AN IMPROVED RED-BLACK ANT COLONY SYSTEM ALGORITHM BASED ON TRAFFIC FOR SUPERMARKET DISTRIBUTION CENTER ROUTE PLANNING

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STATEMENT OF ORIGINALITY

I hereby certify that the work embodied in this thesis is the result of original research and has been submitted for a higher degree to any other University or Institution.

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ABSTRACT

With the rapid growth of retailing during the modernization of Yangon, there is an increasing demand to improve the service quality of supermarkets. The supermarket shuttle service can have a direct impact on extending supermarket access, increasing shared transports, and improving customers' satisfaction. The routing software that helps supermarket delivery drivers to reach the customer's location/branch on time by providing the shortest route is the best one. Using machine learning methods not only provides efficient routes but also helps business owners to save time and fuel. The proposed system presented Route Planning mechanism using the improved Red-Black Ant Colony System Algorithm based on traffic information to apply supermarket delivery business. This system is implemented by using ASP.Net programming language on Microsoft Visual Studio 2013 IDE with Microsoft SQL Server 2008 R2 Database Engine.

Keywords: Red-Black Ant Colony Algorithm, Shortest Route, Route Planning

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ACO	Ant Colony Optimization
ACS	Ant Colony System
AS	Ant System
RB-ACS	Red-Black Ant Colony System
TSP	Travelling Salesman Problem

CHAPTER 1
INTRODUCTION

The chain supermarket has become a major part of Yangon's retail industry, and the optimization of chain supermarkets' distribution route is an important issue that needs to be considered for the distribution center, because for a chain supermarket it affects the logistics cost and the competition in the market directly. Yangon is the largest city in Myanmar and the industrial and commercial city of the country. The central area of the city contains the commercial district of banks, universities, trading corporations, and offices, as well as shops, brokerage houses, and bazaars. In Yangon, many million trips are using road transport every day and appearing traffic in rush hour. The optimization of chain supermarkets' distribution route is extremely depending on the traffic.

There are many kinds of algorithms for the optimization design of distribution routes. These algorithms are the ant colony system algorithm, the red-black ant colony system algorithm, the simulated annealing algorithm, the taboo search algorithm, the neural network algorithm, and so on. In this system, the red-black ant colony system algorithm is used to find the shortest route from the citymart distribution center: Ayer-Won branch to the citymart supermarket branches in Yangon based on traffic information. Then, the presented system executes the potential ways of arriving at all objective areas.

1.1 Objectives of the System

The main objectives of this system are:

- To find the shortest path easily with parallel processing of Red and Black ant based on traffic information;
- To save time and money in the delivering problem between supermarket branches;
- To reduce the searching time by parallel running from different start points (dynamically);

- To apply an improved Red-Black Ant Colony Algorithm based on traffic for Supermarket Distribution Center Route Planning.

1.2 Related Work

The author presented the conveyance administration issue by A* Shortest Path Algorithm as [1]. Providers need to find the way plan to where their items are being conveyed, particularly concerning the geographic place of the articles, its environmental factors and the most limited way of the objective spot from current spot. This framework takes care of the providers dealing with issue in finding their most brief way by utilizing A* Shortest Path Algorithm.

The author showed the framework that is executed a system giving the transport data and course arranging administration to take care of the transport transportation issues in [15]. An electronic transport registry administration and course arranging utilizing Dijkstra's briefest way calculation is created. This framework gives transport data, prevent data from the transport lines and Yangon transport catalog and show the most limited ways for the source and objective.

The authors proposed Red-Black Ant Colony System that is to create improved results for the arrangement of bigger mobile sales rep issues for [17]. This approach would be an extremely encouraging one in light of its consensus and due to its viability in finding generally excellent arrangements effectively to different fields of troublesome issues. The fields of interest might be the troublesome combinatorial issues, for example, load adjusting issue in broadcast communications organizations, numerous fuel financial burden dispatch issue, double requirement fulfillment issue, arbitrary number age, information mining, design acknowledgment, work booking issue and significantly more.

The aim of [20] was to tackle the issue of uneven quest for the briefest distance however disregarding the vacationer experience during the time spent the travel industry course arranging, a superior subterranean insect settlement enhancement calculation is proposed for the travel industry course arranging. Relevant data of grand spots essentially impact individuals' decision of the travel industry objective, so the pheromone update system is joined with the context oriented data like climate and solace level of the beautiful spot during the time spent looking through the worldwide ideal course, so the pheromone update keeps an eye on the way appropriate for vacationers. The trial results show that the upgraded the travel industry course has incredibly further developed the vacationer experience, the course distance is abbreviated by 20.5% and the assembly speed is expanded by 21.2% contrasted and the fundamental calculation, which demonstrates that the better calculation is prominently viable.

The objective of the author was to dissect the ongoing dispersion circumstance of chain general stores both at home and abroad and concentrating on the quantum-enlivened developmental calculation (QEA) [11]. This author set up the numerical model of chain general stores' conveyance course and tackled the streamlined circulation course all through QEA. The specialists take Hongqi Chain Supermarket in Chengdu as an illustration to play out the trial and contrast QEA and the hereditary calculation (GA) in the fields of the combination, the ideal arrangement, the hunt capacity, etc. The investigation results show that the conveyance course streamlined by QEA acts better compared to that by GA, and QEA has more grounded worldwide quest capacity for both a limited scale chain grocery store and an enormous scope chain general store. Besides, the achievement pace of QEA in looking through courses is higher than that of GA.

