A Simulation for Resource Allocation in a Job Selection Process System

Mohamad Toha
Department of Industrial Engineering
President University
Bekasi, Indonesia
mohamad.toha@president.ac.id

***Abstract*—Simulation studies can be carried out in various sectors, including the manufacturing, service, and government sectors. The scope of simulation studies ranges from simple systems to complex systems. This research was conducted on the job selection process system. The simulation method is used to evaluate system performance and make improvements. Based on the analysis of system performance, several improvement strategies were developed for system performance. Strategy selection is based on the low utilization of staffs in the locations. Improvement strategy I and II focus on reducing staff at Registration & Scanning CV location, while improvement strategy III also reduces another staff at the 2nd Interview location. For example, using Strategy III can increase the average utilization of staff at Registration & Scanning CV location to 82.22% and at the 2nd interview location increase to 6.46%. By reducing the number of resources, the company gets cost-savings without increasing the mean time in the job selection system, as can been seen from p-value of ANOVA which is more than 0.05. This simulation study suggests appropriate improvements in this job selection system.**

Keywords—simulation, job selection, improvements, cost-saving

I. INTRODUCTION

The growth of property in Indonesia is increasing. Indonesia is now encountering a high level in the acceleration of the property industry. The growth of property in Indonesia is dominated by residential and commercial property, such as; apartment, retail (shopping centre), industrial land, office and hotel. The needs of Indonesian people to have a high-priced property and acceptance of having a property is one of the best investments in their life. It is the two key factors that lead the property sector for overgrowing.

This study focuses on one of Indonesia's most prominent property developers, which announced its latest and most significant project in West Java, Indonesia. According to the CEO, this project is set to become an independent city of its own with one million residents and claims to be the best home investment in Southeast Asia, considering the extensive range of infrastructure and facilities. Thus, the company's marketing strategy is by doing a massive branding campaign that aims to put the project on the tip of everyone's tongue.

To promote the project to many people in Indonesia, the company offers a massive job opportunity to a wide range of people through their Walk-In-Interview. Nevertheless, the company uses an outsource company to manage their line of marketing and sales candidates, which the candidates will undergo a very intensive and thorough interview process. Because there are so many job applicants that must be served every day, the job selection process looks very busy and takes a very long time.

This study aims to evaluate the work selection process carried out by the company by using the simulation approach. [1] stated that simulation is the process of designing a real system model and conducting experiments with this model to either understand the behaviour of the system or evaluate various strategies (within limits imposed by a criterion or set of criteria) for the operation of the system. Furthermore, [2] concluded that simulation is key technology for developing planning and exploratory models to optimize decision making for complex and smart production systems. The purpose of doing simulation is to either understand the behavior of the system or evaluate various strategies for the operation of the system [3]. It is not surprising that simulation approaches have evolved in operational research [4]. The simulation study has proven to be an effective method for several purposes, i.e., experimental case study (see [5], [6]), manufacturing process improvements (see [7]), inventory allocation (see [8]), customized situational learning (see [9]), healthcare service preparation (see [10], [11]), and estimation (see [12]).

The research was conducted on the job selection process system in a property company. The usage of simulation has been proven in manufacturing companies and service organizations as well. Thus, the simulation approach will be used also to study the job selection process system, in order to find the improvement for the system. The data collection is collected through observation to the real system, time study, and interview to the experts. After collecting the data, a simulation model is built to evaluate the current system performance. The proposed system then proposed to improve the system performance.

A simulation model is developed using several stages. First, making data documentation. This stage is conducted after collecting the data. The data is analyzed to create entity flow diagram and to determine the processing time at each location in the system with its distribution probability. Second, developing simulation model for the current system based on the output from first stage.

After making the simulation model for the current system, verification and validation model is employed to test the similarity of the model with actual system. Third, proposing improvement for the system. After analyzing the current system performance, the improvements are proposed to increase the system performance. Finally, based on the proposed improvement, the model is developed again to see the effect of the improvement strategies to the system performance.

