

**OPTIMAL ROUTING MODEL FOR MULTIMODAL
TRANSPORTATIONS, MINIMIZE WAITING TIME**

THANAWAT BAMRUNGTHAI

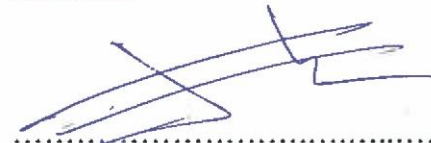
**A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(INFORMATION TECHNOLOGY MANAGEMENT)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2016**

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Thesis
entitled
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TRANSPORTATIONS, MINIMIZE WAITING TIME**

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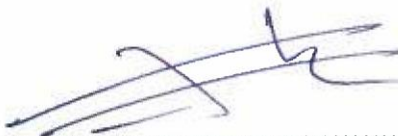
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was submitted to the Faculty of Graduate Studies, Mahidol University
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ACKNOWLEDGEMENTS

This thesis would not be complete, if I did not have my advisers, connoisseurs and others that encourage me in everything to succeed the project. I would like to highly thanks to my advisers Asst. Prof. Supaporn Kiattisin, Ph.D., Assoc. Prof. Adisorn Leelasantitham, Ph.D., and Sotarat Thammaboosadee, Ph.D. who significantly support me in my research. They devoted themselves to accurate guidance on my progress on the project. In addition, they also clearly advise the necessary parts including knowledge bases, thinking methods, procedures and the direction of writing the report. I appreciate for your help and advice toward my achievement.

Finally, encouragement from my family, colleagues and friends were significant parts to move the project. They were always beside me when I was in difficult situations or pressure during performing the project. Moreover, I would like to thanks to Miss Phet Jarujutarat who is a System Analysis at True Information Technology Co., Ltd. She also recommended me to use logic and popular framework for testing the model in my thesis completely.

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ABSTRACT

It is believed that one of the highest national incomes of Thailand is from the tourism industry. The government has hundreds of billion-baht in income each year. In Thailand, there are numerous kinds of the tourism, such as nature based tourism, historical tourism, cultural tourism and so on. Similarly, public transportation is also said to be a significant part of travelling to bring tourists to their expected destinations.

According to the research, time spent is the main factor for travelers to choose a variety of public transport. Generally, there are many points connected to other points and different procedures known as “Multimodal Transportation”. Moreover, “Optimal Routing Model” is the main model created for finding the best solution of travelling with both values of “Travel Time” and “Waiting Time”. In the research, with 300 respondees, over 25 percent of testers chose a way in that they spent the less time travelling following the instruction of the model.

**KEY WORDS: MULTIMODAL TRANSPORTATIONS / OPTIMAL ROUTING
MODEL / TRAVEL TIME / WAITING TIME.**

42 pages

รูปแบบการกำหนดเส้นทางที่เหมาะสมที่สุด สำหรับการขนส่งอย่างต่อเนื่อง, ลดระยะเวลาในการรอคอย

OPTIMAL ROUTING MODEL FOR MULTIMODAL TRANSPORTATIONS, MINIMIZE WAITING TIME

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บทคัดย่อ

อุตสาหกรรมการท่องเที่ยวในประเทศไทยถือเป็นอุตสาหกรรมหลักที่นำรายได้เข้าสู่ประเทศไทยไม่ต่ำกว่าหลายแสนล้านบาทต่อปี เนื่องจากประเทศไทยนั้นมีแหล่งท่องเที่ยวมากมายไม่ว่าจะเป็นด้านธรรมชาติ, ประวัติศาสตร์, หรือแม้กระทั่งตลาด การท่องเที่ยวเหล่านี้จะขาดไม่ได้เลยคือการขนส่งมวลชนหรือการขนส่งสาธารณะ ซึ่งมีบทบาทค่อนข้างมากต่อการขนส่งนักท่องเที่ยวไปยังจุดหมายปลายทางต่างๆและมีผลต่อการตัดสินใจต่อการเลือกการเดินทางอีกด้วย ในงานวิจัยชิ้นนี้จึงสังเกตเห็นว่าเวลาเป็นหนึ่งในตัวแปรหลักที่ส่งผลต่อการตัดสินใจในการเดินทางแน่นอนว่าการเดินทางจากต้นทางสู่ปลายทางที่นักท่องเที่ยวต้องการ โดยส่วนใหญ่แล้วมักจะมีการเดินทางหลายต่อและต่างรูปแบบการขนส่งซึ่งเรียกว่า “การขนส่งอย่างต่อเนื่อง(Multimodal Transportations)” เราจึงได้สร้างโมเดลขึ้นมาเพื่อหารูปแบบเส้นทางที่เหมาะสมที่สุด(Optimal Routing Model) เพื่อให้ได้เวลาที่ดีที่สุดในการเดินทาง โดยมีตัวแปรเวลาการเดินทาง(Travel time)และเวลาการรอคอย (Waiting Time)สำหรับการเปลี่ยนการขนส่ง จากการทดสอบโมเดลจากผู้ใช้งานจริง 300 คน ผลปรากฏว่าจำนวนผู้ใช้มากกว่าร้อยละ 25 ได้เลือกเส้นทางซึ่งใช้เวลาสำหรับการเดินทางน้อยที่สุดตามคำแนะนำของระบบที่ได้จากโมเดล

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CHAPTER I

INTRODUCTION

1.1 Background

Nowadays, the tourism industry in Thailand has the role and the importance. It is the source of revenue [1] that important to country and it also helps stimulate the economy as well. We observe that the number of tourists and tourism revenues during 2012 to 2015 [2], as shown in figure 1.1. Although, it has events which affect the travelling but it affects very little tourism. The travelling of the traveler that depend on many factors such as times, costs, hostels and include convenience. In addition, the travelers need the convenience to travel from one place to another place. We see that traveling must be transit at least two nodes called "Multimodal transportation"[3].

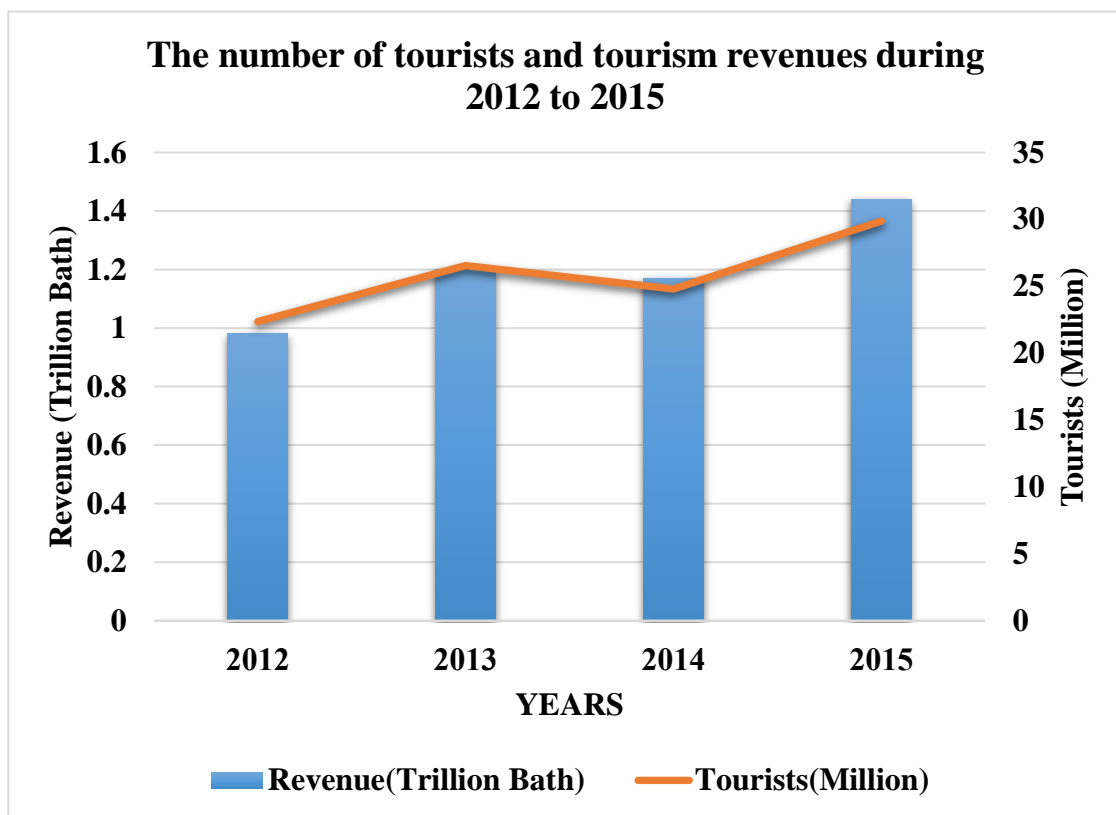


Fig. 1.1 The number of tourists and tourism revenue from 2012 to 2015

The transports have both people and goods which depend on three variables as travelers, different modes of transportation and different operators. The main aim of multimodal transportation is the movement or trip. We show the cheaply multimodal transportation as shown in figure 1.2. Generally, the travel from one place to another place has to wait for transport whether it be rail, bus, plane or boat which these call that “Mass transportations” [4].

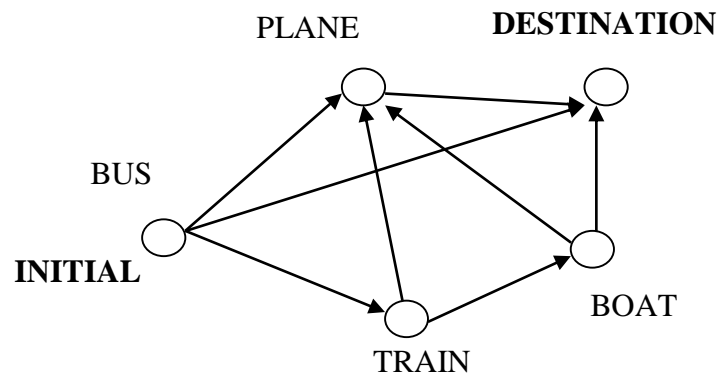


Fig. 1.2 The cheaply multimodal transportation

In this research, we use Ant Colony Optimization (ACO) to improve the quality of travelling with parameters such as the time schedule of transportation each node, the waiting time, quantity for selection node from source to destination.

1.2 Objective

To study the waiting time of multimodal transportations.

To create the optimal routing model for multimodal transportation.

