality and suited to the client's needs. Relevant knowledge is vital to support activities in the company and decision-making. Staff at PT GTI are expected to have sufficient expertise in their respective fields to ensure the smooth operation of the company's operations. However, problems can occur in the control of information and communication technology services that exist now; supervision of information technology governance performance has not been carried out optimally; staff lacks the initiative to investigate

problems, code writing is not uniform, and the team does not want to maintain information. Based on these problems, it is necessary to measure the capability of information technology governance, and this study aims to determine the extent of the level of information technology governance and make a recommendation for the correct information technology management so that it can be used as a guide by users and can increase the optimal use of facilities. This study uses the COBIT 5.0 framework.

In measuring IT capability, a standard is needed that can help make valid and reliable measurements occur. Several criteria often used in measuring IT capabilities include ITIL (Information Technology Infrastructure Library), ISO/IEC 17799, and COBIT (Control Objectives for Information and Related Technology). In this study, the standard used is COBIT version 5 concerning the questionnaire distributed to predetermined respondents. The COBIT (Control Objectives for Information and Related Technology) standard was chosen because the COBIT framework provides the most detailed description of strategies and controls in managing information technology processes that support the alignment of business strategy and information technology objectives [4]. In the COBIT standard, there is also a calculation of the Capability Level value, representing the level of alignment of information technology goals and organizational business goals.

This research is expected to know the extent to which the role of information technology can represent PT GTI's business goals. So that based on the findings from the implementation of the measurement of IT capabilities, produce recommendations that can be used as a reference to improve the role and management of information technology so that it can better support the organization's business goals.

II. METHODS

A. *Capability Measurement of IS*

Auditing is an examination of a company's financial statements by a firm of independent public accountants. The measurement consists of a searching investigation of the accounting records and other evidence supporting those financial statements. The auditors will gather the evidence necessary to determine whether the financial statements provide a fair and reasonably complete picture of the company's financial position and its activities during the period being audited [5].

B. *IT Governance*

IT governance is the responsibility of the Board of Directors and Executive Management. It is an integral part of enterprise governance. It consists of the leadership and organizational structures and processes that ensure that IT sustains and extends its strategy and objectives [6],[7].

C. *COBIT 5.0*

Control objectives for information and related technology or known as COBIT, is a framework used to conduct audits. COBIT is a collection of best practice documentation for IT governance that can assist auditors, system users, and management in bridging organizational risks, control needs, and IT technical issues. COBIT is useful for IT users because they gain confidence in the reliability of the application system used [8]. COBIT 5.0 helps companies create optimal value from information technology by maintaining a balance between realizing its benefits and optimizing the level of risk and use of resources. This framework discusses the business and functional areas of information technology in an enterprise and considers the interests related to information technology internally and externally for stakeholders [9]. COBIT 5.0 has principles and enablers that are general and useful for all sizes of companies/organizations, both commercial and non-profit or the public sector. The five principles are Meeting stakeholder needs, Covering enterprise end-to-end, Applying a single integrated framework, Enabling a holistic approach, and Separating governance from management [10].

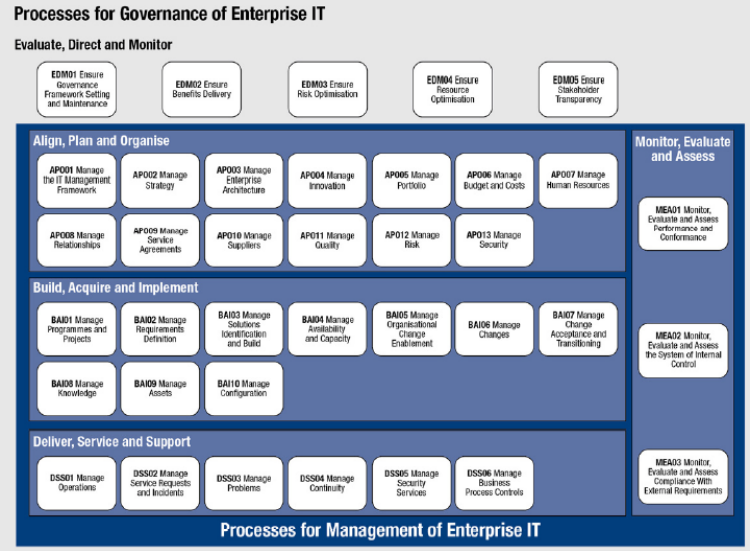

Figure 1. Processes for Governance of Enterprise IT [10]

COBIT 5.0 provides a definition of life cycle processes, along with an architecture that describes the relationships between 5.0 processes. The COBIT process reference model (PRM) consists of 37 processes describing the life cycle for information technology governance, which are divided into 5 domains [8].