II. Data Documentation

A. Entity Flow Diagram

The entity flow diagram is the visualization to describe the entity movement through the system. The entity flow diagram aims to document the overall flow of entities for communicating the entity flow to others. An essential feature of a flow diagram is its ability to incorporate conditional paths that a person or object may follow depending on the state of the system's condition. Fig. 1 shows the entity flow diagram of the job selection process in the company.

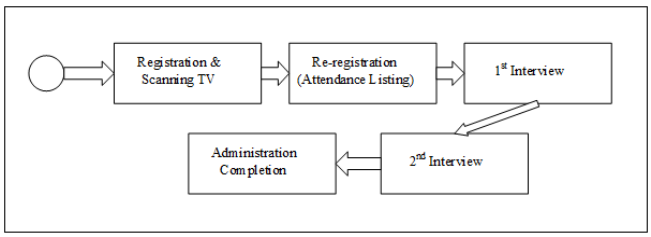


Fig. 1. Entity flow diagram of job selection process

In the beginning, all of the entities, which are candidates, enter the system by doing registration and give the CV data. Having given the CV data, the candidates will be told whether they are allowed to continue the selection process or not, if not then the candidate out of the system candidate reject, if yes then the candidate may continue the process.

The candidate that continue the system move to Re-registration location do the Re-registration. After doing the Re-registration, the candidate moves to the 1st Interview location. In this location, the rules is first in first out. In this location, the candidate will be told whether he is allowed to continue the selection system or not, if not then the candidate out of the system, if yes then the candidate may continue the process.

The candidate that continue the system move to 2nd interview booth, in this location the rules is first in first out, in this location the candidate that has been doing the 2nd Interview can move to the Administration booth. In Administration booth will be notified immediately, whether the candidate accepted to be part of marketing & sales personnel or not. If not, then the candidate will be immediately exiting the system. If yes, then the candidate will be given some of the files and then exit the system.

B. Distribution Fitting

Fitting a theoretical distribution to data attempts to identify the underlying distribution from which the data were generated. Before the distribution fitting test, the data are examined through several tests, namely independency, autocorrelation, and run test. After a particular type of distribution has been selected, the parameter values of distribution based on the sample data must be estimated. Parameter estimates are generally calculated using a moment equation or maximum likelihood equation [13]. The distribution of data of each location is depicted in Table I.

TABLE I. Data Distribution

Location	Distribution	Parameter (Minute)
Registration & Scanning CV	Normal	(2.73, 1.39)
Re-Registration	Normal	(1.95, 0.785)
1st Interview	Normal	(3.9, 1.02)
2nd Interview	Lognormal	(0.754, 1.61, 0.419)
Administration Completion	Normal	(4.5, 1.68)

III. The Current Job Selection System

A. The Simulation of Current System

The simulation study begins by mapping the locations where the entity, in this case, the candidate, will move from one location to another in the job selection process. The simulation model is built according to the observation on the real system. In general, the locations and processing times at each location are shown in Table I. For example, processing time at Registration & Scanning CV location is normally distributed with mean of 2.73 minutes and standard deviation of 1.39 minutes. The data will be used to develop the simulation model of the current system, especially for the input of processing time at each location. However, it is necessary to know the number of resources available at these locations.

There are 12 locations in the current system: queuing line, three units of CV dropping booth (registration & scanning), one attendance listing (re-registration), three units of first interview staffs, two units of second interview staffs and lastly the administration completion that served by two staffs. The layout of the current system is depicted in Fig. 2.

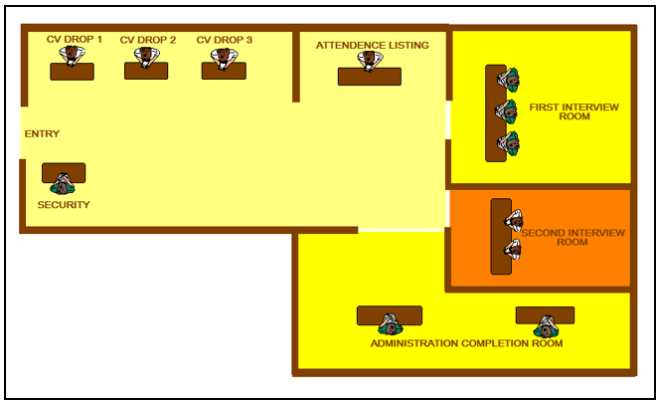
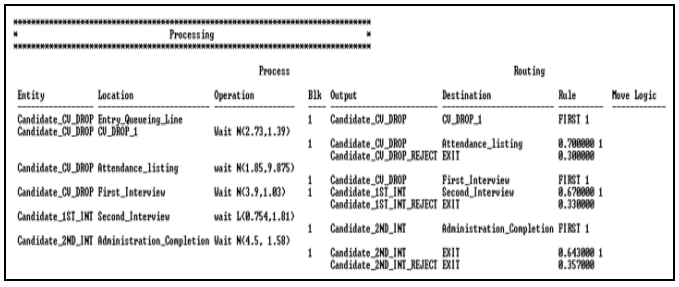


