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Implementation of Finding Shortest Route for Pharmacy Location Using A* Algorithm

Fransiskus Panca Juniawan[1], Dwi Yuny Sylfania[2], Dini Agrina[3]
[1,2,3]Informatics Engineering, STMIK Atma Luhur, Pangkal Pinang, Indonesia
[1]fransiskus.pj@atmaluhur.ac.id, [2]dysylfania@atmaluhur.ac.id, [3]1411500074@mahasiswa.atmaluhur.ac.id

Abstract- The number of pharmacies in the Pangkalpinang City has increased rapidly. This is directly proportional to the needs of the people of Pangkalpinang City to fulfill the health needs, buy medicine or divert doctor's prescriptions. This is a debate for people who do not know the location of pharmacies in this city. Practically, people can just go to a pharmacy with a location that far from user location, even though there is a pharmacy near the user. This is because there is no pharmacy information location in the Pangkalpinang City. To solve this problem, proposed a system that can display the location of all pharmacies in the Pangkalpinang City. In addition, the system can search the shortest path from the user's location to the nearest pharmacy location around using the A * algorithm. This algorithm was chosen because its advantages that are able to produce optimal solutions according to the expected heuristic functions. The results of the testing are that the system can optimize and be able to search the shortest path from the user's location to the nearest pharmacy.

***Keywords*- A* Algorithm, Geographical Information System, Shortest Path, Pharmacy**

I. INTRODUCTION

Nowadays the pharmacy turns out into crucial instrument in health sector. It is accordance with the increased-number of pharmacies that reached approximately 63 widespread all over Pangkalpinang city[1]. It is also indicated that community's healthy lifestyle awareness and the pharmacy needs has increased. Moreover, in line with rise of the number of pharmacies, it is undoubtedly the information requirements linked with the pharmacy location in Pangkalpinang city has also demanded at its peak. The community needs a system that has capability to provide not only detailed information related to pharmacy but also the mapping-tech that shows precise location of each pharmacies in the city.

To overcome prior mentioned concern in this research, the researchers are proposed the utilization of Geographical Information System or abbreviated as GIS which is a databased-technology that integrate the geographical data process or its linked in the object position in earth surface such as taking some typical visualization. It is also offers geographical analysis capability through its map picture [2]. At this time, GIS can be implemented to a web-based system with its advantages such are: to reduce IT staffs operational process, and its excellency in both integration and visualization of Database Management System (DBMS), and effortless implementation process [3].

The GIS implementation in pharmacy mapping has not enough yet. A system could be more invented with adding some of the shortest route search method. Furthermore, this method is useful to user when they search nearest pharmacy to them. One of the shortest route methods is called A* Algorithm (A-Star).

This algorithm is included in the category of search method based on information or known as Informed Search Method. The A-Star Algorithm tends to search fastest route that will traveled from the starting point to the pinned object or destination. Moreover, this algorithm is selected based on its advantages such as Path Finding function and Graph Traversal in its calculation process [4].

The A* Algorithm that has been widely implemented in the research as the solution for every concerning troubleshoot. In year 2018 that held the research in analyzing the comparation of A* Algorithm and the Dynamic Pathfinding Algorithm (DPA) which implemented for NPC Car Racing Game. The results from its experiment showed that NPC of two algorithm combination has better value than the sample data which is only used DPA Algorithm. Meanwhile, the obstacle position and the curve of the NPC track has also impacted towards DPA [5].

The research has conducted the comparation of robotic-moving track planning algorithm that implemented to dynamic circumstances. It is using both Ant Colony Optimization (ACO) and A* algorithms. Moreover, the test result to a simple environment with its static obstacle obtains A* Algorithm better than ACO as can be seen from its traveling time and mileage. Furthermore, less-obstacle test that seen from those mileages, shows the differences around 0,57% while the result from with-obstacle test obtains difference about 9%. To a dynamic environment test which the target and obstacle are moving at the same time with certain pattern, obtains result that ACO algorithm is better because it can find the optimum shortest route [6].