1) Evaluate, Direct, and Monitor (EDM): The management process related to the management of stakeholder objectives, value delivery, risk and resource optimization, including practices and activities aimed at evaluating strategic options, providing information technology guidance and monitoring outcomes.

2) Align, Plan and Organise (APO): Provide guidance on delivery (BAI) and service delivery and support (DSS) solutions. This domain includes strategies and tactics, and focuses on identifying how information technology can best contribute to the achievement of business goals. The realization of the strategic vision must be planned, communicated, and managed from different perspectives. The right organization and technology infrastructure have to be in the right places.

3) Build, Acquire and Implement (BAI): Provide solutions and turn them into services. To realize an information technology strategy, information technology solutions must be identified, developed or obtained, as well as implemented and integrated into business processes. Changes and maintenance of existing systems are also in these domains, to ensure solutions are in line with business objectives.

4) Deliver, Service and Support (DSS): This domain focuses on actual delivery and support of required services, which include service delivery, management of security and continuity, support services for users, and management of operational data and facilities.

5) Monitor, Evaluate and Assess (MEA): Monitor all processes to ensure the directions given are adhered to. All information technology processes should be inspected regularly over time to ensure quality requirements and compliance with control requirements. The domain proposes performance management, monitoring of internal control, compliance and regular governance.

D. Capability Level

Capability level is a model to describe how each core process runs in an organization. Capability level provides a measure of process capability in achieving an organization's current or projected business goals in the future [8]-[15]. Assessment at each level is divided into four categories [10],[11]:

1). N (Not Achieved)
In this category, there is little evidence of the achievement of the attributes of the process. The scores achieved in this category range from 0-15%.

2). P (Partially achieved) Within this category, there is some evidence of the approach and some of the achievement attributes of the process. The range of scores achieved in this category ranges from 16-50%.

3). L (Largely Achieved)
There is evidence of a systematic approach within this category, and significant achievements over the process, although there may still be weaknesses. The scores achieved in this category range from 51-84%.

4). F (Fully achieved)
Within this category, evidence of a comprehensive systematic approach and full achievement of the attributes of the process. There are no weaknesses related to the characteristics of the process. The range of scores achieved in this category ranges from 85%-100%.

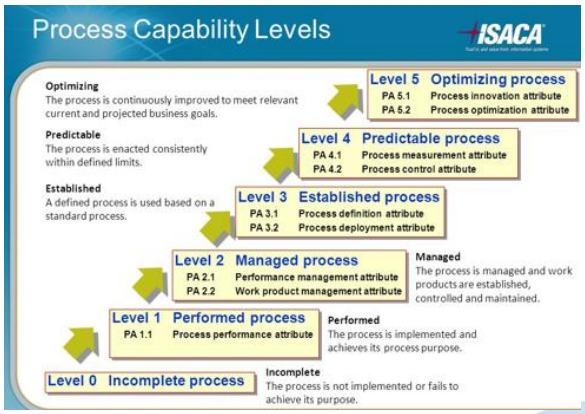

Figure 2. Process Capability Levels [9]

The purpose of process capability is to help organizations improve their capabilities consistently. The capability level of the process is determined based on the achievement of process-specific attributes according to the ISO/IEC 15504-2:2003 standard. The rating scale involving six capability levels is described as follows [9]:

1). Level 0 Incomplete process
The process has not been implemented or failed to achieve its objectives. There is little or no evidence of systematic achievement of the process objectives at this level.

2). Level 1 Performed process (one attribute)
The process area has become part of something mandatory in carrying out activities. However, its implementation still has shortcomings, both in quality and schedule. In principle, the process has been running and has become something mandatory as a starting point.

3). Level 2 Managed processes (two attributes)
A process is at this level if this process is always planned, carried out, monitored, and run on every development activity. This means the organization carries out this process in each development project and has a planning and control function.

4). Level 3 Established process (two attributes)
Managed processes are now implemented using defined techniques to achieve their process outcomes.

5). Level 4 Predictable process (two attributes)
The established process now operates within defined constraints to achieve its process results.

6). Level 5 Optimizing process (two attributes)
The predictable processes have been continuously improved to achieve the company's current business goals.

E. Research Object

PT GTI is a cloud computing provider for medium to large scale companies founded in 1996 and has successfully delivered business solutions for more than 12 years and more than 100 clients in more than 20 industries and 10 countries by designing, implementing, and managing technology solutions. Who helps their business from back office to front office. PT GTI's address is at Komplek Graha Elok Mas, Jl. Panjang Raya 83 F-G, West Jakarta 11510 – Indonesia. PT GTI is a software development company that provides vertical solutions for the automotive business. PT GTI wants to reshape the company's automotive journey with an Automotive Industry Solution that can transform the consumer experience. PT GTI has been rated among the Top 15 Microsoft Dynamics Global ISV solution providers worldwide. PT GTI specializes in providing Automotive Industry Solutions, from distribution, Dealer Management systems (DMS) to Automotive CRM. PT GTI's flagship product is PT GTI DMS for Automotive OEMs and a network of distributors/dealers. Built as an integrated solution, PT GTI leverages the power of the Microsoft Dynamics CRM platform to offer the next generation of solutions and services of DMS products to consumers and partners. PT GTI's quality training and technology services focus on assisting clients in the automotive sector to open consumers' eyes to streamline resources and transform the client experience.