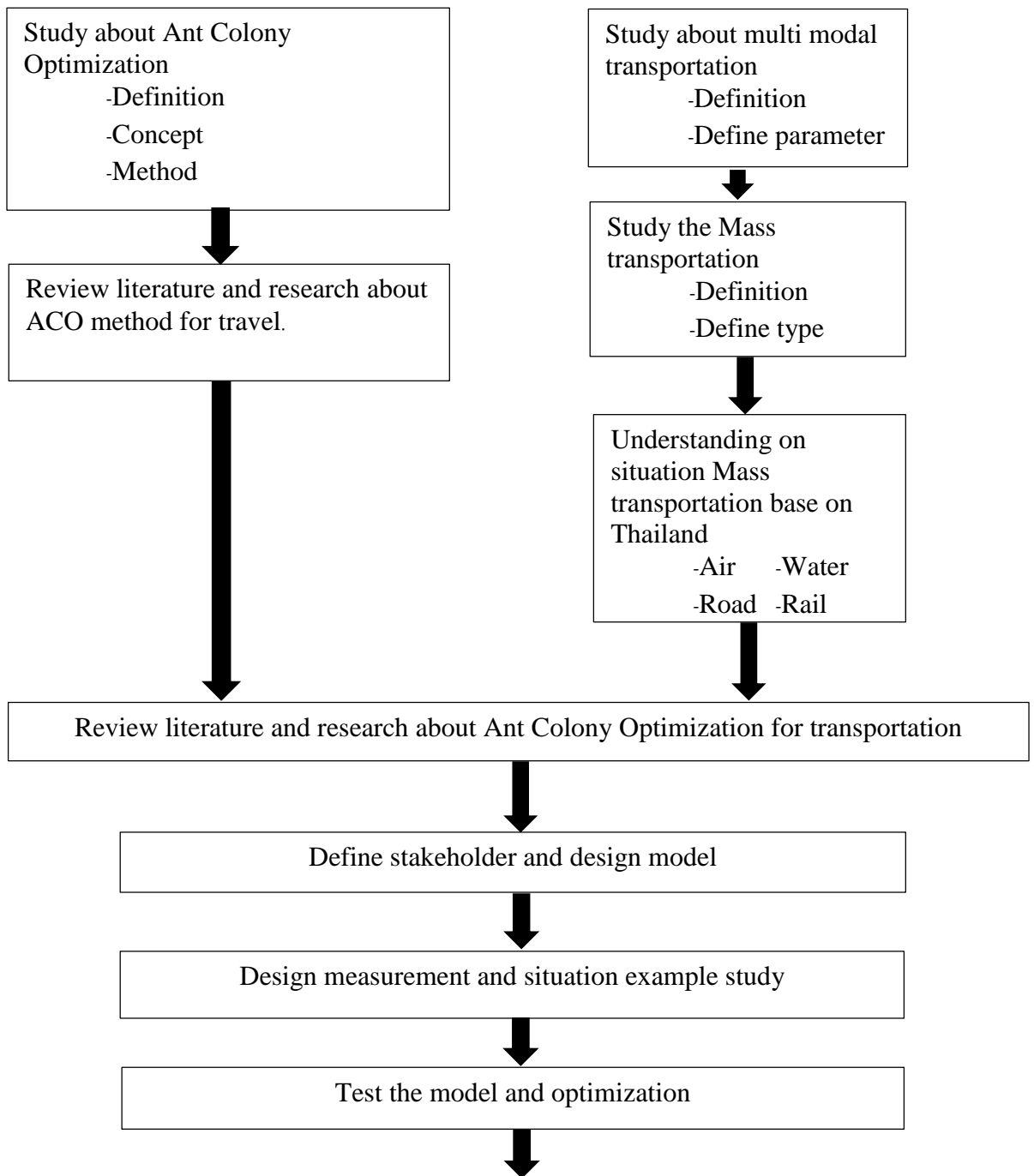
1.3 Scope of work

This research, we interest the waiting time which is the important factors for finding in the best travel time schedule. In term of modeling, we bring time factors of travel from source to destination to create the model.

1.4 Expected result

We want to minimize the total travelling time from source to destination by using model for finding the optimal routing for multimodal transportations.

1.5 Process of work



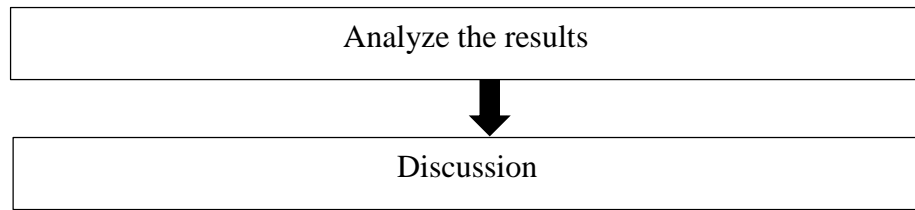


Fig. 1.3 Process of work

CHAPTER II

LITERATURE REVIEW

2.1 Ant Colony Optimization(ACO)

Ant Colony Optimization(ACO) was developed by Ant System(AS) due to a first thinking of ACO that effectively improve and develop AS. ACO has extremely changed the progress of AS. Moreover, ACO have not only used for a resolve of travelling, but also other problems such as, a schedule and a square problem. We are explaining that AS is a former ACO, and ACO is a thinking adjusted by AS is being used as a ideal model for resolve of travelers' s behaviors.

2.1.1 Ant System

The first ACO [5] was presented when 1991 B.S. which was invented by Macro Dorigo and coadjutor known AS. In fact, the old AS have been three types are Ant-density, Ant-quality and Ant-cycle. By Any-quality which have functioned updated instantly pheromone as travel from node or city to city. As Ant-cycle system would update pheromone after that ant had walked fully city.

By quantity of pheromone that would update depend on constant fraction to distant or quality of solution. Finally, Ant-density and Ant-quantity system then have not been next improvement and development. As it could not find solutions or root effectively beside Ant -cycle system. Hence at present when refer AS is Ant-cycle system there.

2.1.2 Ant Colony System

Ant Colony System(ACS) was developed to improve the performance of AS [6]. The improvement was different from previous times because it has not depended on AS anymore by creation of new mechanisms for effective working. ACS was presented in 1997 by Dorigo and Gambardella, and it was different from AS:

1. ACS would develop parts of ants's travelling that would increase ants's experiences, and it would be more an impact for a selection of travelling.
2. An evaporation and release of the Pheromone will be only the best way of selection.
3. In the part of ways that ants move to, ants would release the Pheromone in order to an increases and opportunities of selection of other ways.

2.1.3 The ACS pheromone system

The ACS pheromone system consist of two rules such as the first rule has been said that was used to solve structure problem. Said that has updated local pheromone would next ant select route would go to destination have a few pheromone less than go to route have much pheromone which would said that in next law [7]. And the second rule has to use after all ants have release all pheromone until finished since start point to final point were updated and supported the nearest root to next ant would to decide select route to destination. Which both two rules have shown behavior select route of previously ant has released pheromone as shown in figure 2.1

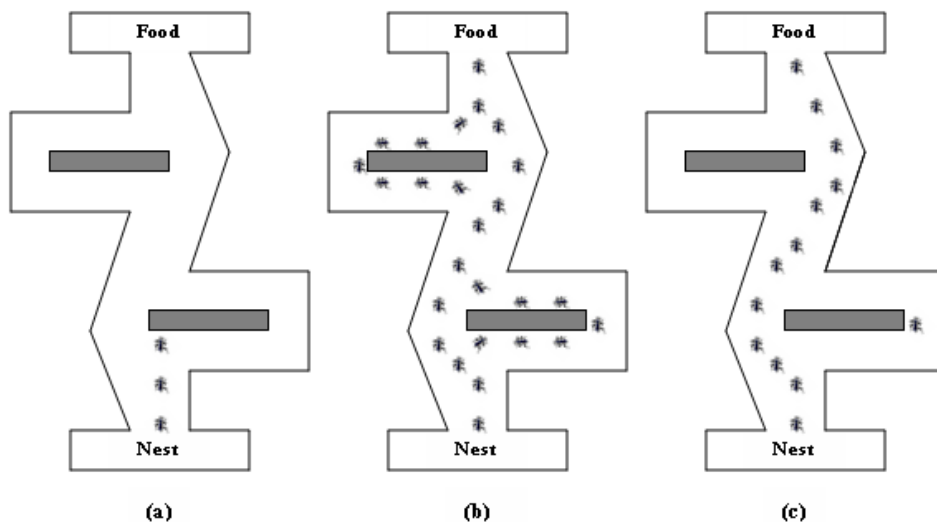


Fig 2.1 Pattern selecting the best route of ant [8]

The general principle's ACO each pattern which have base-on from AS is step working of the ant solution construction and pheromone update [9]. We can see from diagram as shown in figure 2.2

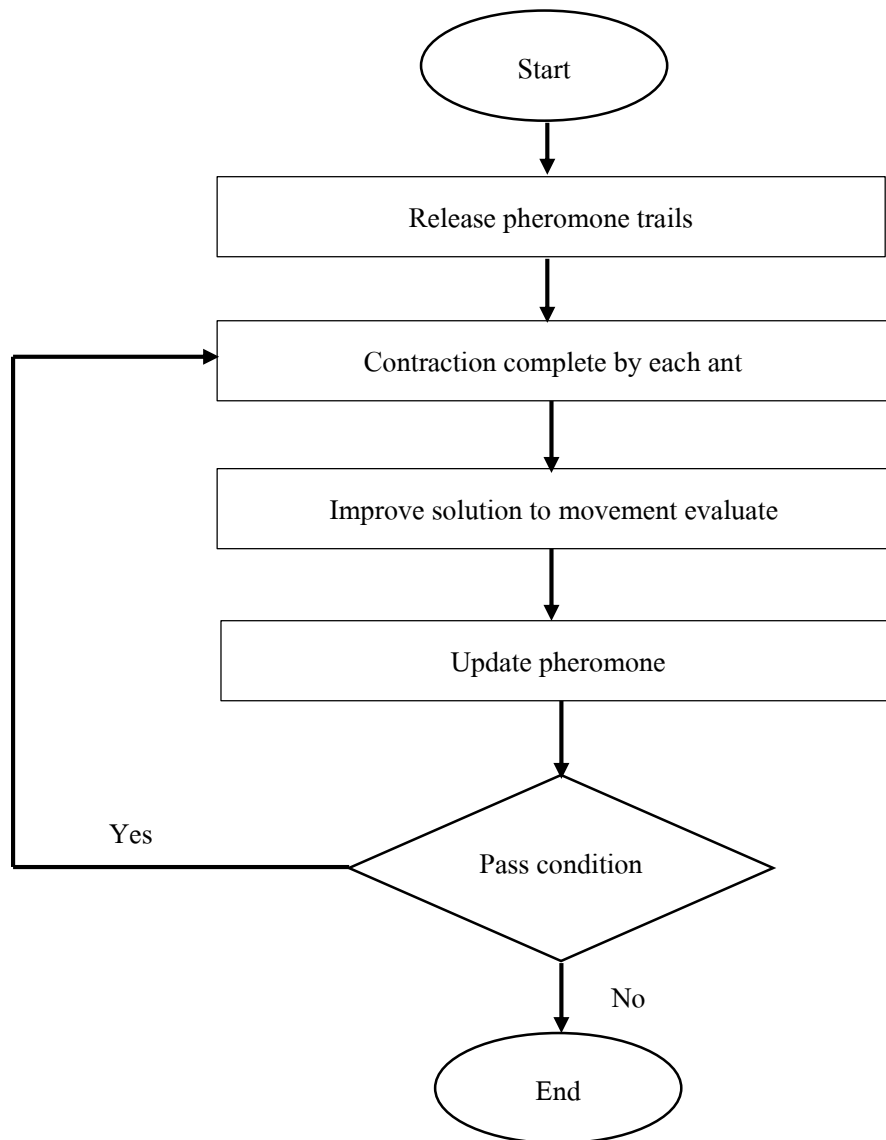


Fig 2.2 The general structure's ACO.