1.3 Organization of the System

This system is organized into five chapters. They are as follows:

In Chapter 1, introduction of the system, objectives of the thesis, related works and thesis organization are described. **Chapter 2** presents the background theory of transaction routing. **Chapter 3** discusses the architecture of the proposed system. **Chapter 4** expresses the implementation and experimental results of the proposed system. Finally, **Chapter 5** presents the conclusions, advantages of the system and limitations and further extensions of the system.

CHAPTER 2
BACKGROUND THEORY

This chapter provides the necessary background for the remaining chapters of this study. Traveling Salesman problem (TSP) consists of finding the shortest route in complete weighted graph G with n nodes and n (n-1) edges, so all other nodes in this tour are visited exactly once. The most famous pragmatic use of Traveling Salesman Problem (TSP) are: normal appropriation of products or assets, finding the briefest way of the client want course, arranging transport lines and so on [9,13].

The most popular practical application of TSP are: regular distribution of goods or resources, finding the shortest path of the user desire route, planning bus lines etc., but also in the areas that have nothing to do with travel routes. In ant colony system (ACS), a number of artificial ants are utilized which are at first positioned arbitrarily in the urban communities [16]. Every ant fabricates a visit, that is to say, a practical answer for the TSP [12]. Be that as it may, when the component of the issue builds, the time has come consuming to create the outcome and the outcome isn't frequently ideal. In this way, a change was expected for tackling enormous voyaging issues. The reason for the change or improvement is to tackle the issue in a brief time frame and simultaneously, the outcome is required to have been streamlined. This issue roused for another calculation by further developing the ant colony system. .

2.1 Graphs

This study is concerned with coordinated diagrams. The perspective are taken that each diagram is coordinated, however at times the course isn't determined or might be overlooked. All through, the terms circular segment and edge for the coordinated and undirected case, are individually utilized. In this case we will utilize both the normal natural mathematical perspective on implanted diagrams and the formal logarithmic plan will also be utilized. We will remark about the connection between the two where proper will be remarked.

2.1.1 Vertex and Edge-Oriented Definitions of Graphs

There are two practically identical meanings of charts. The normal one is the vertex-situated approach, in which a diagram is a couple G = (V, A), where V is the vertex (or hub) set, and A, the curve set, is a subset of V × V. For hubs u, v ∈ V the documentation uv is utilized to mean the component (u, v) of V × V, and it is said that the bend uv is arranged from u to v. The hub u is known as the tail of uv, composed u = tail (uv). Additionally, v = head (uv) is the head of uv. It can be used tailG(uv) at whatever point the chart G being referred to isn't obvious from the unique situation. V (G) is also utilized to indicate the arrangement of hubs of a chart G, and use |V (G)|, or in some cases only |G| to mean the quantity of hubs of G.

Circular segment a ∈ A two darts a+1 and a−1 (it can likewise be utilized just a+ and a−) can stand as a partner. One might recognize the dart a+ with the circular segment an and a− with the curve a subsequent to switching its direction. We rev(•) is characterized to be the bijection on darts rev(a_σ) = a−σ. Darts are advantageous since they permit to squabble over the switches of curves without expecting that these converse circular segments be available in the chart. As will be see later, they are especially helpful for portraying planar diagrams and their embeddings. It can be emphatically trusted that, where suitable, darts ought to turn into a standard idea in chart hypothesis, like edges and curves.

In the edge-situated approach, A will be a bunch of components (curves) and V is a segment of the arrangement of darts A × {+1, −1}. A vertex v is a block of the segment V. The arrangements of darts in that block are supposed to be situated towards v, which can be called the top of every one of these darts. A vertex v is known as the tail of a dart a_σ in the event that v is the head of a−σ. The edge-driven approach is exceptionally helpful for addressing inserted charts and their duals. We will utilize the two methodologies will reciprocally be utilized as helpful.

2.1.2 Paths, Cycles, Trees and Cuts

A x-to-y walk is a succession of darts d1 . . . dk to such an extent that tail(d1) = x, head(dk) = y and, for I = 2, . . . , k, head(di−1) = tail(di). A stroll wherein no dart shows up at least a time or two is known as a way. An unfilled grouping addresses the unimportant way comprising of a solitary vertex. Start (P) is used to mean the main vertex, x, of P and end (P) to indicate the last vertex, y, of P . In the event that furthermore head (dk) = tail (d1) the walk is a cycle. A walk is basic on the off chance that no vertex happens two times as the top of a dart in the walk.

If P = d1 . . . dk and Q = e1 . . . e are strolls to such an extent that end(P) = start(Q), P ◦ Q is used to mean the walk d1 . . . dke1 . . . e . Assuming u and v are vertices in way P to such an extent that u = tail, (di), v = head (dj) and I ≤ j, we use P [u, v] is used to signify the subpath P to such an extent that start(P) = u and end(P) = v. Since strolls might visit vertices or darts on numerous occasions, when this documentation is utilized, u and v are planned to allude to explicit events of vertices inside the way. On the off chance that P is a cycle, and u happens before v in P [u, v] signifies a subpath of the cycle. We use P [u, v) to signify the walk got from the walk P [u, v] by erasing the last dart; P (u, v] and P (u, v) are characterized similarly. P [•, v] means the subpath P with start (P) = start (P) and end (P) = v. P [u, •] is likewise characterized. The opposite of P, rev (P) is characterized as the succession rev (dk), rev(dk−1), . . . , rev(d1).

A chart G is associated if for each sets of hubs u, v ∈ V there exists a u-to-v

way of darts in G. G is supposed to be k-associated on the off chance that there doesn't exist a bunch of k − 1 hub whose evacuation disengages the diagram.