For further, A* algorithm applied to *Strip Packing Problem* (SPP) in a convection company to optimize resources and reduce the left-over material. The test result from it shows that the efficiency of resources consumption reach 68% that is impacted from mapping factor of smallest scale to the biggest one iteratively so that there is possibility of residual inter-pattern left unused[7]. The A* algorithm is also use for searching shortest route inter-building and or rooms in the Bahteramas Hospital. Its result

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is application-based that could determine shortest route that applied in Adobe Flash *Actionscript 3* language program-based Android [8].

It is also used as the determination of culinary travel shortest route in Bandarlampung. The test result is a manual calculation and the application is valid with similar route that around 1,5 Kilometers [9]. A* algorithm mainly applied to search shortest route towards *Hexapod* robot. From the test result, it has proven that A* algorithm could operate in maximum way in determined shortest route from it. Furthermore, success-rate of this robot that can arrive to an object/destination from its less-obstacle track in an arena. The difference of its process accomplishment in a lower failure-rate of the *hexapod* to its pinned destination is 1 *grid* meanwhile the bigger value is 3 *grid* [10]. Although it is also can be use as the search engine to search nearest *Bus Rapid Transit* (BRT) bus stop in Semarang city. from the calculation result, it is summed up that the experiment held around 20 times with different locations that A* algorithm has 100% accuracy in determine both 'Get in' and 'Get out' nearest bus stop. Meanwhile for the record, the Global Positioning System (GPS) has also in precise accuracy[11].

The A* algorithm is also applied as the problem-solver in a game. In 2017, a research has conducted that applying A* to an android-based labyrinth adventure game and obtained some of research results. It is shows that if the player were in trouble when finding the right track to a rabbit's food, so they can use 'help' symbol that automatically activated shortest route search function operated by A* algorithm (A Star). Moreover, the result is that euclideandistance to directly headed location of rabbit's food and the player could arrived as soon as possible [12] A role-playing game or RPG with hygienic plant genre is also can applying A* algorithm. As from the early phase of the test that conducted its experiment around 9 times with the efficiency differences is about 86% in a minimum search and 77% to its test result average [13] The research also contains some reviews from the installation of mesh Pathfinding navigation in which A* as the Artificial Intelligent alternative for villain character in Pacman. Path is designed by using NavMesh concept. As from the test result that have conducted comparison with Djikstra Algorithm, then obtained result showing A* algorithm can make precise movement from villain character is faster to catch Pacman in 43 steps to 348 steps in comparison [14].

Furthermore, from the comparison of prior research, it is known that A* algorithm can be as the solution to determine shortest route to arrive at the precise destination. The result from its installation is also appropriate with conducted research

II. METHOD

This research consists from several phases such as portrayed in figure 1.

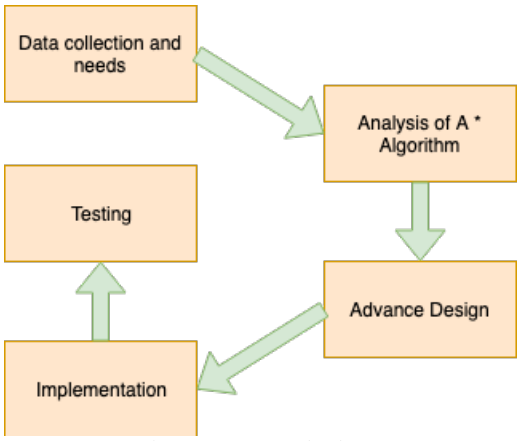


Figure 1. Research Phase

A. *Collecting Data and Requirement*

This phase is collecting data of pharmacy in Pangkalpinang city, such are pharmacy's information, locations and its coordinate. Besides that, direct interview section held towards some of the community related with the trouble or problem that faced when they search location of the pharmacy. Literature study is also conducted to its reference, journal articles or another article in similar theme with this research.

B. *A* Algorithm Analysis*

A* algorithm has mainly applied in the shortest route search application. This is also provide appropriate balance between speediness and accuracy[5].