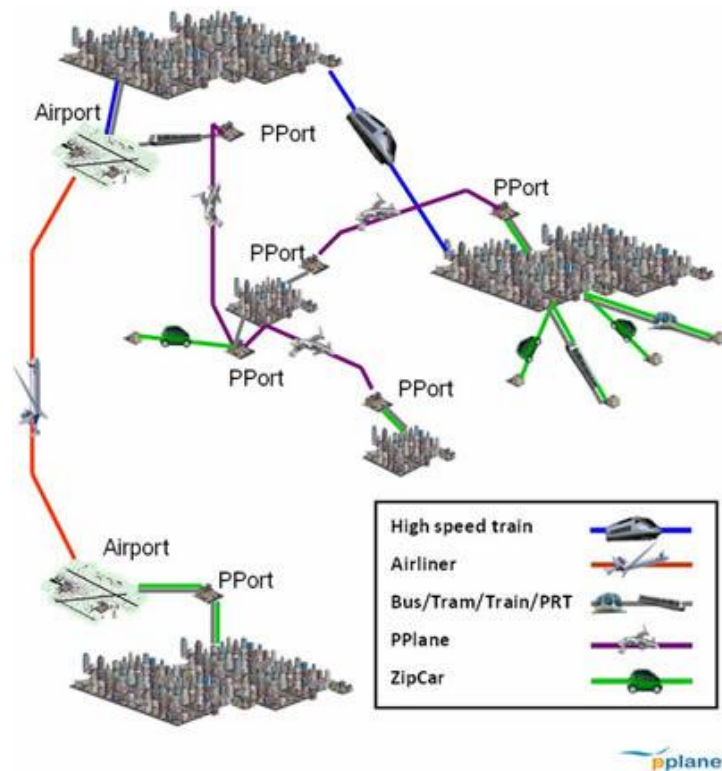
2.2 Multimodal transportations

Biellie [10] has to define about a multimodal transportation system that “the combination of all traveler and transportation systems operated though divers systems. The main of a multimodal transportation system it consists of travelers, different modes of transports and different operators. Distinctive of component of the multimodal transportation system that depend on many factor which as: modes of transportation

route, lines and the infrastructure network from one field, and on the other field the motion of the travelers. These components are the concepts of transfer and transit.

Transfer points are the points for the changing and connect modes from another mode where travelers can change mode. The most important for multimodality is the transfers which is core concept.

We conclude that a group of multimodal transportations are choices of modes transportation or the transfer for traveler which they have various factors.



[11] Fig 2.3 Multimodal transportations

2.3 Transportations and mass transportations

A transportation is a move of human or things from one place to another places. It divides into lands, water, air and rail [12]. We could determine many views of transportation being view of infrastructures, vehicles and a progress of basic infrastructure. A determination of connected transportation such as roads, railroads, airways, canals or tubes and transport stations such as airports, train stations, bus terminals and docks. meanwhile, vehicles that could move into that network are cars,

trains, plane, ship. A progress is interested about a control of systems such as traffic system, air control system and a policy such as account system being toll or fuel's taxes.

A mass transportation means move from one place to another places, especially bring vehicles to transport.



Fig 2.4 Mass transportations [13]

In order to understand multimodal transportations system which it had been defined by our that consumption from 2.3 and 2.4 thus;

- Transportations infrastructure.
- Modes of transport.
- Multimodal trips.
- Transfer points.

2.3.1 Transportation infrastructure

Mandloi and Thill [14] who describing a multimodal transport network involve that the use of different transportation infrastructures same road, rail, water or air. Transportation infrastructures demonstrate the means of transit for the modes of transport.

2.3.2 Modes of transport

Comtois et al. [15] said transportation modes that "the means by which people and freight achieve movement". Modes of transportation have two main part

which are private and public transportation. It has been different for travel when have changing transfer

2.3.3 Multimodal trips

Van Nes [16] define that "when two or more different modes are used for a single trip between which the traveler has to make a transfer" Hoogendoorn-Lanser et al [17]. said about it that "a trip when it involves at least one transfer between-not necessarily different mechanized modes.

2.3.4 Transfer points

Transfer point or switching mode is another important concept for multimodal transportation system which is the transfer between modes when occurs at the so called "switch point" [17]. Transfer points are respected important because they are connectivity between two modal network is established only at these transfer points.

2.4 Mass transportation in Thailand

The Mass transportation substantially has an importance of countries' development both economy and social, especially decreasing human's cost of living. In addition, to have effective mass transportation system has many travelling patterns that vary, comfort and appropriate for costs. Moreover, it could help travel to decide to visit Thailand as well, and make industries that could grow continuously [4]. By mass transportation's Thailand have several types both land, water and air. But in the present, The most popular mass transportation by land. In addition, the government's Thailand has made an effort developed mass transport system by take many technologies for it.

The mass transportation mode has a lot of mode which consider selecting mass transportation system. Maybe consider from distance, time and costs for travelling

2.4.1 Mass transportation by land

It is a mode, which can divide are road and rail transportation.

-The most popular road transportation mode in Thailand because it quickly and a worth cost include to have route for several and cover travelling. Its good respond to need for travelling of human.

-The popular rail transportation use for travelling between province and for low earner. Wherewith have several selecting costs but it has late time limitation.

2.4.2 Mass transportation by water

-The mass transportation by water within country has short distance. Since it has depth's rivers. So vehicle often use a small boat, which a lot transportation and short distance only. But often transportation between countries for travelling

2.4.3 Mass transportation by air

-The most popular mass transportation by air both in the country and between countries. Because more quickly and safety than another transportation mode.

The mass transportation in Thailand that have many modes. But number of customer's domestic during 2009-2013. there are a number of relatively stable as shown in table 2.1 and figure 2.5

Table 2.1 Statistics of domestic transportation passenger during 2009-2013

Mode of transportations	2009	2010	2011	2012	2013
BMTA	406,375	382,682	374,906	355,134	341,540
The Transport Company Ltd.	11,038	10,834	10,545	10,112	9,599
Trains	47,939	44,535	44,054	41,761	37,343
MRT	63,419	64,553	69,502	80,602	84,680
Water	114,322	110,943	112,115	101,568	138,354
Air	26,420	26,935	31,184	36,325	43,331
Total	669,513	640,480	642,305	625,502	654,848

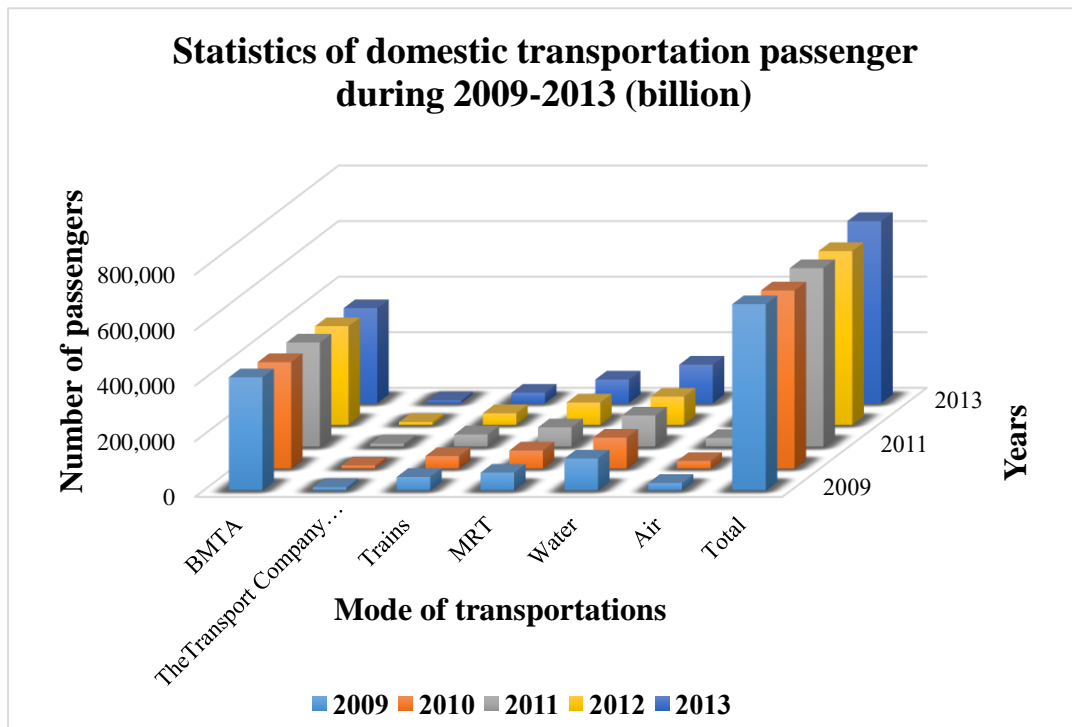


Fig 2.5 Statistics of domestic transportation passenger during 2009 - 2013

2.5 Relate of work

The work of Lyons, Harman, Austin and Duff [18] tried to provide the public with the opportunity to compare travel options across public and private transportation modes, looking to offer a one-stop-shop travelling planning. The work identified critical topics, their findings and limitations. The topics mainly lie in the government's planning perspective, its feasibility and information gathering process. The report offers highlights on the challenges during the government's decision-making.

Li and Wachs [19] had proposes is a group of inter-modal performance indicators in which services input, service output and consumption of services were measured with costs, revenue, and unlinked passenger trips/miles in turn depend on economic principles and evaluation objectives, and concluded that their increased inter-modal performance indicators are more reasonable for comparing the efficiency and effectiveness of different modes or combination of transit modes. The concern of inter-modal performance can be view as a corollary of the importance of differences in multimodal transportation planning process.

John and Patrick [20] studied the vehicle routing problem by using Ant Colony Optimization techniques. They had proposed is the improvement algorithm for finding solutions within 1% of known optimal solution and use ant colonies provide competitive solution technique when it compared with lager problem. By improvement techniques of them represent that could separate ant colonies with separate pheromone trails for each vehicle and using separate pheromone trails results from the need to separate the most likely routes for different vehicles.

Dynamic Travel Path Optimization System Using Ant Colony Optimization [21]. The researcher had applied a Dynamic Travel Path Optimization System(DTPOS) base on Ant Colony Optimization(ACO) could efficiently improve the traffic situation in an urban environment. They compared between DTPOS and DTPOS without ACO for finding the best path. As a result, The DTPOS solution provided better than DTPOS without ACO as shown in figure 2.6, but both solution gave same the result ware reduce the average travel time, average waiting time and number of stopped cars. In addition, increase the average travel speed as well.

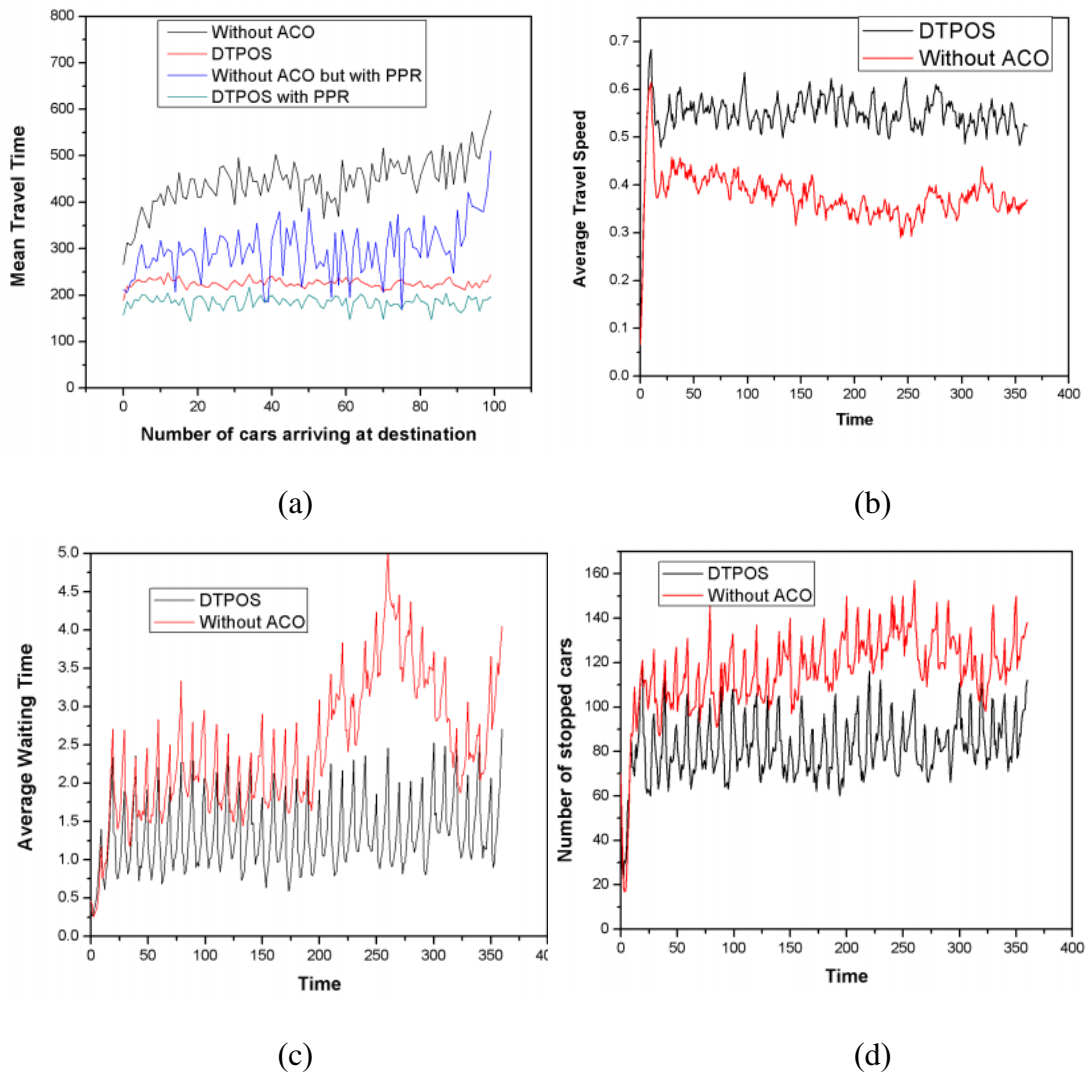


Fig 2.6 Compare DTPOS and without ACO solution, (a) Mean Travel Time, (b) Average Travel Speed, (c) Average Waiting Time and (d) Number of stopped cars