Based on the criteria and primary focus of PT GTI, The company selected 3 IT processes for evaluation, including:

1). APO04 Manage Innovation. PT GTI provides cloud computing business solutions; PT GTI builds a standard system and then sells it to many companies/organizations for use. This process explains information technology and related service trends, identifies opportunities and innovations, and plans to benefit from these innovations. Innovation is crucial at PT GTI because PT GTI builds a system to continue to innovate to add new features needed by users.

2). APO07 Manage Human Resources. Companies must be able to manage human resources well. By working properly, human resources will be structured and ensure optimal structure, placement, decision rights, and human resource skills so that the products produced can be of high quality and appropriate to user needs.

3). BAI08 Manage Knowledge. This process keeps relevant knowledge current, validated, and reliable to support process activities and facilitate

decision-making. Staff at PT GTI are expected to have sufficient knowledge in their respective fields to ensure the smooth running of the project requested by the client to be completed on time and following client expectations.

F. *Evaluation Stage*

The evaluation stage consists of 3 steps, including [13]:

1). Information System Audit Planning Stage
In this planning stage, the author's activity is to determine the object of research that will measure its governance capability. The thing of research that the author chooses is the research and development division at PT GTI. To know the extent of the management and utilization of information technology in improving PT GTI's services and recommend an effective and efficient information technology management policy proposal about the COBIT 5.0 framework.

2). Stages of Implementation of IT Governance Capability Measurement
The author collects and evaluates the evidence and data obtained at this implementation stage. These data are the results of direct observations in the field and the consequences of interviews and questionnaires prepared following the COBIT 5.0 standard. After the results are found, a conclusion is made in the findings of the measurement of IT governance capabilities. The findings can be positive or negative and make impacts and recommendations for PT GTI.

3). Reporting Stage of IT Governance Capability Measurement
The last stage is to report on the results of the measurement of IT governance capabilities. This IT governance capability measurement report consists of a conclusion of all types of findings that contain the impact on PT GTI, and then recommendations for IT governance are given. The results of this report are then addressed to the appropriate party, namely the GM Of Research and Development.

III. Results and Discussion

A. *Information System Audit Planning Stage*

It has been determined that the evaluation process will be carried out at PT GTI, with the selected IT processes being APO04 Manage Innovation, APO07 Manage Human Resources, and BAI08 Manage Knowledge. The purpose of this governance capability measurement is to find out how far the management and utilization of information technology have been in improving information technology services, evaluate the findings of capability measurements made during the data collection process, and recommend improvements to good information technology management in the future following the COBIT 5.0 standard.

B. *Stages of Implementation of IT Governance Capability Measurement*

The evaluation was carried out on the research and development division, consisting of 10 people, each manager under the General Manager of Research and Development and 1 staff in each division. The level 1 measurement contains 79 questions based on the COBIT 5.0 standard. The explanation by the auditee will be converted into quantitative following the provisions of the capability level criteria. The following is a table of capability criteria and evaluation results in each selected IT process.

TABLE 1. APO04 Measurement Level 1

APO04	
Process	**Score**
APO04.01	84,20%
APO04.02	81,00%
APO04.03	85,63%
APO04.04	89,50%
APO04.05	85,75%
APO04.06	87,87%
Final Score	**86,1%**

Based on the calculation results in Table 1, the value achieved for the APO04 domain shows the number 86.1%, which means that the process can be continued to the next level because the score to go to the next level must reach or more than 85% to move up to the next level. In this process, there are still shortcomings in creating an innovation plan that includes the level of risk, the planned budget to be used in innovation creation efforts, and innovation objectives.

TABLE 2. APO07 Measurement Level 1

APO07	
Process	**Score**
APO07.01	81,30%
APO07.02	80,00%
APO07.03	83,07%
APO07.04	82,25%
APO07.05	81,50%
APO07.06	78,32%
Final Score	**81,07%**

Based on the calculation results in Table 2, the value achieved for the APO07 domain shows the number 81.07%, which means the process cannot be continued to the next level and is stopped at level 1 (one) because the score to go to the next level must reach or more than 85 % to advance to the next level. In this process, there is still a lack of regular staff backup plans describing the skills and competencies of the internal and external resources needed and now available to achieve company goals.