Fig. 2. Current system layout

Based on Fig. 2, it can be seen that the job selection process is carried out serially, starting from the location of the CV drop to the location of administration completion. There are parallel activities in each location that can serve more than one candidate, except for attendance listing locations.

This study employes Promodel student version Software to evaluate the job selection process. The processing of the current system can be seen in Fig 3.



Processing

Entity	Location	Operation	Blk	Output	Destination	Rule	Move Logic
			Process			Routing	
Candidate_CV_DROP	Entry_Queueing_Line		1	Candidate_CV_DROP	CV_DROP_1	FIRST 1	
Candidate_CV_DROP	CV_DROP_1	Wait N(2.73,1.39)	1	Candidate_CV_DROP	Attendance_listing	0.700000 1	
				Candidate_CV_DROP_REJECT	EXIT	0.300000	
Candidate_CV_DROP	Attendance_listing	wait N(1.85,9.875)	1	Candidate_CV_DROP	First_Interview	FIRST 1	
Candidate_CV_DROP	First_Interview	Wait N(3.9,1.83)	1	Candidate_1ST_INT	Second_Interview	0.670000 1	
				Candidate_1ST_INT_REJECT	EXIT	0.330000	
Candidate_1ST_INT	Second_Interview	wait L(0.754,1.81)	1	Candidate_2ND_INT	Administration_Completion	FIRST 1	
Candidate_2ND_INT	Administration_Completion	Wait N(4.5, 1.58)	1	Candidate_2ND_INT	EXIT	0.643000 1	
				Candidate_2ND_INT_REJECT	EXIT	0.357000	

Fig. 3. Simulation of current system

From the previous figure, the processing table consists of process and routing in the current system simulation. The candidate arrives in incoming queueing line to be scanned and processed in the CV dropping (scanning and registration). There is no operation in the queuing line. In this case, not all off candidates succeeded to proceed to the next location 30% of the candidates failed in the first round. Furthermore, the approved candidates will go on to attendance listing to re-registration themselves and hence proceed to join the interviews; from the HR and the sales manager. Finally, they will all undergo the administration completion, which will announce if whether they are accepted or not. The simulation output, for eight hours with 25 replications, for the utilization average of each location and its total exits can be seen in Table II.

TABLE II. SIMULATION OUTPUT OF CURRENT SYSTEM

Location		% Utilization	Total Exits
Registration & Scanning CV	Staff 1	42.90	• 24.72 (not accepted)
	Staff 2		
	Staff 3		
Re-registration	Staff 1	62.32	-
1st Interview	Staff 1	16.85	• 22.26 (not accepted)
	Staff 2		
	Staff 3		
2nd Interview	Staff 1	3.19	• 25.44 (accepted) • 13.32 (not accepted)
	Staff 2		
Administration Completion	Staff 1	18.18	-
	Staff 2		

Based on Table II, it can be seen that the average utilization in each location is very low. Most locations have a utilization below 50%, except for the Re-registration location which has a utilization of 62.32%. This indicates that most locations have an excessive number of staff and need to be improved. Based on Table II, it can also be seen that not all of the candidates who applied were accepted. In the second interview, it can be seen that during one working day (eight hours), there are about 25 candidates who are accepted and 13 candidates who are not.