A* algorithm has three values to each node *n* [6]:

1. *Heuristic* value
   To calculate *heuristic* distance between two points is using the formula:
   $$h(n) = \sqrt{(X_n - X_{goal})^2 + (Y_n - Y_{goal})^2} \quad (1)$$
2. Minimum *Cost* from early *node* movement to *n*, *g-value g(s)*
3. Minimum *Cost* early *node* movement through *n* to destination *node* (target), with formula:
   $$f(n) = g(n) + h(n) \quad (2)$$

   Notes:
   - *f(n)* is a cheapest estimated cost solution *node n* to reach the object.
   - *g(n)* is *path* cost or travel
   - *h(n)* is an estimation from *node n* to destination

The illustration from A* algorithm calculation as shown in figure 2

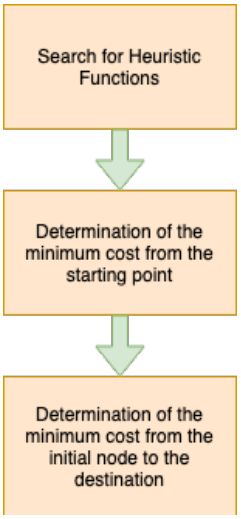


Figure 2. A* algorithm calculation chart

C. Design

This part is conduct system designing using *tool* UML.

D. Implementation

In this phase, applying the A* implementation to a web-based system as early stage of the research.

E. Test

The test is held to assess the under-way system. It is conducted by *alpha* and *beta* system.

III. RESULT AND DISCUSSION

A. A Algorithm Calculation*

To conduct the A* algorithm calculation, we need to change existing distance into a *node*/point form then converted into matrix *graph* to make the calculation easier.

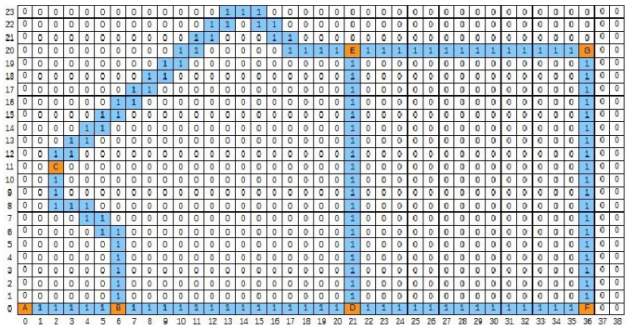


Figure 3. *Graph* Matrix Node

From figure 3 above, we acquired A point coordinate A = (0,0); B = (6,0); C = (2,11); D = (21,0); E = (21,20); F = (36,0); G = (36,20).

B. Determine Heuristic values of each node

To obtain *heuristic* values, it is required some formulas (2) as follows:

- A (0,0) to B (6,0)

$$h(n) = \sqrt{(0-6)^2 + (0-0)^2} = \sqrt{36} = 6$$

- B (6,0) to C (2,11)

$$h(n) = \sqrt{(6-2)^2 + (0-11)^2} = \sqrt{137} = 11{,}7$$

- B (6,0) to D (21,0)

$$h(n) = \sqrt{(6-21)^2 + (0-0)^2} = \sqrt{225} = 15$$

- C (2,11) to E (21,20)

$$h(n) = \sqrt{(2-21)^2 + (11-20)^2} = \sqrt{442} = 21{,}02$$

- D (21,0) to E (21,20)

$$h(n) = \sqrt{(21-21)^2 + (0-20)^2} = \sqrt{400} = 20$$

- D (21,0) to F (36,0)

$$h(n) = \sqrt{(21-36)^2 + (0-0)^2} = \sqrt{225} = 15$$

- E (21,20) to G (36,20)

$$h(n) = \sqrt{(21-36)^2 + (20-20)^2} = \sqrt{225} = 15$$

- F (36,0) to G (36,20)

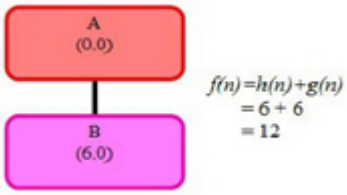
$$h(n) = \sqrt{(36-36)^2 + (0-20)^2} = \sqrt{400} = 20$$