TABLE 3. BAI08 MEASUREMENT LEVEL 1

BAI08	
Process	**Score**
BAI08.01	87,10%
BAI08.02	85,38%
BAI08.03	85,25%
BAI08.04	86,17%
BAI08.05	86,00%
Final Score	**86,03%**

Based on the results of calculations in Table 3, the value achieved for the BAI08 domain shows the figure of 86.03%; the process can be continued to the next level because the score to go to the next level must reach or more than 85% to move up to the next level. At this stage, there are shortcomings in designing and implementing schemes for managing knowledge that is unstructured and not available through traditional sources (e.g., expert knowledge).

APO04 and BAI08 can rise to the next level because it is more than 85%, and the APO07 process stops at level 1 because it is less than 85%. The following are the evaluation results for capability level 2 of the two methods.

TABLE 4. APO04 MEASUREMENT LEVEL 2

APO04	
Process	**Score**
PA2.1	85,58%
PA2.2	86,88%
Final Score	**86,05%**

Based on the calculations in Table 4, the value achieved for the APO04 domain shows a figure of 86.05%. The process can be continued to the next level because the score to go to the next level must reach 85% to move up to the next level. At this stage, PT GTI still lacks in making documented goals before managing innovation.

TABLE 5. BAI08 MEASUREMENT LEVEL 2

BAI08	
Process	**Score**
PA2.1	61,07%
PA2.2	60,88%
Final Score	**61%**

Based on the calculation results in Table 5, the value achieved for the BAI08 domain shows the figure of 61%, which means that the process cannot be continued to the next level and is stopped at level 2 because the score to advance to the next level must reach 85% to move to the next level. The BAI08 Manage Knowledge process cannot be leveled up. The planning and supervision process on knowledge management has not been carried out. There is no interaction between the parties involved in implementing knowledge management, and there is no documentation and control process for performance.

APO04 can rise to the next level because it is more than 85%, and the BAI08 process stops at level 2 because it is less than 85%. The following are the results of the evaluation for capability level 3.

TABLE 6. APO04 MEASUREMENT LEVEL 3

APO04	
Process	**Score**
PA3.1	77,00%
PA3.2	79,35%
Final Score	**78,4%**

Based on the calculation results in Table 6, the value achieved for the APO04 domain shows the number 78.4%, which means that the process cannot be continued to the next level and is stopped at level 3 because the score to advance to the next level must reach 85% to move to the next level. This process cannot be leveled up because the company's operational standards do not cover all the essential elements in the innovation management process. Still, most of them have been carried out by the company.

C. Reporting Stage of IT Governance Capability Measurement

The last stage is to report on the results of the measurement of information technology governance capabilities. This report contains all the findings of measuring the ability of information system governance at PT GTI. Then it also includes the impact of the measurement findings and recommendations for better management of information technology on the part of PT GTI.

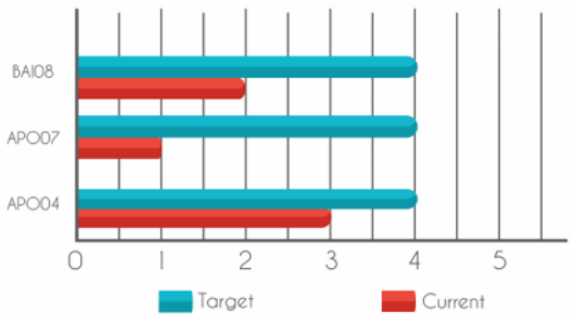

Figure 3. Target Vs Current

In Figure 4.1, it can be seen that PT GTI has not been able to achieve the desired target, namely level 4. The achievement value of PT GTI only reached level 3 for APO04, level 1 for APO07, and level 2 for BAI08. PT GTI is required to improve its information technology governance to achieve the desired target, and the information technology implemented can support the achievement of company goals.

IV. CONCLUSION

Information technology governance at PT GTI, based on the COBIT 5.0 standard carried out on the APO04 (Manage Innovation), APO07 (Manage Human Resource), BAI08 (Manage Knowledge) processes, data collection, and implementation steps to reporting

the results of governance measurements Information technology management has been successfully carried out; From the results of filling out questionnaires, interviews, and observations related to the specified process, it was found that the company's capability level is APO04 (Manage Innovation) Level 3 Defined Process, which means the company at this stage has standardized IT processes within the company's scope. Overall, APO07 (Manage Human Resource) Level 1 Performed Process, which means the company has successfully implemented the IT process at this stage. The objectives of the IT process have been achieved, BAI08 (Manage Knowledge) Level 2 Managed Process, which means that the organization is at this stage in implementing IT processes and achieving its objectives is carried out in a well-managed manner; Based on the findings and impacts, recommendations are given to improve the management of information technology so that the capability of PT GTI's information technology governance can be increased. The advice given includes making company operational standards to cover all elements in the innovation management process, providing appropriate training to staff areas, completing documents that are not available, making innovation management process goals, making a reward system approach, making documented goals before managing knowledge, create documentation and control processes.

