Proceeding

IORA International Conference on Operations Research 2017

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UNIVERSITAS TERBUKA

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PROCEEDING

IORA International Conference on Operations Research 2017

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THE CONFERENCE

IORA International Conference on Operations Research 2017

Date: 12th October 2017 (Thursday), 08.00 – 17.00
Venue: Universitas Terbuka Convention Center (UTCC)
Jl. Cabe Raya, Pondok Cabe, Pamulang,
Tangerang Selatan 15418, Indonesia

In the spirit to promote decisions based analytics through OR/MS, the theme of the conference is

"*Competing in the Era of Analytics*."

The primary objectives of the conference are:

1. to facilitate interaction between OR/MS researchers and academicians in discussing current challenges that need to be addressed as well as highlighting new developments of methods, algorithms, and tools in the field,
2. to provide OR/MS researchers, academicians and practitioners an appropriate platform for sharing experiences, communication and networking with other experts within the nation and from around the world in maximizing the contribution of OR/MS for sustainable growth, promoting of a knowledge-based economy, and utilizing the limited resources.

FOREWORD

IORA International Conference on Operations Research 2017

Conference Chair:
Dr. Agnes Puspitasari Sudarmo, *Universitas Terbuka*, *Indonesia*

It is well-known that the use of data in decisions making is not a new idea. But the field of business analytics that was born in the mid-1950s, with the advent of analytical tools that could digest a bulky quantity of information and perceive patterns in it far more quickly than the unassisted human mind ever could. Taking full advantage of big data's potential means companies must comprehend analytics into their strategic vision and utilize it to provide better and faster decisions, i.e., promote decisions based on analytics rather than instinct, while in other side, volume of data continues to double every three years as information surges in from digital platforms. Thus, analytical capability helps decision makers look beyond their own perspective in discerning real pattern and expecting opportunity.

Operation research as well as management science (OR/MS) has had an impressive contribution on improving the efficiency of numerous organizations around the world by offering a best solution. In the process, OR/MS has made a significant support to increasing the productivity of the economies of various countries. In this era of data-driven analytics, OR/MS is an ultimate tool for technical professionals who want to acquire the knowledge and skills required to incorporate analytics to solve real business problems.

This second conference, IORA International Conference on Operations Research 2017, is held in conjunction with Universitas Terbuka National Seminar on Mathematics, Sciences, and Technology 2017. The conference and seminar initiate to bring together OR/MS researchers, academicians and practitioners, whose collective work has sustained continuing OR/MS contribution to decision-making in many fields of application. It can be considered as good platforms for the OR/MS community, particularly in Indonesia, to meet each other and to exchange ideas. Thank you!

WELCOME REMARKS

IORA International Conference on Operations Research 2017

From the President
Indonesian Operations Research Association (IORA)
Prof. Sudradjat Supian

Drawn extensively from the divisions of mathematics and science, operations research (OR) applies cutting-edge statistical analysis and mathematical modeling to address a number of conflicting interests in inventory planning and scheduling, production planning, transportation, financial and revenue management and risk management as well as to improve decision-making mechanism. Yet, the importance of analytics inclusion into managerial decision making has grown significantly in the recent years. Massive amounts of data are now available for many organizations and businesses to be analyzed to support decision making process. How will big data fundamentally change what we do in OR? Analytics—the scientific process of transforming data into insight for making better decisions is now our key point.

For this conference we choose the following theme for our stand of work: "Competing in the Era of Analytics." It is our conviction that OR can make significant contribution to this emerging situation and challenging domain of research. It seems that the practice of big data analytics would fall entirely in the field of OR. By this conference we aim to promote the increase in the use of OR as a practical tool for problems in many aspects of data analysis. The ability to analyze large and complicated problems with operations research techniques is expected to suggest better decisions.

Establishment of Indonesian Operations Research Association (IORA) in 2014 is evidently intended to reinforce the above mentioned initiative. We hope IORA can be considered as good platforms for OR researchers, academicians and professionals in Indonesia to meet each other, exchange ideas and strengthen their collaboration.

Welcome to Tangerang Selatan, Indonesia, and welcome to IORA-ICOR 2017.

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Proceeding of IORA International Conference on Operations Research 2017
Universitas Terbuka, Tangerang Selatan, Indonesia, 12th October 2017

Optimization Techniques using ARENA Simulation

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Abstract. Extreme delays and process times as the required task cannot be completed on time are the problem face in a furniture manufacturing company. To solve this problem a computerized simulation model is developed, with the use of specialist software known as Arena. The ARENA simulation software will be run to evaluate the utilization of forklift of a transportation process in a warehouse at a furniture manufacturing. The objective of this study is to analyse and improve the loading and unloading process using forklift in warehouse of a furniture company. The Furniture manufacturer regularly facing delays in the warehouse while using forklift. This declaration was taken from the interview conversation with the production manager of the company. The parameter that used in the simulation study is uniform distribution (UNIF) which shows the minimum and maximum time used for duration of forklift movement. To achieve the objectives of these study, some assumption has made such as reduce the number of forklifts and increase the routes. The final conclusion can be summarized that the objective to design and optimize the utilization of material handling for this study is successful because the alternative layout is the best layout based on utilization of forklifts and stations using ARENA simulation software.

1. Introduction

Material handling and warehousing have a direct impact on the cost of goods that everyone buys (Butler & Butler, 2014). One of the major problem that faced by manufacturing sectors to run the activities effectively is the material transport (Census & Office, 2008). This study will apply simulation method to solve transportation problem in a warehouse of a furniture manufacturing company. This project will use ARENA simulation software to evaluate the utilization of forklift of a transportation process in a warehouse at a furniture manufacturing company in Muar, Johor. Simulation technology has been used in logistic operations and warehouse management to solve a number of problems related to transportation (Al-bazi & Emery, 2013). It will be useful to solve the material handling problem in warehouse of the company. The simulation results provide a useful tool for decision makers to evaluate strategies and policies for the design and operation of the systems, with valuable insights into the behaviour of the dynamic and stochastic system (Abduljabbar & Tahar, 2012).The result from the simulation will predict level of forklift utilization that can be used to recommended necessary action in order to increase the effectiveness.

1.1 Problem statement

The Furniture manufacturer frequently facing delays in the warehouse while using forklift. This statement was taken from the interview conversation with the production manager of the company. The purpose of this project is to obtain a strategy for optimizing the time of forklift loading and unloading in the warehouse by build an animated process for evaluating the actual condition of the system and for simulating changes to see the results. Insufficient amounts of these resources can result in extended process times and decreased efficiency, whereas zero resource availability will cause in extreme delays and process times as the required task cannot be completed on time (Al-bazi & Emery, 2013).

2. Literature Review

This chapter discuss deeply about what is simulation and the need of simulation in industries nowadays, including the advantage of simulation in evaluating the advantage of using simulation in evaluating manufacturing system. Optimization technique and simulation are the approach that been applied in several studies to solve material handling problems. Alia et al, had run a thesis on solving transportation problems by using the best candidate's method. They use best candidate method (BCM), to minimize the combinations of the solution by choosing the best candidates to reach the optimal solution. Linear Programming Problem (LPP) also one of the optimization technique that been used to solve material handling problem. (Ahmed, Sadat, Tanvir, & Sultana, 2014) had studied about new method of finding an Initial Basic Feasible Solution (IBFS). An early work on optimizing warehouse loading and unloading can be found in Choong-Yeun Liong and Careen S.E. (Loo, 2009). They had experimented four improvement models in order to find a strategy that will optimize the residence time of any customer's lorry without affecting the other processes. From the experimental the model IM2 the arrival of vehicles is scheduled and an additional forklift and a driver have been used they could overcome the overtime problem and reduces the waiting time of the customers by almost two hours from. For this thesis, the model that been applied is model that developed by (Maziar Gholamian Moghandam, 2011) and Kunene et al (2012) by running simulation models with proposed analyzing method. It helps us to study the case close to real world situation and experiment the proposed improving alternatives without any disruptions for the company. In the end, we came up with a simulation model which is capable of modelling that useful to the company apply in their routine working process in warehouse especially in the loading and unloading process which uses forklift as transportation tool.

3. Research Methodology

The discussion in this chapter will include the research design, sampling, research, data collection methods, data collection procedures, data analysis process and limitation for analyzing the data. Firstly, the aim of the research are directed at providing an in-depth and interpreted understanding of the social world of research participants by learning about their social and material circumstances, their experiences, perspectives, and histories. Other than that, the data collection methods usually involve close contact between the researcher and the research participants.

3.1 Research Framework

The framework of this study includes three phase, namely Phase 1, Phase 2 and Phase 3. Phase 1 is user input. In this phase, we define the problem by providing the simulation model. Phase 2 is solution generation. This phase is to generate new system by a search procedure. Phase 3 is selection of the best. When this phase finished, the systems are passed to a procedure that provides a statistical to guarantee to the best system.

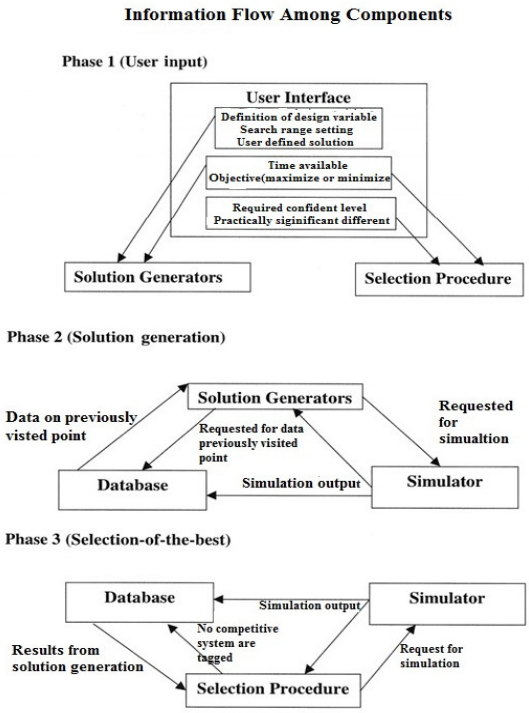

Figure 1: The three phase of simulation-optimization. Source: (Justin Boesel, 2011)

3.2 Data Analysis Process

Data analysis process is a process of inspecting, cleaning, transforming, and modelling data with the goal of discovering useful information, suggesting conclusions, and supporting decision-making. According to Baskarada (2014), during the test phase using observation data the researchers collect additional information.

4. Results and Discussion

4.1 Introduction

In order to comprehend the problem presented, a thorough study of the problem background needed to be investigated. Understandings of the basis, as well as the surrounding areas needed to be created. Meetings were set up with the various divisions that are involved with the warehouse, the warehouse management as well as operational staff. Interviews were conducted in a non-standardized way as to provide free an open communication. The interviews were used to create on overview of the big picture with an objective viewpoint of the problem.

4.2 Warehousing and Storage Activities

The key activities in warehousing are receiving put-away, storage, and picking/ distribute to other stations, packing and finally shipping. These activities are visualized in Figure 2.

4.3 Material Handling

4.3.1 Layout/ Routes

Routes of material transport system is the foremost thing in identify the distance between each of assembly or manufacturing station that involve. In order to recognize the routes, the plant layout of the company or organization must be referred. Furthermore, in the plant layout, manufacturing station that involved with the material transport should be acknowledged as shown in Figure 3.

Figure 2: Warehouse steps of Furniture Company

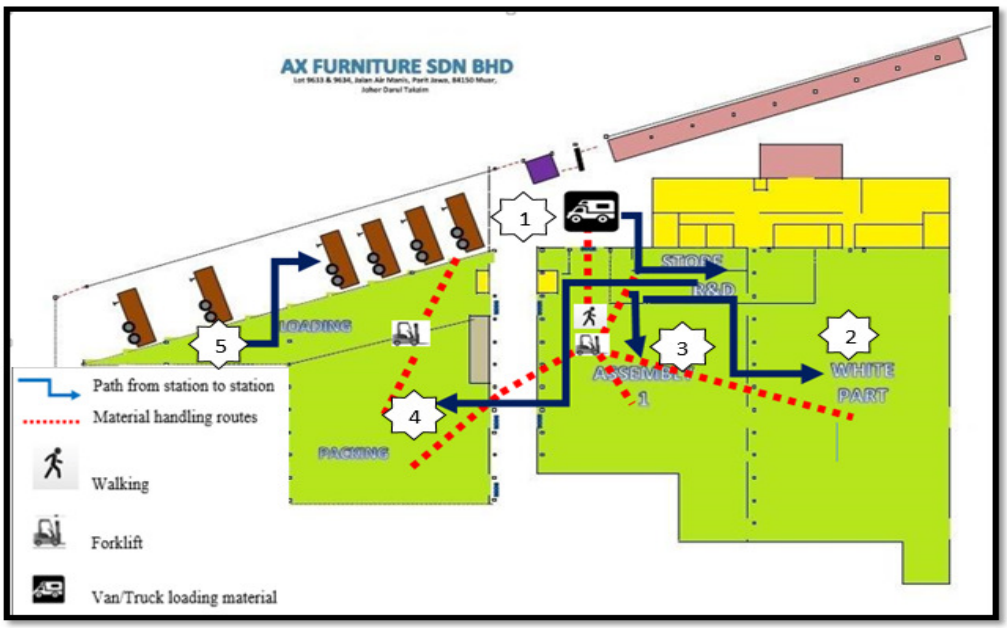

Figure 3: Routes of warehouse process in Furniture Company

Once the station identified, the process of the route is been recorded in video and the duration of the routes been recorded with the help of stop watch as shown in Table 1.

Table 1: shows the duration from station to station

DESTINATION	STATIONS		Distance (feet)	DURATION (minute)	
	FROM	TO		Min	Max
1	VAN	STORE	100	1.50	2.54
2	STORE	WHITE PART	150	2.02	3.01
3	STORE	ASSEMBLY 1	120	1.30	2.32
4	STORE	PACKING	190	2.00	6.25
5	LOADING	CONTAINER	120	1.00	6.33

4.3.2 Forklift Process / Schedule

The forklift plays important role in the Furniture Company. The forklift used to move the goods from one place to another.

4.4 Labour

4.4.1 Forklift Drivers

The forklift drivers are the vast majority head of the area of the personnel working in the Furniture Company. There is not any specific team to handle the forklift in the company. Most of the time a leader of the station will handle the forklift..

4.5 Loading Goods

All shipments from the AX are made by road. The load carrier is a truck carrying a container. The container will be transported to a harbour for further transportation by sea. The trailer is usually delivered directly to the customer.

4.6 Simulation Model

4.6.1 Simulation Model Description

The simulation models for this case study is based on the movement of the forklift from station to station. Firstly, the material will arrive at the station and then it will be distributed to the station that needed in their processes and after the product completed it will be finally shipped.

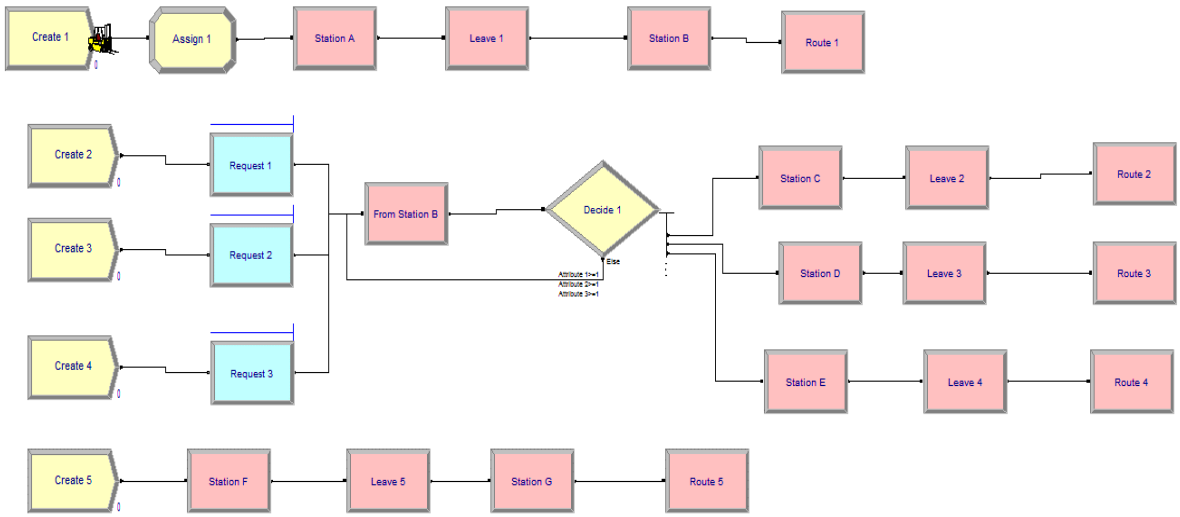

Figure 4: Simulation model using ARENA for existing layout

4.6.2 Initial Model

Figure 4 shows the simulation model of the exiting layout. There 5 destination in the current layout with five route. The path from one station to another station is vary from time and distance. The simulation model of the current layout consist of seven station which is Station A, Station B, Station C, Station D, Station E, Station F and Station G. Station B plays two roles which receive material and distribute the materials to other station such as Station C, Station D and Station E.

4.6.2.1 Result and Output Data Analysis of Initial Model

Table 2 shown a negative result for the existing layout. Only forklift 2 and forklift 3 are busy in this model. So the utilization level of this 2 forklift is high than forklift 1 and forklift 4.

Table 2: Result of the simulation model of existing layout

Time

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
Request 1.Queue	0.00	(Insufficient)	0.00	0.00
Request 2.Queue	0.00	(Insufficient)	0.00	0.00
Request 3.Queue	0.00	(Insufficient)	0.00	0.00

Other

Number Waiting	Average	Half Width	Minimum Value	Maximum Value
Request 1.Queue	0.00	(Insufficient)	0.00	0.00
Request 2.Queue	2.9895	(Insufficient)	0.00	3.0000
Request 3.Queue	0.00	(Insufficient)	0.00	0.00

Station

Other

Number Entities Transferring	Average	Half Width	Minimum Value	Maximum Value
Station 1	0.00	(Insufficient)	0.00	0.00
Station 2	1.9993	(Insufficient)	0.00	2.0000
Station 2A	0.00	(Insufficient)	0.00	0.00
Station 3	0.9979	(Insufficient)	0.00	1.0000
Station 4	0.9979	(Insufficient)	0.00	1.0000
Station 5	0.9979	(Insufficient)	0.00	1.0000
Station 6	0.00	(Insufficient)	0.00	0.00
Station 7	9.9134	(Insufficient)	0.00	10.0000

Transporter

Usage

Number Busy	Average	Half Width	Minimum Value	Maximum Value
Forklift 1	0.00	(Insufficient)	0.00	0.00
Forklift 2	2.0000	(Insufficient)	0.00	2.0000
Forklift 3	1.0000	(Insufficient)	0.00	1.0000
Forklift 4	0.00	(Insufficient)	0.00	0.00

Number Scheduled	Average	Half Width	Minimum Value	Maximum Value
Forklift 1	1.0000	(Insufficient)	1.0000	1.0000
Forklift 2	2.0000	(Insufficient)	2.0000	2.0000
Forklift 3	1.0000	(Insufficient)	1.0000	1.0000
Forklift 4	1.0000	(Insufficient)	1.0000	1.0000

Utilization	Average	Half Width	Minimum Value	Maximum Value
Forklift 1	0.00	(Insufficient)	0.00	0.00
Forklift 2	1.0000	(Insufficient)	0.00	1.0000
Forklift 3	1.0000	(Insufficient)	0.00	1.0000
Forklift 4	0.00	(Insufficient)	0.00	0.00

4.6.3 Model Assumption

The number of forklift reduce to three and the number of store increased to two. The second store is situated near packing area as shown in Figure 5. So, there will be total of eight station in the alternative layout.

4.6.4 Alternative Model

Figure 6 shows the simulation model of the alternative layout. The simulation model of the alternative layout consist of eight station which is Station A, Station B1, Station B2, Station C, Station D, Station E, Station F and Station G. For the alternative model the store is divided into two station. The both station plays the same roles which receive material. But as for Station B1, it distribute the materials to station such as Station C and Station D only. Whereby Station B2 distribute to Station E only.

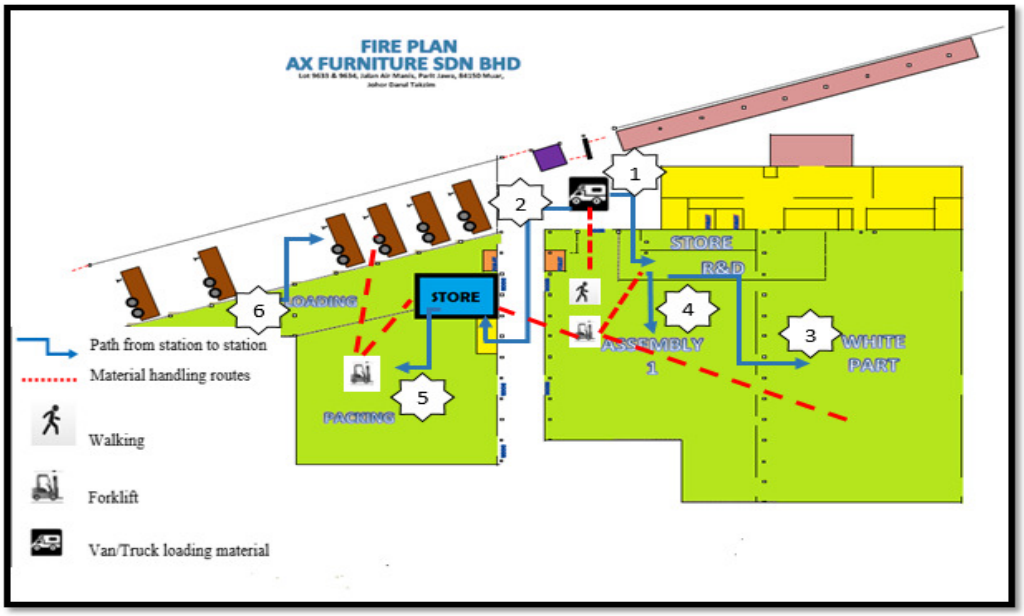

Figure 5: Alternative routes of warehouse in Furniture Company

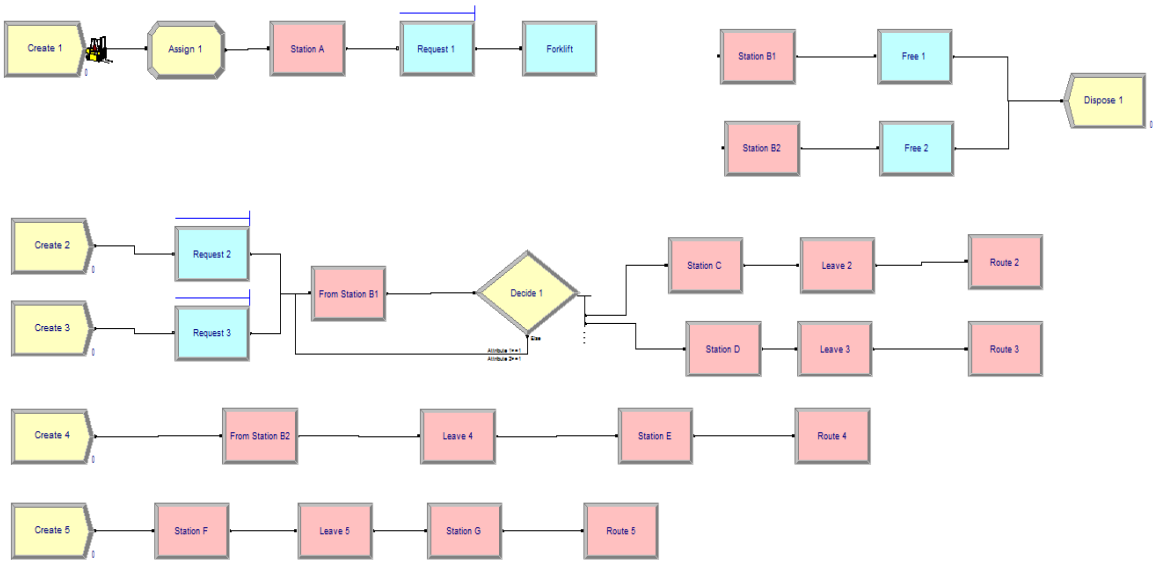

Figure 6: shows the simulation model of the alternative layout

4.6.4.1 Result and Output Data Analysis of Alternative Model

The utilization of forklift is vary in different station as shown in Table 3. As for Station 1 which is van arrival with material, the usage of forklift is based on the stoke card. If there is a need or request of material from the Store 1 and Store 2 there will be arrival of material and the forklift will be used. As Station 2B1 and Station 2B2 which represent the store of the company. These three station are not busy station in this company. This is because the materials that been stored in this station will be distributed to several stations such Station 3, Station 4 and Station 5.