A subset A ⊆ A prompts a subgraph (V, A) of G, where V is the arrangement of hubs that are endpoints of bends in A (in the edge-driven definition, V is the limitation of the segment V to the dart set of A). For a set An of circular segments, we signify by G − A the subgraph of G instigated by A − A.

A cut X is a parcel of V into two disjoint subsets (X, V − X). The sets X and V − X are at times alluded to as the sides of the cut. The darts crossing the cut X are those with endpoint in X and the other not in X. This arrangement of darts is signified Γ(X). Likewise, the arrangement of darts leaving the cut is Γ+(X) = {dart d : tail(d) ∈ X and head(d) ∈/X}, and the arrangement of darts entering the cut is Γ−(X) = {dart d : head(d) ∈ X and tail(d) ∈/X}. A cut X is called basic if both G − X and G − (V − X) are associated.

2.2 Lengths and Shortest Paths

Diagrams can be increased with various types of qualities. One of the most well-known credits is lengths (once in a while called loads). A length task is a capability length (•) from the arrangement of darts to the genuine numbers. Frequently bend lengths are discussed, in which case the length of the dart a+ is length (a) and the length of a− is endless. As a general rule, length tasks might be negative, albeit in different conditions just non-negative lengths are thought of. At the point when no disarray emerges it might be referred to lengths of the comparing bends rather than the darts. The documentation is stretched out to sets of darts (and to ways specifically). For a set D of darts, the length (or weight) of D is length (D) = $f_{d \in D}$ length (d). For two hubs u, v, the separation from u to v is the length of a briefest u-to-v way in the diagram. The single-source most brief way issue is to find, for a predefined hub s, the good ways from s to all hubs in the diagram as well as the genuine ways understanding these distances. In coordinated charts with no regrettable length cycles, these ways can forever be picked so they structure a tree established at s which is known as a most brief way tree.

2.2.1 Dijkstra's Algorithm

Dijkstra's algorithm is the normal name for a calculation for registering single source most limited ways in a coordinated chart with non-negative bend lengths. It is named after E. J. Dijkstra, albeit a few very much like calculations were freely found and distributed in the final part of the 1950's by Leyzorek, Gray, Johnson, Ladew, Meaker, Petry, and Seitz and by Dantzig.

The pseudocode which is presented is somewhat not the same as the typical one, to make it reasonable for the productive execution.

The method UPDATEHEAP(Q, s, d) diminishes the key of component s in the pile Q to be d. The system EXTRACTMIN(Q) returns the component with least key in the stack Q.

For a curve vu, unwinding vu is an endeavor to diminish the distance name of u by considering a way that gets to u through v utilizing vu. The methodology ACTIVATE loosens up every one of the circular segments whose tail is v.

Algorithm: Dijkstra (G,s)

Input Data:

Graph G, directed or undirected :

Positive edge lengths ; vertex v ∈ V

Output:

For all vertices v reachable from s, dist (v) is set to the distance from s to v

Begin

1: for all $v \in V(G)$: $d(v) \leftarrow \infty$

2: $d(s) \leftarrow 0$

3: initialize an empty heap Q

4: UPDATEHEAP(Q, s, $d(s)$)

5: $S \leftarrow \emptyset$

6: **while** $S = V(G)$

7: $v \leftarrow$ EXTRACTMIN(Q)

8: ACTIVATE(Q, G, v, d)

9: $S \leftarrow S \cup \{v\}$

End

Figure 2.1 General Flow of a Dijkstra's Algorithm

2.2.2 The Bellman-Ford Algorithm

The Bellman-Ford calculation is the normal name for a calculation for figuring single-source most limited ways in coordinated charts within the sight of negative lengths, however no regrettable length cycles. The calculation can be utilized to distinguish negative-length cycles. It is named after R. Bellman, who distributed the calculation in 1958, and after L. R. Portage Jr., who put forth the structure of edge relaxations. Very much like calculations were autonomously acquired and distributed by Shimbel and Moore. Once more, see Schrijver for a point by point verifiable survey. The calculation comprises of stages. On each stage every one of the bends of the chart are loose. It follows that toward the finish of the stage k, the distance mark d (v) stores the length of a briefest s-to-v way that comprises of all things considered k bends. In this way, after at most n cycles, the distance marks store the genuine good ways from s in the whole diagram, and the running time is O(mn). Likewise with Dijkstra's calculation, it is not difficult to expand the calculation to create a most limited way tree inside a similar running time.

Algorithm: Bellman-Ford (G,s)

Input Data: Graph G, source vertex

Output: Shortest distance and predecessor arrays

Begin

1: for all $v \in V(G)$: $d(v) \leftarrow \infty$

2: $d(s) \leftarrow 0$

3: **repeat** $V(G)$ times

4: **for** each arc *uv*

5: $d(v) \leftarrow \min\{d(v), d(u) + f(uv)$

End

Figure 2.2General Flow of Bellman-Ford Algorithm

2.3 Introduction of Ant Colony Optimization

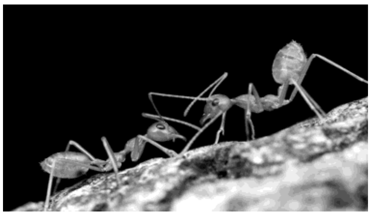
Since its introduction, in the PhD proposition of [5], the field of Ant Colony Optimization (ACO) has been developed colossally. The ACO metaheuristic structures the class of nature-enlivened enhancement calculations, especially inspired by the component for tracking down most limited ways between wellsprings of food and the nest in colonies of ants. This system is altogether founded on the self-association of moderately basic people. Specifically, a more definite portrayal of the way of behaving of ants in a province is presented, the popular twofold scaffold try that has brought about the principal neighborhood model of subterranean insect navigation having the option to repeat worldwide subterranean insect settlement conduct, lastly ACO itself. The ACO system, remembering the subtleties for the AS, the ACS, and a combination evidence for an exceptional class of ACO calculations are particularly significant for the comprehension of the resulting sections.