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Analysis and Design of Web-Based Information System for Church Congregations Case Study: Church BNKP Pewarta

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***Abstract*— During the COVID-19 pandemic, worship activities at the Church were limited. The lack of preparation and data collection on the congregations who visit to worship regularly every week increases the risk of transmission. It needs to be minimized and anticipated. One effort that can be made to reduce this risk is to collect data on the health condition of the congregation who will attend worship. The data collection process is recorded in writing on the attendance list. This requires an iterative approach to be updated and creates a build-up to the attendance record. In addition, media information about the BNKP Pewarta Church activities is not yet available. To overcome this problem, an information system is needed as a medium for collecting congregation data, storing congregation data and providing general information about the BNKP Pewarta Church. This website-based information system's design was successfully carried out using the Web Development Life Cycle (WDLC) method. The functional testing results carried out using black-box testing show that this website-based information system can store Church congregation data and present general Church information as needed.**

***Index Terms*— Church; WDLC; Web based Information Systems**

I. INTRODUCTION

The determination of the micro-based PPKM is aimed at increasing community awareness at the village level against the spread of COVID-19 in accordance with the Instruction of the Minister of Home Affairs Number 03 of 2021 concerning the Enforcement of Restrictions on Micro-Based Community Activities and the Establishment of the 2019 Corona Virus Disease Handling Command Post at the Village and Sub-District Levels. Control of the Spread of Corona Virus Disease 2019 [1].

Due to the impact of the spread of COVID-19, the Church has become one of the public facilities that is temporarily closed. Under these circumstances, churches must rely on technology, both in conveying information and storing data to avoid physical contact. The church has difficulty in obtaining information, because the delivery of information is still in the form of print media and the use of paper. So it has the potential to causing problems in getting church information for the congregation in the church. To prepare for online worship activities and direct worship, it is necessary to make some preparations, one of which is congregational data collection, and one solution that can be done is to create a Church information system [1].

Although the impact of PPKM makes direct worship activities very limited, but it can still be carried out with strict health protocols that have been set by the government, but the risk that must be faced is the health condition of the BBKP Pewarta Church congregation which cannot be monitored and recorded, especially in terms of history of being exposed to the Covid-19 Virus or not. This is quite important to do so that worship activities at the BNKP Pewarta Church can run comfortably and safely.

This research was conducted based on previous research that focused on cruch website development in Indonesia, This study aims to create a website-based application system with the aim of building a service system that can reach the congregation so that the congregation can easily obtain information quickly, precisely, and accurately, and the church can process data more easily [1]. The following research focuses on usability assessment of the websites of the small churches of Zionskirche and Harry United Methodist Church. This study explores specific characteristics that technical and professional communicators must consider when designing and evaluating churches and non-profit websites. The study included a literature review that found that organizations in these categories took longer to adopt web technology than commercial organizations fully. This is the result of several factors, including lack of technical skills and concerns about the impact of trying to duplicate or enhance the face-to-face experience in the digital domain. The survey also revealed that such websites require special consideration, such as rhetorical situations, the

degree of organizational independence, and goals for creating an online presence. These results were applied to usability analysis of the websites of the smaller churches that represent the two affiliated United Methodist churches [2]. The motivation behind next reseacrh is to plan and create an information handling framework for the congregation. Utilizing this framework can work with information handling in the GKPI Buddy Merah Jambi Church. This review utilizes a cascade advancement strategy, a technique that gives a precise and successive way to deal with framework needs examination, plan, execution and unit testing, framework testing and care [3]. The reason for next research is to plan an electronic administration data arrangement of the congregation, sanctification, and marriage administrations to help each faith gathering movement for the assembly. The strategy utilized in fostering the framework is the Cascade technique with planning technique that utilizations Bound together Displaying Language (UML) charts. The consequences of the framework configuration in this review show data connected with chapel, worker sets, church exercises, church news, articles, assembly enlistment administration, sanctification and marriage, reports of enrollment information introduced in realistic structure, baptismal print report and authentication of marriage, just as the administration of all assemblage and church information [4].

II. Research Methodology

In the present turn of events, there is no a standard procedure or rule which we can be continued in creating static site. Despite the fact that the course of the web improvement has likenesses with the interaction in ordinary programming advancement life cycle (SDLC) model, still there is a need to have a very much custom fitted or committed methodology for web improvement dependent on explicit prerequisite [4].

The term of web improvement life cycle (WDLC) that is utilized by many web engineer can be misconstrued in term of its degree. Some of them comprehend WDLC as another model of SDLC. Some of them comprehend it as new strategies in WDLC. Additionally, some of them even comprehend it all in all new investigation of SDLC as a result of its overall term of WDLC itself. Notwithstanding of the issues, the thought behind WDLC is to plan a particular methodology for web improvement particularly for static web advancement. The methodology may not be an entirely different model of SDLC yet it could be an inference of SDLC model that infers with the run of the mill interaction of web improvement life cycle.