Table 3: Result of the simulation model of alternative layout

Time

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
Request 1.Queue	0.00544873	(Insufficient)	0.00	0.01089746
Request 2.Queue	0.00	(Insufficient)	0.00	0.00

Other

Number Waiting	Average	Half Width	Minimum Value	Maximum Value
Request 1.Queue	0.00136218	(Insufficient)	0.00	1.0000
Request 2.Queue	0.00	(Insufficient)	0.00	0.00
Request 3.Queue	3.9922	(Insufficient)	0.00	4.0000

Station

Other

Number Entities Transferring	Average	Half Width	Minimum Value	Maximum Value
Station 1	0.00	(Insufficient)	0.00	0.00
Station 2B1	0.00	(Insufficient)	0.00	0.00
Station 2B2	0.00	(Insufficient)	0.00	0.00
Station 3	0.9979	(Insufficient)	0.00	1.0000
Station 4	0.00	(Insufficient)	0.00	0.00
Station 5	1.0000	(Insufficient)	0.00	1.0000
Station 6	0.00	(Insufficient)	0.00	0.00
Station 7	9.9107	(Insufficient)	0.00	10.0000
Station B1	0.00416667	(Insufficient)	0.00	1.0000
Station B2	0.00	(Insuffi 1:40:40	0.00	0.00

Transporter

Usage

Number Busy	Average	Half Width	Minimum Value	Maximum Value
Forklift 1	0.00625000	(Insufficient)	0.00	1.0000
Forklift 2	1.0000	(Insufficient)	0.00	1.0000
Forklift 3	0.00	(Insufficient)	0.00	0.00

Number Scheduled	Average	Half Width	Minimum Value	Maximum Value
Forklift 1	1.0000	(Insufficient)	1.0000	1.0000
Forklift 2	1.0000	(Insufficient)	1.0000	1.0000
Forklift 3	1.0000	(Insufficient)	1.0000	1.0000

Utilization	Average	Half Width	Minimum Value	Maximum Value
Forklift 1	0.00625000	(Insufficient)	0.00	1.0000
Forklift 2	1.0000	(Insufficient)	0.00	1.0000
Forklift 3	0.00	(Insufficient)	0.00	0.00

5. Conclusion

The performance of the forklift has shown to be extremely sensitive to the routes of each station. In an alternative layout, each material order would have with a matching station. In the real system, this is not always possible due to lack of space. The goal should be to have a layout with additional station and consider a proper maintenance to avoid mixing of orders. This would reduce the double handling and in a wider perspective, reduce the waiting time for the material to distribute to each station. If Company finds these results interesting, the recommendation would be to simulate the forklift for a shorter routes with more simulation runs. The management can adjust or control the time in this study. For the future study, it is recommended that a different research methodology is used, in particular different software's. So that we can get more ideas to solve material handling problems.

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The Padovan-like sequence raised from Padovan *Q*-matrix

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Abstract. The sequence of Padovan numbers is formed from the sum of the previous two and three term provided that the first three terms are given 0, 0, 1. The sequence of Perrin numbers is obtained by the same rule as the first three terms are 3, 0, 2. Some of the terms of the Padovan number sequence are 0, 0, 1, 0, 1, 1, 1, 2, 2, 3, 4, 5, 7, 9, 12, 16, 21, 28, 37, 49, 65, 86, ... Some of the terms of the Perrin number sequence are 3, 0, 2, 3, 2, 5, 5, 7, 10, 12, 17, 22, 29, 39, 51, 68, 90, 119, 158, ... The Padovan *Q*-matrix is a matrix of 3×3 sizes with the entries in all three columns consecutively being the first three terms, the third to the fifth, and the second to the fourth of the Padovan number. Furthermore, a *P*-matrix of 3×2 sizes with the entries in both columns consecutively the first three terms of the Padovan number and the first three terms of Perrin number. In this article a formula for the Padovan-like sequences is generated from the result of the development of Padovan *Q*-matrix and the development of the *P*-matrix.

1. Introduction

The sequence of Padovan numbers was discovered by Richard Padovan [3: 86]. The formula for obtaining the Padovan number sequence is [1]:

$$P_n = P_{n-2} + P_{n-3}, \text{ with } P_0 = 0,\ P_1 = 0, \text{ and } P_2 = 1 \tag{1}$$

Some of the terms of the Padovan number sequence are 0, 0, 1, 0, 1, 1, 1, 2, 2, 3, 4, 5, 7, 9, 12, 16, 21, 28, 37, 49, 65, 86, ...

In 1876 Eduardo Lucas studied the numbers sequence whose rules of arrangement were the same as the rules of composition in the Padovan numbers, but differed in the first three terms. Furthermore, the idea was developed by R. Perrin so that the sequence of numbers formed was known as the Perrin sequence [3: 92]. The formula for obtaining the Perrin number sequence is [2]:

$$R_n = R_{n-2} + R_{n-3} \text{ with } R_0 = 3,\ R_1 = 0,\ R_2 = 2 \tag{2}$$

Some of the terms of the Perrin number sequence are 3, 0, 2, 3, 2, 5, 5, 7, 10, 12, 17, 22, 29, 39, 51, 68, 90, 119, 158, ...

The Padovan *Q*-matrix is a matrix of 3×3 sizes with the entries in all three columns consecutively being the first three terms, the third to the fifth, and the second to the fourth of the Padovan number. Here is the Padovan *Q*-matrix [1]:

$$Q=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}=\begin{bmatrix}P_0 & P_2 & P_1\\ P_1 & P_3 & P_2\\ P_2 & P_4 & P_3\end{bmatrix} \tag{3}$$

Furthermore, Sokhuma [2] introduces a *P*-matrix of 3×2 sizes with the entries in both columns consecutively the first three terms of the Padovan number and the first three terms of Perrin number. The *P*-matrix is defined as [2]:

$$P=\begin{bmatrix}0 & 3\\ 0 & 0\\ 1 & 2\end{bmatrix}=\begin{bmatrix}P_0 & R_0\\ P_1 & R_1\\ P_2 & R_2\end{bmatrix} \tag{4}$$

Sokhuma [1] develop the Padovan *Q*-matrix at (3) into a Q^n-matrix for any integer $n\geq 3$ with

$$Q^n=\begin{bmatrix}P_{n-1} & P_{n+1} & P_n\\ P_n & P_{n+2} & P_{n+1}\\ P_{n+1} & P_{n+3} & P_{n+2}\end{bmatrix}$$

Wijayanti [4] proves that the applicability of the Q^n-matrix can be extended to each natural number $n\geq 1$. Sokhuma [1] manipulate Q^n-matrix into $Q^n=Q^mQ^{n-m}$ for $0<m<n$ and obtained

$$P_n=P_{m-1}\cdot P_{n-m}+P_{m+1}\cdot P_{n-m+1}+P_m\cdot P_{n-m+2}, \tag{5}$$

$$P_n=P_m\cdot P_{n-m-1}+P_{m+2}\cdot P_{n-m}+P_{m+1}\cdot P_{n-m+1}. \tag{6}$$

By substituting m on equation (5) and (6), Sokhuma [1] obtains the general form of the formula for the Padovan numbers sequence as in the equation (1).

Wijayanti [4] using a similar manipulation ie $Q^n=Q^{n-m}Q^m$ for $0<m<n$ obtained

$$P_n=P_{n-m-1}\cdot P_m+P_{n-m+1}\cdot P_{m+1}+P_{n-m}\cdot P_{m+2}. \tag{7}$$

$$P_n=P_{n-m}\cdot P_{m-1}+P_{n-m+2}\cdot P_m+P_{n-m+1}\cdot P_{m+1}. \tag{8}$$

By substituting m on equation (7) and (8), obtains the general form of the formula for the Padovan numbers sequence as in the equation (1).

Wijayanti [4] states that there are three other matrices Q^n, each expressed by

$$(Q_1)^n=\begin{bmatrix}P_{n-1} & P_{n+3} & P_n\\ P_n & P_{n+2} & P_{n+1}\\ P_{n+1} & P_{n+1} & P_{n+2}\end{bmatrix},\ (Q_2)^n=\begin{bmatrix}P_{n-1} & P_{n+3} & P_{n+2}\\ P_n & P_{n+2} & P_{n+1}\\ P_{n+1} & P_{n+1} & P_n\end{bmatrix},\ \text{dan}\ (Q_3)^n=\begin{bmatrix}P_{n-1} & P_{n+1} & P_{n+2}\\ P_n & P_{n+2} & P_{n+1}\\ P_{n+1} & P_{n+3} & P_n\end{bmatrix}.$$

Of the three matrices, none of the manipulations can produce equations (1).

Sokhuma [2] prove that for every *n* natural number apply

$$Q^nP=\begin{bmatrix}P_n & R_n\\ P_{n+1} & R_{n+1}\\ P_{n+2} & R_{n+2}\end{bmatrix}. \tag{9}$$

By manipulating the matrix Q^nP on equation (9) into a matrix $Q^nP=Q^mQ^{n-m}P$ for $3\leq m<n$, Sokhuma [2] gain equation (10) and (11):

$$P_n=P_{m-1}\cdot P_{n-m}+P_{m+1}\cdot P_{n-m+1}+P_m\cdot P_{n-m+2}, \tag{10}$$

$$R_n = P_{m-1} \cdot R_{n-m} + P_{m+1} \cdot R_{n-m+1} + P_m \cdot R_{n-m+2}. \qquad (11)$$

By substituting the value m of the equation (10) and (11), Sokhuma [2] obtains the general form of the Padovan sequence numbers in the equation (1) and Perrin sequence numbers in the equation (2).

With similar manipulation ie $Q^n P = Q^{n-m} Q^m P$ for $3 \le m < n$, Wijayanti [4] to the equation (12) and (13):

$$P_n = P_{n-m-1} \cdot P_m + P_{n-m+1} \cdot P_{m+1} + P_{n-m} \cdot P_{m+2}, \qquad (12)$$

$$R_n = P_{n-m-1} \cdot R_m + P_{n-m+1} \cdot R_{m+1} + P_{n-m} \cdot R_{m+2}. \qquad (13)$$

By substituting the value m of the equation (12) and (13), Wijayanti [4] to the general form of the sequence of the Padovan numbers in equation (1) and the sequence of Perrin numbers in equation (2). In this study we will examine the general form of similar formula Padovan sequence symbolized by S_n that obtained from the multiplication of two matrices $Q^n P^*$.

2. Research methodology

The methodology in this research is literature study and describes some related research results that have been obtained by previous researchers. This research is conducted in two stages: (1) construct P* matrix and prove $Q^n P^*$ and (2) generate the formulas of sequences of the Padovan, Perrin, and similar Padovan from the matrix $Q^n P^*$

3. Result and discussion

In the introduction it has been suggested that Sokhuma [2] has reviewed the development of the matrix Q^n with matrix P. The same way is also done by Wijayanti [4] by obtaining the same result.

Sokhuma [2] has given the matrix definition *P* on (4). Next, the development of the matrix *P* into a matrix P^* sized 3×3 done by adding one column to the matrix *P* so obtained

$$P^* = \begin{bmatrix} 0 & 3 & a \\ 0 & 0 & b \\ 1 & 2 & c \end{bmatrix} \qquad (14)$$

with *a, b, c* are natural number.

The result of the matrix Q^n with matrix *P** will produce a matrix whose entries form the Padovan, Perrin and a new sequence called the sequence of Padovan-like numbers, symbolized by S_n on the definition 1.

Definition 1. Sequence-number $S_n = aP_{n-1} + bP_{n+1} + cP_n$ is a sequence of numbers formed from the sum of the times between the three consecutive numbers on the Padovan number sequence row each with a, b, c are the natural number.

From Definition 1 the following Proposition 1 can be derived.

Proposition 1. From the number row $S_n = aP_{n-1} + bP_{n+1} + cP_n$ with a, b, c are natural number, a new sequence can be formed called a sequence of Padovan-like numbers with the formula $S_n = S_{n-2} + S_{n-3}$ for every natural number $n \ge 3$.

Proof: Given equations $S_n = aP_{n-1} + bP_{n+1} + cP_n$. Take the original number *a, b, c.*

For $n=1$, obtained $S_1 = a\cdot P_0 + b\cdot P_2 + c\cdot P_1$
$= a\cdot 0 + b\cdot 1 + c\cdot 0$
$= b$,
For $n=2$, obtained $S_2 = a\cdot P_1 + b\cdot P_3 + c\cdot P_2$
$= a\cdot 0 + b\cdot 0 + c\cdot 1$
$= c$,
For $n=3$, obtained $S_3 = a\cdot P_2 + b\cdot P_4 + c\cdot P_3$
$= a\cdot 1 + b\cdot 1 + c\cdot 0$
$= a+b$,
For $n=4$, obtained $S_4 = a\cdot P_3 + b\cdot P_5 + c\cdot P_4$
$= a\cdot 0 + b\cdot 1 + c\cdot 1$
$= b+c$
$= S_2 + S_1$,
For $n=5$, obtained $S_5 = a\cdot P_4 + b\cdot P_6 + c\cdot P_5$
$= a\cdot 1 + b\cdot 1 + c\cdot 1$
$= a+b+c$
$= (a+b)+c$
$= S_3 + S_2$,
For $n=k$, obtained $S_k = S_{k-2} + S_{k-3}$. (15)

From the equation $S_n = aP_{n-1} + bP_{n+1} + cP_n$ on definition 1 with a,b,c natural number, a new sequence of formulas can be formed $S_n = S_{n-2} + S_{n-3}$ called the sequence of Padovan-like sequence, applies to every original number $n \geq 3$ ■

Next, we examine the product of the matrix Q^n with $P*$ which produces a matrix with its column entries in terms of rows in the Padovan, Perrin and row of similar numbers Padovan S_n

Theorem 1. Let $P* = \begin{bmatrix} 0 & 3 & a \\ 0 & 0 & b \\ 1 & 2 & c \end{bmatrix}$ with *a, b, c* natural number. For every natural number *n*, prove that $Q^n P* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$, with the first, second and third columns respectively are successive term in the Padovan, Perrin, and Padovan numbers.

Proof: By using mathematical induction, will be investigated whether $Q^n P* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$ apply to any original number *n*.

1. Step base

It will be proven that $Q^n P^* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$ obtained for $n = 1$.

Note that $$QP^* = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 3 & a \\ 0 & 0 & b \\ 1 & 2 & c \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & b \\ 1 & 2 & c \\ 0 & 3 & a+b \end{bmatrix}$$

$$= \begin{bmatrix} P_1 & R_1 & S_1 \\ P_2 & R_2 & S_2 \\ P_3 & R_3 & S_3 \end{bmatrix}$$

$$= \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$$

Thus, $$QP^* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$$ obtained for $n = 1$.

2. The induction step

Assume $Q^n P^* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$ apply true *to* $n = k$. It will be shown that $Q^n P^* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$ applies to $n = k+1$ so as to obtain

$$Q^{k+1} P^* = (QQ^k) \begin{bmatrix} 0 & 3 & a \\ 0 & 0 & b \\ 1 & 2 & c \end{bmatrix}$$

$$= Q \left(Q^k \begin{bmatrix} 0 & 3 & a \\ 0 & 0 & b \\ 1 & 2 & c \end{bmatrix} \right)$$

$$= \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} P_k & R_k & S_k \\ P_{k+1} & R_{k+1} & S_{k+1} \\ P_{k+2} & R_{k+2} & S_{k+2} \end{bmatrix}$$

$$= \begin{bmatrix} P_{k+1} & R_{k+1} & S_{k+1} \\ P_{k+2} & R_{k+2} & S_{k+2} \\ P_k + P_{k+1} & R_k + R_{k+1} & S_k + S_{k+1} \end{bmatrix}.$$

Based on the equation (1), (2), and (14), obtained

$$\begin{bmatrix} P_{k+1} & R_{k+1} & S_{k+1} \\ P_{k+2} & R_{k+2} & S_{k+2} \\ P_k + P_{k+1} & R_k + R_{k+1} & S_k + S_{k+1} \end{bmatrix} = \begin{bmatrix} P_{k+1} & R_{k+1} & S_{k+1} \\ P_{k+2} & R_{k+2} & S_{k+2} \\ P_{k+3} & R_{k+3} & S_{k+3} \end{bmatrix}$$

$$= \begin{bmatrix} P_{k+1} & R_{k+1} & S_{k+1} \\ P_{(k+1)+1} & R_{(k+1)+1} & S_{(k+1)+1} \\ P_{(k+1)+2} & R_{(k+1)+2} & S_{(k+1)+2} \end{bmatrix}.$$

So, it proves that $Q^n P^* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$ applies to $n = k+1$. ■

Since the proof using mathematical induction is proved true, then the product of the matrix Q^n withmatrix P* produces a matrix whose entries in the first, second and third columns are consecutive respects on the sequence of Padovan, Perrin, and rows of similar numbers Padovan S_n, apply to any natural number *n*. ■

Next, the matrix $Q^n P^*$ can be manipulated into matrices $Q^n P^* = Q^m Q^{n-m} P^*$ to obtain a common form of Padovan, Perrin, and new lines S_n.

Theorem 2. The general formulas are the sequences of the Padovan, Perrin, and similar Padovan numbers S_n can be generated from the matrix $Q^n P^*$

Proof:

By using the power rule in the matrix operation, it is obtained $Q^n = Q^m Q^{n-m}$ so

$$Q^n P^* = Q^m \left(Q^{n-m} P^* \right).$$

Referring to Theorem 1 is obtained,

$$\begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix} = \begin{bmatrix} P_{m-1} & P_{m+1} & P_m \\ P_m & P_{m+2} & P_{m+1} \\ P_{m+1} & P_{m+3} & P_{m+2} \end{bmatrix} \begin{bmatrix} P_{n-m} & R_{n-m} & S_{n-m} \\ P_{n-m+1} & R_{n-m+1} & S_{n-m+1} \\ P_{n-m+2} & R_{n-m+2} & S_{n-m+2} \end{bmatrix}.$$

From the result of the first matrix line multiplication Q^m with the first column of the matrix $Q^{n-m} P^*$, obtained

$$P_n = P_{m-1} \cdot P_{n-m} + P_{m+1} \cdot P_{n-m+1} + P_m \cdot P_{n-m+2}, \tag{16}$$

From the result of the first matrix line multiplication Q^m with the second column of the matrix $Q^{n-m}P*$, obtained

$$R_n = P_{m-1} \cdot R_{n-m} + P_{m+1} \cdot R_{n-m+1} + P_m \cdot R_{n-m+2}, \tag{17}$$

and from the result of the first matrix row multiplication Q^m with the third column of the matrix $Q^{n-m}P*$, obtained

$$S_n = P_{m-1} \cdot S_{n-m} + P_{m+1} \cdot S_{n-m+1} + P_m \cdot S_{n-m+2}. \tag{18}$$

In equations (16), (16), and (18), without prejudice to announce if values are taken $m = 3$ soobtained

$$\begin{aligned} P_n &= P_2 \cdot P_{n-3} + P_4 \cdot P_{n-2} + P_3 \cdot P_{n-1}, \\ &= 1 \cdot P_{n-3} + 1 \cdot P_{n-2} + 0 \cdot P_{n-1}, \text{ (with } P_2 = P_4 = 1 \text{ and } P_3 = 0\text{)} \\ &= P_{n-2} + P_{n-3}, \end{aligned}$$

$$\begin{aligned} R_n &= P_2 \cdot R_{n-3} + P_4 \cdot R_{n-2} + P_3 \cdot R_{n-1}, \\ &= 1 \cdot R_{n-3} + 1 \cdot R_{n-2} + 0 \cdot R_{n-1}, \text{ (with } P_2 = P_4 = 1 \text{ and } P_3 = 0\text{)} \\ &= R_{n-2} + R_{n-3}, \end{aligned}$$

and

$$\begin{aligned} S_n &= P_2 \cdot S_{n-3} + P_4 \cdot S_{n-2} + P_3 \cdot S_{n-1}, \\ &= 1 \cdot S_{n-3} + 1 \cdot S_{n-2} + 0 \cdot S_{n-1}, \text{ (with } P_2 = P_4 = 1 \text{ and } P_3 = 0\text{)} \\ &= S_{n-2} + S_{n-3}. \end{aligned}$$

Then, for the value $m = 4$, so obtained

$$\begin{aligned} P_n &= P_3 \cdot P_{n-4} + P_5 \cdot P_{n-3} + P_4 \cdot P_{n-2}, \\ &= 0 \cdot P_{n-4} + 1 \cdot P_{n-3} + 1 \cdot P_{n-2}, \text{ (with } P_3 = 0,\ P_4 = 1, \text{ and } P_5 = 1\text{)} \\ &= P_{n-2} + P_{n-3}. \end{aligned}$$

$$\begin{aligned} R_n &= P_3 \cdot R_{n-4} + P_5 \cdot R_{n-3} + P_4 \cdot R_{n-2}, \\ &= 0 \cdot R_{n-4} + 1 \cdot R_{n-3} + 1 \cdot R_{n-2}, \text{ (with } P_3 = 0,\ P_4 = 1, \text{ and } P_5 = 1\text{)} \\ &= R_{n-2} + R_{n-3}, \end{aligned}$$

and

$$\begin{aligned} S_n &= P_3 \cdot S_{n-4} + P_5 \cdot S_{n-3} + P_4 \cdot S_{n-2}, \\ &= 0 \cdot S_{n-4} + 1 \cdot S_{n-3} + 1 \cdot S_{n-2}, \text{ (with } P_3 = 0,\ P_4 = 1, \text{ and } P_5 = 1\text{)} \\ &= S_{n-2} + S_{n-3}. \blacksquare \end{aligned}$$

Thus, if the original number $m > 1$ substituted on the equation (15), then obtained the general form of formula sequence number Padovan ie $P_n = P_{n-2} + P_{n-3}$, and if the natural numbers are substituted at (16) and (17), then the general formula of the sequence is obtained Perrin numbers are $R_n = R_{n-2} + R_{n-3}$, and the general formulas of sequences of Padovan-like numbers $S_n = S_{n-2} + S_{n-3}$. A formula that builds a sequence of numbers S_n together with the formula that built the sequence of Padovan and Perrin numbers.

4. Conclusion

From above, we conclue that:

1. From the number sequence $S_n = aP_{n-1} + bP_{n+1} + cP_n$ with a, b, c natural number, a sequence of Padovan numbers can be formed $S_n = S_{n-2} + S_{n-3}$ and apply to each natural number $n \geq 3$.
2. For each natural number *n*, apply $Q^n P^* = \begin{bmatrix} P_n & R_n & S_n \\ P_{n+1} & R_{n+1} & S_{n+1} \\ P_{n+2} & R_{n+2} & S_{n+2} \end{bmatrix}$, with the first, second and third columns respectively are successive terms in the Padovan, Perrin, and Padovan-like sequence numbers S_n
3. Matrix manipulation $Q^n P^*$ into $Q^n P^* = Q^m Q^{n-m} P^*$ produces the general formulas of the sequences of the Padovan, Perrin, and Padovan-like numbers S_n.

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Prediction of the number of international tourist arrival to West Java using Holt Winter method

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Abstract. Forecasting is a scientific method which may help predict individuals or groups in predicting the number of objects presenting in the future. One of the utility is to help the Government of West Java in predicting the number of international tourist arrival to West Java in the future. This paper uses Holt Winter method for prediction. Data of international tourist arrival to West Java during 2012-2016 were used. MAPE and MAE error parameter were used to determine the error margin from this method. It was obtained from calculation that the prediction of international tourist arrival to West Java with MAPE error of 16.49797487 and MAE error of 2239. Prediction revealed that there would be 26005 international tourist arrival in December 2017 through Husein Sastranegara Airport and Baiuhuni Port.

1. Introduction

Based on a study about the association between international tourist arrival and absorbance of manpower in tourism sector in Indonesia, it is known that the association between the two is positive. Thus, the more international tourist arrival to Indonesia, more manpower will be employed. Furthermore, there are still many benefits to be obtained from international tourist arrival to Indonesia. There are many tourist destinations in Indonesia. West Java is one of the most favorite tourist destinations for international tourists. Prediction of the number of international tourist arrival is required for certain purposes, such as building plan of places of interests in West Java. Thus, prediction of the number of tourist arrival in the future is needed. Previous research in [2] analyze the effect of international tourists visit and travel in Indonesia archipelago toward the absorption of labor in tourism sector. This paper will be discussing prediction technique using Holt Winter method. The motivation of this research is that by using Holt Winter method, the prediction of international tourist arrival to West Java in 2017 is known.