Privacy-Aware Ant Colony Optimization Algorithm for Real Time Route Planning [22]. The researcher had applied an inverted Ant Colony Optimization(IACO). The aim of them wanted present pro-actively for solve traffic jam. In the method, they wanted distribute possible routes for real-time city demand for eliminating privacy concern. In addition, they used to shortest time and shortest distance algorithm brought to compare the efficiency of inverted Ant Colony Optimization. As a result, IACO provide result better than shortest time. The results shown in figure 2.6 which compared between IACO and ST algorithm.

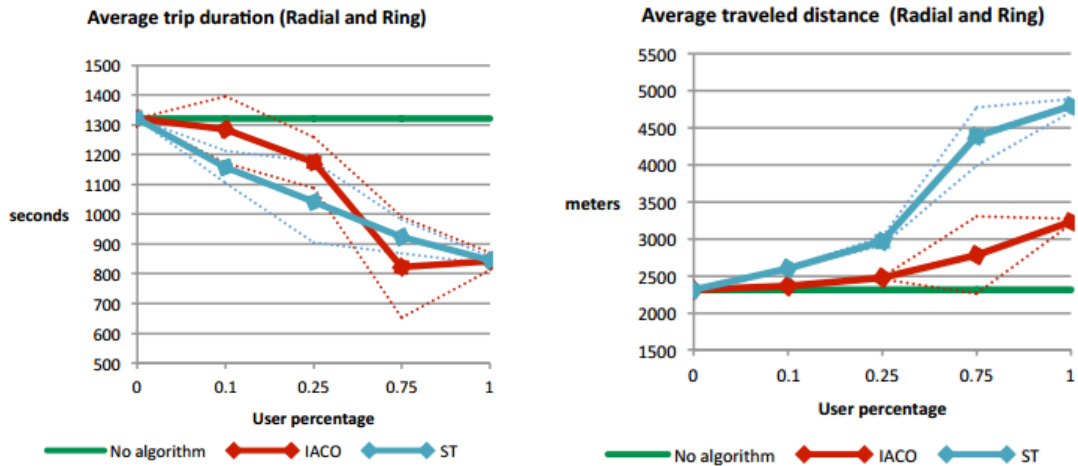


Fig 2.7 Compare IACO and Shortest Time

(a) Average trip duration and (b) Average traveled distance

Ant-based vehicle congestion avoidance system using vehicular networks [23]. The researcher had applied an Ant-base vehicle congestion avoidance system(AVCAS). This research had two challenge were the dynamic and unpredictable nature of the network topology of vehicular environments, especially in urban areas. The aim of this research was decreasing serious congestion. They brought Dijkstra, PACO and HRS algorithm compare with AVCS. As a result, The AVCS provide a result better than other algorithm. This research shown a result that can increase speed, decrease time, but it increases the travel distance.

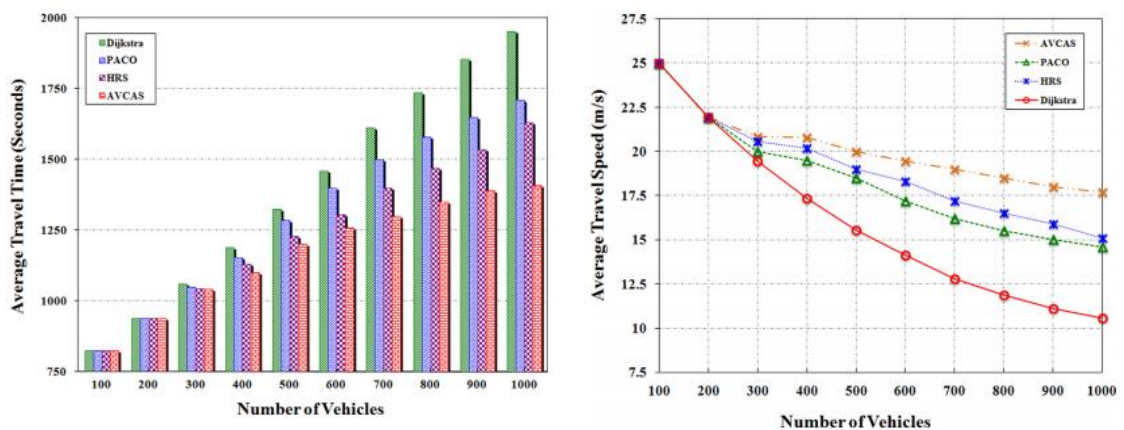


Fig 2.8 Compare Dijkstra, PACO, HRS and AVCAS

(a) Average Travel Time and (b) Average Travel Speed

Ant Colony Optimization for Traffic Dispersion [24]. The researcher had applied Ant Dispersion Routing. They wanted distribute traffic flows for solving of the traffic network equilibrium problem, in order to increase network efficiency. As a result, this solution it can reduce travel time of individual drivers.

In addition, there are other algorithm which applied traveling problem as A Hybrid Cuckoo Search Algorithm-GRASP for Vehicle Routing Problem [25] and Solve Traveling Salesman Problem Using Particle Swarm Optimization Algorithm [26].

From the research which mentioned above. Those led to research methodology in the next chapter. We conclude that the Ant Colony Optimization concept it caps applied to create optimal routing model for increasing the travel time. The next chapter will explain process optimal routing model.

CHAPTER III

RESEARCH METHODOLOGY

In this chapter, we mention the creation model which obtain from a problem of traveler. Those problems will be improved by model which we interest in the time problems such as waiting time, travel time and total time. Those factors are created under the optimal route model. It is used by user amount 300 people.

3.1 Research Requirement and Model Development

We want tester amount 300 people which invite to test model by web-base system. Model development, we have separate to 3 processes are get information of time schedule, transformation data and build model to website.

1. Get Information About Time Schedule

This process we keep data time schedule from website of NokAir[27] and Prempracha Transport[28]. We select time schedule on 26 January 2016 of the two companies.

2. Transformation Data

Because the two companies have the different some instants we need to transformation all instants in the same format.

3. Build Model to web application

The last process will bring the 2 process enter the model then brought up to website and test on model for usage.

3.2 Understanding Factors Affect Model

The time is the important factors which affect a decision of travelers. Certainly, traveling from source to destination there may be one transit which it easy to selection schedule for travelling but if more than one transit, it will has number of

schedule to a decision more and more. Total number of schedule can be obtained from eq 3.1

$$\text{Total number of schedule} = S_1 \times S_2 \times S_3 \times \dots \times S_f \tag{3.1}$$

When S is the number of schedule each nodes

f is the order of transit node

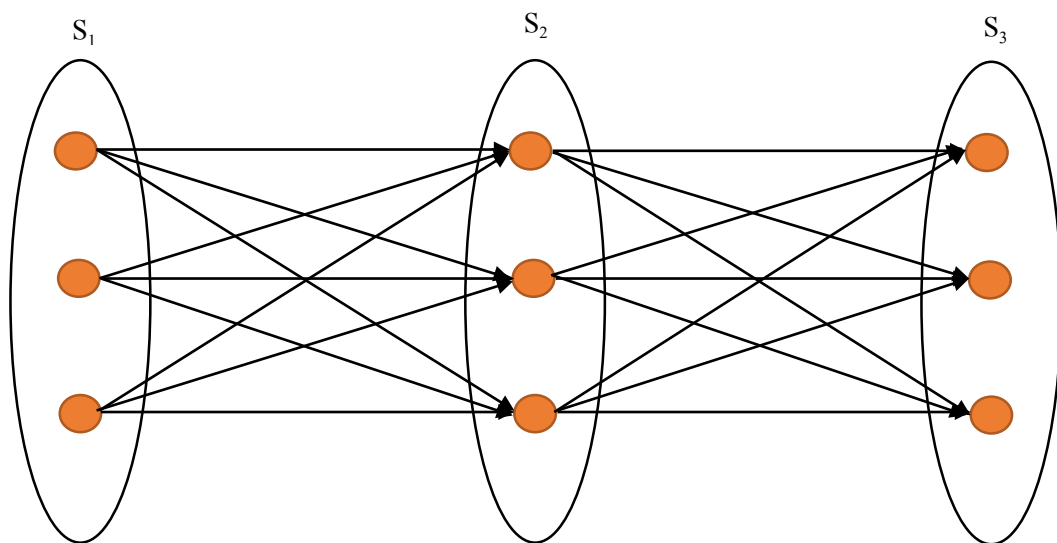


Fig 3.1 The example for the calculation total number of schedule

From figure 3.1 show the example for the calculation total number of schedule which both S_1 , S_2 , and S_3 have number schedule as 3. When calculate then will has total number of schedule as 27 schedules.

3.3 Build Optimal Model for Multimodal Transportation

From eq 3.1 we know that when increase number of schedule will give difficult decisions for the selection optimal routing. Certainly, in this research we interest the time factor only. We create model for find optimal routing by depend on time. In factor time has the waiting time and travel time. By total time will depend on the waiting time because travel time from source to destination will be constant.