C. Determine f(n)

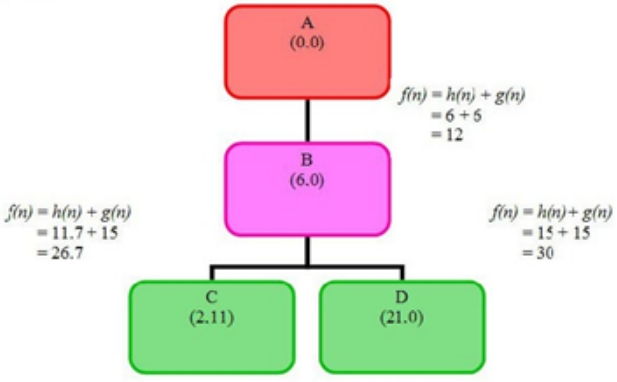
Next phase is to determine *f(n)* value using formula (1) with using obtained *heuristic h(n)* value

- Step 1

- Step 2

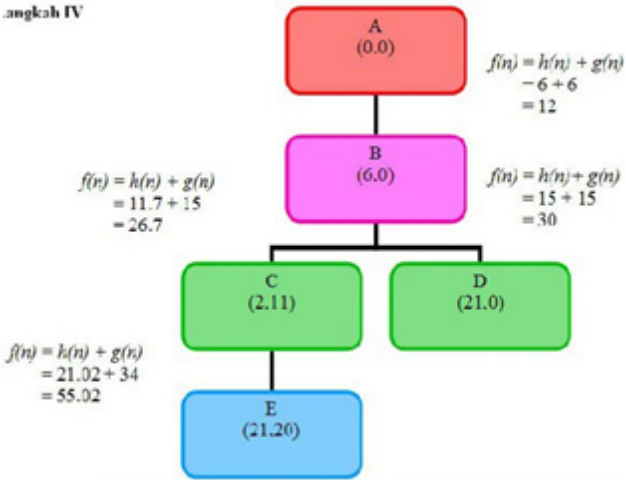


- Step 3

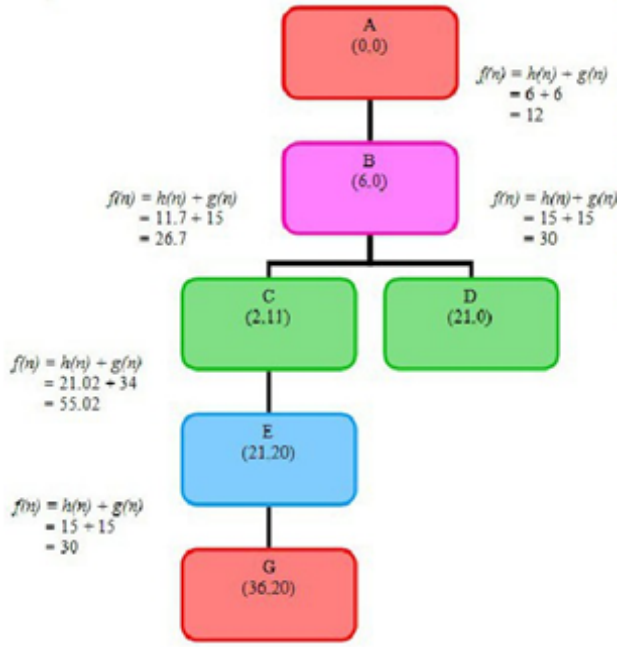


Node B has two branches (C dan D) then selected f(n) is a f(n) with smallest cost such as node C.

- Step 4



- Step 5



After calculating whole *f(n)*, so that we acquired shortest distance total from the possibility of node A to G, where:

= 12 + 26,07 + 55.02 + 30
= 123,72

From that result above, we can determine that shortest track/path that traveled are: A – B – C – E – G.