2. Holt Winter

There are several methods used to predict non-stationary data, can studied in [3] and [4], one of which is Holt Winter method. This method is a derivate of simple exponential smoothing using α, β and γ parameters, which is widely used projection method that can cope with trend and seasonal variation ([5]). Further study of this method also done in [6] that is about time series forecasting using Holt-Winters Exponential Smoothing. In [1] the research of Holt Winter method was used to predict the number of library visitors of University Riau in Pekanbaru. Our paper will only explain in detail about the Additive Holt Winter method elaborated as given in the following.

Let F_{t+k} is the Holt Winter Equation, L_t is overall smoothing (level), T_t is trend smoothing and S_{t+k-c} is a seasonal smoothing. The additive Holt Winter Equation is given by,

$$F_{t+k} = L_t + kT_t + S_{t+k-c}$$

whereas:

a. Overall Smoothing (Level)

$$L_t = \alpha(X_t - S_{t-c}) + (1-\alpha)(L_{t-1} + T_{t-1})$$

b. Trend Smoothing

$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$

c. Seasonal Smoothing

$$S_t = \gamma(X_t - L_t) + (1-\gamma)S_{t-c}$$

Note:

c = number of season

k = period

$$0 < \alpha, \boldsymbol{\beta}, \gamma < 1$$

Normal calculation begins in the second season; the first season was utilized to set initial value. The components of this initial value are S_t with t = 1,2,3,…,c ; L_c, and T_c;
Hereby is the formula to calculate these three components:

$$L_c = \frac{1}{c}(X_1 + X_2 + X_3 + \cdots + X_c)$$

$$S_m = X_m - L_c \; ; m = 1,2,3, \ldots, c$$

$$T_c = \frac{1}{K}\left(\frac{X_{c+1}-X_1}{c} + \frac{X_{c+2}-X_2}{c} + \cdots + \frac{X_{2c}-X_c}{c}\right),$$

with K as dividing constant.

3. Data and Method

The number of international tourist arrival to West Java during 2012-2016 through Husein Sastranegara Airport in Bandung and Baiuhuni Port was used in this study. Data were presented in forms of tables (Table 1) and charts (Figure 1). The figure showed that data were very fluctuative, hence Holt Winter method is used.

Table 1. Number of International Tourists during 2012-2016

Year	Month	Actual Data	Year	Month	Actual Data
2012	January	9737	2014	July	6241
2012	February	10771	2014	August	10648
2012	March	13366	2014	September	14132
2012	April	12711	2014	October	15086
2012	May	12829	2014	November	16644
2012	June	15533	2014	December	20840
2012	July	11736	2015	January	10453
2012	August	7194	2015	February	13138
2012	September	13749	2015	March	15224
2012	October	7537	2015	April	16978
2012	November	15017	2015	May	18902
2012	December	18265	2015	June	15423
2013	January	14077	2015	July	6688
2013	February	12088	2015	August	10387

Year	Month	Actual Data	Year	Month	Actual Data
2013	March	16815	2015	September	10652
2013	April	14068	2015	October	10755
2013	May	18023	2015	November	14951
2013	June	16640	2015	December	17067
2013	July	7803	2016	January	11065
2013	August	8808	2016	February	8497
2013	September	14742	2016	March	15964
2013	October	12292	2016	April	30922
2013	November	18243	2016	May	16841
2013	December	24401	2016	June	9055
2014	January	16397	2016	July	9499
2014	February	14618	2016	August	12663
2014	March	21538	2016	September	15141
2014	April	13631	2016	October	17444
2014	May	14725	2016	November	12876
2014	June	16942	2016	December	22510

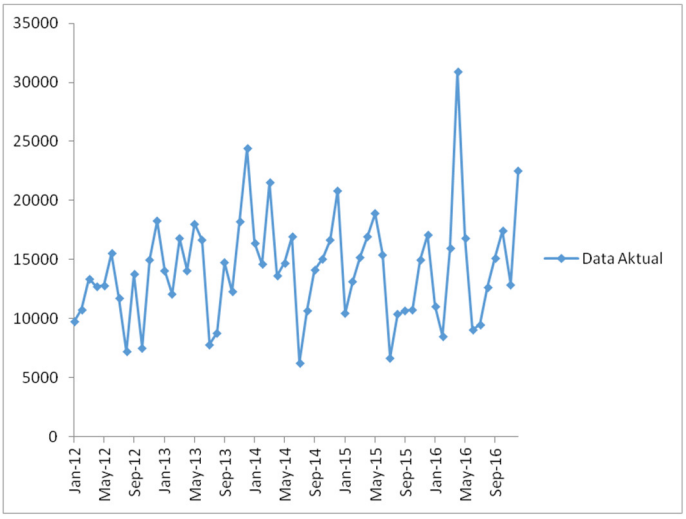


Figure 1. Number of International Tourists during 2012-2016

4. Result and Discussion

4.1. Holt Winter Method

The equation below must be completed in order to make prediction using this method:

$$F_{t+k} = L_t + kT_t + S_{t+k-c}$$

Assume that c = 12 (months), and by using Microsoft Excel it was obtained that the values of α, β, and γ with minimal MAPE were:

α: 0.096835282

β: 0.278974061

γ: 0.582295643

The first step was to obtain initial values:

a) $L_c = \frac{1}{c}(X_1 + X_2 + X_3 + \cdots + X_c)$

$$L_{12} = \frac{1}{12}(X_1 + X_2 + X_3 + \cdots + X_{12})$$
$$= 12370{,}41667$$

b) $S_m = X_m - L_c$; $m = 1,2,3,\ldots,12$

$S_1 = 9737 - 12370{,}41667 = -2633{,}416667$

$S_2 = 10771 - 12370{,}41667 = -1599{,}416667$

.

.

.

$S_{12} = 18265 - 12370{,}41667 = 5894{,}583333$

c) $T_c = \frac{1}{K}(\frac{X_{c+1}-X_1}{c} + \frac{X_{c+2}-X_2}{c} + \cdots + \frac{X_{2c}-X_c}{c})$

$$T_{12} = \frac{1}{60}\left(\frac{X_{13} - X_1}{12} + \frac{X_{14} - X_2}{12} + \cdots + \frac{X_{24} - X_{12}}{12}\right) = 41{,}04861111$$

The next step would be conducted after all initial values had been obtained:

i. Overal Smoothing (Level)

$L_t = \alpha(X_t - S_{t-c}) + (1-\alpha)(L_{t-1} + T_{t-1})$

$L_{13} = (\alpha)(X_{13} - S_1) + (1-\alpha)(L_{12} + T_{12}) = 12827{,}75545$

$L_{14} = (\alpha)(X_{14} - S_2) + (1-\alpha)(L_{13} + T_{13}) = 13052{,}96291$

.

.

$L_{60} = (\alpha)(X_{60} - S_{48}) + (1-\alpha)(L_{59} + T_{59}) = 16010{,}93435$

ii. Trend Smoothing

$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$

$T_{13} = (\beta)(L_{13} - L_{12}) + (1-\beta)T_{12} = 157{,}1827697$

$T_{14} = (\beta)(L_{14} - L_{13}) + (1-\beta)T_{13} = 176{,}1598961$

.

.

$T_{60} = (\beta)(L_{60} - L_{59}) + (1-\beta)T_{59} = 339{,}8891893$

iii. Seasonal Smoothing

$S_t = \gamma(X_t - L_t) + (1-\gamma)S_{t-c}$

$S_{13} = (\gamma)(X_{13} - L_{13}) + (1-\gamma)S_1 = -372{,}559955$

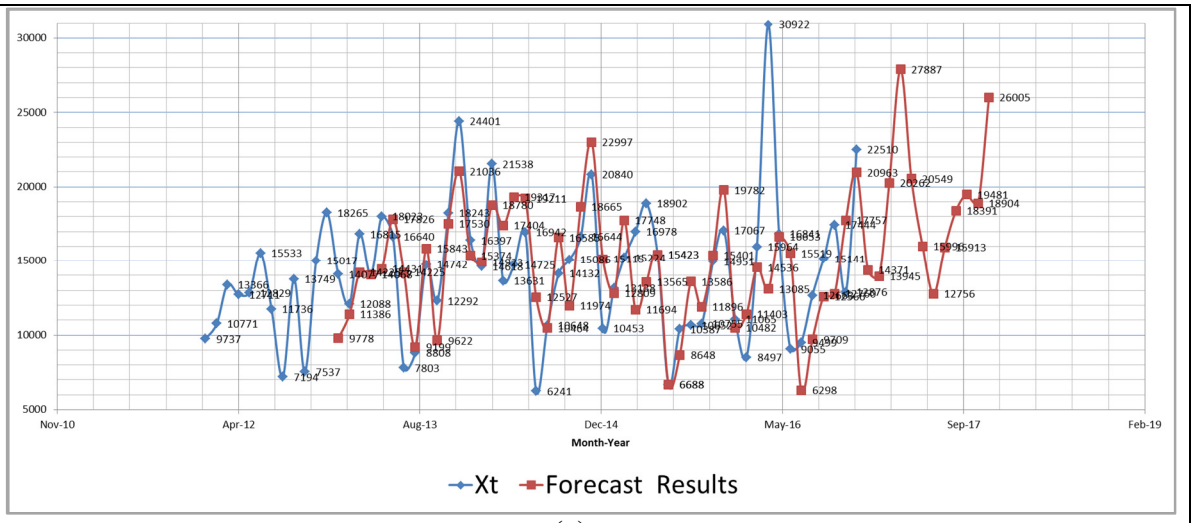
$S_{14} = (\gamma)(X_{14} - L_{14}) + (1-\gamma)S_2 = -1229{,}977011$

.

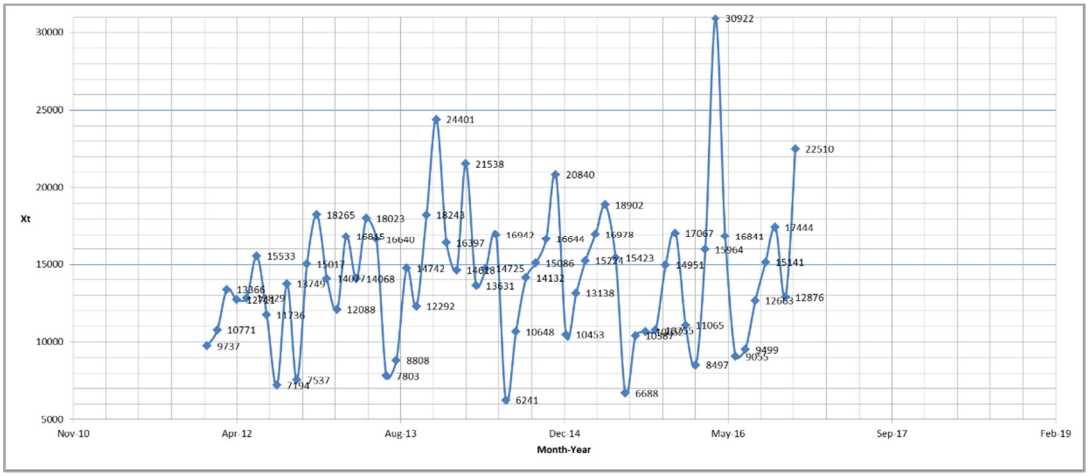
.

$S_{60} = (\gamma)(X_{60} - L_{60}) + (1-\gamma)S_{48} = 5915{,}559873$

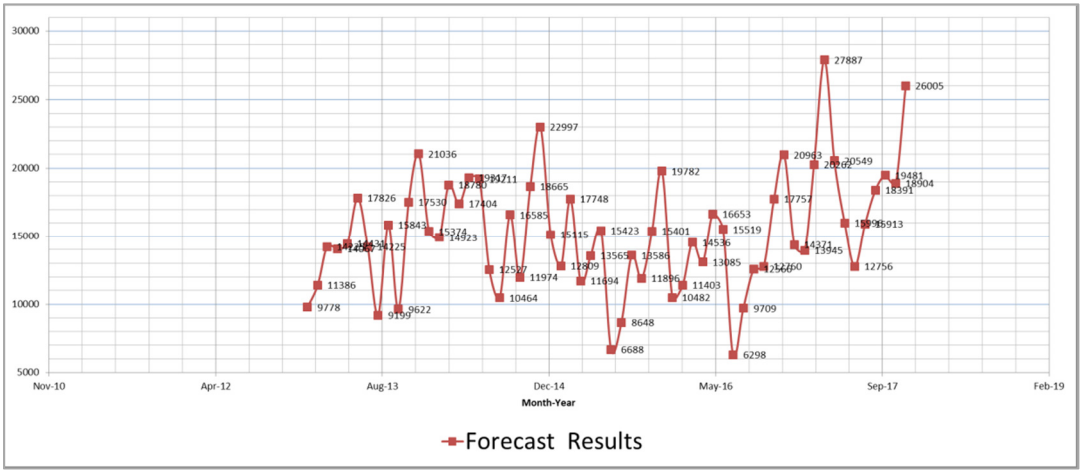
From the previous calculation, the complete data can be presented on Figure 2 below. Figure 2 show the forecast result using Holt Winter method, the graph of X_t toward Month-Year and the graph of forecast result toward Month-Year.



(a)



(b)



(c)

Figure 2. (a) Forecast result using Holt Winter method; (b) The graph of X_t toward Month-Year; (c) The graph of Forecast result toward Month-Year

5. Conclusion

Based on Holt Winter method, it was known that the prediction of international tourist arrival to West Java in 2017, as shown in Table 3, with MAPE error of 16.49797487 and MAE error of 2239, was 26005 international tourist arrivals to West Java per December 2017.

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Dynamic models of provision non-classical raw water on village level to support smart village (case on Bendungan village, Ciawi sub-distric, in Bogor district)

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Abstract. The purpose of this research is: arrange a dynamic model of provision raw water at village level with a new paradigm in relation to rural area planning i.e. non-classical, where the village is a water basin. The provision raw water comes from rural water supply (water supply company /PDAM, ground water, and spring water), and water bodies (river, *situ/embung*). Biside that by utilizing natural drainage (runoff), treatment waste water from domestic and non-domestic (gray water), and recycle industrial waste water. This research use a new concept i.e. *Water Smart Village* is a modification of Water Smart City, and Water Sensitive City. The data was used are primary data through interview and expert opinion, and secondary data. Data analysis using dynamic system with Powersim version 2.5c. The results show that; if using the classical approach, then in meeting the needs of raw water in the Bendungan village for the next 18 years is very vulnerable, because supply raw water is smaller than the water requirement, so the necessary breakthroughs are poured in the scenario, namely non classical i.e. pessimistic, moderate, and optimistic scenario. From 3 scenarios that can be applied is the 3rd scenario, is firstly making Installation communally of household waste disposal (IPA) every neighborhood association (RT) 1 IPA, secondly the runoff is accommodated in the *embung* (retention pound), where every citizens association (RW) 1 *embung*, and thirdly treatment of industrial wastewater (recycle), so that the fulfilment of raw water need to be increased from 18 years to 70 years

Keywords: non classical paradigm, retention pound, IPA, recycling

1. Introduction

As an agrarian country, Indonesia consists of 79,702 villages [1], where the people in supply the needs of clean water still rely on natural availability such as river water, springs, *setu* (*embung*) and ground water, so that access to water is still low at 44.8%, and the provision of raw water to drinking that has

been served by pipeline has only reached 8.60% [2]. This condition causes the position of rural community to the availability of raw water is relatively vulnerable, because the variation of natural condition and the variation of climate condition which is changing recently has a very influential effect on water production, and it will determine how the raw water needs of rural community will be fulfilled [3]. In addition, water quality is also a constraint of its own.

This condition is strengthened [4] who had identified several constraints related to the provision of clean water in the third world such as Indonesia, as political factors (water sector and environmental sanitation not yet a priority), financial (poverty), institutional (lack of institutions strong, and non-functioning of existing institutions), and technical (sprawl of settlements), as well as climatic factors (floods and droughts). Whereas according to WHO [5] in [2], the provision of feasibility clean water includes: house connections, public hydrants, boreholes, protected dug wells, protected springs, and rainwater collection so that water supply at the village level not yet achieved.

With the above conditions, the provision of raw water in rural areas recently become issue of development in Indonesia it is related to the priority strategic agenda of the current Government as outlined in the 7th Nawacita: The government realizes economic independence by moving the domestic economic sectors with a strategic development priorities such as increasing food sovereignty and increasing water security. This is due to the lack of access and clean water and healthy water service levels in rural areas.

The low level of raw water service in rural areas cannot be separated from the failure of drinking water development which is caused by the absence of sustainability of provision rural raw water system that is not optimally. The development of raw water in rural only limited to the pursuit of the target of clean water facilities and infrastructure.

Access to feasible raw water in rural is relatively low. This reflects that the rate of water infrastructure provision has not been able to keep pace with population growth, and even many facilities and infrastructure water not maintained. Poor management, will lead to the provision of raw water in rural areas is not sustainable, resulting in the village experiencing prone to clean water. In addition, the water supply crisis in rural areas was triggered by the increase of population, the change of rural economic structure which was originally agrarian based became service-based, thus increasing the demand and pressure on the condition of water resources.

The problem of provision of raw water in rural areas is also experienced by the village of Bendungan in Ciawi sub-district, Bogor District, where based on the water balance analysis shows the village of Bendungan experienced water crisis (prone to water), i.e., in 1 year experience of vulnerability for 6 months. Various efforts have been made by the government, both central and local governments, NGOs, as well as communities themselves both individually and communally, but still using conventional or classical methods is to build clean water facilities and infrastructure, resulting in less than optimal results. For that reason, the Dynamic model of Raw Water provision is integrated with non-classical method with water smart village approach. The purpose to be achieved are: to make dynamic mode of raw water provision at the village level other than coming from rural water supply (ground water, PDAM, and water bodies as rivers, and *situ*/*embung*,), can also be done by managing natural drainage channels (water run off), residual water either from domestic or non-domestic water, and process (recycle) industrial waste water into raw water in accordance with the quality standards set by the law.

2. Material and Method

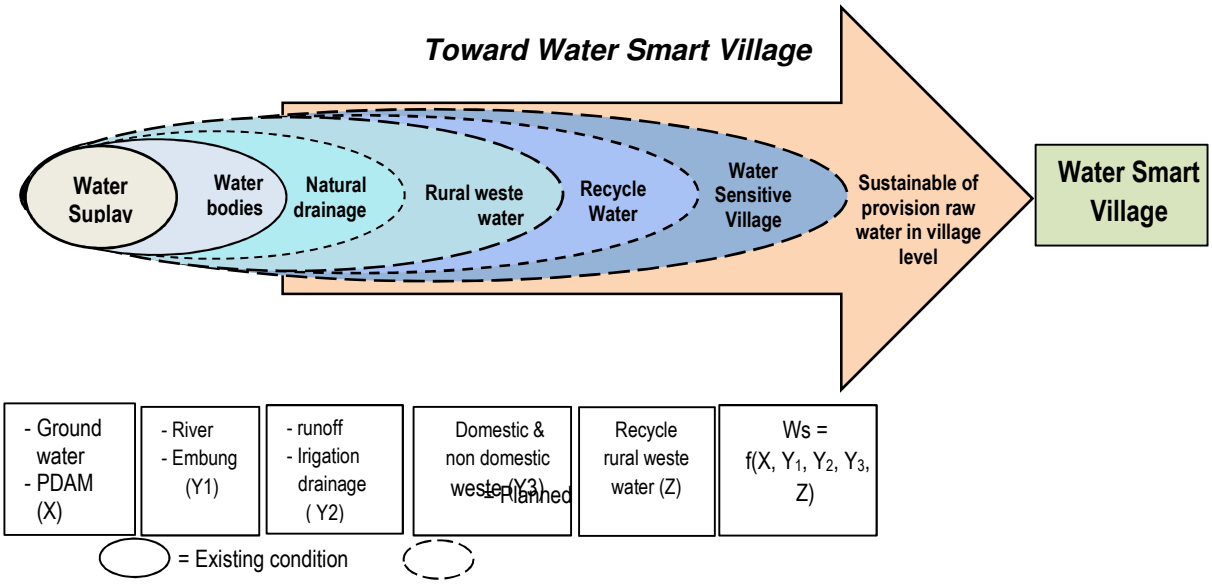
Materials used in the form of secondary and primary data. Secondary data were obtained from the Ciawi District Statistics Agency 2010 – 2015[6], Regional spatial planning Bogor District 2008 - 2038[7], Gadog Station rainfall for 10 years period (2005 – 2015), map of upper Ciliwung basin scale 1:50.000, and literature related to water provision. Primary data were obtained based on in-depth interviews with experts, are: Staff of Public Works Office of West Java Province, Staff of Ciawi Sub-district, community leader of the Bendungan village, and lecturer from IPB as expert resource or

informant to validate data, as well as field observation. Data analysis using dynamic system with Powersim version 2.5c.

This research uses a new paradigm in the provision of raw water that is non classical, where the village is a water basin. Existing water as much as possible is retained, then optimally utilized through various treatments and gradually released through the drainage channels. The approach used is Water Smart Village, which is a modification of Water Smart City from Hattum [8], and *Water Sensitive City* [9]. The concept of thinking is Water Smart City starting from Water Smart Village. If each water smart village is fulfilled, then Water Smart District will automatically be fulfilled as well, so Water Smart City will be achieved if the water smart district is fulfilled. While the concept of Water Smart Village developed is The village is a water reservoir. To reach Water Smart Village the stages are:

1. Rural supply raw water from ground water, springs, and PDAM (*Ws*)
2. Water bodies (river, embung, situ etc) (*Wb*)
3. Natural drainage (run off) (*Dn*)
4. Reduce grey water from both domestic and non-domestic waste water (*Ru*)
5. Recycle industrial waste (*Rw*)

Water Sensitive Village is the sum of the elements: raw water suplay,water bodies, natural drainage, reduce grey water, and recycle water or is a function of *f(Ws, Wb, Dn, Ru, Rw).* Based on the formula, then if water sensitive is reached, automatically the provision of sustainable non-classic raw water at the village level will be achieved as well. Diagrammatically the provision of sustainable non-classic water at the village level is presented in Figure 1.



Source: Modified from [8] and [9]

Figure 1. Provision of non-classic raw water at the village level with Water Smart Village approach

Water Smart Village is a method where water resources are guarded sustainable so as to enable future generations of rural communities to have access to manage water in the region with supporting infrastructure so that it can survive and function despite pressure from the more extreme climate [8]. The approach is integration of rural planning by maintaining the rural water cycle so that economic activity can run well, so that rural society's welfare is more secure. The purpose is to minimize the impact of hydrological rural development on the surrounding environment. The concepts include the integration of rainwater, ground water, wastewater management and water supply to overcome challenges community related to climate change, resource efficiency and shift energy, in order to

minimize environmental degradation to increase the efficiency of rural infrastructure, thus a combination of 3 components / main pillars interacting, i.e., (a) sustainability of water provision, (b) reduction and wastewater treatment, and (c) reduction and surface water treatment, which is presented in Figure 2.