B. Model Verification and Validation

For a simulation model to be of the most significant value, it must be an accurate representation of the system being modelled. Verification and validation are two activities that should be performed with simulation models to establish credibility. Model verification is the process of debugging the model to ensure that it accurately represents the conceptual model and that the simulation runs correctly. Model validation begins at the data-gathering stage and may not end until the system is finally implemented, and the existing system can be compared to the model.

The simulation model will be compared with the existing system; the objective is to test the simulation's output close with the existing system. After doing the simulation, then continue to compare the simulation model with the existing system by asking people who are knowledgeable about the system, to ensure that both the model and the system are run under the same condition by using the same inputs to see the result match.

The face validity is conducted with the HR Manager. The HR Manager is asked to evaluate the simulation model and the output of the simulation model, as well. After that, based on the knowledge of the HR Manager and actual data, the job selection process in eight hours, number of candidates who are accepted and not accepted at 2nd interview location are similar to the simulation output Table II. this shows that the model can be declared verified and valid. After this step, improvement strategies are identified for the current system. In this study, three strategies are proposed to compare their performance.

IV. SYSTEM IMPROVEMENT

Based on the output of the current system simulation, it is found that the average utilization is very low. Several locations or resources are not used optimally utilized. Therefore, this study provides several suggestions for improving the system by reducing the location or resources used in the job selection system.

A. Improvement Strategy I

The improvement in here is reducing the number of Registration & Scanning CV, from three become two Registration & Scanning CV since three Registration & Scanning CV is not useful. For the improvement in the strategy I, the Registration & Scanning CV 3 is deleted, since based on the detailed simulation output, the average utilization of Registration & Scanning CV Staff 3 is only 27.29%, which is smaller than Registration & Scanning CV Staff 1 and Registration & Scanning CV staff 2. The average utilization of each location for the improvement strategy I can be seen in Fig. 4.

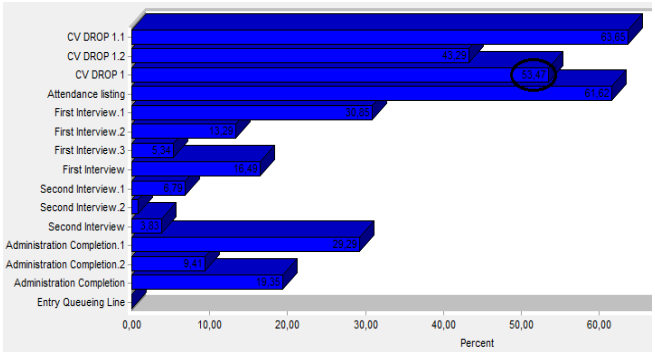


Fig. 4. Average utilization - strategy I

Based on Fig. 4, it can be seen that average utilization at the CV drop (Registration & Scanning CV) location increase to 53.47%. This shows that the reduction of one staff at this location has increased the utilization performance of the location, without compromising the utilization at the next locations.

B. Improvement Strategy II

The improvement in here is reducing the number of Registration & Scanning CV, from three staffs to one staff only. Thus, for the improvement in strategy II, the Registration & Scanning CV staff 2 and staff 3 are deleted, since the utilization of Registration & Scanning CV 2 and 3 smaller than Registration & Scanning CV 1. The average utilization of each location for the improvement strategy II can be seen in Fig. 5.

In the improvement strategy I, there has been a reduction of one staff at the CV Drop location. However, if we look at the resource utilization at the CV Drop location, there are still opportunities for improvement, namely by reducing one more staff at that location. Therefore, improvement strategy II only uses one staff serving at the CV Drop location for registration and CV scanning activities.

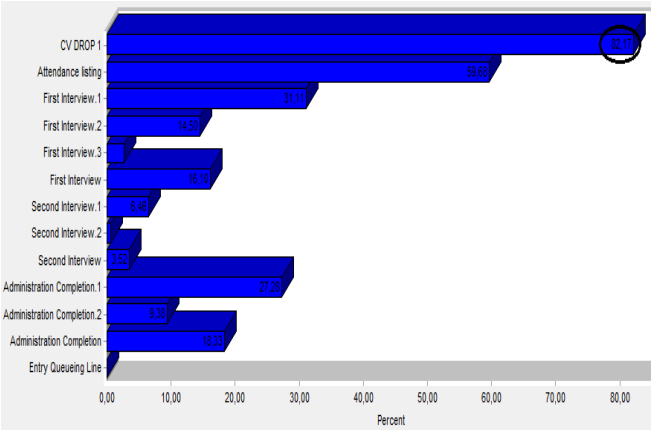


Fig. 5. Average utilization - strategy II

Based on Fig. 5, it can be seen that average utilization at the CV drop (Registration & Scanning CV) location increase to 82.17%. This shows that the reduction of two staffs at this location has increased significantly the utilization performance of the location, without compromising the utilization at the next locations.