2.4 Ant Colonies

One-self getting sorted out components at the groundwork of the association of every ant province have empowered them to be such developmental effective species. They have been available on the earth for a huge number of years and take care of a large portion of the earth, with the exception of Antarctica2. In this part, the fundamental attributes of ant colonies and the examinations are momentarily framed that have brought about the principal models of ant conduct, determined to show the wellspring of motivation that has prompted ACO calculations.

2.4.1 Ants in Nature

An ant colony consists of a queen, male ants, and sterile female workers. A state is established when a virgin queen and a couple of males, all with wings, leave the nest in look for another spot to begin a colony. The queen mates with the guys, after which the males die and the queen digs herself into the dirt where she will begin laying eggs until the end of her life, which might keep going for up to 15 years. After the main eggs have transformed into hatchlings, they will form into pupae lastly into grown-up female specialists. These specialists will play out all errands in and around the home. For the majority of the 10,000 ant species on the planet, these assignments can be partitioned into scrounging, watching, home support, and midden work. Scavenging is the main errand in the colony and comprises of strolling around in look for food and returning it to the nest entry. Different ants will then take this food and bring it inside the nest, generally for taking care of the hatchlings. Watching ants are quick to leave the nest in the first part of the day and decide the paths along which the foragers will begin looking for food. They do this by leaving the home and leaving a path of a synthetic substance, called pheromones, returning. The sole returning of these ants is the sign that it is protected to investigate around that path for food. Home support is the errand of taking bits of soil from the nest to the nest entry and heaping it into what is known as a midden, and to keep up with the inside design of the nest. Midden laborers take the midden from the nest entry, mark it with some synthetic trademark for this colony, and lay it down elsewhere. These stacks of artificially stamped decline are denoting the colonies territory and guiding ants belonging to the nest entrance. Furthermore, some specialized foraging ants may act as soldier, ants attacking intruding ants from other colonies in order to protect the territory.



(a)Oecophylla longinoda workers encounter each other on a tree branch and by quickly touching each other with their antennae are informed about each others task.

(b) Argentine ants, introduced by human commerceto California, attack a native *Pogonomyrmex* harvesterant. Native ants in many places around the world have disappeared in areas invaded by argentine ants.

Figure 2.3: Two images of ants illustrating some of their behavior described in this section.

Around 25% of the laborers are working external the nest, while another 25% is dealing with the larvae inside the home, and the excess half is inside the nest and sitting idle. They appear to trust that something will do and go about as a buffer between the ants working external the nest and those taking care of the larvae somewhere inside the nest. The buffer ants might be selected to work outside once the requirement for that emerges. Subterranean insects playing out a specific undertaking convey a specific errand explicit scent from investing a great deal of energy near one another. Ants contact each other when they meet, detecting every others scent, and by the pace of these experiences they are accepted to have the option to gather whether they ought to continue to do the errand they were doing, or change their undertaking. Along these lines, ants are fit for turning undertakings based on a powerful requirement for it. For example, assuming that a ton of food is found and being taken back to the nest, scavenging subterranean insects will zero in on that trail leaving a lower thickness of rummaging ants at different areas, consequently prompting the pressure in different insects to change to searching. It has turned out that not all switches are conceivable. A wide range of laborers might change to scrounging, while at the same time rummaging ants won't ever change to doing different positions. Home support laborers might change to watching also, while new home upkeep insects must be enrolled from the cradle ants in the home. Along these lines, rummaging ants are the sink in this organization of exchanging assignments and the cushion ants inside, she will continue to lay eggs from the main insemination, and the state will continue to fill in size. The size of the settlement is in this manner a component of the age of the province and uncovers specific properties of the state. For example, more youthful states are more versatile to abrupt changes around their home, yet will quite often zero in on known great wellsprings of food and won't investigate a lot. Then again, more established provinces appear to adjust less to changes in their nearby environmental elements and have all the earmarks of being more ready to face the challenge of investigating more and further away from the nest.

The focal angle in ant colonies, which is particularly fascinating for the motivation to foster subterranean ant based calculations, is that the cooperation between insects is occurring on a huge scale and that there is irregularity engaged with the connections. The way of behaving of the singular ants because of this is by all accounts extremely tumultuous and not exceptionally viable. Gordon (2003) makes reference to that she frequently feels the inclination of assisting the ants as they with doing not appear to be working effectively of accomplishing something valuable. Be that as it may, the subsequent conduct on a worldwide level is exceptionally effective and unsurprising generally. The way of behaving may not be awesome, however excellent, and with the extra advantages of adaptability, versatility, and power.

2.4.2 Double Bridge Experiment

The authors of [4] have been quick to play out the popular twofold extension tests to show oneself getting sorted out conduct of rummaging ants. This model has later turned into the reason for the principal ACO calculations. We make sense of the twofold scaffold explores, the fitted model, and the main outcomes with the end goal that the ground works of ACO can be perceived and the astounding self-association standards in insect settlements can be valued far and away superior.

The main twofold extension analyze was completed by Deneubourg in 1990 and involved the Argentine ant Iridomyrmex humilis, which was renamed in the mid 1990s to the variety Linepithema, consequently changing its logical name to Linepithema humile. The laborers of the Argentine subterranean insect are around 3 millimeters in length with their sovereign being two to multiple times this length.