D. System Interface Display

1. Route Search

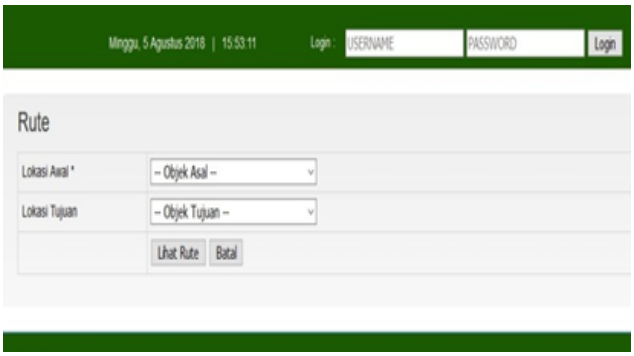


Figure 4. Route Input Form

Users input their starting position with their targeted pharmacy in this page. The shortest route search result displayed after user clicked 'see route' button.

2. Shortest Route Result

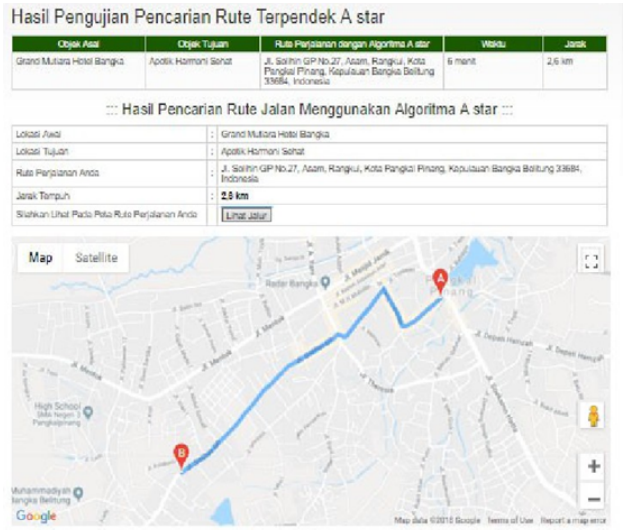


Figure 5. Shortest Route Result

After input process of user location, then the display from shortest route in system is shown as in figure 5. This system can directly provide travel route reference for user to get shortest distance to arrive in destination pharmacy. It is also the mileage of total travel in kilometer unit and some estimated times to get arrive in minutes unit.

3. Pharmacy Location in Admin Page

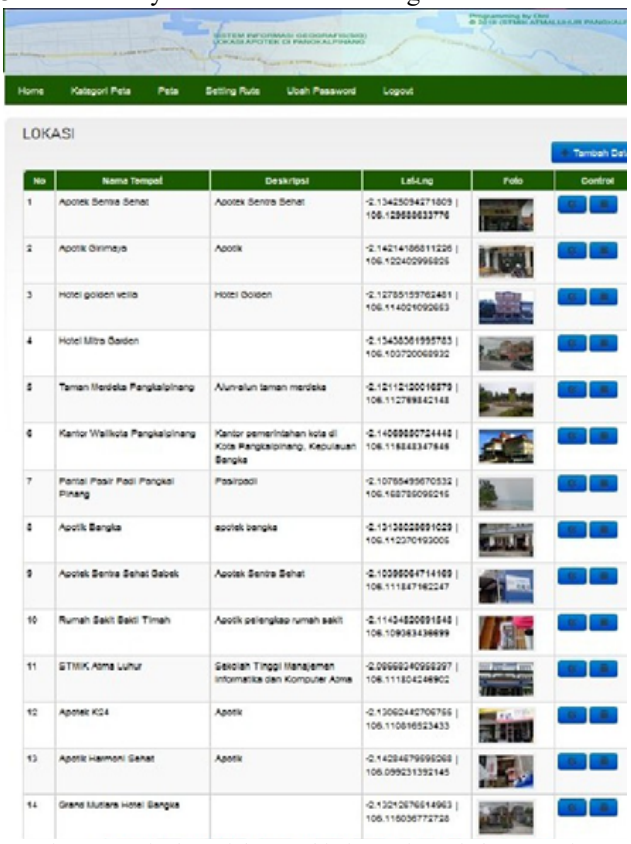


Figure 6. Display of data and information of pharmacy in admin's page

This page is used by admin to add more data and pharmacy location in system. It is also displayed picture of front-side of the pharmacy and its *lattiude-longitude* coordinates.