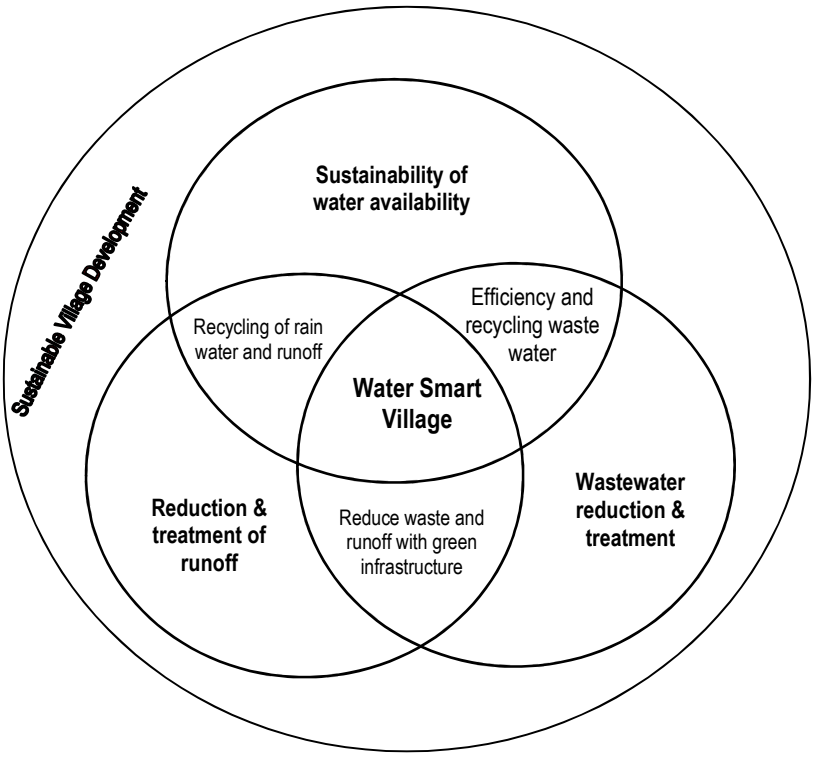


Figure 2. Integration of sustainable rural development and sustainable water management, (modification of [8])

3. Condition of Research Sites

The research location is located in Bendungan Village, Ciawi Sub-district, Bogor Regency. Hydrologically located in Ciseuseupan Sub watershed which is part of Ciliwung Hulu basin, and geographically located at coordinates $6^0$6'55 "- $6^0$6'76" LS, and $106^0$8'25 "- $106^0$8; 59" LE, with the area 1.33 km^2, with is composed 11 RW, and 48 RT. By 2015 total population is 10.509 person, with 5.465 males, and 5.044 females. The population density is quite high 7.901 person/km^2 [6]. The population growth rate is 0.8 person/year. The majority of the population is engaged in the self-employed sector of trade and services is 60%. Topographical condition is bumpy to hilly. Land use is dominated by settlements 49%, andthan farm/garden 38%, rice fields 10%, and other land use 3%. Precipitation 2.408 mm/year.

The selection of research sites based on the results of the analysis of water resources vulnerability with water balance approach that begins from the analysis of water resource vulnerability in each sub watershed in Ciliwung Hulu watershed. From 6 sub watershed, it is shown that Ciseuseupan sub-catchment is the most vulnerable sub-watershed (score 3 is very vulnerability). The Bendungan village is one of the 8 villages in the sub-catchment of Ciseusuepan, and is the most vulnerable village of water resources. The location of the study is presented in Figure 3.

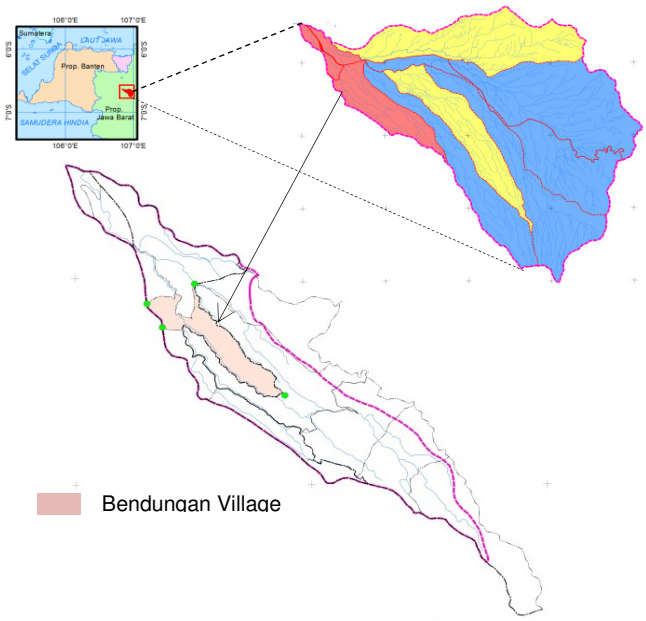


Figure 3. Location Research of Bendungan Village, District Ciawi, Ciseuseupan sub-watershed

4. Result and Discussion

4.1. Dynamic Modeling

In constructing a dynamic model, first step is processing and sorting data, both primary and secondary data are related and considered important in influencing the availability of provision raw water [10]. Important secondary data are population, industry and public facilities affecting raw water requirements, while water availability is obtained from surface water (water bodies is river, *situ/embung*), ground water, and PDAM, which is referred to as rural water supply in water smart village concept.

The obtained of model then simulated using the Powersim 2.5c program [11], in [12] The modeling and simulation data obtained is the basic data in formulating the policy of non-classical provision raw water at the village level in accordance with the characteristics of the research area. This model can also be used to perform non-classical raw water provision modeling activities in other areas, after the value of each model parameter adjusted to the characteristics of the area concerned.

Conceptually, the availability of raw water of the Bendungan village is derived from nature which consists of: surface water is Ciseuseupan tributary which has flow character is perennial (rivers that have water throughout the year), spring water from river bank, which amounted to 5 then collected in a communal tank, groundwater extracted through 784 dug wells, and 157 pump well [8], as well as from Tirta Kahuripan PDAM Service Branch X Ciawi, but the population utilizing the PDAM is still low at 10%, so the total water availability of Bendungan village is 5.3 x 10^5 m^3/year. The volume of availability raw water will be depreciated, because the water supply from surface water and groundwater effect of land conversion. The result is rain water falling on the land surface is immediately wasted (drained) to the drainage channel (gully, rivers etc.), and that enter into the soil as ground water (infiltration) is only ± 20%.

The volume of rural water availability when were linked with the need for raw water which around 4.7 x 10^5 m^3 / year, consisting of: the population water requirement of 10,509 people in the year 2015 that is equal to 4.5 x 10^5 m^3 / year (water requirement of population is 120 liters / person / day, because located of Bendungan village in suburban area [13], added with non-domestic water requirements covering public facilities of 10% of the total number of households [14] is as much 2.2 x

10^4 m^3 / year, and the need for industry, which is developing small and household industries amounted to 99 that is 1.8 x 10^4 m^3 / year (water standard small industry is 180 m^3 / unit / year).

Based on the results of dynamic system analysis presented in Figure 4, it is indicated that: if the condition of non-classical provision raw water is allowed continuously without any government orders and intervention, then within the next 18 years is in 2034th the availability of raw water in the Bendungan village is very vulnerable, because the water will run out or empty or the raw water supply is less than the water requirement. This condition can happen because the increasing of population is exponential series with a growth rate of 0.8% per year which automatically the need of raw water will also increase, added with the lifestyles of people who tend to consumptive, while the raw water supply actually decreased, impact of land conversion and climate change. The existing condition and result of modeling of raw water supply at Bendungan village is presented in Figure 5.

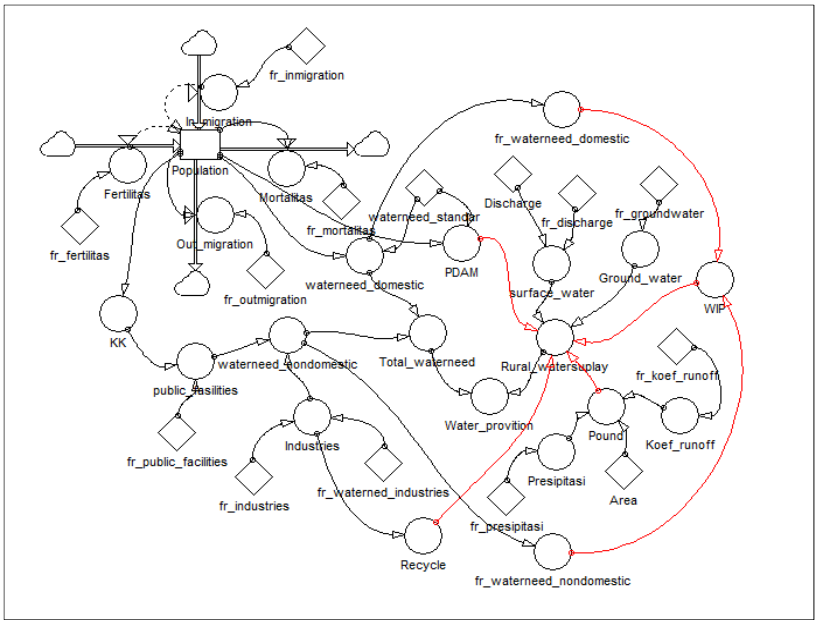
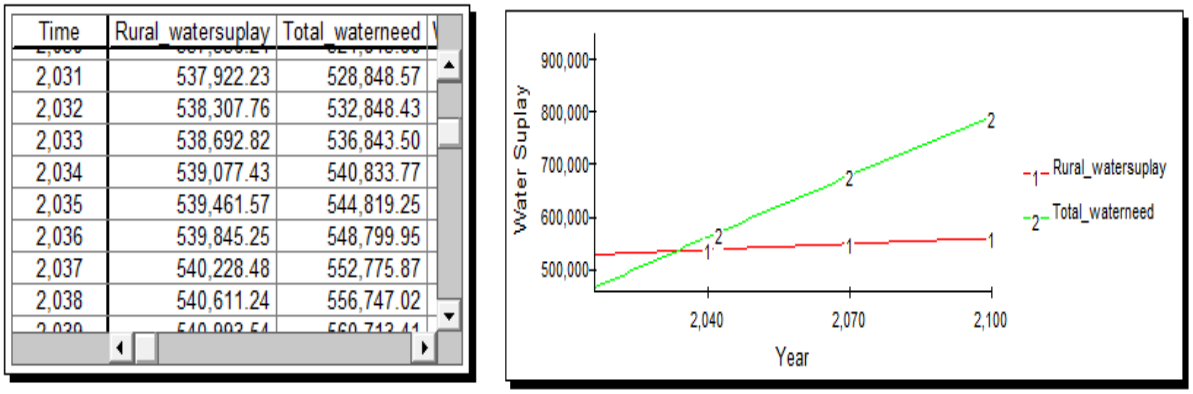


Figure 4. Dynamic model structure diagram of provision non-classic raw water in Bendungan village, Ciawi sub-district, Bogor District



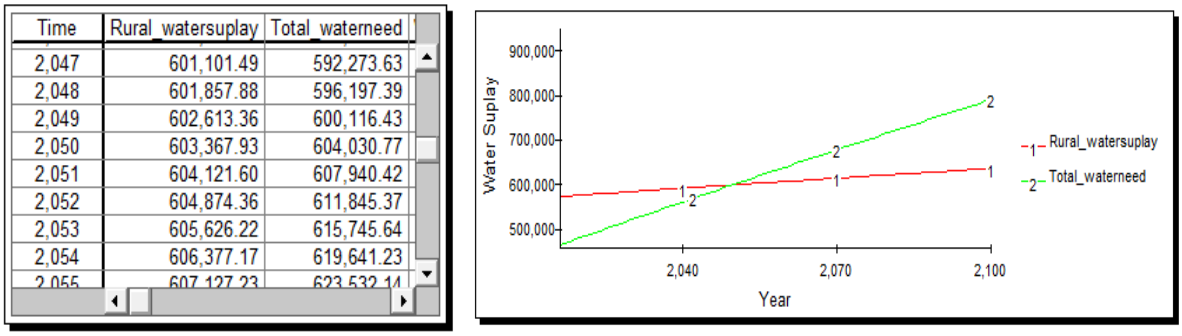
Time	Rural_watersuplay	Total_waterneed
2,031	537,922.23	528,848.57
2,032	538,307.76	532,848.43
2,033	538,692.82	536,843.50
2,034	539,077.43	540,833.77
2,035	539,461.57	544,819.25
2,036	539,845.25	548,799.95
2,037	540,228.48	552,775.87
2,038	540,611.24	556,747.02

Figure 5. Results of dynamic modeling of raw water availability in Bendungan village, Ciawi sub-District, Bogor District.

4.2. Simulation Model

Model simulation is a behavioral imitation of a behavior or process [11]. The goal is to understand the behavior or processes, make analysis, and forecast behavioral or processes in the future. Based on figures 4 and 5, then made a scenario so that the provision of raw water in the Bendungan village increases or grows longer, so that the economic activities of society running smoothly that ultimately the welfare of the community is guaranteed. Scenarios which is developed there are 3, namely:

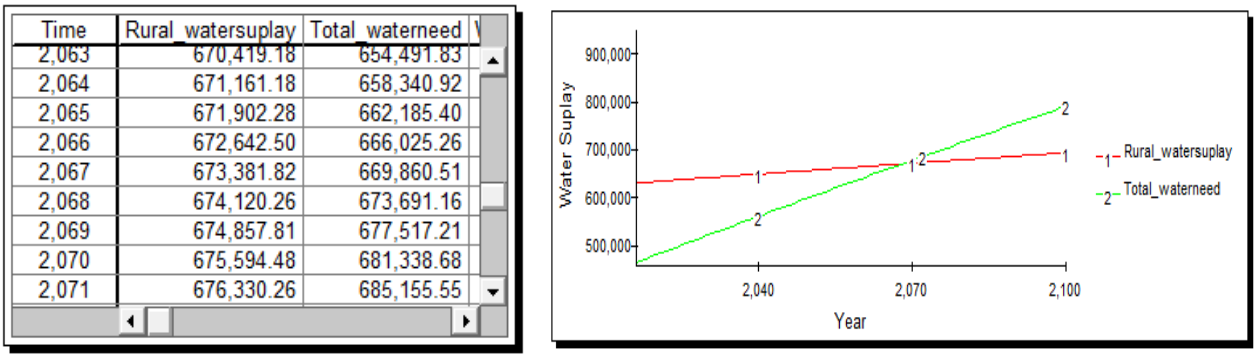
1. Scenario I or pessimistic scenario ie: the provision of raw water from rural water supply plus the increase of service from PDAM Kahuripan region X which was originally 10% to 20%. The result is a significant provision of raw water, because provision of raw water increases from 18 years to 34 years in 2050 (Figure 6).



Time	Rural_watersuplay	Total_waterneed
2,047	601,101.49	592,273.63
2,048	601,857.88	596,197.39
2,049	602,613.36	600,116.43
2,050	603,367.93	604,030.77
2,051	604,121.60	607,940.42
2,052	604,874.36	611,845.37
2,053	605,626.22	615,745.64
2,054	606,377.17	619,641.23
2,055	607,127.23	623,532.14

Figure 6. Scenario I (pessimistic) provision of non-classic raw water at the village level

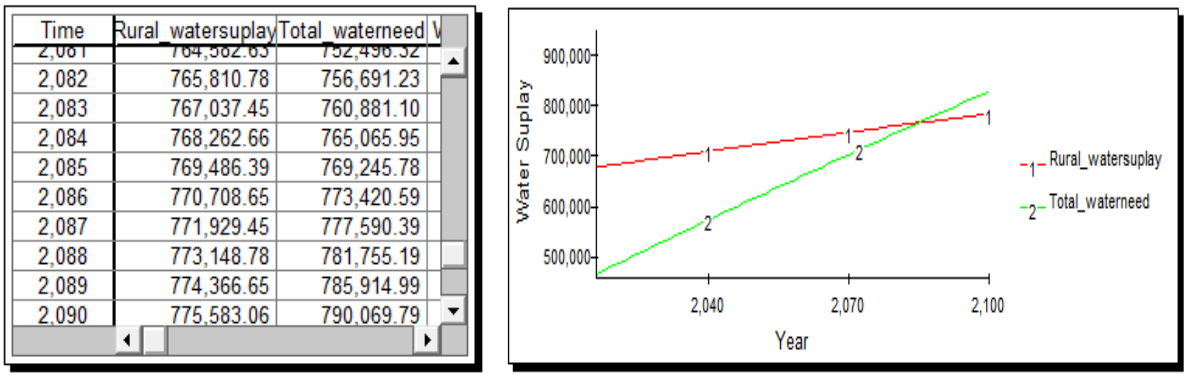
2. Scenario II or moderate scenario: provision of raw water, beside from conventional (rural water supply), engineered by make *embung* (retention pound). The goal is for rain water not quickly



Time	Rural_watersuplay	Total_waterneed
2,063	670,419.18	654,491.83
2,064	671,161.18	658,340.92
2,065	671,902.28	662,185.40
2,066	672,642.50	666,025.26
2,067	673,381.82	669,860.51
2,068	674,120.26	673,691.16
2,069	674,857.81	677,517.21
2,070	675,594.48	681,338.68
2,071	676,330.26	685,155.55

Figure 7. Scenario II (moderate) provision of non-classic raw water at the village level

3. Scenario III or optimistic scenario, is: the provision of raw water other than rural water supply, will be improved by: (a) building the *embung* in every RW 1 *embung*, (b) building grain water storage installations (IPA), where each RT 1 IPA. The assumption used is that each person will produce waste water 20% of raw water requirement, while for non-domestic waste water is 10% of raw water requirement, and (c) building waste treatment plants (IPA) from each industry that releases waste of 10% of the industry's raw water requirement. The simulation results show that this scenario is quite significant, because the raw water supply has increased quite sharply from 18 years to 70 years in 2086 (Figure 8).



Time	Rural_watersuplay	Total_waterneed
2,081	764,562.65	752,496.32
2,082	765,810.78	756,691.23
2,083	767,037.45	760,881.10
2,084	768,262.66	765,065.95
2,085	769,486.39	769,245.78
2,086	770,708.65	773,420.59
2,087	771,929.45	777,590.39
2,088	773,148.78	781,755.19
2,089	774,366.65	785,914.99
2,090	775,583.06	790,069.79

Figure 8. Scenario III (optimistic) provision of non-classic raw water at the village level

4.3. Discussion

Based on the simulation result, it can be applied all scenarios, either scenario 1, 2 or 3, but with technical consideration, the scenario I, cannot be applied even though the simulation result of raw water supply at village level is significant that has increased from 18 to 34 years . This is because the involvement of the community is very small, beside that with the community's ability to pay for water usage per month is very burdensome. In addition, PDAM Kahuripan area X Ciawai allocation priority is for the provision of raw water of Bogor city, and the capital of Bogor regency of Cibinong City.

For a moderate scenario, in the medium term is the most applicable, because with the creation of retention pound (*embung*) in addition to the provision of raw water can also for flood mitigation for the downstream area, but the implementation of the development cannot be done at once, should be gradual, can be started by making 2 *embung* each year, so that within 5 years has been achieved. One thing to note is community involvement.

For scenario III that is optimistic scenario, with the making of retention pound (*embung*) in every citizens association (RW) 1 *embung*, and make installation of waste water storage with IPA both household and communal public facilities, where every neighborhood association (RT) 1 IPA, as well as the manufacture of industrial waste water recycle households in a communal manner. The determination of this scenario, because the community can play an active role starting from the process of planning, implementation, and even to monitoring, considering the community is the object in the water supply not as subjects.

The constraints in scenario II and III lie in the cost, because to build a considerable retention pound (*embung*) that is 11 and 48 waste water storage (IPA) installations require substantial funds, so it cannot be implemented together, but can be done gradually, which can be started from the making of 2 IPA and 1 retention pound each year, or the development of retention pound first, then proceed to the making of IPA.

For funding or financing can be taken from the village funds that are rolled out by the Central Government through the *Kementerian Desa, Daerah Tertinggal dan Transmigrasi*, as well as the community self-reliance, so that the community feels owned, then they will take care of the water supply infrastructure. Can also through APBD funds in Bogor regency.

The linkages between the provision raw water scenarios and the water smart village lies in the of sustainable provision rural water, so there are 4 (four) main components that need attention:

1. Productivity; rural water supply can ensure the continuity or sustainability of both domestic and non-domestic water needs. This is already the scenario that is in scenario I, II, and III, where the results are very significant.
2. Harmonization; with the provision of non-classical raw water is expected to synchronize between stakeholders i.e., between users (community), village officials, and related institutions (Public Works and Housing Officer District Bogor, Development Planning Agency District Bogor,

Ministry of villages, disadvantaged areas and transmigration which expend village funds), universities and NGOs for appropriate use technology.

3. Beauty; with sufficient water availability, other water utilization can be done such as for the utilization of plants in village parks, the utilization of plants in the yard of the population, so that the village is more beautiful and beautiful, and the more productive people.
4. Smart village; with the fulfillment of the need for raw water, the community together with NGOs or universities to create an integrated water supply information system that is uploaded on the village website, so that the public can access with the hope that other villages can follow the system.

5. Conclusion and Recommendation

5.1. Conclusion

Provision of raw water at village level still conventional is from rural water supply (groundwater, water body and PDAM) is only up to 18 years ahead, it is very vulnerable, so it needs a new paradigm called non-classical water supply, where the village it as a water reservoir. Water is retained for as long as possible to be optimally utilized, then released slowly into the drain. Besides that, by utilizing the return of waste water both domestic and non-domestic, and by processing (recycle) the remaining water production from industry to raw water.

The result of scenario with dynamic system that can be applied is scenario II (moderate), and III (optimistic), that is provision raw water: (a) rural water supply, (b) make retention pound (*embung*), where each RW 1 *embung*, c) to make installation of household waste water container and public facilities (IPA) which each RT 1 IPA, and (d) recycle the remaining industrial water (IPAL) into raw water, the result is raw water supply increased from 18 years to 70 year.

To achieve water smart village requires 4 (four) main components, namely: (a) water productivity, (b) harmonization, (c) beauty, and (d) integrated water supply information system.

5.2. Recommendation

The dynamic model of non-classic water provision in Bendungan village is expected to be the prototype of raw water provision at the village level, so it can be applied in other villages with similar characteristics, so that the village is more self-sufficient in the provision of raw water.

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Application of matrix and numerical methods in the estimation of multiple index model parameters for stock price predictions

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Abstract. A stock price prediction is necessary for investors in the capital market. Because stock price changes are often influenced by some exogenous factors, multiple index models can be used in stock price predictions. To get the corresponding multiple index model for stock price prediction, model estimation method parameter is needed that can give more accurate result. In this paper intends to apply matrix and numerical methods in estimating the parameters of multiple index models for stock price predictions. In this paper, parameter estimation is done by using the method of Gauss-Jordan method, decomposition LU method and Gauss-Seidel method. The result of coefficient parameters estimation is performed by using these three methods is different, but the difference is not too large. Based on the estimation of the parameters of the multiple index models, the prediction of a stock's price can be determined.

Keywords: Multiple index models, invers matrix method, Gauss-Jordan method, decomposition method, Gauss-Seidel method.

1. Introduction

Investment cannot be separated from the risk that must be faced by investors. Investors will usually attempt to minimize those risks by various analyzes [9]. One of the analysis tools that can be used is multiple index models. The multiple index models assume that the correlation of return of each stock occurs because of the response of the stock to changes in a particular index [11]. In the multiple index models, the commonly used index is the composite share price index and the rupiah exchange rate against foreign currencies [1; 12; 13]. In the equations of multiple index models, that individual stock returns consist of unique return and the rate of return associated with the index coefficient affecting it is often called the beta coefficient. The techniques for estimating the beta can be based on historical beta, taking into account the fluctuation of the historical profitability level of individual stocks, and subsequently formed the regression equation of stock returns on the return index that influences it [7; 8]. Since the beta coefficient is related to the rate of gain, the estimation of the beta coefficient is very important to do accurately.

Predicted stock prices by using multiple index models, within the framework of optimal portfolio formation, has been largely done by previous researchers. Among others, Wahyuni [12], conducted a study entitled "Analysis of the application of single index model and double index to form optimal portfolio (case study on LQ-45 stock index listed on Jakarta Stock Exchange)". The results concluded

that the establishment of an optimal portfolio based on multiple indexes can provide optimal returns, compared to the formation of a single indexed portfolio. Research Widyasari [13], entitled "The establishment of an optimal portfolio using a double index model (Study on property companies and real estate on the JSE)", states that the stocks formed in the optimal stock portfolio, are shares whose independent variables affect the dependent variable, and have a positive expected return value. Andayani Research [1], entitled "Application of multiple index models in determining portfolio priority on LQ-45 stock listed on Jakarta Stock Exchange", concludes that the calculation result using multiple index model yields some shares that become priority in portfolio formation. From some of these studies show that the multiple index model is very useful in the selection of stocks for optimal portfolio formation. To estimate the parameters of multiple index models is generally done by using least square method [4]. One thing to look for is an alternative method of parameter estimation from a more precise double index model [10].

Therefore, in this research, an application of numerical and matrix method is used to estimate the parameters of the double index model in relation to the predicted stock price traded on the Indonesian capital market. The goal is to obtain more accurate multiple index parameter estimators through several approaches. So we get an alternative estimation method that can be used in the estimation of multiple index model parameters.

2. Methodology

In this section we discussed the methodology which includes: stock return, multiple index model, matrix equation system, Gauss-Jordan numerical method, numerical decomposition method LU, and Gauss-Seidel numerical method.

2.1. Stocks return

Suppose the stock price at time to-t amounted P_t. The value of stock return R_t, can be calculated using the following formula:

$$R_t = p_t - p_{t-1}, \tag{1}$$

with $p_t = \ln P_t$, $t = 1,2,...,T$ where T the number of data analysed, and assumed $P_0 = 1$. Return saham ini selanjutnya digunakan untuk proses estimasi parameter beta berikut ini [9].