The methodology depends on the current innovation and might be shifts later on. Concerning today, the generally utilized of web content administration framework (CMS), progressed web composing instruments that can facilitate the most common way of prototyping to execution stage are major contributing variables of why this methodology is present at the primary spot.Consequently, it is important to comprehend SDLC which incorporates the philosophies and the models inside every one of them. Additionally it is likewise essential to comprehend the site trademark and its sort like static site and dynamic site. Besides, understanding the most recent and ordinary advancement process patterns is likewise significant as it will recognizes the advances includes in it. Thus, the data will assist with deciding the suitable model of SDLC and consequently can be inferred by web improvement life cycle patterns. The design method using the WDLC (Web Development Life Cycle) model is a step in developing the website cycle model. Although the Waterfall model introduced in the SDLC (System Development Life Cycle) model provides a sequential structure for Software Development, but WDLC provides a basic structure that also includes various guidelines for meeting the requirements with the final product. It can be adopted by all types of web application development processes such as waterfall, prototyping, and spiral. This model can also be modified to include a Prototyping structure to improve the quality of the website [13] [4].

Structured analysis and design is an approach to solving problems in a business activity into small parts that can be compiled and linked and then can be put back together into a single unit that can be used to solve problems. Structured techniques focus on data and processes [4]. Structured analysis and design are used because it is a method that is commonly known in various industries, is relatively simple and easy to understand, and has been applied for a long time so that this method is feasible to use, relatively simple, and easy to understand [5]. The system design includes the CRUD (Create, Read, Update and Delete) functions on the Content Management System (CMS) of the Church Information System Website [6].

Figure 1. WDLC Model

A. *Planning*

The planning stage is the initial stage of designing a website using the WDLC method. Identifying the goals and objectives of the website to be built is the first step in the planning process. After the purpose is known, it must understand the criteria for system users. Then determine the website technology that will be used and identify who will later be involved

in the website. After that, determine where the information will be distributed later.

B. Analysis

At this stage, user needs are identified by collecting information from users, systematically analyzing the function of the system to be created, what data is needed and where the data is collected, and what results from you want to get from the system. After this is done, then the Analysis of the function of the system can be carried out by considering the processes needed to support the features on the website [12].

C. Website Design and Development

At this stage, prepare a blueprint for the website to be created. Then also various diagrammatic representations of logical and physical objects. The main objects include the data model, process model, and presentation model. Next, document the system design. The website composition stage includes planning site format and acquires the imaginative UI-UX creators to the cutting edge. The format includes planning an unpleasant sketch, which might be graphical, to get a vibe of the plan of the site. The reason for the design is to introduce a data structure, empowering a visual visit through the substance and base highlights for your customers.

The wireframe planned in the last stage is changed into buttons, tabs, menus, dashboards, shading topics, typography, and illustrations to make a base design of the site.

D. Testing using Black-box Testing

The testing stage shows how the work of the website builder is, whether the results of the website that have been created are the same as the expectations of the users, from the information needed to the performance obtained. The components tested in this stage include content, functionality, usability, and system accuracy. The outcome of this research will be tested using Black-Box testing, a software testing method in which the functionalities of software applications are tested without having knowledge of internal code structure, implementation details and internal paths. Black Box Testing mainly focuses on input and output of software applications and it is entirely based on software requirements and specifications. There are three types of Black Box Testing such as: Functional testing, Non-Functional testing and Regression testing. The test focuses on the functions of the system to ensure that the user can use the existing functions on the system [7].

E. Website Implementation and Maintenance

In the implementation phase, the website is placed in the user's computer to interact directly with the system, and the user gets the opportunity to work on it for the first time [8].

F. Bootstrap CSS Framework

Bootstrap is a CSS framework that was developed by Twitter developers in mid-2010. Before it officially became open source, Bootstrap was known as Twitter Blueprint. Until now, bootstrap version 3.3.7 has been released and has become one of the most popular front-end frameworks and an open-source project in the world. Bootstrap is described as simple CSS but built with a preprocessor which provides more power and flexibility than standard CSS. Bootstrap already provides CSS classes and integrates with JQuery. Responsive layout in CSS bootstrap with 12 column grid system produces a website layout that automatically adjusts to the width of the user's browser. This is what causes Bootstrap to support all types of devices such as smartphones, tablets, laptops, or desktop PCs. In addition, bootstrap also supports HTML 5 and CSS 3 [9].

G. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Abbreviations that incorporate periods should not have spaces: write “C.N.R.S.,” not “C. N. R. S.” Do not use abbreviations in the title or heads unless they are unavoidable.