Despite the fact that being local to Northern Argentine, Uruguay, Paraguay, and Southern Brazil, they have spread over enormous regions of the planet, principally with Mediterranean environments, including the United States, Europe, and Japan, with the guide of people. This makes them one of the most boundless intrusive ant species [25], frequently dislodging most, or every single local ant. Thusly, they are broadly viewed as a nuisance. Not at all like most other insect species, Argentine insects from far off areas actually act non-forcefully when put together. Among different discoveries, this has prompted the conviction that all ant truth be told structure one single uber state. As per Walker (2009): "At whatever point insects from the fundamental European and Californian super-provinces and those from the biggest state in Japan came into contact, they went about as though they were lifelong companions. These ants scoured radio wires with each other and never became forceful or attempted to keep away from each other. So, they went about as though they generally had a place with a similar settlement, notwithstanding residing on various landmasses isolated by immense seas". What made the Argentine subterranean insect intriguing for the twofold extension tests is that, not normal for most other insect species, they store pheromones while getting back with food, yet additionally while progressing from the home investigating new districts for tracking down food. In the arrangement examined in [4], there are two contained fields, isolated from one another, yet associated by an extension. In one field is the nest of Argentine ants, which can leave the field simply by the scaffold, driving them to the main access to the next field, in which food are found. The scaffold, but has two branches, subsequently the name twofold extension. A schematic of this twofold extension arrangement is displayed in Figure 2.4(a). The two branches are at a point of 60◦, to such an extent that ants arriving at the field are probably going to continue on advances, as opposed to returning straightforwardly back on the other branch. The distance covered by the extension was 15 cm. The width of each branch is 1 cm. The extension is covered with white sand, to such an extent that restarting the trial includes just supplanting the sand with new (artificially plain) sand, and returning all subterranean insects to the home. During the examination, the quantity of insects on each extension was included in 3-minute stretches.

(a) Double bridge with branches of equal size. (b) Double bridge with branches of unequal

Figure 2.4: Schematic view of the setups used in the double bridge experiments

It was seen that at first, the two branches were picked by an equivalent number of subterranean insects. Notwithstanding, as every subterranean insect leaves a pheromone trail ceaselessly, and the degree of pheromone power impacts different ants in their choice of picking the right, or the left branch, a little distinction between the pheromone forces on the branches might bring about the breaking of this balance. This positive input instrument animates the insects to lean toward one of the branches over the other, to such an extent that quickly by far most of the insects will pick a similar branch. The hypothesis was that the decision making of the ants could be described bythe following probability function:

$$P_A = \frac{(C+N_A)^{\infty}}{(C+N_A)^{\infty} + (C+N_A)^{\beta}} = 1 - P_{\beta} \qquad (2.1)$$

where P_A and P_B are the probabilities that an ant will choose branch A and B respectively, and where N_A and N_B represent the number of ants that have passed branch A and B respectively after in total $N = N_A + N_B$ ants have crossed the bridge. The parameters C and α should be picked with the end goal that the model matches the noticed way of behaving. Note that this likelihood capability doesn't straightforwardly incorporate the pheromone values, yet relies upon the quantity of intersections of a branch, which is thought to be reflected by the pheromones. The dissipation of pheromones isn't displayed. On account of the Argentine insects, the mean lifetime of a pheromone is 30 minutes: significantly longer than it takes a subterranean insect to cross the extension. The impact of pheromone dissipation was in this manner dismissed in the analyses. Through Monte Carlo reproductions on this model, the boundaries α and C were fitted to the information, coming about in α = 2 and C =20. This was the principal experimental proof that a basic likelihood rule, including just neighborhood measures, was the fundamental component behind oneself getting sorted out conduct of rummaging ants.

The subsequent twofold scaffold explore, significant for the inevitable improvement of the principal ACO calculations, was distributed by Goss et al. what's more, involved parts of various length. The arrangement was like the one from Deneubourg et al. The two branches were associated with one or the flip side of the hole under a point of 60◦ to such an extent that there would be no inclination of the insects for one of the branches by their underlying point. Notwithstanding, after a couple of centimeters, one of the branches continued at a bigger point, bringing about that branch being longer than the other. The arrangement is portrayed in Figure 2.4(b). As a matter of fact, in the extension, the ants pick again between two branches, and presently the more drawn out and more limited branch are traded, with the end goal that conceivable inclination of an ant of picking left or right is counterbalanced. At first, the subterranean insects were similarly prone to pick the more extended, or the shorted branches. In any case, the ants that had picked the more limited branch arrived at the food sooner and coming back, the pheromone fixation on the more limited branches was to some degree more grounded than that on the more extended branches. They were hence bound to pick a more limited branch, further including to the pheromone focus that branch. Rapidly, the pheromone contrast became significant and successfully all ants continued to pick the more limited branches.

Monte Carlo reenactments involving a similar probability capability as in (2.1) were equipped for imitating these outcomes in Silico. Oneself getting sorted out standards in this way exhibited that the worldwide choice issue of finding the most limited way can be tackled based on neighborhood data and an enormous number of people. An extra perception was made when the more limited branches were missing from the very outset of the examination and presented just later, when the insects had made areas of strength for a path on the more drawn out branches. The insects were viewed as unequipped for changing to the more limited spans. The Monte Carlo recreations affirmed this way of behaving: with just saving pheromones and without a critical vanishing, a subsequent solid path is for all intents and purposes irreversible. In [4], similar scientists went above and beyond by displaying the investigating and rummaging conduct of ants in a two-layered field by a grouping of parallel choice issues like picking one of two branches in the twofold scaffold tests. They found that with Argentine subterranean insects, the front of the investigating subterranean insects continues gradually, cautiously pushing ahead and stretching out through the field. The paths that they abandon empower different subterranean insects to pursue choices all the more rapidly, framing the roadways for ant colonies of some kind or another. When a subterranean insect has discovered some food, it gets back to the home over these equivalent paths, consequently supporting the paths considerably more. The outcome is an example of branches, where fruitful investigation brings major areas of strength for about prompting these food-rich districts, and in additional investigation around these locales. A subsequent system adding to the expansion in investigation and the support of pheromone trails is the enrollment of new specialists from the nest by the insects getting back to the nest and conveying food.