2.2. Multiple index model

The multiple index models can generally be expressed as the following equation:

$$R_i = \alpha_i + \beta_{i1} I_1 + \beta_{i2} I_2 + ... + \beta_{iL} I_L + \varepsilon_i, \tag{2}$$

where R_i stock return i ($i = 1,...,N$ and N number of stock), I_j index return j ($j = 1,...,L$ and L number of index), α_i regression parameters constants i ($i = 1,...,N$ and N number of stock), β_{ij} regression parameters constants i ($i = 1,...,N$ and N number of stock) for index j ($j = 1,...,L$ and L number of index), and ε_i residual regression i ($i = 1,...,N$ and N number of stock). Estimator model of multiple indexes on equation (2) is [11]:

$$\hat{R}_i = \alpha_i + \beta_{i1} I_1 + \beta_{i2} I_2 + ... + \beta_{iL} I_L. \tag{3}$$

To estimate the parameters of the constants and coefficients in equation (3), can be done by establishing a system of linear equations, which consists of N equations with N parameters of constants and coefficients. The system of equations can be established if it is established that $N = L + 1$. Thus, with reference to the equations (1) and (3), it can be formed the linier equation system as follow:

$$\sum R_{it} = \alpha_i n + \beta_{i1} \sum I_{1t} + \beta_{i2} \sum I_{2t} + ... + \beta_{iL} \sum I_{Lt}, \tag{4}$$

$$\sum R_{it} I_{1t} = \alpha_i \sum I_{1t} + \beta_{i1} \sum I_{1t}^2 + \beta_{i2} \sum I_{1t} I_{2t} + ... + \beta_{iL} \sum I_{1t} I_{Lt}, \tag{5}$$

$$\sum R_{it} I_{2t} = \alpha_i \sum I_{2t} + \beta_{i1} \sum I_{1t} I_{2t} + \beta_{i2} \sum I_{2t}^2 + ... + \beta_{iL} \sum I_{2t} I_{Lt}, \tag{6}$$

...

$$\sum R_{it} I_{Lt} = \alpha_i \sum I_{Lt} + \beta_{i1} \sum I_{1t} I_{Lt} + \beta_{i2} \sum I_{2t} I_{Lt} + ... + \beta_{iL} \sum I_{Lt}^2 . \quad (7)$$

2.3. Matrix equation system

To simplify the system of equation (4), (5), (6), and (7), each regression of stock i ($i = 1,...,N$ and N number of stock) can be expressed as following system of equations:

$$y_1 = \alpha x_{11} + \beta_1 x_{12} + \beta_2 x_{13} + ... + \beta_L x_{1L} , \quad (4')$$

$$y_2 = \alpha x_{21} + \beta_1 x_{22} + \beta_2 x_{23} + ... + \beta_L x_{2L} , \quad (5')$$

$$y_3 = \alpha x_{31} + \beta_1 x_{32} + \beta_2 x_{33} + ... + \beta_L x_{3L} , \quad (6')$$

...

$$y_n = \alpha x_{n1} + \beta_1 x_{n2} + \beta_2 x_{n3} + ... + \beta_L x_{nL} . \quad (7')$$

with $n = L+1$. System of equation (4'), (5'), (6'), and (7'), can be expressed in terms of the following matrix equation [8]:

$$\begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ ... \\ y_n \end{pmatrix} = \begin{pmatrix} x_{11} & x_{12} & x_{13} & ... & x_{1L} \\ x_{21} & x_{22} & x_{23} & ... & x_{2L} \\ x_{31} & x_{32} & x_{33} & ... & x_{3L} \\ ... & ... & ... & ... & ... \\ x_{n1} & x_{n2} & x_{n3} & ... & x_{nL} \end{pmatrix} \begin{pmatrix} \alpha \\ \beta_1 \\ \beta_2 \\ ... \\ \beta_L \end{pmatrix} . \quad (8)$$

with $n = L+1$. Equation (8), if we simplified in a matrix symbol, it can be expressed as $\mathbf{C} = \mathbf{AB}$. Because A is a matrix of size n x n, to determine the vector $\mathbf{B}$, the solution vector is [3]:

$$\mathbf{B} = \mathbf{A}^{-1}\mathbf{C} . \quad (9)$$

2.4. Gauss-Jordan numerical method

In the numerical elimination of the Gauss-Jordan method, the matrix $\mathbf{A}$ is eliminated to the identity matrix $\mathbf{I}$. The solution is directly obtained from the resultant vector column $\mathbf{C}$ of the elimination process. In matrix form, Gauss-Jordan elimination is written as [2; 5; 6]:

$$\left(\begin{array}{ccccc|c} x_{11} & x_{12} & x_{13} & ... & x_{1L} & y_1 \\ x_{21} & x_{22} & x_{23} & ,,, & x_{2L} & y_2 \\ x_{31} & x_{32} & x_{33} & ... & x_{3L} & y_3 \\ ... & ... & ... & ... & ... & ... \\ x_{n1} & x_{n2} & x_{n3} & ... & x_{nL} & y_n \end{array}\right) \Rightarrow \left(\begin{array}{ccccc|c} 1 & 0 & 0 & ... & 0 & y_1' \\ 0 & 1 & 0 & ,,, & 0 & y_2' \\ 0 & 0 & 1 & ... & 0 & y_3' \\ ... & ... & ... & ... & ... & ... \\ 0 & 0 & 0 & ... & 1 & y_n' \end{array}\right) . \quad (10)$$

From (10), the vector $\mathbf{B}$ is resulted:

$$\mathbf{B} = \begin{pmatrix} \alpha \\ \beta_1 \\ \beta_2 \\ ... \\ \beta_L \end{pmatrix} = \begin{pmatrix} y_1' \\ y_2' \\ y_3' \\ ... \\ y_n' \end{pmatrix} . \quad (11)$$

2.5. LU Decomposition Numerical Method

If the matrix A is non-singular, then it can be factored into the lower triangular matrix L (lower) and the upper triangular matrix U (Upper). In the matrix form is written as follows:

$$\begin{pmatrix} x_{11} & x_{12} & x_{13} & \dots & x_{1L} \\ x_{21} & x_{22} & x_{23} & \dots & x_{2L} \\ x_{31} & x_{32} & x_{33} & \dots & x_{3L} \\ \dots & \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & x_{n3} & \dots & x_{nL} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & \dots & 0 \\ l_{21} & 1 & 0 & \dots & 0 \\ l_{31} & l_{32} & 1 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ l_{n1} & l_{n2} & l_{n3} & \dots & 1 \end{pmatrix} \begin{pmatrix} u_{11} & u_{12} & u_{13} & \dots & u_{1L} \\ 0 & u_{22} & u_{23} & \dots & u_{2L} \\ 0 & 0 & u_{33} & \dots & u_{3L} \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & u_{nL} \end{pmatrix}. \tag{12}$$

The lower triangular matrix L, all the diagonal elements is 1, while in the upper triangular matrix, there is no special requirement for its diagonal value [2; 3; 5].

Solving the matrix equation $\mathbf{AB} = \mathbf{C}$, if it is done by using LU decomposition, then factorize the matrix equation $\mathbf{A} = \mathbf{LU}$, thus $\mathbf{AB} = \mathbf{C}$ is doing so $\mathbf{LU} = \mathbf{C}$. If so $\mathbf{UB} = \mathbf{D}$, then $\mathbf{LD} = \mathbf{C}$, referring to the matrix equation (12), to obtain the vector, use the advanced substitution technique as follows:

$$\mathbf{LD} = \mathbf{C} \Rightarrow \begin{pmatrix} 1 & 0 & 0 & \dots & 0 \\ l_{21} & 1 & 0 & \dots & 0 \\ l_{31} & l_{32} & 1 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ l_{n1} & l_{n2} & l_{n3} & \dots & 1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \dots \\ x_n \end{pmatrix} = \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ \dots \\ y_n \end{pmatrix}. \tag{13}$$

Next, to obtain a vector $\mathbf{B}$, use the backward substitution technique as follows:

$$\mathbf{UB} = \mathbf{D} \Rightarrow \begin{pmatrix} u_{11} & u_{12} & u_{13} & \dots & u_{1L} \\ 0 & u_{22} & u_{23} & \dots & u_{2L} \\ 0 & 0 & u_{33} & \dots & u_{3L} \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & u_{nL} \end{pmatrix} \begin{pmatrix} \alpha \\ \beta_1 \\ \beta_2 \\ \dots \\ \beta_L \end{pmatrix} = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \dots \\ x_n \end{pmatrix}. \tag{14}$$

Based on the matrix equation (13), we can calculate the parameter values $\alpha, \beta_1, \beta_2, ..., \beta_L$ [5].

2.6. Gauss-Seidel Numerical Method

Gauss-Seidel method is the most common iteration method used. Suppose the given n equation is given as (8), with the coefficient constant n to be determined by its value. If the diagonal elements of the matrix of the coefficient constant are all nonzero, then the first equation can be solved for α, the second for β_1, and so on to produce [3; 6]:

$$\alpha = \frac{y_1 - \beta_1 x_{12} - \beta_2 x_{13} - ... - \beta_L x_{1L}}{x_{11}}, \tag{15}$$

$$\beta_1 = \frac{y_2 - \alpha x_{21} - \beta_2 x_{23} - ... - \beta_L x_{2L}}{x_{22}}, \tag{16}$$

$$\beta_2 = \frac{y_3 - \alpha x_{31} - \beta_1 x_{32} - ... - \beta_L x_{3L}}{x_{33}}, \tag{17}$$

...

$$\beta_L = \frac{y_n - \alpha x_{n1} - \beta_1 x_{n2} - ... - \beta_{L-1} x_{nL-1}}{x_{nL}}, \tag{18}$$

Furthermore, the process of completion is carried out by using the initial value of the coefficient constant at equation (15), then for calculating equations (16) to (18). This same way is repeated until equations (16) to (18) are convergent. Convergence of estimator values of coefficient constants $\alpha, \beta_1, \beta_2, ..., \beta_L$, can be checked using criteria that:

$$|\in| = \left| \frac{\hat{\mathbf{B}}^{j} - \hat{\mathbf{B}}^{j-1}}{\hat{\mathbf{B}}^{j}} \right| 100\% < \boldsymbol{\varepsilon}, \tag{19}$$

where j and $j-1$ are iteration j and previous [2; 5].

Since the specified coefficient constants are related to the estimation of the regression equation parameter of the multiple index models, the parameter coefficient estimator obtained should test the significance and the normality assumption of the residual distribution of the multiple index model estimators. As a numerical illustration, the methods described above are used for the analysis of a stock traded on the Indonesian capital market.

3. Result and discussion

This section discusses the results and discussions that include: data analyzed, the formation of linear equations, parameter estimation using Gauss-Jordan method, parameter estimation using LU decomposition method, parameter estimation using Gauss-Seidel method, and model significance test.

3.1. Data analyzed

The data analyzed here is obtained through the website http://www.finance.go.id//, for the period from January 2, 2013 up to March 31, 2017. Data includes AALI, LSIP, ASII, BMRI, and UNTR, hereinafter symbols are given S_1 up to S_5. While the index factor data used include Composite Stock Price Index (IHSG), rupiah exchange rate against USD, EURO and YEN, then respectively given the symbol I_1 up to I_4.

Both the stock asset data, as well as the index factor data, are each determined by return using equation (1), and then used for the following analysis. From five available stocks S_1 up to S_5, only one stock will be selected to be analyzed. The selection is based on the largest ratio between the average and the variance.

Table 1. Ratio of mean to variance

Stocks	Mean	Variance	Ratio (Average/Variance)
S_1	0.01526431	0.000862431	17.69916666
S_2	0.00927532	0.000546127	16.98381201
S_3	0.00352611	0.000434172	8.121466259
S_4	0.031478906	0.000750158	**41.96303979**
S_5	0.02325163	0.000721524	32.22570605

Taking into account the value of ratio in Table 1, the stock with the largest ratio is BMRI of 41.96303979, so that the S_4 stock is selected to be analyzed.

3.2. Establishment of a system of linear equations

Referring equations (4) to (7), the system of equations of the multiple index models is as follows:

$$5.03663 = 160\alpha_{40} + 24.87205\beta_{41} + 0.37544\beta_{42} + 0.02859\beta_{43} + 2.06228\beta_{44}$$
$$0.79386 = 24.87205\alpha_{40} + 4.17432\beta_{41} + 0.05776\beta_{42} + 0.00690\beta_{43} + 0.32125\beta_{44}$$
$$0.01021 = 0.37544\alpha_{40} + 0.05776\beta_{41} + 0.00240\beta_{42} - 0.00029\beta_{43} + 0.00487\beta_{44}$$
$$0.00098 = 0.02859\alpha_{40} + 0.00690\beta_{41} - 0.00029\beta_{42} + 0.00818\beta_{43} - 0.00031\beta_{44}$$
$$0.06821 = 2.06228\alpha_{40} + 0.32125\beta_{41} + 0.00487\beta_{42} - 0.00031\beta_{43} + 0.07541\beta_{44}$$

In the matrix form:

$$\begin{pmatrix} 5.03663 \\ 0.79386 \\ 0.01021 \\ 0.00098 \\ 0.06821 \end{pmatrix} = \begin{pmatrix} 160.0000 & 24.87205 & 0.375440 & 0.028590 & 2.062280 \\ 24.87205 & 4.174320 & 0.057760 & 0.006900 & 0.321250 \\ 0.375440 & 0.057760 & 0.002400 & -0.0029 & 0.004870 \\ 0.028590 & 0.006900 & -0.00029 & 0.008180 & -0.00031 \\ 2.062280 & 0.321250 & 0.004870 & -0.00031 & 0.075410 \end{pmatrix} \begin{pmatrix} \alpha_{40} \\ \beta_{41} \\ \beta_{42} \\ \beta_{43} \\ \beta_{44} \end{pmatrix}. \tag{20}$$

3.3. Estimation of parameters using Gauss-Jordan method

In this sub-section the solution of the matrix equation (20) is performed using the Gauss-Jordan method, referring to (10). Through row and column operations, the result of Gauss-Jordan iteration is as follows:

$$\left(\begin{array}{ccccc|c} 160.0000 & 24.87205 & 0.375440 & 0.028590 & 2.062280 & 5.03663 \\ 24.87205 & 4.174320 & 0.057760 & 0.006900 & 0.321250 & 0.79386 \\ 0.375440 & 0.057760 & 0.002400 & -0.0029 & 0.004870 & 0.01021 \\ 0.028590 & 0.006900 & -0.00029 & 0.008180 & -0.00031 & 0.00098 \\ 2.062280 & 0.321250 & 0.004870 & -0.00031 & 0.075410 & 0.06821 \end{array}\right) \Rightarrow$$

$$\left(\begin{array}{ccccc|c} 1 & 0 & 0 & 0 & 0 & 0.0281 \\ 0 & 1 & 0 & 0 & 0 & 0.0334 \\ 0 & 0 & 1 & 0 & 0 & -1.1333 \\ 0 & 0 & 0 & 1 & 0 & -0.0442 \\ 0 & 0 & 0 & 0 & 1 & 0.0671 \end{array}\right) \Rightarrow \hat{\mathbf{B}}_{GJ} = \begin{pmatrix} \alpha_{40} \\ \beta_{41} \\ \beta_{42} \\ \beta_{43} \\ \beta_{44} \end{pmatrix} = \begin{pmatrix} 0.0281 \\ 0.0334 \\ -1.1333 \\ -0.0442 \\ 0.0671 \end{pmatrix}$$

then, referring to (11) we obtained vector parameter estimator as given as vector $\hat{\mathbf{B}}_{GJ}$.

3.4. Parameter estimation using LU decomposition method

In this sub-section the solution of the matrix equation (20) is performed using the LU decomposition method. Referring to equation (12), the parameter coefficient matrix,

$$\mathbf{A} = \begin{pmatrix} 160.0000 & 24.87205 & 0.375440 & 0.028590 & 2.062280 \\ 24.87205 & 4.174320 & 0.057760 & 0.006900 & 0.321250 \\ 0.375440 & 0.057760 & 0.002400 & -0.0029 & 0.004870 \\ 0.028590 & 0.006900 & -0.00029 & 0.008180 & -0.00031 \\ 2.062280 & 0.321250 & 0.004870 & -0.00031 & 0.075410 \end{pmatrix}$$

is described to be $\mathbf{L}$ and $\mathbf{U}$.

$$\mathbf{L} = \begin{pmatrix} 1.0000 & 0 & 0 & 0 & 0 \\ 0.1555 & 1.0000 & 0 & 0 & 0 \\ 0.0023 & -0.0020 & 1.0000 & 0 & 0 \\ 0.0002 & 0.0080 & -0.5124 & 1.0000 & 0 \\ 0.0129 & 0.0022 & -0.0109 & -0.4894 & 1.0000 \end{pmatrix}$$

$$\mathbf{U} = \begin{pmatrix} 160.0000 & 24.8721 & 0.3754 & 0.0286 & 2.0623 \\ 0 & 0.3080 & -0.0006 & 0.0025 & 0.0007 \\ 0 & 0 & -0.0030 & 0.0082 & -0.0007 \\ 0 & 0 & 0 & 0.0012 & -0.0003 \\ 0 & 0 & 0 & 0 & 0.0487 \end{pmatrix}$$

Furthermore, by referring to equations (13) and (14), the parameter coefficients obtained are given in vector form as follows:

$$\hat{\mathbf{B}}_{LU} = \begin{pmatrix} \alpha_{40} \\ \beta_{41} \\ \beta_{42} \\ \beta_{43} \\ \beta_{44} \end{pmatrix} = \begin{pmatrix} 0.0334 \\ 0.0387 \\ -3.5727 \\ -1.2948 \\ 0.0512 \end{pmatrix}$$

3.5. Estimation of parameters using Gauss-Seidel method

In this sub-section the solution of the matrix equation (20) is performed using the Gauss-Seidel method. Gauss-Seidel Iteration that is to determine the values of the parameter coefficient estimator $\alpha, \beta_1, \beta_2, ..., \beta_L$ is done by referring to equations (15) to (18). The initial guess value is set equal to zero, and recursively iterated until the parameter coefficient estimator is obtained $\alpha, \beta_1, \beta_2, ..., \beta_L$ approached its exact value.

The correction if the value of the parameter estimator $\alpha, \beta_1, \beta_2, ..., \beta_L$ reach the exact value is done using equation (19), where the value of ε =0.001. After the 15th iteration, the iteration process is terminated because it satisfies the equation (19), and the estimated value of the parameter coefficient as given as the parameter vector as follows:

$$\hat{\mathbf{B}}_{GS} = \begin{pmatrix} \alpha_{40} \\ \beta_{41} \\ \beta_{42} \\ \beta_{43} \\ \beta_{44} \end{pmatrix} = \begin{pmatrix} 0.02991 \\ 0.02365 \\ -1.16900 \\ -0.04378 \\ 0.06128 \end{pmatrix}$$

Furthermore, since the parameter coefficient estimators are related to the regression equation of multiple index models, the estimator values expressed in vectors. $\hat{\mathbf{B}}_{GJ}$, $\hat{\mathbf{B}}_{LU}$, dan $\hat{\mathbf{B}}_{GS}$, are need a significance test

3.6. Testing the significance of multiple index model parameters

In this sub-section test of significance of estimator values of parameter coefficients are given as $\hat{\mathbf{B}}_{GJ}$, $\hat{\mathbf{B}}_{LU}$, and $\hat{\mathbf{B}}_{GS}$ vectors, and. The significance test is performed by covering: individual significance testing of each parameter estimator, as well as simultaneous testing of all parameters, and testing the assumption of normality against the residuals of the regression equations of multiple index models.

In the individual test, the hypothesis used is H_0: $\hat{\alpha}_{40} =$ 0, with alternative H_1: $\hat{\alpha}_{40} \neq$ 0. The test has been done using Wald statistic or t statistic, at the level of significance c = 0.05. The testing criterion is reject H_0, if $\Pr ob < c$. In the sam way, the test has been applied to parameters estimators $\hat{\beta}_{41}, \hat{\beta}_{42}, \hat{\beta}_{43}$, dan $\hat{\beta}_{44}$. The individually test results are given in the Table 2.

Table 2. The result of individual significance test

	$\hat{\mathbf{B}}_{GJ}$			$\hat{\mathbf{B}}_{LU}$			$\hat{\mathbf{B}}_{GS}$		
Parameter	Nilai	Prob.	Significancy	Nilai	Prob.	Significancy	Nilai	Prob.	Significancy
α_{40}	0.0281	0.001	Significance	0.0334	0.002	Significance	0.0299	0.001	Significance
β_{41}	0.0334	0.005	Significance	0.0387	0.004	Significance	0.0237	0.006	Significance
β_{42}	-1.1333	0.002	Significance	-3.5727	0.009	Significance	-1.1690	0.008	Significance
β_{43}	-0.0442	0.008	Significance	-1.2948	0.009	Significance	-0.0438	0.008	Significance
β_{44}	0.0671	0.006	Significance	0.0512	0.007	Significance	0.0613	0.006	Significance

While the testing simultaneously has been done with hypothesis H_0: $\hat{\alpha}_{40} = \hat{\beta}_{41} = \hat{\beta}_{42} = \hat{\beta}_{43} = \hat{\beta}_{44} = 0$, with alternative H_1: $\exists\ \hat{\alpha}_{40} \neq \hat{\beta}_{41} \neq \hat{\beta}_{42} \neq \hat{\beta}_{43} \neq \hat{\beta}_{44} \neq 0$. The test has been done using Wald statistic or t statistic, at the level of significance $c = 0.05$. The testing criterion is reject H_0, if $\Pr ob < c$. The result of simultaneously test are given in Table 3.

Table 3. The result of the simultaneoulsy significance test

	$\hat{\mathbf{B}}_{GJ}$			$\hat{\mathbf{B}}_{LU}$			$\hat{\mathbf{B}}_{GS}$		
Statistic	Nilai	Prob.	Significancy	Nilai	Prob.	Significancy	Nilai	Prob.	Significancy
F_{Stat}	7.6121	0.005	Significance	9.2101	0.007	Significance	6.1351	0.008	Significance

To test the assumption of residual normality of multiple index model is done with the hypothesis: H_0: ε_4 is a normal distribution with zero approximation, with the alternative H_1: ε_4 is not normally distributed with a near-zero average. The test here is performed using Kolmogorov-Smirnov statistic, at a significance $c = 0.05$ level. The testing criterion is reject the hypothesis H_0, if $\Pr ob < c$. The results of these residual normality assumptions are given in Table 4.

Table 4. The result of residuals normality assumption

	$\hat{\mathbf{B}}_{GJ}$			$\hat{\mathbf{B}}_{LU}$			$\hat{\mathbf{B}}_{GS}$		
Residual	Mean	Variance	Distribution	Mean	Variance	Distribution	Mean	Variance	Distribution
ε_4	0.0007	0.068	Normal	0.0006	0.051	Normal	0.0008	0.063	Normal

After testing the parameter estimators $\hat{\alpha}_{40}, \hat{\beta}_{41}, \hat{\beta}_{42}, \hat{\beta}_{43}$, dan $\hat{\beta}_{44}$ which is all stated as significance, as well as the testing of normality residuals assumption ε_4 is normally distributed, therefore, the multiple index model estimator can be written as the following equation:

Gauss-Jordan method : $\hat{R}_{4t} = 0.0281 + 0.0334 I_{1t} - 1.1333 I_{2t} - 0.0442 I_{3t} + 0.0671 I_{4t}$

Dekomposisi LU method : $\hat{R}_{4t} = 0.0334 + 0.0387 I_{1t} - 3.5727 I_{2t} - 1.2948 I_{3t} + 0.0512 I_{4t}$

Gauss-Seidel method : $\hat{R}_{4t} = 0.0299 + 0.0237 I_{1t} - 1.1690 I_{2t} - 0.0438 I_{3t} + 0.0613 I_{4t}$

The estimators of the multiple index models can be used to predict stock returns S_4, if it is known the returns from certain I_1 up to I_4 indexes. As an illustration, when given the return index returns I_1 up to I_4, and the prediction of stock returns S_4, as given in Table 5.