C. Improvement Strategy III

The improvement here is reducing the number of Registration & Scanning CV and 2nd Interview. In strategy III, the Registration & Scanning CV staff 2 and staff 3 are deleted. In addition, the 2nd Interview staff 2 is also deleted, since the utilization of 2nd Interview staff 2 is smaller than staff 1. The average utilization of each location for the improvement strategy III can be seen in Fig. 6.

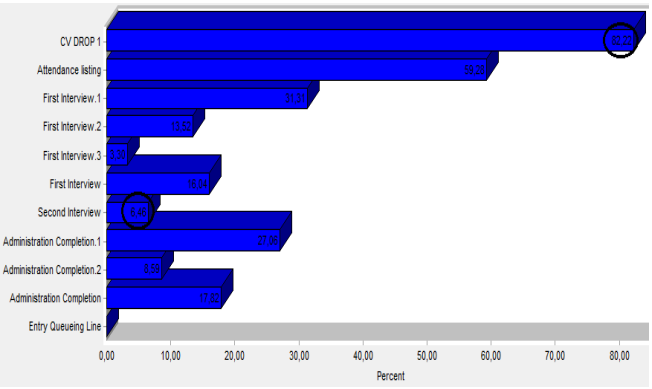


Fig. 6. Average utilization - strategy III

Improvement strategy III continues the idea of improvement strategy II. In strategy II, it only focuses on reducing staffs at the CV drop location. However, improvement strategy III also reduced the number of staff at the 2nd interview location, where the number of staffs was initially two and reduced to one staff. Based on Fig. 6, it can be seen that average utilization at the CV drop (Registration & Scanning CV) location increase to 82.22% and average utilization at the 2nd interview location increase to 6.46%.

V. System Comparison

Simulation is conducted to compare the current system of the job selection process and improved systems. There are 25 replications of each system to be compared. ANOVA and Tukey test is used to compare the output of different simulation models. ANOVA is used to determine whether there are differences in the performance of the current system with the proposed system. Tukey test is conducted to find out in detail which system performance is the same and which system performance is different from one another. The ANOVA and Tukey test statistical analyzes were performed using Minitab software.

The system performance that will be compared first is the resource utilization, particularly the resource utilization at the CV Drop location because the system improvement proposal being developed is focused on this location. The average utilization of staffs at the CV Drop location based on the current job selection system's simulation results and the proposed system (improvement strategy I, II, and III) is shown in Table III.

TABLE III. Average Utilization of CV Drop

Current System	Strategy I	Strategy II	Strategy III
42.9%	53.47%	82.17%	82.22%

Based on Table III, it can be seen that the average utilization at the CV Drop location continues to increase if an improvement is made to the job selection process system. In the current job selection system with three staffs at the CV Drop location, based on the simulation results, it was found that the average utilization of staffs was only 42.9%. The simulation results show that by implementing the improvement strategy I, namely by using two staffs at the CV Drop location, it was found that the average utilization had increased to 53.47%. The increase in utilization of staffs at CV Drop looks very significant if management use the improvement strategy II or strategy III, which only uses one staff at the CV Drop location. The simulation results show that the utilization of staffs increases to 82.17% and 82.22%.

To find out whether the difference in utilization of staffs at the CV drop location was significant or not, an ANOVA test was performed. ANOVA results showed a p-value of 0.000, which means that there is a significant difference from the average utilization of staffs at the CV drop location. To see more details about these differences, then proceed with the Tukey test. The results of the Tukey test can be seen in Fig. 7.