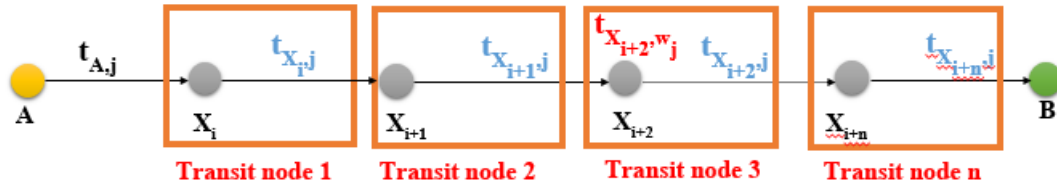


Fig 3.2 The factors for create optimal model

As shown in figure 3.2 will be brought build optimal model which those factors have the mean follow. A is a source

B is a destination

X_i is a node for transit

$t_{A,j}$ is a travel time to node for transit

t_{X_i,w_j} is a waiting time

$t_{X_i,j}$ is a travel time from transit node to next node

$i = 1, 2, 3, \dots, n$ where i is a transit node sequential

$j = 1, 2, 3, \dots, m$ where j is a time schedule sequential

n is the number of transit node

$$t_{total} = t_{A,j} + t_{X_1,w_j} + t_{X_1,j} + t_{X_{i+1},w_j} + t_{X_{i+1},j} + t_{X_{i+2},w_j} + t_{X_{i+2},j} + \dots + t_{X_{i+n},w_j} + t_{X_{i+n},j} \tag{3.2}$$

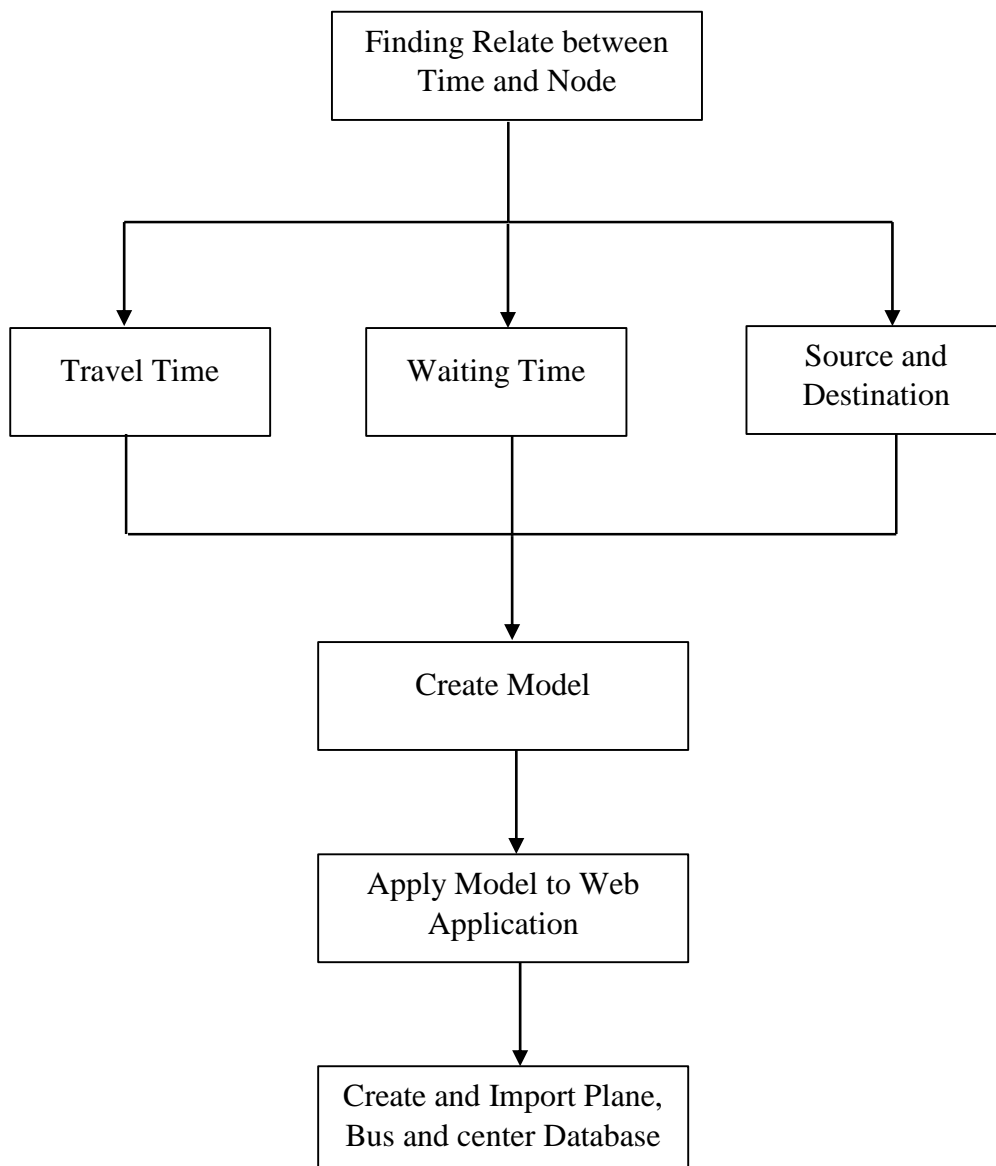
Those factors and figure 3.2 will be explained follow eq 3.3 which is model for finding optimal rotheuting of multimodal transportations.

$$t_{total} = t_{A,j} + \sum_{i=1}^n (t_{X_i,w_j} + t_{X_i,j}) \tag{3.3}$$

t_{total} is a total time from a source to a destination

From eq 3.3 and figure 3.2 can describe as one time travel schedule must have travel time and waiting time of each node. Exactly, you depart from source to transit node, it occurs travel time when you arrive it has waiting time for transit to

destination. On the way, it has travel time from transit node to destination or next node. If have many transit node, it has many waiting time and travel time to destination as well. The implementation optimal routing model to web application, we must have prepared a traveling schedule data as covert data to same format. After that, we must be created the centralize database for support calculation by ant colony algorithm. In part of user interface what they select time schedule complete, the system collects to centralize database for calculate and sequel table. Finally, we show the methodology of the optimal routing model as shown on figure 3.3.



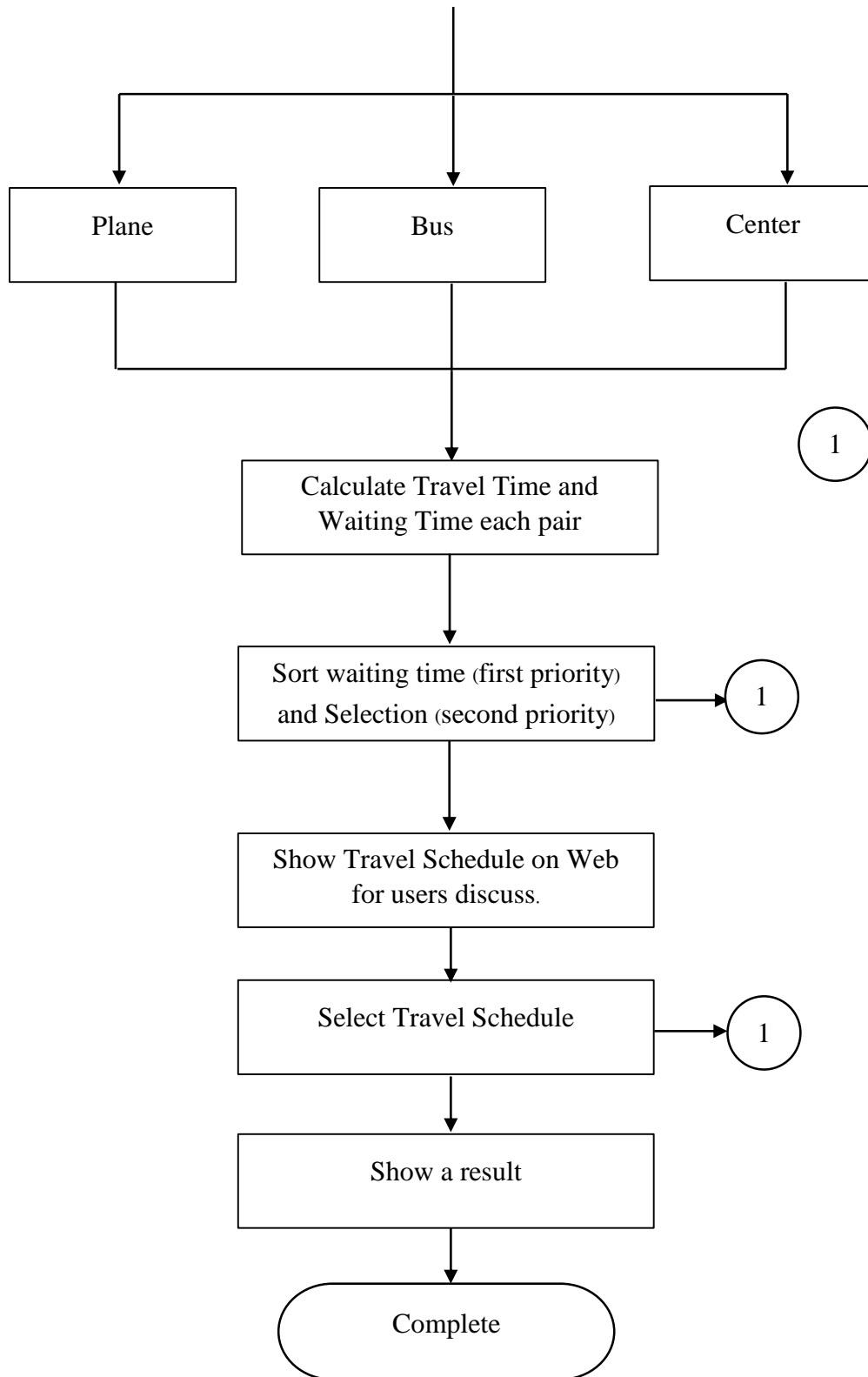


Fig 3.3 The Methodology of the optimal routing model

CHAPTER IV

RESULTS AND DISCUSSION

We discussed about methodology in chapter 3 which will be used to this chapter for find the optimal route from model which build up from previous chapter. In this here, we use tools in solving solution of model which is HTML5, SQL and PHP.

4.1 Data Collection for Prepare Analyze the Optimal Routing

As mentioned in the previous chapter we had selection the source is Bangkok and the destination is Mae Sa Rieng at Mae Hong Son province which has one transit node at Chiang Mai province. For case study, we have select travelling from Bangkok to Chiang Mai province by airplane of NokAir airline and Chiang Mai province to Mae Sa Rieng at Mae Hong Son province. The detail of schedule time thus.

เที่ยวไป : กรุงเทพฯ (ดอนเมือง) ไป เชียงใหม่

พ. 27 ม.ค. 2559

	จ. 25 ม.ค. 1,300.93 บาท	อ. 26 ม.ค. 1,020.56 บาท	พ. 27 ม.ค. 1,020.56 บาท	พฤ. 28 ม.ค. 1,300.93 บาท	ศ. 29 ม.ค. 1,394.39 บาท	
ออก	ถึง	เที่ยวบิน	เครื่องบิน	PROMOT PRO	NOK ECO	NOK FLEXI
06:50	08:00	DD8302	B737-800		1,300.93	2,702.80
09:05	10:15	DD8306	B737-800		1,394.39	2,702.80
12:40	13:50	DD8312	B737-800		1,300.93	2,702.80
13:40	14:50	DD8314	B737-800		1,300.93	2,702.80
14:30	15:40	DD8316	B737-800		1,020.56	2,702.80
16:30	17:40	DD8318	B737-800		1,300.93	2,702.80
19:00	20:10	DD8324	B737-800		1,300.93	2,702.80
20:25	21:35	DD8326	B737-800		1,300.93	2,702.80

Fig 4.1 Show the flight table of NokAir airline.

จาก เชียงใหม่ [สถานีขนส่งผู้โดยสาร จ.เชียงใหม่ (อาเขต)] ถึง แม่ฮ่องสอน [จุดจอด อ.แม่สะเรียง]
 วันรถออก พุธ, 27 มกราคม 2559

เลือก	เส้นทาง	มาตรฐานรถ	จำนวนที่นั่ง	ราคา	เวลารถออกต้นทาง	รถออกจากจุดขึ้นรถ	ถึงปลายทางโดยประมาณ	ผู้ให้บริการ	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง	รถตู้	15	200	09:00	09:00 น.	09:00 น.	เปรมประชาขนส่ง	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง	รถตู้	15	200	10:00	10:00 น.	10:00 น.	เปรมประชาขนส่ง	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง	รถตู้	15	200	12:00	12:00 น.	12:00 น.	เปรมประชาขนส่ง	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง	รถตู้	15	200	14:00	14:00 น.	14:00 น.	เปรมประชาขนส่ง	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง	รถตู้	15	200	15:00	15:00 น.	15:00 น.	เปรมประชาขนส่ง	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง	รถตู้	15	200	17:00	17:00 น.	17:00 น.	เปรมประชาขนส่ง	
<input type="radio"/>	เชียงใหม่-แม่สะเรียง-ขุนยวม-แม่ฮ่องสอน	ป.2	27	180	21:00	21:00 น.	21:00 น.	เปรมประชาขนส่ง	

Fig 4.2 Show the bus schedule of Prempracha transports.