Taking into account to the estimation values of the parameter coefficients summarized in Table 2, whether done using Gauss-Jordan methods, LU decomposition, and Gauss-Seidel, the results are indeed different. But the difference is not too big. These differences may occur because there is a rounding of numbers when the iteration process of each method. Similarly, if the predicted return

values based on parameter coefficients estimators made using Gauss-Jordan methods, LU decomposition, and Gauss-Seidel, the results are indeed different. But the difference is not too big. Therefore, Gauss-Jordan's methods, LU decomposition, and Gauss-Seidel, can be used as an alternative to estimate the coefficients of multiple index model parameters.

Table 5. Prediction of stock return S_4

I_1	I_2	I_3	I_4	$\hat{\mathbf{B}}_{GJ}$ Return $\hat{R}_{4t}$	$\hat{\mathbf{B}}_{LU}$ Return $\hat{R}_{4t}$	$\hat{\mathbf{B}}_{GS}$ Return $\hat{R}_{4t}$
0.250102	-0.002248	0.014623	0.025882	0.040092	0.033503	0.039402
0.172066	0.004834	-0.004099	0.004862	0.028877	0.028346	0.028805
0.167814	0.004855	-0.011209	0.020152	0.030051	0.038095	0.029928
0.082248	0.004744	-0.006184	0.017892	0.026945	0.028557	0.027671
0.049927	0.003613	0.000610	0.029697	0.027639	0.023155	0.028654

4. Conclusion

In this paper we have estimated the parameters of multiple index models on stock S_4 (BMRI) which influenced by index factor including: Composite Stock Price Index (IHSG), rupiah exchange rate against USD, EURO and YEN. Parameter estimation by using Gauss-Jordan methods, LU decomposition, and Gauss-Seidel, yielded different parameter estimators, but the difference was not significant. Estimators of the resulting parameters need to be tested for significance. Based on the test of model significance, at a significance level of 5%, the model parameters estimated using Gauss-Jordan methods, LU decomposition, and Gauss-Seidel, are all significant. The result of stock return prediction S_4 is done based on parameter estimators from Gauss-Jordan method, LU decomposition, and Gauss-Seidel, the value also varies. However, the difference is also not too large.

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Analysis of quality of service (QoS) traffic network of Pakuan University website with queue system model

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Abstract. Information technology services and communications especially in the field of computer networks play a very important role in supporting performance in the exchange of data communication. Quality of Service (QoS) is a method of measurement to determine how well the services of network traffic. The intensity of the use of services in a computer network can be measured based on data traffic in the form of data packets, bandwidth, and internet protocol. QoS analysis of website network traffic using queuing system in determining analysis of website performance of Pakuan University (www.unpak.ac.id). In this research will be observed network traffic and analyse data packet inter-arrival and service time using R Consule.

1. Introduction

The rapidly growing use of the internet today has led to a demand for quality of services (QoS) to be improved. Not enough if only able to connect to the internet, connectivity performance becomes an important factor in the use of the internet today. In improving the performance of the connectivity, which is to ensure that the data traffic on the network running smoothly. One way to do this is to debug the network and observe the data traffic. Components in network traffic such as bandwidth, protocol, data packets, etc. can be used as a benchmark to determine whether or not a network [1]. The traffic data of Pakuan University website (www.unpak.ac.id) captured via online the whole package and the best way to debug the network is by tracking the package. R Console Application will try to capture packets through the network then display the data packet as much detail as possible so that can know the data distribution. Therefore through queue analysis to determine QoS Network Traffic is generated the right information and correct.

2. Research Steps

The queue process is a process associated with a customer on a service facility then waits in a row or queue because the waiter is being and finally. While the queue system is defined as the set of customers, servants and a rule governing the arrival of customers and processing the problem [2]. The queue analysis process is done using WebLog Expert and R software based on data distribution and distribution of data packets. Weblog Expert is one of the network analysis tools used for analysis,

observing data from a network that is in operation or from data on the disk, and directly view and sort the captured data. Brief and detailed information for each package, including full headers and portions of data.

Measurement process to determine how well the service of traffic network traffic one of them using QoS. The QoS service provides bandwidth, overcoming jitter and delay. QoS parameters are latency, jitter, packet loss, throughput, MOS, echo cancellation and PDD. QoS is determined by the quality of the network used.

In performing data traffic analysis there are parameters that can be measured [3], including:

Average number of packets in the system:

$$E(L) = \sum_{n=0}^{\infty} np_n = \frac{\rho}{1-\rho}$$

Average time required by packets in the system:

$$E(S) = \frac{1/\mu}{1-\rho}$$

Number of packets in the queue:

$$E(L^q) = E(L) - \rho = \frac{\rho^2}{1-\rho}$$

Average waiting time:

$$E(W) = E(S) - 1/\mu = \frac{\rho/\mu}{1-\rho}$$

In little's law the relationship between E (L), E (S), and λ is shown as follows: E(L) = λE(S), meaning the capacity of the system is sufficient, or the number of customers in the system does not grow unlimited.

3. Results and discussion

Acquisition of traffic data then it is necessary to read the mean data (λ) time between arrival and miyu (μ) service time derived from data obtained from the website server of Pakuan University (www.unpak.ac.id) which contains the time data between arrival, and time of service shown in Table 1.

Table 1. Data network traffic website university pakuan (June 2017)

Interrarival	Time Lambda (λ)	Time Service (μ)
1	49.13	91.30
2	48.38	87.72
3	47.53	82.67
4	47.8	82.38
5	47.62	81.98
6	45.87	83.02

7	45.42	100.37
8	51.18	122.12
9	53.18	143.93
10	53.28	148.73
11	55.58	148.52
12	62.47	163.45
13	63.97	126.67
14	62.15	137.15
15	60.78	131.88
16	62.35	140.65
17	60.2	123.82
18	48.12	112.78
19	47.58	104.78
20	46.82	102.83
21	47.63	109.78
22	48.03	104.50
23	47.53	93.73
24	48.13	95.67

The display of the graph Mean (λ) Inter-arrival time in R language is shown in Figure 1.

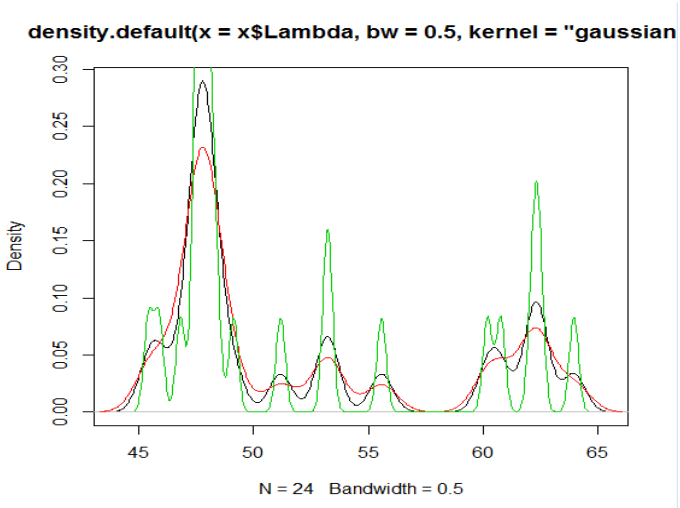

Figure 1. Histogram mean (λ) of inter arrival time

Based on Figure 1, the density function graph compares the bandwidths of 0.5, 0.2 and 0.7. This function is used to refine the graph data more accurately, the graph can be seen with the bandwidth 0.7 (red graphics), bandwidth 0.5 (black graphics), and bandwidth 0.2 (green color chart). From the graph it can be seen that the graph with a bandwidth of 0.7 has a lower accuracy compared with graphics with other bandwidth but has a more smooth graphic form, whereas graphs with bandwidth 0.2 have better accuracy than other bandwidths but have graphic shapes that tend to be rougher than bandwidths of 0.5 and 0.7.

The display the Mean Service graph (μ) Service Time in R language is shown in Figure 2.

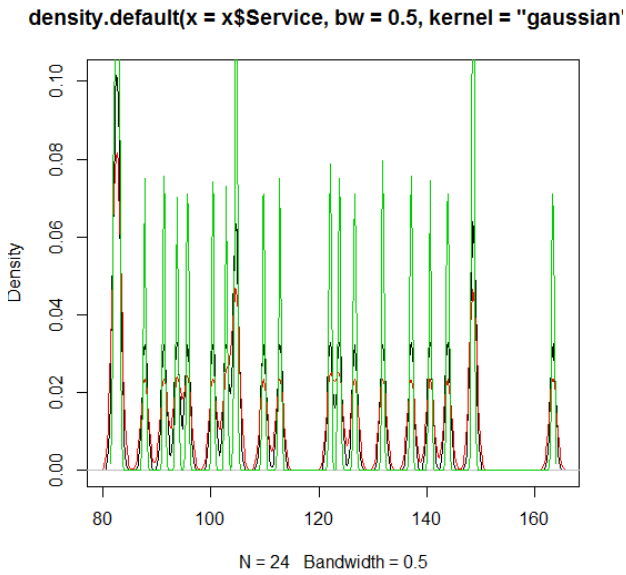

Figure 2. Mean Concentration Functions Mean (μ) Service Time

Network traffic analysis, among others, to determine the Server utility (ρ), Number of packets in the system (E (L)), sojourn time (E (S)), Waiting Time (E (W)), Number of packets in queue ($E(L^q)$).

a. Service utility (Rho)

Rho is the value of server utility [4], rho value is formulated as follows:

$$\rho = \lambda / \mu < 1$$

where ;
λ = 52.11 package/minute
μ = 113.35 package/minute
ρ = 52.11 / 113.355 = 0.46

Because the value of ρ is far from 1 then it can be analyzed that the network utility is running well, in other words all incoming packets can be served in the server, so the server does not experience the condition of the bottleneck.

b. Number of packets in system E (L)

E (L) is a calculation to analyze the number of packets in the system [4] and formulated as follows:

$$E(L) = \rho / (1 - \rho)$$

Where ρ = 0.46
E(L) = 0.46 / (1 – 0.46) = 0.851 package.

From the calculation of E (L) it can be seen that the average number of packets in 1 minute in the system is 0.851.

c. Sojourn Time (E (S))

E (S) is a time to analyze how long the packet gets service in system [5] and formulated as follows:

$$E(S) = (1/\mu)/(1-\rho)$$

E(S) = (1/133.355)/(1- 0.48) = 0.016 minute.

The system in the network can serve the average of each packet that comes in for about 0.016. The higher the value of soujern time then the network has a low utility.

d. Waiting Time (E (W))

E (W) is the time to analyze how much time the packet is waiting to get the service in system [5] and formulated as follows:

$$E(L^q) = E(L) - \rho$$

$E(L^q)$ = 0.851 – 0.46 = 0.39 package.

From the calculation of $E(L^q)$ can be seen that the average number of packets in 1 minute in the queue is 0.39 package.

4. Conclusions

1. The utility value of the service is about 0.46, this indicates the service unit on the Pakuan University website in general access is in the medium category
2. The result of network performance measurement on data traffic of website of Pakuan University is good, it can be seen from the distribution of data and queue analysis which shows that the number of packets in the system, the number of packets in the queue, the distribution of waiting time and the packet time in the system with the average either average or normal.

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Cost control of drugs in primary healthcare facilities: from health information to quality control

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Abstract. One of the functions of primary care health service is to be gate keepers of fund in national health security system. In this research we will use data from health information management system of Atma Jaya primary care clinics at Penjaringan to acquire statistical descriptive parameters such as drugs costs average, standard deviation, maximum and minimum values. We choose to study drugs costs of upper respiratory tract infections (URTI) which are the most frequently diagnosis found in primary care. We also construct control chart of drugs costs of every observation selected during the study. We found that the administration URTI's drugs in this study are a controlled process.

Keywords: Health Information, Individual Variable Control Chart, Moving Range

1. Introduction

One of the benefits of strengthening primary healthcare is to reduce health cost by not reducing the quality of the healthcare[1]. In other words, good quality of primary healthcare will be more efficient to the management service.Indonesia has entered the National Health Insurance era where the primary healthcare facilities that have been working with social security management body (BPJS) will obtain capitation data to care for the health of the society.

The national health insurance system has shifted the paradigm of health care from treating the sick to prevent people from becoming sick. This will cause the funds which are used for health prevention and health promotion become more dominant than the treatment. The impact of the paradigm shift is the control of the drug cost.

Health costs need to be prevented from rising (WHO 2000). Health services need to be cost-effective in the sense that they can reduce the costs of unnecessary action or treatment without sacrificing quality. One of the challenges faced in providing health services to the public is the rapid increase in costs due to the growing number of medical specialists, overproduction of hospital beds, insurance schemes with fee-for-service reimbursements that stimulate the increasing demand for expensive diagnostic tests and unnecessary treatment according to scientific evidence (Starfield 2000). High-quality services need to be provided at the lowest possible cost, this is one of the dimensions of health-care quality which is called efficiency (Woodward CA 2000) [2].

Meanwhile, the usage of health information from the management system has assisted medical staff in making clinical decisions [3, 4]. These facilities often contain administrative modules that can

record medications which are prescribed by medical staff for a particular diagnosis. This development in information technology can help the process of quality control (cost) of medicines prescribed by medical personnel.

This study intends to obtain descriptive statistical parameters such as average, standard deviation, maximum and minimum value, and normality of upper respiratory tract infection drug price data and display the price of each observed drug in the control chart by using health information system.

This study intends to explore the possibility of applying the process of quality control of statistics in drug cost control by utilizing clinical management information system facilities. Problems in this research are:

1. What is the average and standard deviation of the cost of medicine prescribed by the doctor for the most commonly found disease of upper respiratory tract infection (URTI)?
2. Is the cost of prescribed ARD drugs a controlled process?

The purpose of this research are:

1. Obtain statistical descriptive parameters such as average, standard deviation, maximum and minimum value, normality of URTI drug price data.
2. Obtain a control chart showing the medication price of each observation and recognize if the observation value is out of control.

2. Methodology

The data is taken from the management information system of Atma Jaya Institute for Networking Development of Primary Care Clinics (Sistem Informasi Manajemen Lembaga Pengembangan Jejaring Klinik Pratama Atma Jaya/SIM LPJKP Atma Jaya) which is a supporting service facility in every clinic of Atma Jaya Pratama Clinic (Klinik Pratama Atma Jaya/KPAJ). The data collected were patient visit data at Atma Jaya Pratama Clinic (KPAJ) from April 3, 2017 to August 10, 2017 and were diagnosed as a single categorized upper respiratory ract infection (URTI), such as acute pharyngitis, acute tonsillofaringitis, acute tonsillitis, common cold or acute upper respiratory tract infections.

SIM LPJKP consists of several modules. In this research, we use pharmaceutical module and medical record module. The medical record module is used to obtain patient identity data (medical record number, visit number, name, gender, age, address, diagnosis). The pharmacy module is used to obtain data of the total price of drugs paid by the patient while visiting and prescribed medications.

The data is in Microsoft Excel form of 3 electronic reports, i.e., patient identity and diagnosis, patient identity and drug prices, and the name of the drug for each number of patient visits. The first two sets of data sets incorporate frame data to obtain diagnostic information and medicinal prices for each drug and then selected only those diagnosed with a single category of URTI. For drug type data sets, drug selection was screened based on the patient's visit number of the previous frame data.

Furthermore, descriptive statistical analysis of total drug price with parameters that are calculated as the average value, standard deviation, maximum value and minimum value. We also test the data normality with the Shapiro-wilk test and evaluate the plot qq diagram. It also presents the relative frequency of the most commonly prescribed medication.

The next step is to create a control chart to assess whether URTI drug prescribing is a controlled process, then we calculate upper control limits and lower control limits. The type of graph created is an individual control chart. Finally, we inspect whether there are values that violate the control limit and we analyse it.

Management and data selection as well as descriptive statistical analysis were performed using statistical software R version 3.1.1. While the statistical quality control study was conducted by using SPSS software version 21.

3. Results

From April 3, 2017 to August 10, 2017, there were 188 visits of patients who were diagnosed according to ICD-X classification in KPAJ Penjaringan. Screening was then conducted to select only single diagnosis of URTI which were only 33 visits of the 188 visits. During that period, there were 318 prescribed drugs, but only 93 drugs were prescribed for those 33 visits. Parameters of URTI drug price statistics in KPAJ Penjaringan in the study related periods can be seen in Table 1.

From the descriptive statistical analysis to URTI drug prices, it is seen that medication cost of ARI is close to Rp. 30,000 but the standard deviation is quite large close to the average rating. This becomes a challenge of quality control. The maximum value of URTI drug price is approximately five times the average value so it can be assessed as an unusual surge.

Table 1. Descriptive statistics of drug price of ISPA KPAJ Penjaringan
April 3, 2017 – August 10, 2017

Parameter	Value (n = 33)
Mean	Rp. 29.090,91
Standard deviation	Rp. 24.350,35
Maximum value	Rp. 152.000
Minimum value	Rp. 4.200

Although the middle band of boxplot (on the left of Figure 1) slightly shifts upward, the shape of the box and stem are relatively symmetrical. And unless the extreme point value is on the upper right corner, the other point values on the qq plot (on the right of Figure 1) approach the line. From both assessment of boxplot and qq plot, it is seen that the distribution of URTI drug price in KPAJ Penjaringan is normal. This is also confirmed by the Shapiro-Wilk normality test which gives a significant p = 1,038.10-8 (p <0,05) value.

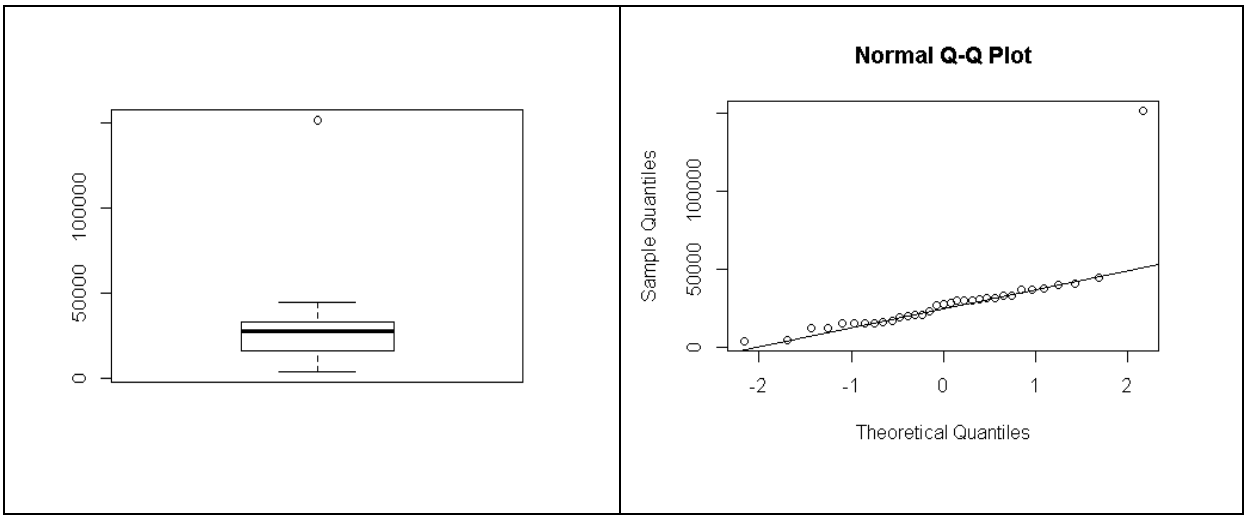

Figure 1. Distribution of URTI drug price from boxplot and qq plot

3.1 Understanding Quality

The definition of quality according to an expert of quality Armand V. Feigenbaum is as follows: "The quality of products and services is a whole combination of properties of products or services of marketing, engineering, manufacturing, and maintenance where products or services in use will meet with customer expectations "[5].

Understanding quality according to Imbalo S. Pohan (2004) is as follows: "Quality of goods or services is the overall characteristics of goods or services that indicate its ability to satisfy the needs of consumers, both in the form of expressed needs and implied needs" .[5]

3.2 Understanding the Quality of Health Services

Understanding quality Health care is a bit complicated to define because healthcare is a unique commodity or service. Everyone will assess the quality of health services based on different standards or criteria. This is because the quality of health care is closely related to the subject matter of the interested person, either the patient / consumer, the provider of the health service (provider), the funder, the community, or the owner of the health care facility.

Therefore, the definition of quality needs to be viewed from various viewpoints of interested parties such as served communities, service providers and funders.

3.3 Health Service Quality Perspective

Patient / community perspective: Patient / community sees quality healthcare as a health service that can meet their perceived needs and is organized in a polite and courteous, timely, responsive manner and able to cure their complaints and prevent the development or spread of disease.

Healthcare Perspective Perspectives: The healthcare provider will view quality health services based on the availability of equipment, work procedures or protocols, the freedom of the profession in performing health services in accordance with the latest technology, and how the outcomes or outcomes of the health services are.

Perspectives of funders: Funders perceive quality healthcare as an efficient and effective health service until the cost of health services can be efficient.

Perspective of owners of health-care facilities: The owners of health care facilities assess quality health services as income-generating health services that cover operational and maintenance costs, but with tariffs that are still affordable to patients/communities, at the cost level when there are no patient complaints and society.

3.4 Health Service Quality Measurements

The quality of health care is measured by comparing it with predetermined health care standards. In the health insurance system, the role of family doctor is vital as a gate keeper to provide efficient yet effective management and reduce unnecessary management. In the context of this study the aspect of quality highlighted is the efficiency of drug costs. The measure used is the total cost of medication the patient pays on each visit.

To assess that drug prices are efficient it is necessary to see whether the total fluctuations in drug prices prescribed are fluctuated within reasonable limits and there is no very high or very cheap drug prices. A suitable method to meet this need is the control chart method. A suitable method to meet this need is the control chart method.

The use of statistical quality control approaches has been used in industries including service industries such as healthcare. In the use of the approach, the role of the control chart is crucial in monitoring the current production process. Examples of the use of control charts in the primary health care process can be seen in table 1 (source: Pohan, 2004) [5]. In the context of this research, the production process in question is the preparation of prescriptions for related diagnoses.

3.5 Control of Drug Prices

To determine whether drug prescriptions for URTI diagnosis at KPAJ Penjaringan are within controlled price limits, then prescribed medicinal prices need to be displayed in a control chart. In statistical quality control, from several types of control charts, a suitable control chart for this case is a diagram of the control of individual variables.

Table 2. Some examples of the use of control charts in the health care process at the primary level[5]

Type	Application
Xbar – R	Lenght time to get medical record
P	The proportion of births handled by indigineous medical practitioner
Np	Number of prescriptions that contain errors
C	Number of patient complaints per day
U	The number of prescription errors in each observation (the number of samples per observation is not the same

In the diagram of the control of individual variables of this study, the variables measured are the URTI drug price and the sample group that is taken only 1 (n = 1), ie from patients who visited KPAJ Penjaringan. Then the important parameters that need to be calculated are the average value of obeservation and the average of roaming. The roaming averages are calculated using the formula:

$$R_i = |x_i - x_{i-1}|$$

Note: x_i is the value of observation to i.

After knowing the average value of roaming ($\bar{R}$), upper control limit (UCL) and lower control limit (LCL) could be calculated. These latter two parameters coupled with the average observation are important measures in the control chart. All those three variables are stated as follows:

$$UCL = \bar{x} + 3\frac{\bar{R}}{d_2}$$

$$midline = \bar{x}$$

$$LCL = \bar{x} - 3\frac{\bar{R}}{d_2}$$

Note: d_2 is taken at 1,128 so Upper and Lower Control Limit of $\bar{x} \pm 2{,}66\ \bar{R}$.

From the results of this study, the average value of observation is the average value of medicinal value of the value of 29090.91 and the average roaming of 17659.38 so obtained UCL = 76064.84 and LCL = -17883.02. Because the last negative value that is taken for LCL2 = 0.

Figure 2 shows the price control diagram of URTI drugs in KPAJ Penjaringan for 33 observations of patient visits. Figure 2 shows a price spike in the 18th observation. This is the time when the value of price observation reaches the maximum value of Rp. 152,000. Next look for the cause of the price spike. Of the prescribed drugs, it is found that on the 18th observation, the doctor prescribed the inhaled bronchodilator drug for asthma that have quite expensive price of Rp. 130,000. When this drug is issued then we get the price of the URTI drug as much as Rp. 22,000 which are still within the limits of control.

After correction of URTI drug price on the 18th observation, the resulting control chart can be seen in Figure 2. It appears that the price of URTI drug in KPAJ Penjaringan is within the control limits. This shows that the prescription of URTI drug in KPAJ Penjaringan is a controlled process from the point of cost control.