III. Results and Discussion

In the description of the current procedure, it can be described as follows:

1) Congregants of the BNKP Pewarta church will regularly attend worship activities every Sunday at the church.
2) The routine worship activities are carried out according to the 4M health protocol (wearing masks, washing hands, maintaining distance, and avoiding crowds).
3) The day before the service begins, church officials will collect data by providing an attendance list via the WhatsApp Group application and recording it in the congregation's attendance recap.
4) On the day of worship, before starting the worship service, body temperature will be checked with the aim that it can be detected if there are congregations whose body temperature is above 37.3 Celsius and are not allowed to attend worship.

A. *Proposed Use Case Diagram*

Designing the Use Case Diagram serves to make it easier to understand the system. Where this picture consists of actors as actors who interact with the system, and there are various series of activities that occur. The following is an figure of the Use Case Diagram, namely: [10] [12].

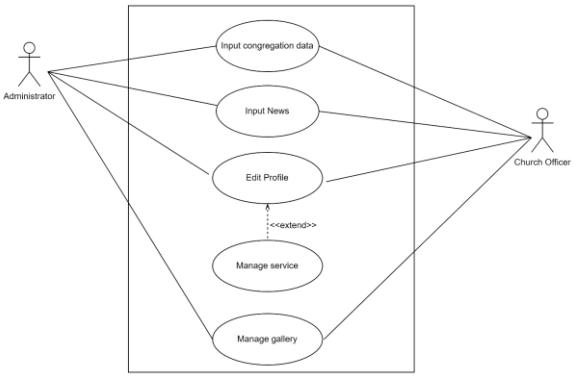

Figure 2. Use Case Diagram Proposed System

Users who will use the information system website are Church Administrators and Officers with the following functions: Login, Access user Dashboard pages, CMS News, CMS Gallery, CMS File Download, Congregational Data, and Logout [11].

B. *Proposed Activity Diagram*

Activity diagrams are made with the aim of making it easier to understand the processes that occur in the system. The proposed Activity Diagram in designing the BNKP Pewarta Church information system website is as follows:

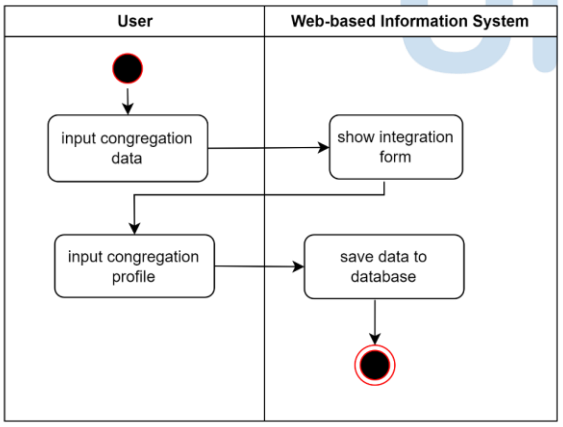

Figure 3. Activity Diagram add data congregation

This activity diagram shows the flow when a user (church officer) will input congregation data into a website-based information system.

C. *Proposed Class Diagram*

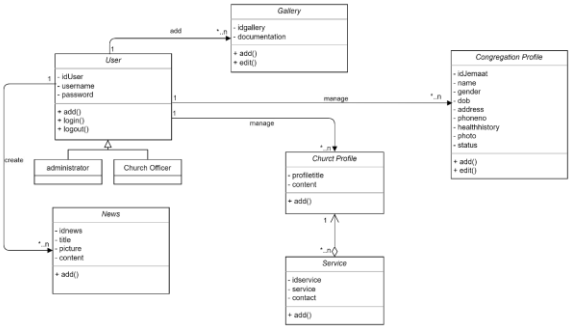

Figure 4. Class Diagram Proposed System

From Figure 4, there are 4 (four) classes and each Attribute that will be made in the design of the BNKP Pewarta Church information system website.

D. *User Interface*

The result of this research is an information system website for the BNKP Pewarta Church, which is able to display information about the Church, monitor and collect data on the congregation who will carry out worship directly. The following is a screenshot from the BNKP Pewarta Church information system website that has been successfully created:

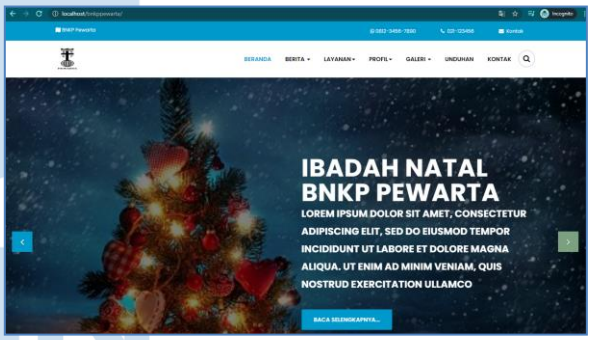

Figure 5. Website home page

This is the result of the design of the home page display from the BNKP Pewarta church website. The layout color is white, and the menu bard color is blue. This home page contains several menus, such as Home; News; Services; Profile; Gallery; Resources; Contact and search bar.