In most ant species, foraging ants don't store pheromones on out of the home, or store considerably less pheromones. Additionally, how much pheromones saved coming back might rely upon the quality, or measure of food that has been found, in this way rein-driving the paths prompting better food sources significantly more. Note that with just storing pheromones coming back to the nest, oneself getting sorted out component of finding briefest ways actually works. This structures the reason for ACO.

2.5 ACO Metaheuristic

The ACO metaheuristic has been created to tackle combinatorial advancement issues (Dorigo and Blum, 2005). A metaheuristic is a bunch of algorithmic ideas that can be utilized to characterize heuristic techniques that can be applied to a wide arrangement of various issues. The proper meaning of ACO is consequently an exceptionally broad one. In this segment we will characterize the ACO meta-heuristic (or system) will be characterized in a to some degree less broad way, currently fitted it could be said to match the meaning of our Ant Colony Learning (ACL) calculation. To begin with, in any case, it will be characterized what is a combinatorial streamlining issue.

2.5.1 Framework for ACO Algorithms

In ACO, the combinatorial improvement issue is addressed by a chart, called the development diagram, which comprises of a bunch of vertices and a bunch of curves associating the vertices. For example, on account of the TSP the vertices mean the urban communities and the bends address the streets connecting the urban areas. On account of the control of dynamic frameworks, the vertices address the discrete conditions of the framework and the circular segments relate to the framework answering a contribution to a specific state.

A specific arrangement found by an ant c is an arranged arrangement of arrangement parts, s_c = (s (1), s (2), …) and every arrangement part comprises of a couple of vertices, say i and j, which c are associated by the bend ij. The arrangement addresses a way over the development chart, where "development" alludes to the ants building the arrangement steadily by moving over the diagram. An insect on the development chart begins an underlying vertex and moves from one vertex to another and adds the relating arrangement parts to its halfway arrangement s_p, c until it arrives at the terminal vertex and the fractional arrangement turns into the (up-and-comer) arrangement found by this insect. How the terminal vertices are characterized relies upon the issue considered. For example, in the TSP, the terminal vertex is equivalent to the subterranean insect's underlying vertex, subsequent to having visited any remaining vertices precisely once. For the application to control issues, as viewed as in this proposition, the terminal vertex compares to the ideal condition of the framework and is no different for every one of the subterranean insects. To ensure that the subterranean insects visit all vertices just a single time on account of the TSP, a subterranean insect likewise adds the arrangement parts to its confidential unthinkable rundown. At the point when an ant should choose to which vertex it will move straightaway, it can pick any vertex that isn't in its unthinkable rundown.

Two factors are related with a circular segment ij: a pheromone variable τ_{ij} and a heuristic variable η_{ij}. The pheromone factors (likewise basically called pheromones) address the procured information about the ideal arrangements after some time and the heuristic factors (which won't be essentially called heuristics to stay away from disarray with the way that ACO calculations are heuristic calculations) give deduced data about the nature of the arrangement part, i.e., the nature of moving from vertex i to vertex j. On account of the TSP, the heuristic factors ordinarily address the reverse of the distance between the individual sets of urban communities. By and large, a heuristic variable addresses a transient quality proportion of the arrangement part, while the errand of the improvement issue is to procure a link of arrangement parts that together structure an ideal arrangement. A pheromone, then again, encodes the proportion of the drawn out nature of connecting the individual arrangement parts.

2.5.2 Relation to Real Ants

The metaphorical ants in the ACO algorithm are simply called ants. Obviously being physically quite different from real ants, they show important similarities and differences in the following ways:

- ACO ants use a similar probability rule for their decision making (2.2) as the model(2.1) for decision making by real ants;
- Unlike real ants, ACO ants have a memory for the places (vertices) they have visited;
- Like most real ant species, ACO ants only drops pheromones after reaching the terminal vertex (food source), simulating walking back to the nest (initial vertex);
- Like in some ant species, the amount of pheromones dropped by the ACO ants isproportional to the quality of the solution (food source).

With these similarities and differences in mind, the ACO algorithms described in the nextsection can be related to the behavior of real ants.

2.6 ACO Algorithms

Numerous ACO calculations have been grown, the greater part of them just contrasting from the rest in a couple of minor focuses to cause them to perform better on a particular kind of issues. This part surveys the two most notable and most generally applied ACO calculations, the ant system and the ant colony system. These calculations stand at the reason for the majority of the calculations later created, as well as the ACO calculation that is the primary subject of this proposition. To comprehend the systems of ACO, these calculations should be surely known.