4. Pharmacy Route in Admin Page

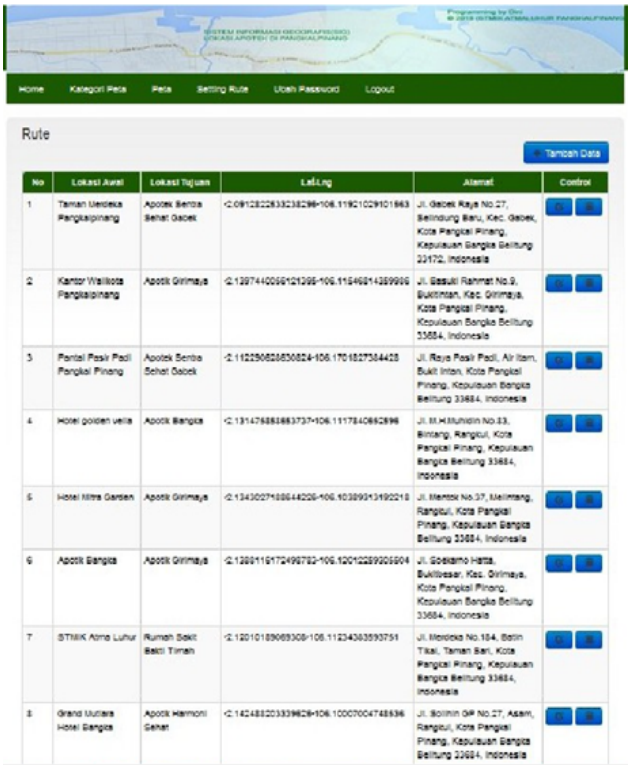


Figure 7. Display of Route Setting in the admin page

In this page, admin can add pharmacy new route such as complete address with its *Latitude-Longitude* coordinates.

5. *Input* Data of Pharmacy Location

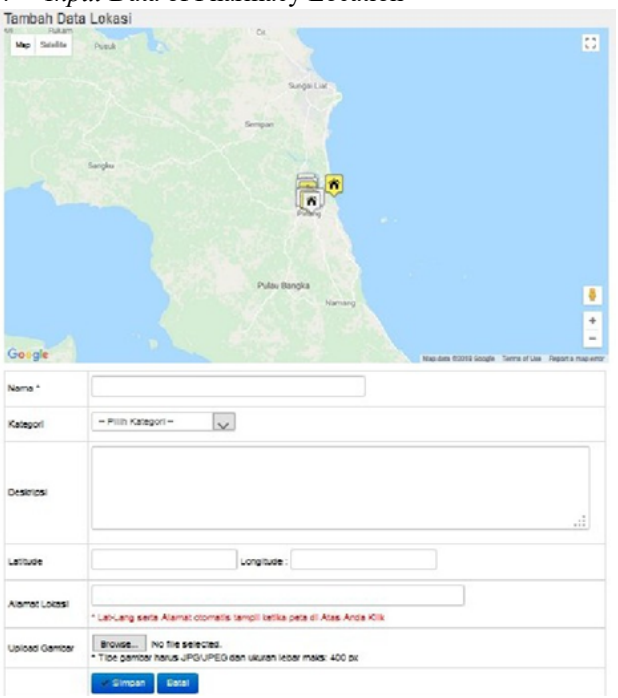


Figure 8 Display of *input* pharmacy location in admin page

Figure 8 describes the display of admin page to add data pharmacy location into system

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E. *Alpha* Testing

In this test with using blackbox test method as its alpha. The implementation in finished system is tested and produce some of test results as follows:

Table 1. Blackbox Test

No.	Testing	Result	Validation
1.	User *Input*	User can well-conducted *input* to system	Yes
2.	Search of Shortest Route	System is success to provide shortest route search that begin in starting point of user location to pharmacy location destination	Yes
3.	*Input* pharmacy new location	System is success to keep newest data location into *database*	Yes
4.	*Input* Newest Route	System is success to keep newest data route into *database*	Yes
5.	Edit Newest Location	System is success to keep newest data location that has changed into *database*	Yes
6.	Edit New Route	System is success to keep new route data that has changed into *database*	Yes

From the test result, it determined the blackbox test result with using certain formula as follows:

$$N = \frac{Y}{P} * 100\% \quad (3)$$

Notes:
N : Value of Blackbox testing
Y : Number of Positive Validation
P : Number of Question

So that obtained 100% result from Blackbox testing.