From figure 4.2, We found that destination time same source time we have to ask operator of Prempracha transports for accurate data. Both figure 4.1 and 4.2 would have amount of instants which differ we will transform data in the same format.

4.2 Data Transformation of Travel Schedules

From the above data we must be transform data before being put in to the system and decrease duplication data. By define to just 4 instants thus;

Table 4.1 Show the flight table of NokAir airline which be transformation already.

IDF	Departure	Arrival	Time
F1	6:50:00	8:00:00	1:10:00
F2	9:05:00	10:05:00	1:10:00
F3	12:40:00	13:50:00	1:10:00
F4	13:40:00	14:50:00	1:10:00
F5	14:30:00	15:40:00	1:10:00
F6	16:30:00	17:40:00	1:10:00
F7	19:00:00	20:10:00	1:10:00
F8	20:25:00	21:35:00	1:10:00

Table 4.2 Show the bus schedule of Prempracha transports which be transformation already.

IDB	Departure	Arrival	Time
B1	9:00:00	12:30:00	3:30:00
B2	10:00:00	13:30:00	3:30:00
B3	12:00:00	15:30:00	3:30:00
B4	14:00:00	17:30:00	3:30:00
B5	15:00:00	18:30:00	3:30:00
B6	17:00:00	20:30:00	3:30:00
B7	21:00:00	0:30:00	3:30:00

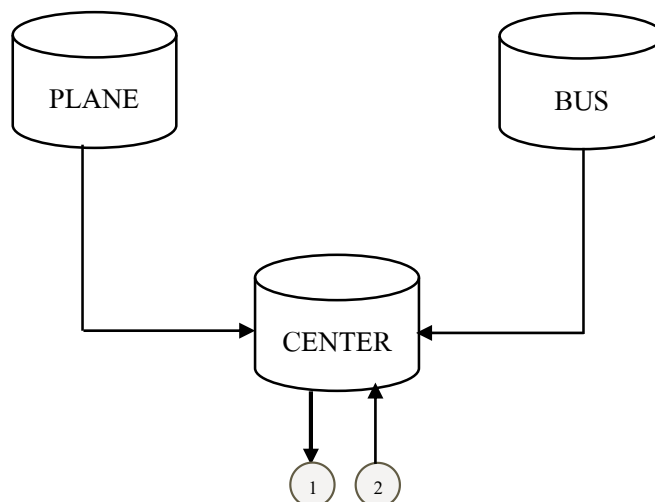
When we transformed data already our will bring those data prepare to website and test case with 100 users.

4.3 Prepare The Optimal Routing Model and Data to Web Application

We used HTML5 and PHP language combined with bootstrap framework for build up website and phpMyadmin for database. We can simulation diagram for working of the optimal routing model thus;

1. Activity diagram for users

The activity show step for using of user on website.



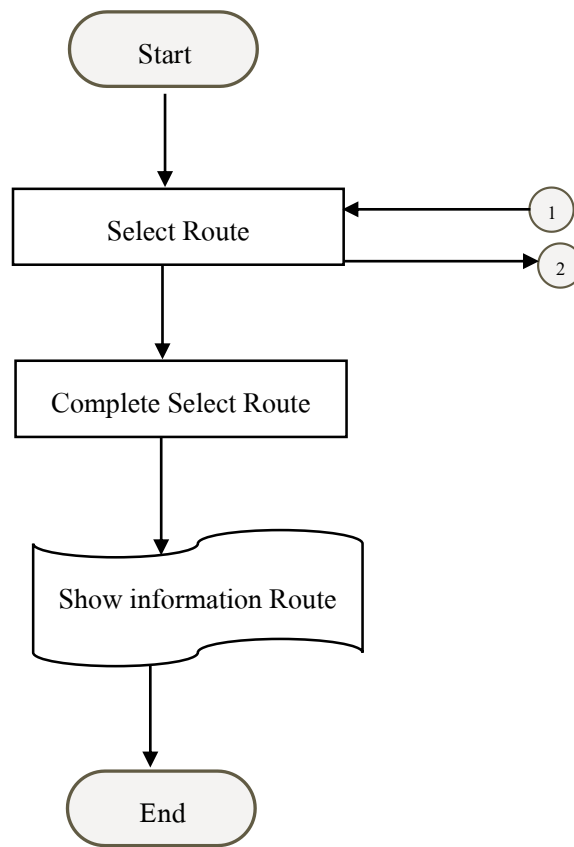


Fig 4.3 Show the activity diagram for users

2.UML Use Case Diagram

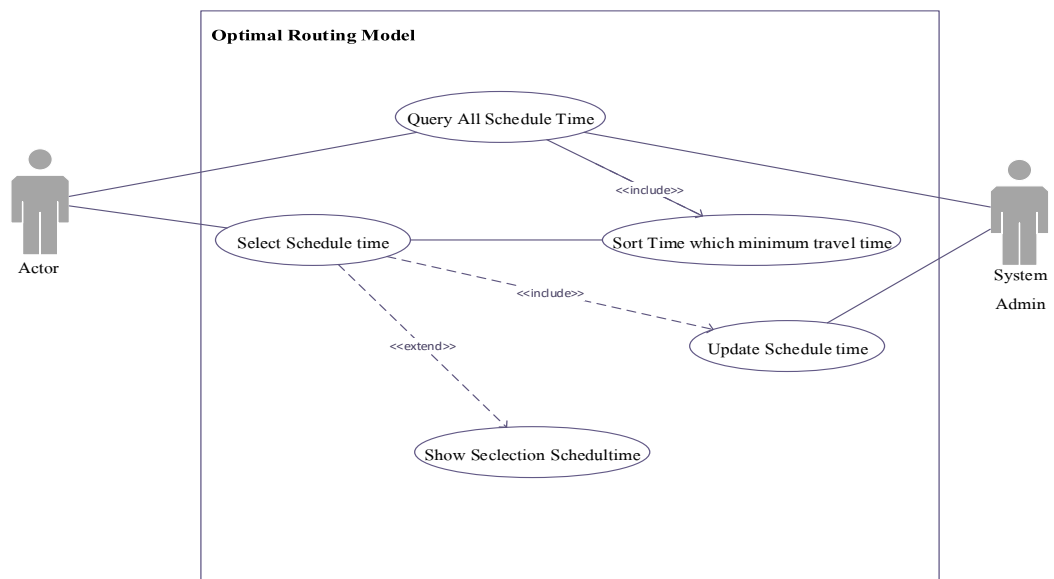


Fig 4.4 UML Use Case Diagram

Table 4.3 The use case description of select schedule time.

Use Case Name	Select Schedule Time	
Actor	Users	
Purpose	Select time both source and destination	
Level	Primary Use Case	
Preconditions	Users preview schedule time table	
Post conditions	Users selected schedule time	
Main Flows	Actor Input	System Response
	1.Select time schedule both source and destination	2.Keep information about selection time schedule
Alternate condition	Not selected	

Table 4.4 The use case description of query all schedule time.

Use Case Name	Query All Schedule Time	
Actor	Users, System Admin	
Purpose	Show all schedule time table	
Level	Primary Use Case	
Preconditions	Users must be selected source and destination	
Post conditions	Users preview schedule time table	
Main Flows	Actor Input	System Response
	1.Select source and destination	2.Show information about schedule time table
Alternate condition	Not selected	

Table 4.5 The use case description of sort time which minimum travel time.

Use Case Name	Sort Time which minimum travel time
Actor	System Admin
Purpose	Sort travel time
Level	Include Use Case

Table 4.5 The use case description of sort time which minimum travel time. (cont.)

Preconditions	Select source and destination	
Post conditions	Show at least travel time of these schedule.	
Main Flows	Actor Input	System Response
	1.Select source and destination	2. Show at least travel time of these schedule
Alternate condition	Not selected	

Table 4.6 The use case description of update schedule time.

Use Case Name	Update Schedule Time	
Actor	System Admin	
Purpose	Collection new record to database from selection of users	
Level	Include Use Case	
Preconditions	Summited schedule time both source and destination	
Post conditions	Update new record	
Main Flows	Actor Input	System Response
	1.Submitted schedule time	2. Update new record to database
Alternate condition	Not submitted	

Table 4.7 The use case description of show selection schedule time.

Use Case Name	Show Selection Schedule Time	
Actor	Users	
Purpose	Confirm information schedule travel time of users	
Level	Primary Use Case	
Preconditions	Users must be selected source and destination for travelling	
Post conditions	Users confirm	

Table 4.7 The use case description of show selection schedule time. (cont.)

Main Flows	Actor Input	System Response
	1.Users must be selected source and destination for travelling 2.Users must be schedule time both source and destination 3.Users must be submitted schedule travel time	4. The system show information about schedule travel time
Alternate condition	Not select schedule time	

For final part that we brought process designed from above to develop web application for test model. Users will use test by this web amount 300 people. After that we will bring the result from testing for analyze.

SHOW MINIMUM TRAVEL TIME FOR ROUTE

NODE1	NODE2	Waiting TIME	Travel TIME	SELECT
F4	B5	01:10:00	05:50:00	74

BKK to CHX : 27/01/2016 (+1 hr for check-in)

Select	IDF	Departure	Arrival	Time
<input type="radio"/>	F1	06:50:00	08:00:00	01:10:00
<input type="radio"/>	F2	09:05:00	10:05:00	01:10:00
<input type="radio"/>	F3	12:40:00	13:50:00	01:10:00
<input type="radio"/>	F4	13:40:00	14:50:00	01:10:00
<input type="radio"/>	F5	14:30:00	15:40:00	01:10:00
<input type="radio"/>	F6	16:30:00	17:40:00	01:10:00
<input type="radio"/>	F7	19:00:00	20:10:00	01:10:00
<input type="radio"/>	F8	20:25:00	21:35:00	01:10:00

CHX to MSR: 27/01/2016

Select	IDB	Departure	Arrival	Time
<input type="radio"/>	B1	09:00:00	12:30:00	03:30:00
<input type="radio"/>	B2	10:00:00	13:30:00	03:30:00
<input type="radio"/>	B3	12:00:00	15:30:00	03:30:00
<input type="radio"/>	B4	14:00:00	17:30:00	03:30:00
<input type="radio"/>	B5	15:00:00	18:30:00	03:30:00
<input type="radio"/>	B6	17:00:00	20:30:00	03:30:00
<input type="radio"/>	B7	21:00:00	00:30:00	03:30:00

Fig 4.5 The example web application for test the optimal routing model

You select your travelling follow below:

ID1	Departure	Arrival	Time	Waiting time1	ID2	Departure	Arrival	Time	Waiting time2	Travel Time
F2	09:05:00	10:05:00	01:10:00	01:00:00	B5	15:00:00	18:30:00	03:30:00	04:55:00	10:35:00

Fig 4.6 Show the result about time for selection schedule travel time.

4.4 Result

After build model completed we had put schedule time into model. As a result, we found that if the waiting time more value, the travel time is more accordingly because the waiting time is the variable which can be changed as the selection schedule time both source, transit and destination node. But the travel time of each schedule time that it is always constant.

SHOW MINIMUM TRAVEL TIME FOR ROUTE

NODE1	NODE2	Waiting TIME	Travel TIME	Count
F3	B4	01:10:00	05:50:00	76
F4	B5	01:10:00	05:50:00	51
F7	B7	01:50:00	06:30:00	16

Fig 4.7 Show minimum travel time for route

The final test result, we had web application to take the test by 300 users. We expect that users will select the schedule time which uses at least time that is F4 to B5 or F3 to B4. As a result, that the schedule is more selected is F3 to F4 which was selected by 76 users (25.33% of total), F4 to B5 was selected by 51 users (17% of total) and F7 to B7 is selected by 16 users (5.33% of total) as shown on figure 4.7.