2.6.1 Ant System

The most essential ACO calculation is known as the Ant System (AS) [5] and functions as follows: M ants are arbitrarily appropriated over the vertices of the development diagram. The heuristic factors η_{ij} might be set to encode earlier information on the issue by inclining toward the decision of some vertices over others. For every ant c, the incomplete arrangement $s_{p,c}$ is at first vacant and all pheromone factors are set to a little beginning worth $\tau 0 > 0$. Each move of the ants will be called over the chart a stage. In each step, every ant chooses in view of some likelihood dispersion, which arrangement part (i, j) to add to its fractional arrangement $S_{p,c}$. The probability pc {j|i} for a ant c on a vertex i to move to a vertex j inside its feasible neighborhood $N_{i,c}$ is characterized as:

$$p_c\{j/i\} \quad = \quad \frac{\tau_{ii}{}^{\alpha}\, \eta_{ij}{}^{\beta}}{\Sigma\ l \in N_{i,c}\, \tau_{jl}{}^{\alpha}\, \eta_{jl}{}^{\beta}} \quad , \quad \forall j \in N_{i,c} \qquad (2.2)$$

with α>=1 and β>=1 deciding the overall significance of η_{ij} and τ_{ij} separately. The plausible neighborhood $N_{i,c}$ of an ant c on a vertex i is the arrangement of vertices not yet visited (by ant c) that are associated with i and is directed by the issue structure. By moving from vertex i to vertex j, ant c links the related arrangement part (i, j) to its halfway arrangement $s_{p,\,c}$ until it arrives at the terminal vertex and finishes its up-and-comer arrangement by putting away $s_{p,\,c}$ as s_c. The ant is presently said to have finished a preliminary. After all ants have completed their trial, in the AS the candidate solutions of all ants are evaluated using the fitness function F(s) and the resulting value are used to update the pheromone levels as follows:

$$R_{ij} \leftarrow (1\text{-}\,\rho)\ \Sigma\ r_{ij} + \Delta\tau_{ij}(s),\ \forall(i,j),\ s \in S_{upd} \qquad (2.3)$$

with ρ (0, 1) the vanishing rate and S_{upd} the arrangement of arrangements that are qualified to be utilized for the pheromone update, which will be made sense of additional on in this segment. This update step is known as the worldwide pheromone update step, rather than the nearby pheromone update step that will be presented in the ACS later on. The worldwide pheromone update alludes to the arrival of the ants to their nest, while leaving a pheromone trail. Not quite the same as genuine ants in ACO, all ants "stand by" for one another previously "strolling back" together. The pheromone store $\Delta\tau_{ij}(s)$ is registered as:

$$F(s) = \Delta\tau(s), \text{ if } (i,j) \in S \qquad (2.4)$$

$$F(s) = 0, \text{otherwise}$$

The pheromone levels are a proportion of the fact that adding the related arrangement part to the halfway solution is so attractive. By pheromone dissipation, it very well may be stayed away from that the calculation rashly meets to sub-standard arrangements. Note that in (2.4) the pheromone levels on all vertices are dissipated and just those vertices that are related with the arrangements in the update set get a pheromone store.

In the following preliminary, every ant rehashes the past advances, yet presently the pheromone levels have been refreshed and can be utilized to come to better conclusions about which vertex to move to. After a halting model has been fulfilled, for example when a specific number of preliminaries have passed, the upsides of τ_{ij} and η_{ij} on the diagram encode the answer for all (i, j) matches. This last arrangement, as far as the ideal vertex j to browse a vertex i, can be separated from the diagram as follows:

$$j = \arg\max\,(\tau^{\alpha}\eta^{\beta}) \qquad (2.5)$$

where ties are broken randomly in case the product $\tau^{\alpha}{}_{ij}\,\eta^{\beta}{}_{ij}$ has the same maximum value for a given *i* and different values of *j*.

There exist different principles to develop S_{upd}, of which the most standard one is to utilize all the applicant arrangements tracked down in the preliminary. This update set is then called: Strial3. This update rule is run of the mill for the AS. Be that as it may, other update rules have displayed to outflank the AS up-date rule in different combinatorial streamlining issues. As opposed to utilizing the total arrangement of competitor arrangements from the last preliminary, either the best arrangement from the last preliminary, or the best arrangement since the instatement of the calculation can be utilized. The previous update rule is called emphasis best in the writing (which could be called preliminary best in our wording), and the last option is called best-up until this point, or worldwide best in the writing [6]. These strategies bring about areas of strength for an of the pheromone trail support towards arrangements that have been demonstrated to perform well. Moreover, they decrease the computational necessities of the calculation. As the gamble exists that the calculation rashly combines to sub-standard arrangements, these strategies are simply better than AS assuming additional actions are taken to forestall this, for example, the neighborhood pheromone update rule, made sense. Two of the best ACO variations that execute the update rules referenced above, are the Ant Colony System (ACS) [7] and the Max-Min Ant System [24]. On account of its connection to ACL, we will make sense of the ACS next.

2.6.2 Ant Colony System

The ACS [7] is an expansion to the AS and is one of the best and broadly utilized ACO calculations. There are some significant contrasts between the AS and the ACS. The ACS, most importantly, utilizes the worldwide best update rule in the worldwide pheromone update step. This implies that main the one arrangement that has been found starting from the beginning of the calculation that has the most elevated wellness (i.e., that has a rigorously higher wellness than the past best arrangement), called s_{gb}, is utilized to refresh the pheromone factors toward the finish of the preliminary. This is a type of elitism in ACO calculations that has displayed to accelerate the combination to the ideal arrangement essentially. A second significant distinction is that the worldwide pheromone update is just performed for the (i, j) coordinates that are a component of the worldwide best arrangement. This implies that not all pheromone levels are dissipated, likewise with the AS, yet just those that additionally get a pheromone store. Besides, the pheromone store is weighted by ρ. Thus and the past two contrasts, the global pheromone update rule is:

$$F(s) = (1\text{-}\rho)\tau_{ij} + \rho\Delta\tau_{ij}(s_{gb}), \text{ if } (i, j) \in s_{gb}\tau_{ij} \qquad (2.6)$$