F. *Beta* Testing

This test is conducted by distributing questionnaire to user sample. It consists of four question using Likert scale from 1 to 5. The test result is in user's satisfactory-rate to system. Meanwhile the point from proposed question to user as follows:

1. An attractive *user-friendly* system interface.
2. System can help users to search shortest route to a nearest pharmacy from their location.
3. System can fulfill and enrich the information of pharmacy in Pangkalpinang city.
4. System provides simplicity in the process of searching nearest pharmacy.

From each question, researchers determined highest score scale for positive value that 5. It is also to lowest score negative value that is 1. From each respondent answer results, researchers add some formula:

$$Tn = R * Pn \quad (3)$$

Notes:
T_n = Total of value
R = Total respondents
Pn = Selection of Likert numbers score

Add up the total number of T_n in accordance with the Likert scale value that the respondent filled in to get the T_{tot}. Then we determine the interpretation of the calculation score using the formula:

$$Y = Higher\ Score * number\ of\ respondents \quad (4)$$
$$X = Lower\ Score * number\ of\ respondents \quad (5)$$

Insert T_{tot} to search *index* formula percentage (%) with formula:

$$Index\ \% = \frac{T_{tot}}{Y} * 100\% \quad (6)$$

Notes:
Index % : Percentage value
T_{tot} : Total Score
Y : Higher Score * number of respondents

As well as Likert Scale it has determined the criteria of score interpretation based on the interval around 20% as follows:

Table 2. Interpretation Criteria Based on Interval

No.	Interval Value	Final Result
1	0 - 19,99	Very Disagree
2	20 – 39,99	Disagree
3	40 – 59,99	Average
4	60 – 79,99	Agree
5	80-100	Very Agree

From the calculation using mentioned formula above, this research obtained test result as illustrated in the graphic in figure 9:

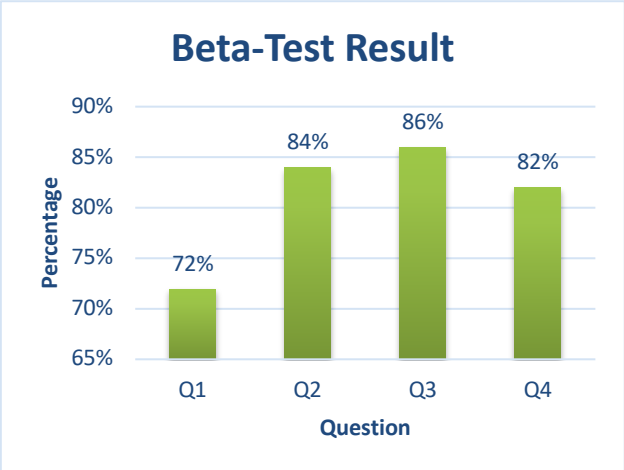

Figure 9. Beta-test result

IV. CONCLUSION

This research has succeeded the development of search system especially in shortest route search for nearest pharmacy that using A* algorithm. From the test result of *alpha* testing that using blackbox testing, it obtained result from this system has reached 100% as expected. Meanwhile, from the *beta* testing with the distribution of questionnaire that involving 10 respondents which have got perfect results. For the example, as the first question regarding the display of system with its *user-friendly* and attractive design then obtained value around 84% in the category of "very agree". Furthermore, the results from third question regarding system that can fulfill and enrich the information of the pharmacy in town has gained value around 86% in the category of "very agree". Last but not least, from the fourth question that has gained 82% in the category of "Very agree" towards question of system that provides simplicity in the process of searching nearest pharmacy from user's location.

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