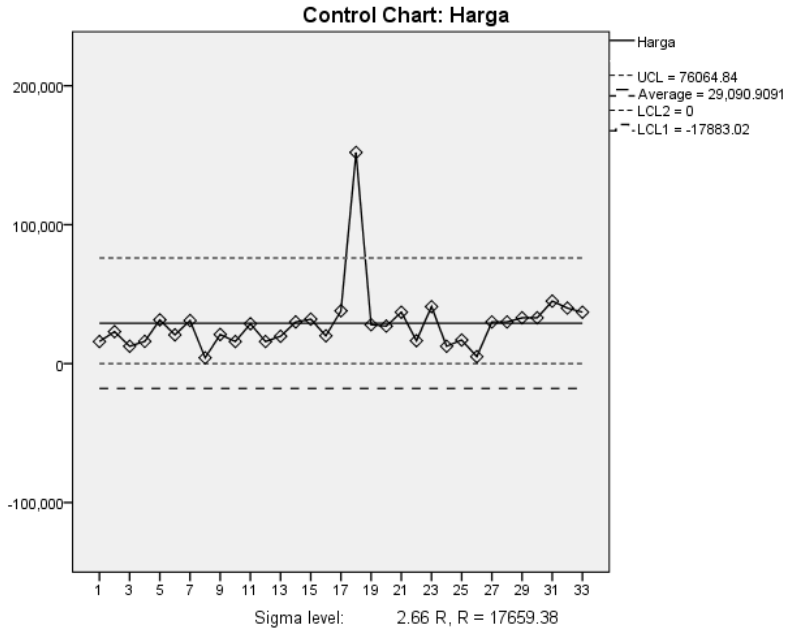

Figure 2. Control chart X bar individual of URTI drug price at KPAJ Penjaringan from April 3, 2017 until August 10, 2017

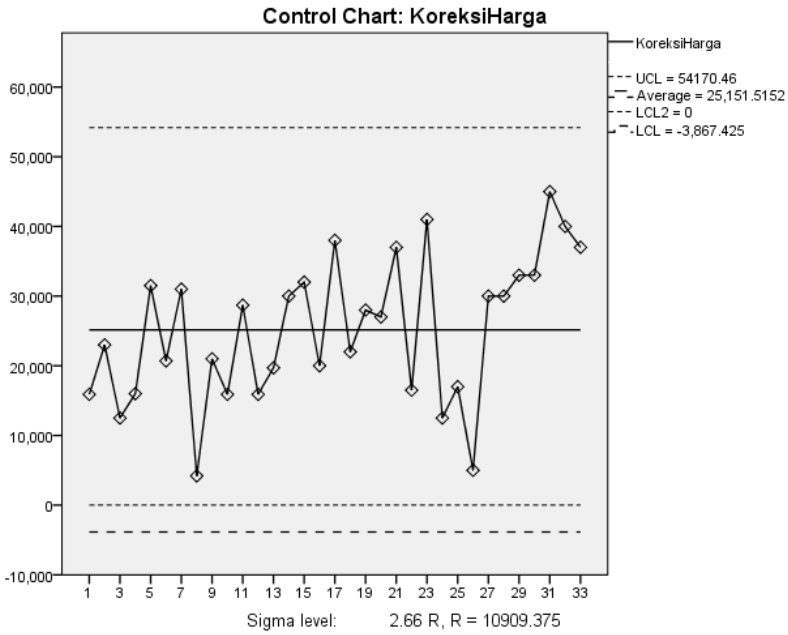

Figure 3. Control chart X bar individual of URTI drug price in Fig. 2 that has been corrected.

4. Conclusions

The usage of clinical management information system of Atma Jaya Primary Care Clinics (SIM KPAJ) is proved to be very helpful in determining the median price of a drug for a particular disease and drug price control. However, the management information system functions primarily provide the

data warehouse needed for those needs. We still needed a rough data processing efforts using statistical software to obtain information useful for decision making.

In this study, the median price of the drug for upper respiratory tract infections is Rp. 25.152 (after correction). The control charts used for drug cost monitoring are individual variable control charts. In this study, it is found that the total price of ARD drug in KPAJ Penjaringan is within the limits of control so prescribing drugs in the clinic is a controlled process.

This study can be expanded to obtain the median drug cost of drug prices and control the price of drugs for the diagnosis of other diseases. The results of this study are very useful for primary care health providers to improve treatment efficiency. The management team of the clinis need to establish each period of how long the control chart is made and how the quality improvement mechanism if there is a deviation of drug prices.

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Implementation of fuzzy multiple attribute decision making (FMADM) model using analytic hierarchy process (AHP) method and ELECTRE for prioritizing of school management standards

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Abstract. In Indonesia, regular checks of school management was conducted each year, for elementary school, junior high school and senior high school. Organizing school management assessments activities especially in the management system is necessary to noticed because of several criteria must be fulfilled quite a lot. At this time, the school management was still done manually. In line with developments and utilization of information and communication technology in organizing the school assessments activities, it can create excellent services for national education especially in school management systems. So it can help in evaluating and analyzing the initial process of the School Management Priority system intended to determine priority assessment needs. The study conducted using data that has been collected through literature review and some experts in School Management. Application of School Management Standard Priorities as a result of this research, which is applied using Fuzzy Multiple Attribute Decision Making Model by Analytic Hierarchy Process (AHP) and the ELECTRE method based on the parameters which has been determined in each priority calculation, which are 8 standards of school management.

Keywords: School Management, Analytic Hierarchy Process (AHP), ELECTRE

1. Introduction

Implementation of school assessments activities, especially on the management system should be considered several criteria that must be fulfilled, such as objective criteria, this criteria discussed some aspects related to the feasibility of being examined clearly and correctly to obtain information about the existence. The criteria on this assessment is not only limited to certain aspects but rather includes a wide range of educational components that are comprehensive. The assessment includes other criteria such as fair, transparent, and accountable. The criteria must be fulfilled in order to make the assessment process going well. The ongoing assessment process was still done manually through the survey, observation or

interview to obtain information related to the school. The number of schools that apply for the assessment in each year has increased so that the criteria indicator that must be fulfilled became quite a lot, it is necessary to build an assessment application integrated with decision support system that will assist the assessment process itself [4,6].

The model used in this decision support system was Fuzzy Multiple Attribute Decision Making (FMADM) and supported by Analytic Hierarchy Process (AHP) and ELECTRE method [7]. These method chosen because it determines the weighted value for each attribute by the ranking process. Benefits to be gained from this application was the assessment would be more accurate because it used the methods and models that have been determined and facilitate the implementation of assessment, more efficiency and effective in the process. The use of this ranking method, was expected to be more precise because it was based on predetermined criteria and weights that will get more accurate results.

2. Research Methods

The method used in this research was System Development Life Cycle (SDLC) approach. System development life cycle is a series of activities implemented by user of information system to develop and implement information system [1,3]. The stages of SDLC are:
1. Planning
2. Analysis
3. Design
4. Implementation
5. Validation
6. Usage

3. Result and Discussion

3.1. Program Implementation

Implementation of the assessment program using PHP programming language with the application editor of notepad++. It is supported by laravel framework and CSS design using twin bootstrap which each other integrated with the requirement as desired. The implementation process as presented in the form of images as shown in Figure 1 and Figure 2.

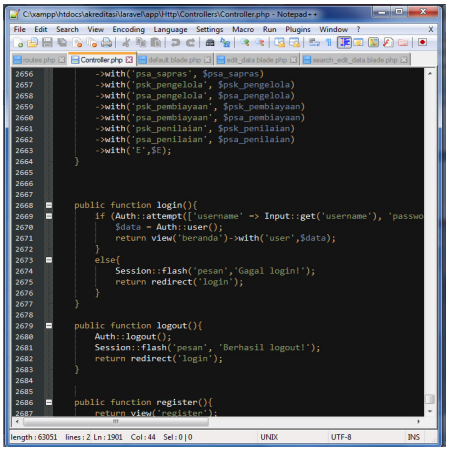

Figure 1. Implementation in notepad++ application editor

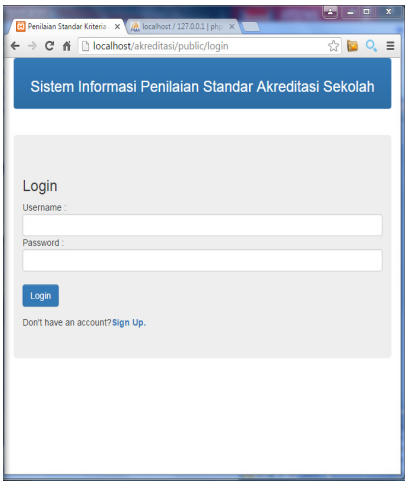

Figure 2. Login program

3.2. AHP Method

Analytic Hierarchy Process Method (AHP) can be completed with several steps, namely:

1. Incorporate a Comparison Matrix for each Criteria
2. Weight the Criteria and Priority Score
3. Calculation of Criteria Matrix
4. Criteria of Consistency Ratio

3.3. ELECTRE Method

Elimination Et Chix the Traduisant La Realite (ELECTRE) is one of the multi-criteria decision-making methods based on outrunning concepts by comparing alternative pairs based on each appropriate criteria [2,5]. The steps taken in solving the problem using the ELECTRE method, namely:

1. Normalization of Decision Matrix
2. A normalized matrix
3. Determining the set of concordance and discordance index.
4. Calculating concordance and discordance matrices.
5. Determining Aggregate dominance matrix

3.4. Validation

The validation on priority standard rating system will be done by calculating standard data of criteria. Criteria in general using either AHP or ELECTRE method. Manual AHP and ELECTRE Calculation Result as shown in Table 1 and Table 2.

The result calculations that have been done either manually or by the system, yield a value of 0.3243 by AHP and a value of 0.324324 yield by the system. The validation of AHP and ELECTRE by manual tends to be the same but there was only slight difference due to the number of digits behind the coma between the system and the results of manual calculations. But does not change significantly to the value itself. After various test was done both manually and by a system, it turns out that the method used was produce different final values, as contained in this case study. Assessment standards using AHP method produced the final value in the form of priorities, whereas using ELECTRE was compare each criterion to produce some criteria that should be prioritized.

Table 1. Results Calculation Standard Criteria Using AHP

No	Criteria Priority	Good Priority	Fair Alternative	Less Alternative
1	0,309722	KTSP	Curriculum	KKM
2	0,192492	RPP	Learning Process	Evaluation Result
3	0,132835	Group Learning	School Activity	Out of School Activity
4	0,113146	Certificate	Statement Letter	Lecturer Statement Letter
5	0,082383	Large area	Rooms	Text Book
6	0,069943	Socialization	Vision and Mission	Work Plan
7	0,047199	Salary	Cross Subsidies	Support costs
8	0,052281	SKHUN	Receipt of certificate	Admission of new students

Table 2. Results Calculation Standard Criteria Using ELECTRE

1	Content Standards	-	0	0	0	0	0	0	0	0
2	Competency standards	0	-	0	0	0	0	0	0	0
3	Graduate competence standard	0	0	-	0	0	0	0	0	0
4	Educators and staf standard	1	0	0	-	0	0	0	1	2
5	Standard of facilities and infrastructure	0	0	0	0	-	1	0	0	1
6	Standard of management	0	0	0	0	0	-	0	0	0
7	Standar of Financing	0	0	0	0	0	0	-	0	0
8	Standard of educator assessment	0	0	0	0	0	0	0	-	0

4. Conclusion

The study concluded that the result of assessment standard using the AHP and ELECTRE method produced different Priority Standard output from each other. The system calculation produced a validity value of 95% to 100% against manual calculations. Assessment of Standard Value using AHP was done through 8 stages of standard criterion of priority criteria namely Content Standard, Competency Standard, Graduate Competency Standard, Educator and Staff Standard, Standard Infrastructure and Facilities, Management Standard, Financing Standard, and Educator Assessment Standard. Each Standard has its own Sub-criteria. Assessment of the Standard Score of ELECTRE used only 8 Criteria Standards was proven to be applicable for determining the value of the Priority Standard in Secondary Schools using either the AHP method or the ELECTRE method. Application of AHP and ELECTRE Methods for Assessment Analysis of Criteria Standard has been implemented in the Priority Assessment System.

The AHP and ELECTRE method used in this study using a combination of ordinal and numerical scales of each other using comparison percentages. It was expected that the methods used can be reviewed and suggested to be developed on the basis of Android and Desktop application.

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The integrated academic information system support for Education 3.0 in higher education institution: students' perspective

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Abstract. Many higher education institutions (HEIs) have been implementing Education 3.0. The implementation of Education 3.0 has been directing the institution toward better educational experience. Somehow, the implementation of Education 3.0 also caused some problems. Previous research has found mobility access problem experienced by the students. Therefore, this research explores deeper from the students, and suggested the solution from students' perspective and combined with information technology capabilities owned by the HEIs. The research used a case study as the method and conducted a qualitative research with a semi-structured interview. The interview analysis has found that the mobility access problem is caused by the application used by the HEIs did not support the mobile platform yet. The most often used applications are e-learning and academic information system (AIS). To overcome the problems, both applications must support the mobile platform. This research suggests enhancing both applications by providing better mobility access.

1. Introduction

Education 3.0 becomes popular among educational institutions, especially in higher education institutions (HEIs) [1, 2]. Most of them implemented the characteristics of Education 3.0 gradually based on their needs and capability. Most of them started with the lecturing characteristic. The lecturing characteristic in Education 3.0 more connected with technology. They implemented the lecturing characteristic by combining the traditional learning (face-to-face) and current technology. They use e-learning technology to produce and share knowledge. Mostly, HEIs implemented e-learning using a ready-to-use application (e.g. Moodle LMS, Edmodo, etc.) [3]. Some of the HEIs also develop their own e-learning application. The whole characteristics of Education 3.0 can see in Table 1.

Most of the students already have smartphone or tablet as their mobile device [5]. They often access the e-learning and AIS through their mobile device. Furthermore, [6] found accessibility problems when the web based applications did not support mobile platform. More specific, [7] found the loss of function and information when students access the applications through the mobile device. This research will explore deeper from the students and aims to find the solution from the students' perspective, combined with information technology capabilities owned by the HEI.

Table 1. The characteristics of Education 3.0 [4].

	Education 3.0
Meaning is …	Socially constructed and contextually reinvented knowledge
Technology is …	Everywhere (digital natives in a digital universe) for ubiquitous knowledge construction and transmission
Lecturing is done …	Lecturer to student, student to student, student to lecturer, people-technology-people (co-construction of knowledge)
Institutions are located …	Everywhere in the "creative society" (thoroughly infused into society: cafes, bowling alleys, bars)
Parents view education institutions as …	Places for students to create knowledge, and for which parents may provide domestic, volunteer, civic, and fiscal forms of support
Lecturers are …	Everybody, everywhere, backed up by wireless devices designed to provide information raw material for knowledge production
Hardware and software in schools …	Are available at low cost and are used purposively, for the selective production of knowledge
Industry views graduate as …	As knowledge-producing co-workers and entrepreneurs who can support the development of focused knowledge construction

2. Literature review

2.1. Academic information system

Academic information system (AIS) is an information system in the educational institution for helping the academic processes. Most of AIS developed in web-based application and connected to the internet. Most of AIS used only for the administrative purpose and developed for desktop environment [8].

According to [9], AIS refer to a set of systems and activities used to organize, to process, and to use information as a source within an HEI. The output of the information resulted from this system will deliver information to the leaders or the decision makers that can be categorized in different utilization and different purposes. AIS in this study not only used for the administrative purpose but also used by leaders of the institution to help them make a decision for institution development. The AIS used by students, lecturer, administration staff and executive.

An academic information system has to cater to the needs of students, faculty and administrative staff [10]. The study compares the AIS in three different HEIs. The study found that AIS mostly have same procedure and function. Hence, they also suggested AIS must be flexible to development. This helps the system to remain up to date, and provides better functionality with changing technology and needs of the users.

From the facts above, current use of AIS in higher education institutions mostly for administrative processes and developed for the desktop environment. AIS must be dynamically changing based on users' needs.

2.2. Education 3.0

Education is a complex process. In education, there are five elements: teacher, learner, subject matter, context, and evaluation. Those elements must be integrated constructively to effect high levels of meaningful learning. The meaningful learning will lead education to empowerment for commitment and responsibility [11]. It demands the very best collaboration from parents, teachers, students, and administrators and technology can help the collaboration.

According to [12], education has always been awash with new ideas about learning and teaching. Teachers and administrators are regularly bombarded with suggestions for reform. They are asked to

use new curricula, new teaching strategies, and new assessments. In the digital age, all those processes can be supported by technology [13].

To achieve collaboration in education, the use of technology becomes compulsory. When technology is implemented and integrated appropriately, they have an opportunity to learn about that technology by using it as a part of their learning. The education for empowerment by [11] and education in the digital age by [13] are played in a new approach to education. This new approach called Education 3.0. Education 3.0 means a rich, collaborative learning experience focused on authentic, project-based learning. Students and teachers should have access to materials, formative assessments and each other "anytime and anywhere," and be able to draw in experts from around their system or around the world at the touch of a button [14].

According to [15], Education 3.0 is characterized by rich, cross-institutional, cross-cultural educational opportunities within which the learners themselves play a key role as creators of knowledge artifacts that are shared, and where social networking and social benefits outside the immediate scope of activity play a strong role. The distinction between artifacts, people and process become blurred, as do distinctions of space and time.

In Education 3.0, students are empowered to produce, not only to consume the knowledge [16]. As in Figure 1, Education 3.0 is made possible by Education 2.0, which is internet-enabled learning, and by centuries of experience with memorization in Education 1.0. Education 2.0 begins the transition to a new educational paradigm based on knowledge production and innovation production, the appropriate engines for viable 21st-century economies. Education 3.0 is qualitatively different incarnations that build upon Education 2.0 information sourcing capabilities and, to a lesser extent, the memorization habits of Education 1.0 [4].

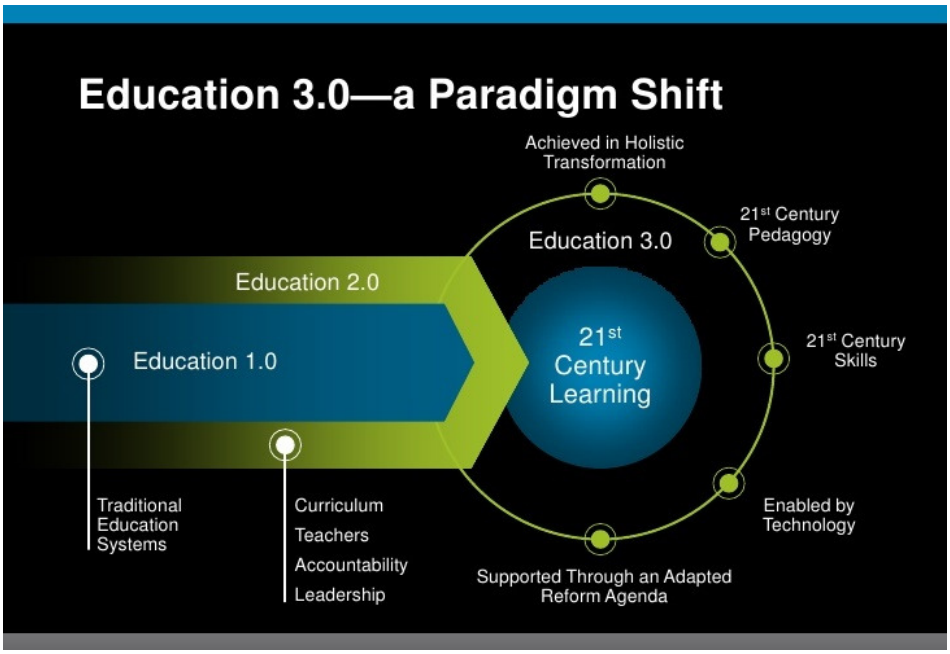

Figure 1. Education 3.0 paradigm [14]

3. Methodology

This research will be qualitative and used a case study. Primary data obtained through semi-structured interview and secondary data obtained from the documentation and publication. The research used Sistem Informasi Akademik Universitas Langlangbuana (SIAk UNLA) in Bandung, Indonesia as a case study. Case study method good for investigating a contemporary phenomenon in depth when the boundaries between phenomenon and context are not evident [17]. In this research, the Education 3.0

is a contemporary phenomenon and the AIS in the HEI is a context. This research starts the interview with 10 (ten) students. After raw analysis, the data from respondents already saturated. The collected data will be analyzed to provide the most suitable solution.

4. Analysis and Discussion

The lecturing characteristic in Education 3.0 more connected with technology. E-learning technology used to produce and share knowledge. They used various e-learning. They used Edmodo, Moodle or their own institution's e-learning. Moodle, Edmodo, and others e-learning application have been used by many HEIs [3]. The HEIs used the application because of it simple to install and supported mobile platform.

For Edmodo and Moodle users, they very helped with the mobile platform services. They can access the e-learning from their mobile device anywhere and very enjoyed with the push notification function. However, when they accessed the AIS with their mobile device, they felt the lack of function on it. They lost some information and function because the AIS did not support mobile platform yet. This also happens to the users that used their own institution's e-learning without mobile platform support. Furthermore, [6] found accessibility problems when the web-based applications did not support mobile platform. Besides that, the mobile platform provides an ideal avenue for the transfer of knowledge, which will improve the students' absorptive capacity when collaboration is used in the learning process [18].

The analysis also found that students must remember user credential for every application they used. They felt not comfortable with this situation. They hope the application can be integrated and can be accessed from anywhere through mobile devices.

5. Conclusion

Based on analysis and discussion, this research has strengthened the problems faced by the students when the HEI implement Education 3.0 in their learning process. This research suggests the main core applications used by the HEIs must support the mobile platform. Based on the analysis, this research also suggests integrating the e-learning and AIS becomes the integrated AIS with mobile platform supports. With the integration and mobility support, students will have better educational experience in the digital era.

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Regression model of simple recirculating aquaculture system

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Abstract. Regression Model the ecosystem for fish ponds built an enclosed (Recirculating Aquaculture System abbreviated RAS). Study this model discusses the variables and parameters that major can affect the sustainability of the ecosystem pond that can describe the transformation of materials in the ecosystem. This model provides convenience in selecting the optimal proportion by optimizing the conditions for the land. Variables observed in experiments conducted over 92 days are: Size Media Renderer Ammonia (Specific Surface Area (SSA)), Volume Water, Total Swimming, temperature, pH, Total Ammonia and Dissolved Oxygen. Initial studies in this research conducted regression test to see the effects between variables and parameters. From the observation and study of regression shows that the vast influence of the media is very dominant on the sustainability of an ecosystem.

Keywords: Regression Model, Specific Surface Area, Ammonia

1. Introduction

The development of information technology today can be used for decision making on a model, it can contribute greatly to the fundamental changes in the management structure of an object of study and the various information technology analysis can also be developed in support of information systems to improve the effectiveness and efficiency of the performance of a system. The current study is to examine an aquaculture regression model in a Recirculating Aquaculture System (RAS), the study of this model discusses the variables and parameters that can influence the survival of the pond ecosystem so that it can describe the material transformation in the pond ecosystem [4]. Regression model can provide ease in choosing optimal proportions to optimize the land [3]. In closed fish ponds required intensive controls for some parameters. More comprehensive understanding of the ecological and physiological mechanisms of fish pond ecosystem development still needs to be done to

support the development of community control technology concept in pond waters. The parameters observed were the area of filter media (SSA), PH, Temperature, TDS, Ammonia and Feed [2]. The growth rate of these parameters can be predicted before planting fish or after fish planning.

2. Multivariate Linear Regression

The data retrieval method was done by direct observation at the experimental location (primary data) for 92 days. The data were used to find correlation with the Multivariate Linear Regression method and implemented with a linear equation system solved using LU matrix decomposition [4].

Many observational data can occur due to the influence of more than two variables. In this study, the relation between the dependent variable y with the independent variables x1, x2, x3, ..., xk is obtained so that the regression of y over x1, x2, x3, ..., xk, this regression line is called Multivariate Linear Regression.