Statistics route selection of users

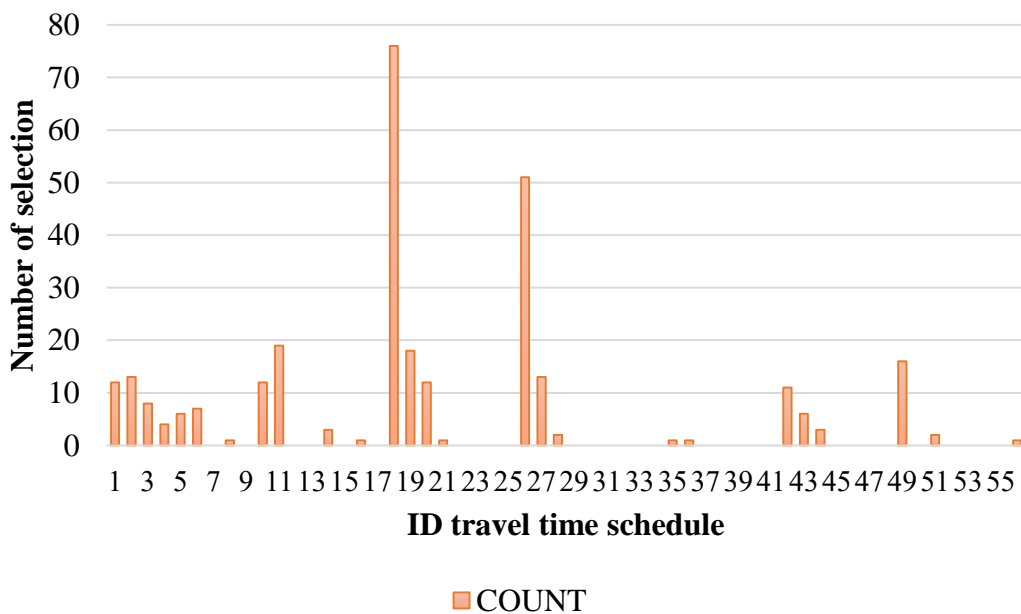


Fig 4.8 Show the selection schedule time of 300 users from web application.

4.4 Discussions

From the results, we can see that the introduction of Ant Colony Optimization Concept applications with Multimodal Transportations System affecting the decision to test is the number one. Since the beginning of the test will not know that travel time schedule where it would take to travel faster and best route that is similar to the concept of Ant Colony, which will be distributed to each route. to find the most appropriate path or global pheromone trail for others. In this way, the probability that a randomly or exactly when selecting travel time schedule it for a test to see Travel time schedule has been selected from the previous test. Of course, when Travel time schedule, it was much more choice. The next test, it is likely that a greater selection Travel time schedule as well.

The researchers chose Ant Colony Optimization Concept is because in all these Swarm Intelligent, Algorithm Ant Colony Optimization Concept is the Algorithm to Search Algorithm and the results were better than the others in terms of getting the Multimodal Transportation. It is in the nature of the trip as well. The only difference is that the public transport system and are changing more than one mode of transport that form Multimodal Transportation. A transportation system that emphasizes convenience and need to change the mode of transport to a minimum. In this research, has chosen to Minimize Waiting Time for change transport modes. Of course we all want to waste time traveling to a minimum in order to reach the destination. Even a change of mode of transportation much. Time to handle the greater the Waiting Time with the Waiting Time travel times will increase much further we have the Ant Colony Optimization Concept application with Multimodal Transportations System for the duration of the trip. Minimal

The important thing now is the time to be a time figuring out the time from the itinerary of each point only. Does not include how long we have to change the travel mode of transport to another mode of transportation. The delay in the middle of each mode. Which itself is a disadvantage of this system. If we want to know the exact timing for this trip was we need to adopt different variables related to relationships and applied to the model. In order to get more accurate results.

CHAPTER V

CONCLUSIONS

5.1 Conclusion

From the results in previous chapter, we conclude that the optimal model routing for multimodal transportations depends on 2 main variables, give as the waiting time and the travel time for each scheduling time. The total travel time would have more or less it will depend on the waiting time of the selection schedule time previously. Not only the previous selection schedule time but also depend on the selection next schedule time. However, the travel time of each schedule time is a constant if it is same mass transportation. When we brought model release on web application for test it as a result that there are a number of users 200 people who test the selection route from Bangkok to Mea Sa Rieng, Mae Hong Son province had selected schedule time F3 to B4 is 25.33% of all users, F4 to B5 is 17% of all users, F7to B7 is 5.33% of all users and other (53 schedule time) is 52.34%. The results of testing, we expect that users could be select F4 to B5 or F3 to B4 because the model has showed the optimal routing is them which use at least the total travel time from all schedule time. The advantages of this research were, it helps to decide the selection optimal routing in view of the time and not only decide but also tell popularity of route as well. The results from testing of users it reflects that the optimal model it helps travelers decrease the travel time as well.

5.2 Limitation of Research

The creating model exclude the speeds of transportation, delay, cost and convenience so it may lack of component to decide. In addition, the value of travel time is accurate.

5.3 Future Work

This research can apply to public transportation whether mass, freight or even develop to the eco-system. In addition, if include cost and convenience into model, it is easy to decide.

REFERENCES

- [1] Tourism investment, "Fundamentals of Thailand", unpublished.
- [2] Department of tourism(2015), "Thailand tourism situation", Ministry of Tourism and Sports, vol. 6, pp. 1-13.
- [3] M. Reem Fawzy(2012), Multimodal transportation systems: modelling challenges, Observation of the University.
- [4] T. Salilathip(2011), "How did Thailand Develop the Public Transportation Systems?", executive journal. Thailand, vol. 4, pp. 55-58.
- [5] Marco Dorigo and Gianni Di Caro, "The ant colony optimization meta-heuristic"
- [6] Marco Dorigo and Luca Maria Gambardella(1997), "Ant Colony System: A Cooperative Learning Approach to the Traveling Salesman Problem", IEEE Transactions on Evolutionary Computation, Vol. 1, pp. 1-24.
- [7] Stephen Gilmour and Mark Dras(2005), "Understanding the Pheromone System within Ant Colony Optimization", Lecture Notes in Computer Science, Vol. 3809, pp. 786-789.
- [8] Pattern selecting the best route of ant. Available at URL: https://qph.is.quoracdn.net/main-qimg-0fcc374caf4833ee2783a1ebe5f8cfdd?convert_to_webp=true
- [9] Kittidech Vongsak and Kittisak Yochanang(2010), "The Shortest and Subordinate – Path Navigational System using Ant Colony Algorithm", NCCIT2010, pp. 161-166.
- [10] Maurizio Bielli, Azedine Boulmakoul and Hicham Mounicif(2006), "Object modeling and path computation for multimodal travel systems", European Journal of Operational Research, Vol. 175m pp.3.
- [11] Multimodal transportations. Available at URL: <http://www.onera.fr/fr/zoominthe-lab/pplane-avionlib>
- [12] Surames Piriyawat, "Public Transportation", Burapha University.
- [13] Mass transportations. Available at URL: <http://th.ynufe.edu.cn/life/service/ttransportation/>
- [14] Mandloi and Thill(2010), "Object-Oriented Data Modeling of an Indoor/Outdoor

- Urban Transportation Network and Route Planning”, *Geospatial Analysis and Modelling of Urban Structure and Dynamics*, Vol. 99, pp. 197-220.
- [15] Comtois C., Slack B. and Rodrigue, “The geography of transport systems, GB: Routledge Ltd.
- [16] Rob van Nes. “Design of multimodal transport networks: A hierarchical approach”.
Paper presented at the Nectar Conference.
- [17] Wang Xin-bo, Zhang Gui-Jun, Hong Zhen, Guo Hai-Feng and Yu Li (2009), “Modeling and Implementing Research of Multimodal Transportation Network”, Paper presented at Information Science and Engineering (ICISE), 1st International Conference on.
- [18] Lyons, Harman, Austin and Duff (2001), “Traveller information systems research: A review and recommendations for transport direct”, University of the West of England.
- [19] Li and Wachs (2000), “A Test of Inter-modal Performance Measures for Transit Investment Decisions”, *Transportation* 27, Vol 27, pp. 243-267.
- [20] John E. Bell and Patrick R. McMullen (2004), “Ant colony optimization techniques For the vehicle routing problem”, *Advance Engineering Informatics* 18, Vol 18, pp. 41-48.
- [21] Jerry Kponyo, Yujun Kuang, Enzhan Zhang and Jerry Kponyo (2014), “Dynamic Travel Path Optimization System Using Ant Colony Optimization”, 16th International Conference on Computer Modelling and Simulation, pp. 141-146.
- [22] José António Capela Dias, Penousal Machado and Francisco Câmara Pereira (2013), Privacy-Aware Ant Colony Optimization Algorithm for Real Time Route Planning”
- [23] Mohammad Reza Jabbarpour, Ali Jalooli, Erfan Shaghghi, Rafidah Md Noor, Leon Rothkrantz, Rashid Hafeez Khokhar and Nor Badrul Anuar (2014), “Ant-based vehicle congestion avoidance system using vehicular networks”, *Engineering Applications of Artificial Intelligence*, Vol 36, pp. 303-319.
- [24] D. Alves, J. van Ast, Z. Cong, B. De Schutter and R. Babuska (2010), “Ant colony

- optimization for traffic dispersion routing,” Proceedings of the 13th International IEEE Conference on Intelligent Transportation Systems (ITSC 2010), Madeira Island, Portugal, pp. 683–688.
- [25] Hongqiang Zheng, Yongquan Zhou and Qifang Luo(2013), “A hybrid Cuckoo Search Algorithm-GRASP for Vehicle Routing Problem”, Journal of Convergence Information Technology(JCIT), Vol 8, pp. 821-828.
- [26] Xuesong Yan, Can Zhang, Wenjing Luo, Wei Li, Wei Chen and Hanmin Liu, “Solve Traveling Salesman Problem Using Particle Swarm Optimization Algorithm”, International Journal of Computer Science, Vol 9, pp. 264-271.
- [27] NokAir. Available at URL: <http://www.nokair.com/nokconnect/aspx/Index.aspx>
- [28] Prempracha. Available at URL: <http://premprachatransports.com/ticket-th/>

APPENDIX

TECHNICAL PAPER OF 2015 INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY

The 2nd Management Innovation Technology International Conference (MITICON2015)

Optimal Routing Model for Multi Modal Transportation

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Abstract— A multi modal transportation is important for travelling of people and goods. This research only focuses on people who have travelled around the world. Generally, moving must consist of more two nodes and each node has a mode of transportation which called "Mass transportation". We use Ant Colony Optimization (ACO) to improve the selecting optimal route. Moreover, it has collecting schedules each node including a collecting record of tourists as well. In addition, the waiting time has a variety of importance to select nodes for a changing mode. Finally, the great nodes need schedules consisting of time, cost and the waiting time.

Keywords—Multi modal transportation, Mass transportation, Ant Colony Optimization(ACO), The waiting time

I. INTRODUCTION

Now a day, the tourism's industry has the role and the importance of Thailand. It's the source of revenue [1] that important to country so it's also the jolly economic as well. We observe that the revenue of tourism is growing since 2007 to July 2015[2], which we see from figure 1.