Figure 6. News content in the website

Figure 6 shows the latest news about the BNKP Pewarta Cruch, such as events, community services, and many more.

Figure 7. Users login form

On Figure 7, we can see the login form for the users of web-based information systems BNKP Pewarta Cruch. It has two fields to input username and password and one button for login. It also has a checkbox to remember the users' login profile to make it easier to log in.

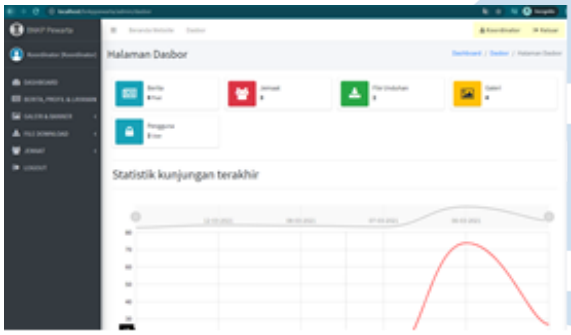

Figure 8. User dashboard

Figure 8 shows the user's dashboard that can be used to manage the website content, also known as Content Management System (CMS). The user can add some new content or edit and delete it in this dashboard. There are several menus in this dashboard similar to the home page.

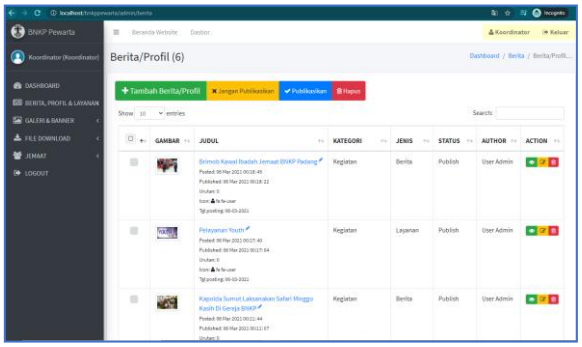

Figure 9. Content management system

From Figure 9, the users can create, read, update and delete the congregation data such as name, gender, birth date, address, phone number, congregation status, photos, and health conditions.

E. Testing Results

TABLE 1. BLACK-BOX TESTING RESULTS

Description	Case	Status
Landing page (home page)	The landing page of the website has successfully created and the users can access the website through localhost/webgereja	PASS
Login page	Administrator and Church Officer (Users) of this website can login using account and password on the Login button at the landing page to manage the website	PASS
Manage the website for Content, News and Gallery.	Users can manage the website using Content Management System (CMS) for Create, Read, Update and Delete (CRUD) the content, news and Gallery.	PASS
CRUD Congregation Data	Users can add new Congregation data, and modify such as Read, Update and Delete.	PASS

At the testing stage, after testing the system using black-box testing, it can be seen that the results of testing the main functionality of the website have been in accordance with the design objectives.

IV. CONCLUSION

After going through the stages of designing an information system website for the BNKP Pewarta church, the following conclusions can be drawn:

1). The design of an information system website at the BNKP Pewarta Church to collect congregation data has been successfully deployed with WDLC methods. The website can be accessed on localhost.

2). The users on this website have been given the CMS feature to create, read, update and delete congregation data.

3). The information/news content upload feature on the information system has been successfully created and can be displayed on the website.

ACKNOWLEDGMENT

I would like to thank the Staff and Clergyman of BNKP Pewarta Churches, who have cooperated enthusiastically in the development of the website in this research. Hopefully, through this research, the activities carried out in the church will be easier.

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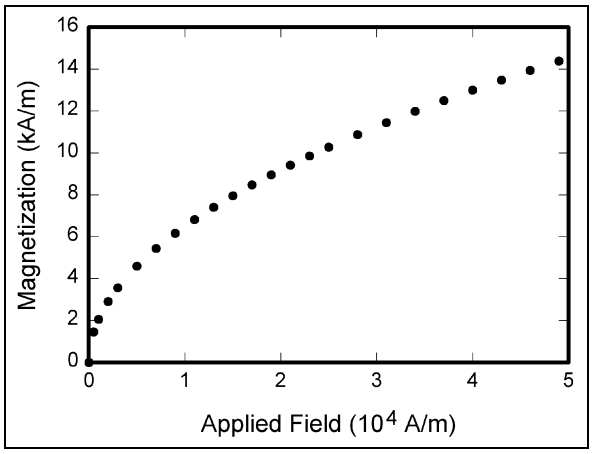

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