The model of the Multivariate Linear Regression equation y on x1, x2, x3, ..., xk is

$$\tilde{y} = a0 + a1 * x1 + a2 * x2 + a3 * x3 + ... + ak * xk, \quad (1)$$

with a0, a1, a2, a3, ..., ak as the coefficients to be determined from the data. Cases in this observation have four independent variables x1, x2, x3, x4 so that multivariate linear regression is

$$\tilde{y} = a0 + a1 * x1 + a2 * x2 + a3 * x3 + a4 * x4, \quad (2)$$

with a0, a1, a2, a3, and a4 determined from the system of linear equations:

$$\begin{aligned}
\sum y &= a_0 n + a_1 \sum x_1 + a_2 \sum x_2 + a_3 \sum x_3 + a_4 \sum x_4 \\
\sum y x_1 &= a_0 \sum x_1 + a_1 \sum x_1^2 + a_2 \sum x_1 x_2 + a_3 \sum x_1 x_3 + a_4 \sum x_1 x_4 \\
\sum y x_2 &= a_0 \sum x_2 + a_1 \sum x_1 x_2 + a_2 \sum x_2^2 + a_3 \sum x_2 x_3 + a_4 \sum x_2 x_4 \\
\sum y x_3 &= a_0 \sum x_3 + a_1 \sum x_1 x_3 + a_2 \sum x_2 x_3 + a_3 \sum x_3^2 + a_4 \sum x_3 x_4 \\
\sum y x_4 &= a_0 \sum x_4 + a_1 \sum x_1 x_4 + a_2 \sum x_2 x_4 + a_3 \sum x_3 x_4 + a_4 \sum x_4^2
\end{aligned} \quad (3)$$

with y = Number of ounce Feed / day, x1 = acidity (PH), x2 = Temperature (Celsius), x3 = Ammonia mg / liter, and x4 = Oxygen (DO). The values a0, a1, a2, a3, and a4 are the coefficients to be determined. Estimated standard error is determined using a formula

$$s^2_{y.123..k} = \frac{\sum (y - y^*)^2}{n - (k+1)} \quad (4)$$

with y * is the estimated value of the regression function.

3. Matrix Decomposition

The A 5x5 matrix can be LU decomposed as follows:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & a_{44} & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} = \begin{bmatrix} l_{11} & 0 & 0 & 0 & 0 \\ l_{21} & l_{22} & 0 & 0 & 0 \\ l_{31} & l_{32} & l_{33} & 0 & 0 \\ l_{41} & l_{42} & l_{43} & l_{44} & 0 \\ l_{51} & l_{52} & l_{53} & l_{54} & l_{55} \end{bmatrix} \begin{bmatrix} 1 & u_{12} & u_{13} & u_{14} & u_{15} \\ 0 & 1 & u_{23} & u_{24} & u_{25} \\ 0 & 0 & 1 & u_{34} & u_{35} \\ 0 & 0 & 0 & 1 & u_{45} \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad (5)$$

Decomposition into an LU matrix is done by following the steps:

Step 1: Find the values of the elements of the matrix L and the matrix U

$l_{i1} = a_{i1}$

$u_{1j} = a_{1j}/l_{11} = a_{1j}/a_{11}$

$l_{ij} = a_{ij} - \sum_{k=1}^{j-1} l_{ik} \cdot u_{kj}$

$u_{ij} = \dfrac{a_{ij} - \sum_{k=1}^{i-1} l_{ik} \cdot u_{kj}}{l_{ii}}$, with i = 1, 2, 3, …, n and j = 2, 3, 4, …, n.

Step 2: find the result matrix vector (H ') by making augmented LH and calculation

$h'_1 = h_1/l_{11}$ $\qquad h'_i = \dfrac{h_i - \sum_{k=1}^{i-1} l_{ik} \cdot h'_k}{l_{ii}}$

Step 3: Establish a UH 'augmented matrix and look for solutions with rules

$x_n = h'_n$ $\qquad x_j = h'_j - \sum_{k=j+1}^{n} u_{jk} \cdot x_k$

4. Aquaculture System

The following observation data is used:

Table 1. Instant observation data

No	PH x1	Temperature (Celsius) x2	Ammonia (mg/liter) x3	DO (Oxygen) x4	Feed (Ounce/day) y
1	8.43	27	0.45	8.9	10
2	7.81	27	0.45	8.1	10
3	7.84	27	0.45	6.2	10
4	7.54	26.5	0.45	6.1	10
5	7.45	26.5	0.55	5	10
6	7.3	27	0.6	7.4	10
7	7.4	26.5	0.65	4.6	10
8	7.3	26	0.65	4.6	7.5
9	6.9	26	0.65	4.5	7.5
10	6.92	26	0.75	4.5	7.5

11	6.8	27	0.75	4.3	7.5
12	6.8	26.5	0.8	4.3	7.5

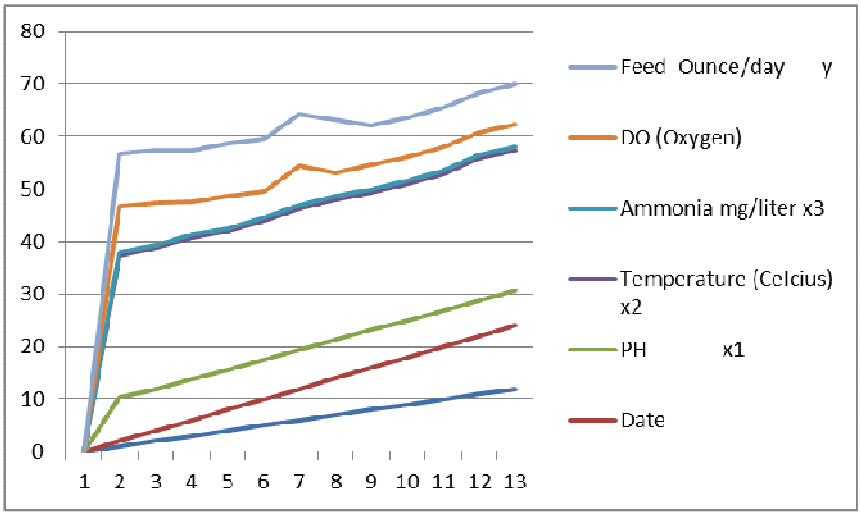

Figure 1. Graph of observed data

From the observation data we obtain:

$\Sigma x_1 = 680{,}65$, $\Sigma x_2 = 2413{,}5$, $\Sigma x_3 = 42{,}2$, $\Sigma x_4 = 2413{,}5$, $\Sigma y = 434{,}0$.
Σx_1^2 = 5040,1753, Σx_2^2 = 63338,25, Σx_3^2 = 19,63, Σx_4^2 = 488,0.
$\Sigma x_1 * x_2 = 17858{,}63$, $\Sigma x_1 * x_3 = 313{,}7815$, $\Sigma x_1 * x_4 = 4888{,}0$.
$\Sigma x_2 * x_3 = 1112{,}275$, $\Sigma x_2 * x_4 = 17329{,}07$, $\Sigma x_3 * x_4 = 304{,}4295$.
$\Sigma y * x_1 = 3236{,}56$, $\Sigma y * x_2 = 11419{,}75$, $\Sigma y * x_3 = 201{,}45$, $\Sigma y * x_4 = 3102{,}825$.

These values are substituted in equation (1). The result is in the form of the equation Aa = y with

$$A = \begin{bmatrix} 92{,}0 & 680{,}65 & 2413{,}5 & 42{,}4 & 660{,}51 \\ 680{,}65 & 5040{,}175 & 17858{,}63 & 313{,}7815 & 4888{,}0 \\ 2413{,}5 & 17858{,}63 & 63338{,}25 & 1112{,}275 & 17329{,}07 \\ 42{,}4 & 313{,}7815 & 1112{,}275 & 19{,}63 & 304{,}4295 \\ 660{,}51 & 488{,}0 & 17329{,}07 & 304{,}4295 & 4754{,}689 \end{bmatrix},$$

$$a = \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_4 \\ a_5 \end{bmatrix}, \text{ and } y = \begin{bmatrix} 434{,}0 \\ 3236{,}56 \\ 11419{,}75 \\ 201{,}45 \\ 3102.825 \end{bmatrix}$$

The LU decomposition of A given by

$$L = \begin{bmatrix} 92,0 & 0 & 0 & 0 & 0 \\ 680,65 & 4,4750554 & 0 & 0 & 0 \\ 2413,5 & 2,665054 & 21,63841 & 0 & 0 \\ 42,4 & 0,09063 & -0,087669 & 0,08694 & 0 \\ 660,51 & 1,3031184 & 0,675631 & -0.00311 & 12.1856 \end{bmatrix},$$

$$U = \begin{bmatrix} 1 & 7,39837 & 26,2337 & 0,46087 & 7,179457 \\ 0 & 1 & 0,595535 & 0,020252 & 0,291196 \\ 0 & 0 & 1 & -0,00405 & 0,0312237 \\ 0 & 0 & 0 & 1 & -0,03578 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

By augmented Ly and the process in step 2 of the LU decomposition method we obtain

$$y' = \begin{bmatrix} 4,7173913 & 5,7357074 & 0,8799221 & 11,386289 & -1,730938 \end{bmatrix}^T,$$

and with augmented matrix Uy 'obtained values

$$a = \begin{bmatrix} -53,9295 & 5,426869 & 0,97985 & 11,32436 & -1,73094 \end{bmatrix}^T.$$

So the multivariate linear regression function is:

$\tilde{y} = -53.9295 + 5.426869\ x_1 + 0.97985\ x_2 + 11.32436\ x_3 - 1.73094\ x_4$.

Estimate standard error is calculated using equation (2), obtained

$$s^2_{y.123...k} = 2.314886.$$

5. Conclusion

The result of observation and study of optimization model from regression can be concluded that standard error estimation is 2,314886 or 2,3% and stability of normal pond ecosystem if parameter value of x1, x2, x3 and x4 in accordance with condition of filter media area (SSA), and the sustainability of the ecosystem in accordance with expectations, which graphs can be seen in figure 1. It is further suggested that observations for growth of fish and certain fish species can be distinguished so that other equations for certain fish species and application program design will be based on the filter media area (SSA)

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Algorithm design model and formulation for recirculating aquaculture system

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Abstract. Recirculating Aquaculture System is a fish maintenance system by utilizing pond water by recycling through filters without any water being replaced or disposed of. To achieve optimal results, intensive controls are required in stabilizing the pond ecosystem. Pond ecosystem can be stable if Ammonia dissolves can be controlled and not more than 1ppm, Ammonia is a parameter result of fish feces and dissolved waste in pond water and very influential to ecosystem and can become poison for fish. The designed algorithm is to find out how much fish can be maintained and how much feed can be administered daily and highly dependent on the area of filter media used. It is hoped that the design of this algorithm can help define the initial design in developing an application program for control of a closed pool ecosystem.

1. Introduction

Information technology now and the future is more directed to life system informatics (management of information systems about nature and living things). The research being developed is aimed at the system of fish maintenance in recirculating aquaculture system. In closed system ponds are required filters with certain media that can stabilize pond ecosystem. Until now our country is still far behind in the utilization of Information technology to design and control the ecosystem of small-scale closed fish pond. Model Information System and Closed Fish Pond Formulation is one of the indispensable factors for determining the optimality of land use. Information Technology is very possible to be able to control aquatic ecosystems with made through modeling and computation of pond fish ecosystem. In the achievement of the first optimal control system required a model design algorithm and fish pond formulation and required calculations through computer programming for optimization model formulation can be achieved through the application program.

2. Design Model and Formulation

Recirculating Aquaculture System is a dynamic system model, modelling algorithm design and aquaculture formulation only to predict the maximum level of fish and feed populations to be achieved in one pond. Bio filter Size or Specific Surface Area (SSA) is a filter media that can determine the survival of the pond ecosystem. Pond ecosystem will be stable if it can control the maximum ammonia

content 1 ppm [6]. The ammonia removal rate by nitrifying bacteria is 0.2-2 g per square meter per day [1], provided that the water flowing from the entire pool passes through the average filter media reaching within 1 hour to 3 hours [5]. Fish consume 1% to 3% feed per day per fish body weight, and remove the average ammonia (0.1-1) gram / 1 kg fish / day [3]. The first step based on [1] can be designed algorithm to calculate ammonia nitrification process into unit of SSA area is:

$$X\ g\ feed\ x\ \frac{a\%\ g\ protein}{100\ g\ feed}\ x\ \frac{16\ g\ nitrogen}{100\ g\ protein}\ x\ \frac{61\ g\ wasted\ nitrogen}{100\ g\ total\ nitrogen}\ x\ \frac{1.2\ g\ NH3}{1\ g\ nitrogen} = Y\ g\ ammonia \quad (1)$$

for Y grams of ammonia requires a filter media with a unit area of SSA:

$$Y\ g\ ammnia\ x\ \frac{1\ m^3}{(0.1-1)\ g\ ammonia} = Z\ m^2 \quad (2)$$

Suppose for SSA area inside $300\frac{m^2}{m^3}$ required $Z\ m^2 x \frac{1\ m^3}{300\ m^2} = A\ m^3$ (3)

The formulation can be used as a starting point to determine the simple pool design with the desired SSA area as well as to maximize the number of fish and feed quantities with conditions for parameters: temperature, ph, tds, ammonia and DO as per standard [6]

3. Algorithm Design

The algorithm is designed for the values of parameters with the assumption according to the standard according to [6] namely: Temperature (Degree of Celsius): 25 <0C <30, PH: 6.4 <PH <8.6, Total Dissolved Solid: 100 <TDS <750, Ammonia: 0.1 <NH3 <1, Dissolved Oxygen (DO): 4 <DO <10, Zooplankton: Plankton> 2000 / liter.

{The algorithm is designed to maximize the amount of fish and feed that can be maintained within one maintenance pool, according to SSA capacity}

Initialize variables and initial values
Temperature: = 27; PH: = 7.5; TDS: = 350; Ammonia: = 0.5; DO: = 6.5
Plankton: = 2000
Feed: = X
Protein Feed: = P
Total Ammonia: = Y
SSA: = Z
SSA Volume: = A

Input: Number of Feed in Gram unit: = X
Percentage of Proteins Contained in the Feed: = P

Process :
based on Formula (1) Total Ammonia:

$$Y := X\ x\ \frac{P}{100}\ x\ \frac{16}{100}\ x\ \frac{61}{100}\ x\ \frac{1.2}{1}$$

Example : If the value of X = 1000, and P = 30 then

$$Y := 1000\ x\ \frac{30}{100}\ x\ \frac{16}{100}\ x\ \frac{61}{100}\ x\ \frac{1.2}{1}$$

$$Y := 35.136 \text{ gram Ammonia}$$

calculate based on Formula (2) for the ammonia decomposition process required Total SSA, for example take the average value of ammonia dissolved in water = 0.5 ppm, then:

$$Z := Y \; x \; \frac{1}{(0.5)} \;\; ; \;\; Z := 35.136 \; x \; \frac{1}{(0.5)} \;\; ; \;\; Z := 70.272 \; m^2 SSA$$

so that 35,136 gram of ammonia required 70.272 m^2 SSA decomposer media

based on Formula (3) SSA Total Volume in m3:
if 1m^3 of filter media have SSA 300 m^2, then:

$$A := Z \, x \, \frac{1}{300} \;\; ; \;\; A := 70.272 \, x \, \frac{1}{300} \;\; ; \;\; A := 0.234 \, m^3$$

Output :
X := 1000
P:= 30
SSA := 70.272 m^2
Volume SSA := 0.234

The above example is for 1000 grams of feed with 30% protein content required Volume Biological filter media 0.234 m3, every 1 kg of fish can consume 2% feed from fish weight, obtained 2/100 x 1000 = 20 gram, in that condition maximal fish can be maintained is 1000/20 = 50 kg. 50 kg is the maximum value, in a pond ecosystem there is a growth rate of other parameters that are very influential, therefore the initial fish planting should be much smaller than the maximum value so that the maximum target can be achieved in accordance with the desired period.

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Implementation of artificial neural networks in detection of vehicle registration number by region based on digital image processing

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Abstract. Pattern number plate recognition can be applied to many traffic monitoring application applications one of which is electronic toll payment. Character recognition of the success of the classification process is determined by the successful feature extraction of each character so that the various character form will increase the difficulty level in the process of introduction. Pattern recognition on vehicle number plate consists of several stages, namely detection of plate number location, number plate preprocess, choosing test data and training data, identification using ANN including JST classification model, ANN test and SJT Accuracy. Detection of the number plate location is a major component in plate pattern recognition to find environmental imagery that may have meaning and value on the number plate object. The data were taken as many as 120 consisting of 30 images of Bogor area (F), 30 images of Jakarta area (B), 30 images of Bandung (D) and 30 images of Purwakarta (T). Data from each plate type number is divided into two parts, 20 pieces for training data and 10 pieces for test data. From the experiment based on 40 training data, there were 28 undefined test data or 70% accuracy.

1. Introduction

One unique part of a motor vehicle is a police license plate. In Indonesia it has been specified in the rule that the vehicle license plate mark must meet the terms in terms of shape, size, color and location of the installation. Pattern recognition license plate can be applied to many applications of monitoring traffic activity such as payment of road tolls electronically, payment at parking area as well as detect the number of vehicles by region In character recognition success of the classification process is determined from the successful extraction of the features of each character so that the character shapes that vary will increase the difficulty level in the introduction process.

In this study the digital image will be taken preliminary object to determine whether the vehicle plate from Bogor region or not. So the future is expected to know the number of vehicles that enter into certain areas in this city of Bogor.

2. Methodology

The method used in this study is as shown in Figure 1.

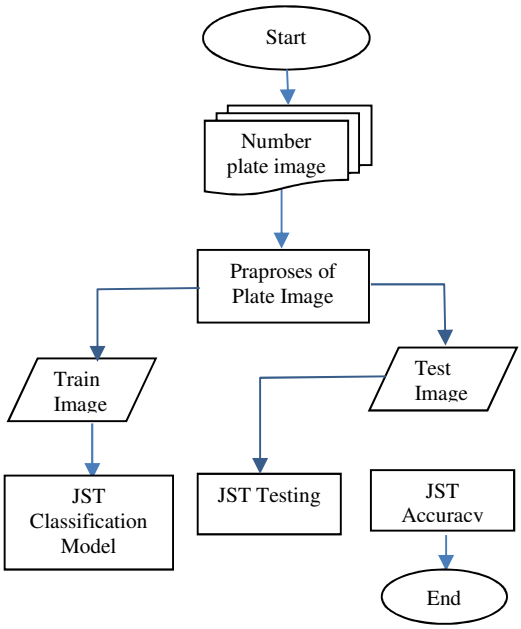

Figure 1. Research Methodology

2.1. Data collection

The data collection stage is done to facilitate the identification of vehicle license plate data number. The data collection of vehicle number plate is done by way of direct dropping to field in various area and place, among them Bogor, Jakarta, Bandung and Purwakarta as many as 30 images in each region. The overall data taken in this study is as many as 120 images. Sample data license plate shown in Figure 2.

Figure 2. Sample Car Plate Figure

2.2. Image Preview

Image preview is done by cutting the image of the vehicle number and separating it from the vehicle image background through the segmentation process. The image that has been segmented and then processed retrieval feature extraction in order to recognize a characteristic of the image using texture

analysis that is entropy, energy, contrast, homogeneity. The feature extraction aims to take the value of an image to be processed through the identification stage.

2.3. Test Data Sharing and Train Data

Vehicle license plate data in this study a total of 120 images comprising 30 image Bogor (F), 30 the image of Jakarta area (B), 30 images Bandung (D) and 30 images Purwakarta region (T). Data from each plate type number is divided into two parts, 20 pieces for training data and 10 pieces for test data.

2.4. Identification Process

The image of the feature extraction process is an input for JST. The number of outputs is 4 class areas, namely Bogor (F), Jakarta (B), Bandung (D), and Purwakarta (T). Class 1 characterizes Jakarta, Purwakarta region characterize class 2, class 3 characterizes the area of Bandung, and Bogor Grade 4 characterizes the region. The identification process using the shortest distance with the value of neighborhood 3 and 5, while the second will be used for ANN training functions backpropagation network that is trainlm and trainrp.

3. Results and Discussion

Data of Number Plate from Region Bogor, Jakarta, Bandung and Purwakarta 30 image in each region. The overall data taken in this study is as many as 120 images. Image Segmentation Process. The image that has been segmented and then processed retrieval feature extraction in order to recognize a characteristic of the image using texture analysis that is entropy, energy, contrast, homogeneity. Application identification number plate based on region-based image using Artificial Neural Network (ANN) is structured like the flow chart presented in Figure 3.

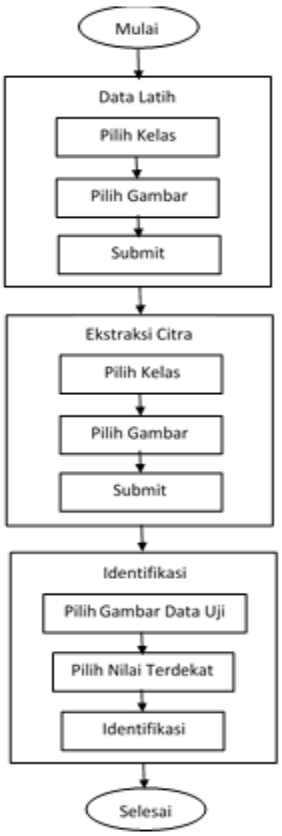

Figure 3. Application flowchart

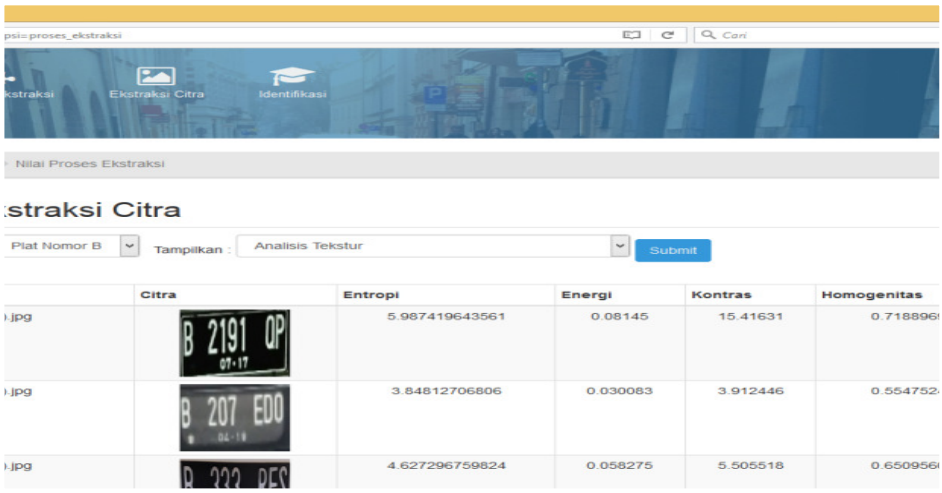

Figure 4. Image Identification

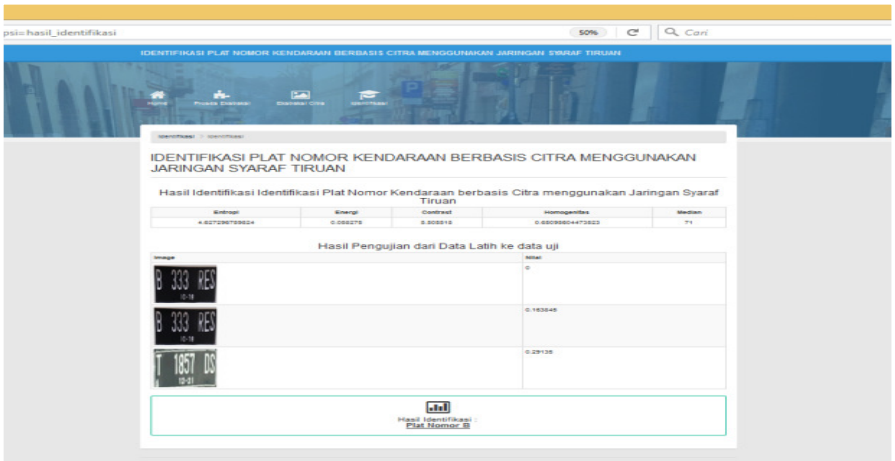

Figure 5. Result of Identification

The process of identification by inputting test data by selecting the image to be tested into the system. The identification results will display the number plate code by region. The application displays the value of the image feature extraction of test data that is the value of entropy, energy, contrast and homogeneity.

4. Conclusion

Application Identification of vehicle number plate based on region using Artificial Neural Network (ANN) based on digital image processing aims to identify number plate using image divided into 4 classes, namely class 1 for Jakarta (B), class 2 for Purwakarta (T) grade 3 for Bandung (D), and Grade 4 for Bogor (F). The data consisted of 120 pieces, with each class divided into 30 pieces of image. Image data is divided into 80 training data and 40 pieces as test data. The characteristic extraction used in this research consists of 4 parameters: entropy value, energy, contrast, and homogeneity, while identification process using artificial neural network. The identification results will display test data with the region code based on the value closest to the training data. The results of the test resulted in a score of 70 percent.

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