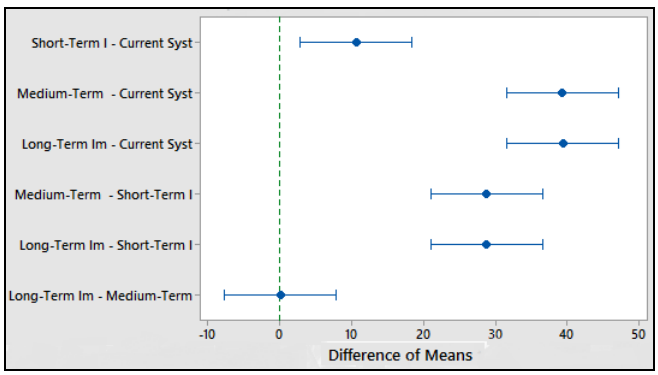


Fig. 7. Tukey's comparison test for CV Drop staffs' utilization with 95% Confidence Interval

Based on Fig. 7 it can be seen that there is a significant difference in the average utilization of staffs at the CV Drop location between the current system compared to the improvement strategies I, II, and III. Besides, there are also significant differences between improvement strategy I ("short improv") and improvement strategy II ("medium improv") and improvement strategy III ("long improve"). The results of the Tukey test show that only improvement strategy II ("medium improv") and improvement strategy III ("long improve") have no significant difference. This can be seen from Fig. 7 that the comparison of the two systems touch the vertical line "0".

Furthermore, a system performance comparison will be carried out related to the average time needed in the system, starting from the candidate entering the system to leaving the job selection system. The ANOVA results show a p-value of more than 0.05, which means that there is no significant difference from the mean time in the job selection system, either for the current system or for the proposed system. This can also be seen in the Tukey test in Fig. 8, which indicates that all comparisons touch the vertical line "0" which means not statistically different.

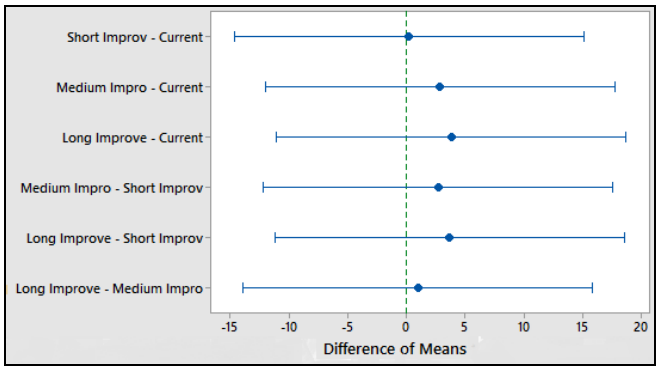


Fig. 8. Tukey;s comparison test for the average time in the system

The simulation results show that by doing improvement strategy I and II, namely by reducing the number of staffs at the CV Drop location; and improvement strategy III, namely by reducing the number of staff at the 2nd interview location, can significantly increase the utilization of staffs. In addition, the simulation results also show that the reduction in the number of staffs based on the proposed system improvement has no significant impact on the average time in the job selection system. By reducing the number of staffs, the company can save on labour costs.

VI. Conclusion

This study aims to evaluate the job selection system using a simulation approach. The simulation begins by modelling the current job selection system. After the current system simulation model is complete, the model's verification and validation are carried out to ensure that the simulation model mimics the real system. After the simulation model is declared verified and valid, it can be continued by developing a system improvement proposal, by identifying improvements that can be made based on the simulation output on the current system performance. This study develops three strategies for developing a job selection system. Each of the strategy can improve the system performance. Specifically, using Strategy III can increase the average utilization of staff at Registration & Scanning CV to 82.22% at the 2nd interview location increase to 6.46%.

This study provides an example of the application of simulation studies for simple systems. If done correctly, simulations can be of great benefit to decision-makers. Through simulation, decision-makers can carry out "trial error" in the simulation model without affecting the performance of the real system. After getting a lesson from the simulation model, an appropriate system improvement proposal will be obtained.

The simulation method used in this study provides a basis for improving the job selection system without sacrificing the job selection process's overall time. The simulation results also provide an opportunity for savings in labour costs if the system is improved.

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