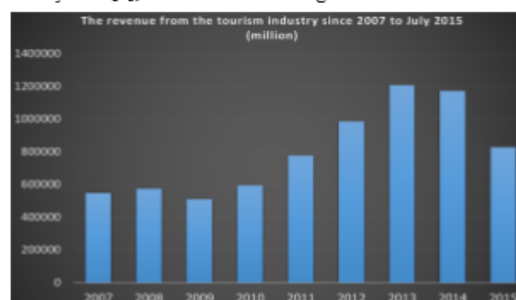


Fig. 1. This graph show the revenue from the tourism industry since 2007 to July 2015 in Thailand

Although, it would has events that effect to whatever tourism but it was little affect the traveler. The travelling of the traveler that depend with many factors such as times, costs, hostels and also include convenience. In addition, the tourist yet need to the convenience for tourism, in order to

travel from node to another node.[3] We see that traveling must have change nodes at least two nodes which characteristic called "Multi modal transportation". Of course, Transportations have people and goods which depend on three variables as travelers, different modes of transportation and different operators, other than the main aim of multi modal transportation is the movement or trip. We show the cheaply multi modal transportation follow to figure 2. Generally, the travelling form point to another point has to wait for transport whether it be rail, bus, plane or boat which these call that "Mass transportation"[4]. Waiting be held to be one of the important factor for tourist which will affect to feel of they. Therefore, this research focus it. By use Ant Colony Optimization (ACO) algorithm for helping to develop the selecting route optimal of tourist for convenience.

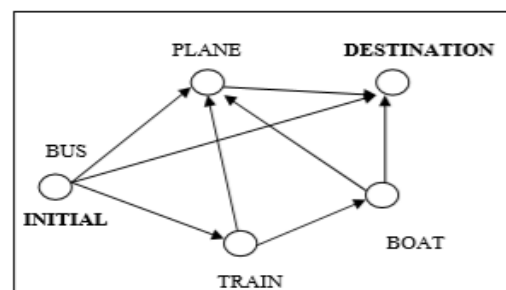


Fig. 2. The cheaply multi modal transportation

[5]Ant Colony Optimization (ACO) is the counterfeit of behavior's ant. Normally, the first finding a food of each ant that often random selected route to destination. When the first ant selected route it would release pheromone along the path to destination. All the route would have pheromone, when they choose to use the path. After, next ants would decide for select optimal route by it decided from quantity of pheromone of each path. Every time, they selected a path would have update pheromone and whenever the path wasn't selected by them and it would evaporate until away. We will see behavior

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of ant that they often have swarm behavior or also known as "Swarm Intelligence (SI)". Commonly, [6] it would have the agent for action around it which called "Zone of repulsion". By many agents around zone of repulsion will call "Zone of attraction" and the interaction that distributed then those agents have the behavior same the focal agent would call "Zone of alignment" see that figure 3.

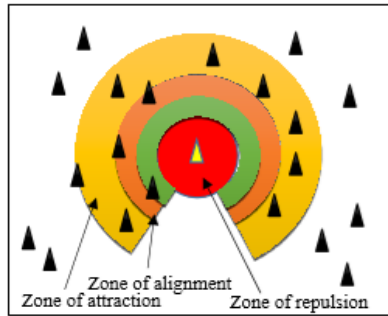


Fig. 3. Show pattern of swarm intelligence

The troubleshooting for waiting of tourist, in order that move a node to another and helping to choose the optimal route for the convenience of them. We will apply ACO with this research for the selecting route system have high performance and still lead tourist to destinations as required include recommend the selecting route as well.

II. TRANSPORTATION PROBLEM

Currently, the number of tourist in Thailand there are more. As a result quantity of mass transportation lacking to service then effect to waiting of tourist. So it will be considered for the selecting route. Waiting held that is the important factor for update path. If any node have more waiting time, it will feel bad and waste of time to tourist. Most of each terminal would tell time for arrive, departure and travel but often wouldn't tell waiting time therefore they can't correct estimate time for travelling.

TABLE I. EXAMPLE TABLE INFORM TIME FOR THE TRAVELLING

Initial	Destination	Departure	Arrive	Time
Bangkok	Korat	18.00	21.00	3
Bangkok	Phuket	22.30	08.30	10
Chonburi	Mea sod	14.00	00:00	10
Nan	Bangkok	09.30	10.30	1
Loei	Bangkok	11.00	23.00	12

From figure 4, we will see that each node will have parameter is define for travelling when $M_{i,j}$ is mode of transportation form node i to node j , t is time for travelling, w is waiting time, c is cost and d is distance.

Of course, when have compare between nodes for the selecting route to convenience. If each nodes was selected for compare then it equal but has one factor helping to decide for selecting node is waiting time(w). Since it will effect to feel of traveler to loss time.

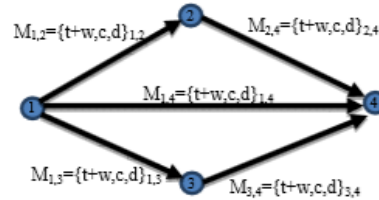


Fig. 4. Show pattern for travelling by have the control factor

ACO will has the role for tracing and improve then record in table by will use Ant Colony System (ACS) which is algorithm of ACO and popular in transportation field. Mostly, ACS will along have process 5 step thus:

- Select route
- Release pheromone
- Construction completed by each ants
- Improve solution to movement evaluate
- Update pheromone

Thereby, we will use the ACS for improve performance of mass transportation and include helping to decide the selecting route of tourist as well.

III. DESIGN AND METHODOLOGY

We applied ACS with this research by use the problem was found that is waiting time for each node. Of course, when tourist need to travel form node to another node which often considered time and cost to be decide for traveling. Generally, before tourist will have information for traveling tell according to various such as web board, social network or spread widely which this behavior will same release pheromone. In this section, will been collected in routing table. In fact, moving from initial node to destination node on the way not only one node but still have other nodes that can changed node to destination. In this segment, will have collected and usually update local pheromone when have selecting node for change. In addition, this part will waiting

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time for decide the selecting node. We will improve this part for increase performance.

Form figure 4, we designed collecting data in database by routing table will have 9 instance and all table will have tracing with counting. If routing table hasn't record input data. It will create new transaction and start count. But, when have input data so have the original data it will count. After, all transaction will been call when have user (tourist) need to check traveling of them. We see diagram follow to figure 6 which use ACS for improve the system.

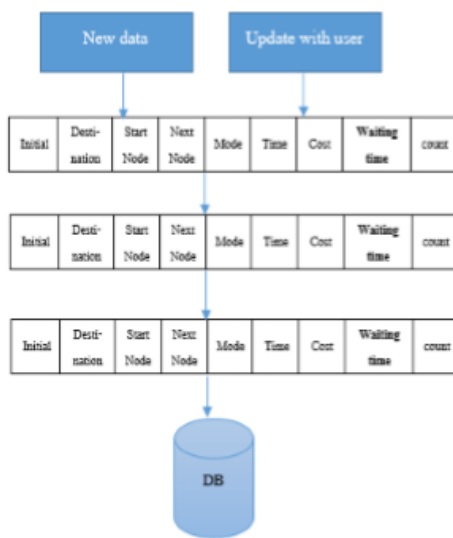


Fig. 5. Collecting data in database for using.

After, we have the sample for testing the system was improved ACS. By this sample come from a groups of tourists need to travel from Chiang Mai to Kho Larn.

IV. RESULT AND DISCUSSION

We have set 1 case for an example in order to test the method was developed by ours. A group of tourists need to travel from Chiang Mai to Kho Larn by have behavior changing node as following table II.

From table II, we will see input the requirement of the first tourist so it will been collected to database for information of the next tourist. Whenever it was called for review by tourist so they submit it will be counted as following table III.

Next case, waiting time can change any time then the system can be update any time for the waiting time. In addition, when have occur the new change node the system will be created the new transaction so record to database follow table IV.

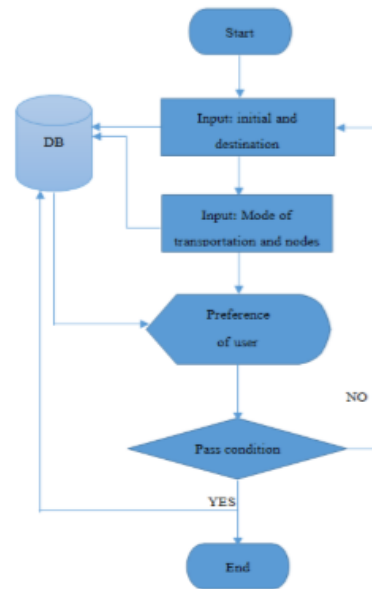


Fig. 6. Show input data flow of user.

We will see that if have the center system for record the route of each tourists, it will easy to them. Therefore, all tourists need to convenience for traveling. Of course, they will have plan for tourism but to make better should will have the recommendation system that whichever change node is popular for the traveling of tourists. Whereas, every node will have the waiting time for changing mode. Therefore, we should add it to record for they can predict their accuracy plan ever more. And it also effect to the mental and the selecting route as well.

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TABLE II. TABLE ROUTING OF TRAVELING FORM CHIANG MAI TO KHO LARN

Initial	Destination	Start Node	Next Node	Mode	Time	Cost	Waiting time	Count
Chiang Mai	Kho Larn	Arca de 3	Mo chit2	Bus	09:00	550	00:15	1
		Mo chit2	Pattaya	Bus	02:30	120	00:10	
		Pattaya	Harbor	Bus	00:20	40	00:20	
		Harbor	Kho Larn	Boat	00:50	30	00:15	
Total					12:40	740	01:00	

TABLE III. TABLE ROUTING OF TRAVELING FORM CHIANG MAI TO KHO LARN

Initial	Destination	Start Node	Next Node	Mode	Time	Cost	Waiting time	Count
Chiang Mai	Kho Larn	Arca de 3	Mo chit2	Bus	09:00	550	00:15	28
		Mo chit2	Pattaya	Bus	02:30	120	00:10	
		Pattaya	Harbor	Bus	00:20	40	00:20	
		Harbor	Kho Larn	Boat	00:50	30	00:15	
Total					12:40	740	01:00	

TABLE IV. UPDATE THE NEW CHANGING NODE

Initial	Destination	Start Node	Next Node	Mode	Time	Cost	Waiting time	Count
Chiang Mai	Kho Larn	Airport CNX	Airport BKK	Plane	01:00	1,200	01:00	14
		Airport	Harbor	Van	02:00	100	00:15	
		Pattaya	Kho Larn	Boat	00:50	30	00:15	
Total					03:50	1,330	01:30	

V. CONCLUSION

We conclusion that having ACS in system helping to tourists can select the comfortably traveling and meets the requirement of them. Benefit of this research have 3 mains hence 1) tourist can predict plan for using cost and time 2) the system collect all route when have recording 3) everybody can review before record for decide in the selecting path. But this system would collect all route when have recording. As a result, when have increase the quantity information will be slow query information. Although it's slow but can accuracy query information. In addition, having schedule each node to help more easily decision of travelers.

REFERENCES

- [1] Tourism investment, "Fundamentals of Thailand", unpublished.
- [2] Department of tourism, "Thailand tourism situation", Ministry of Tourism and Sports, vol. 6, pp. 1-13, 2015.
- [3] M. Reem Fawzy, Multimodal transportation systems: modelling challenges, Observation of the University, 2012.
- [4] T. Saliathip, "How did Thailand Develop the Public Transportation Systems?", executive journal. Thailand, vol. 4, pp. 55-58, 2011.
- [5] John E. Bell and Patrick R. McMillen, " Ant colony optimization techniques for the vehicle routing problem", Advanced Engineering Informatics, vol. 18, pp. 41-48, July 2004.
- [6] J.M. Miller, A. Kolpas, J.P. Juchem Neto and L.F. Rossi, "A Continuum Three-Zone Model for Swarms", Bulletin of Mathematical Biology, vol. 74, pp. 536-561, July 2011

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