$$F(s) = r_{ij}, \quad \text{otherwise.}$$

An important element from the ACS algorithm that acts as a measure to avoid premature convergence to suboptimal solutions is the local pheromone update step, which occurs for each ant after each step within a trial and is defined as follows:

$$\tau_{ij} \leftarrow (1 - \gamma)\tau_{ij} + \gamma\tau_0 \qquad (2.7)$$

where γ (0, 1) is the nearby pheromone update rate, like ρ (the worldwide pheromone update rule), ij is the file relating to the (i, j) match just added to the halfway arrangement, and $\tau 0$ is the underlying worth of the pheromone trail. The impact of (2.6) is that during the preliminary, the visited arrangement parts are made less alluring for different insects to visit, in that way advancing the investigation of other, less regularly visited, arrangement parts. The last significant contrast contrasted with the AS is that there is an express investigation double-dealing step with the determination of the following vertex j, where with a likelihood of ϵ, j is picked similar to the vertex with the most elevated worth of $\tau\alpha\eta\beta$ (double-dealing) and with the likelihood $1 - \epsilon$, an irregular activity is picked by (2.2) (investigation).

2.7 Applications of ACO

The Ant System, which is the fundamental ACO algorithm, and its variations, has effectively been applied to different advancement issues, like the mobile sales rep issue [8], load adjusting [21], work shop booking (Huang and Yang, 2008; Alaykran et al., 2007), ideal way making arrangements for portable robots (Fan et al., 2003), and steering in telecom organizations [25] An execution of the ACO idea of pheromone trails for truly automated frameworks is portrayed by[18]. A study of modern utilizations of ACO is introduced by Fox et al. (2007). An early distribution of insect based control is [19]. In this paper, the creators present a strategy for accomplishing load adjusting in media transmission organizations, where calls are steered by the pheromone circulation on the hubs. An outline of ACO and other metaheuristics to stochastic combinatorial enhancement issues can be viewed as in [2].

One of the principal genuine uses of the ACO structure to streamlining issues in consistent pursuit spaces is depicted in [22] and [23]. In [22], the application is the preparation of feed-forward brain networks for design order, and their constant variant of ACO shows a presentation equivalent to slope based brain network preparing calculations. A prior utilization of the insect illustration to persistent streamlining shows up in [3] and later work like the Aggregation Pheromones System and the Differential Ant-Colony Algorithm can be found in separately [25] and [14].

CHAPTER 3
ARCHITECTURE OF THE PROPOSED SYSTEM

This chapter represents proposed system, system flow, algorithm flow, sequence diagram, database design and case study of the system. In this chapter, the detail process of the system is described.

3.1 The Proposed System

The proposed system presents delivery date, start time, end time and the list of Citymart Branches in the Yangon Region. The user can choose delivery date, start time, end time and the desired branches from the list where they should deliver the stock from the Citymart Distribution Center. After accepting the user defined locations, the shortest traverse time between these locations will be calculated. The traverse delivery time depends on four time-intervals (weekday traffic time, weekday non-traffic time, weekend traffic time, weekend non-traffic time). Then, the system will execute the possible ways to reach all destination location. It will display the shortest route for all user defined places. If the total traverse time exceeds the user defined start time and end time, the system will show shortest route of the user desired branches and the list of Citymart branches which can deliver between start time and end time. If the total time is enough, the system will show the shortest route of the desired branches.

3.2 Citymart Supermarket and Traffic Information

This system managed the stocks distribution of Ayer -Won Distribution center by using Red-Black Ant colony system algorithm. The thirty-four Citymart supermarket branches information and their traffic information are collected from Google Maps [28]. Table 3.1 shows the names of Citymart Branches in Yangon Region. Table 3.2 shows the sample collected information for the proposed Supermarket Distribution Center Route Planning system.

Table 3.1 Names of Citymart Branches in Yangon

No.	Names of Citymart Branches
1	Marketplace by Citymart (6.5 mile)
2	Citymart Supermarket Aung San Stadium
3	Citymart Supermarket (47 Street)
4	Citymart Supermarket Pwat Kan
5	Citymart Supermarket South Dagon
6	Citymart Supermarket(Hlaing Thar Yar)
7	Citymart Supermarket AKK,
8	Citymart Supermarket Thanlyin
9	Citymart Supermarket (Central Women's Hospital)
10	Citymart Supermarket Dagon Seikkan
11	Citymart Supermarket(Thamine Train Station Road)
12	Citymart Supermarket @Junction Mawtin
13	Citymart Supermarket Kyan Sitt Min
14	Citymart waizayantar
15	Citymart (Pinlon)
16	Citymart (North Dagon)
17	Citymart Ye Kyaw
18	RoadCitymart (B. 02, Basement, Yankin Centre)
19	Citymart (Neighborhood)
20	Citymart (Neighborhood) North-Okkalapa
21	Citymart (Basement 01, Hledan Center)
22	Citymart Shin Saw Pu Street
23	Citymart (ChinaTown Point Branch)
24	Citymart (Thamine Junction)
25	Citymart Neighborhood (Anawrahta Road)
26	Citymart (Junction 8 Branch)
27	Citymart Shwe Pyi Thar
28	Citymart Thanlyin Kyaik Kaut
29	Citymart (Baho Road.)
30	Marketplace by Citymart (Golden Valley)
31	Marketplace by Citymart Kan Thar Yar Shopping Center
32	Marketplace by Citymart MM Plaza
33	Marketplace by CItymart Sule Square

34	Marketplace by Citymart (Junction City Branch).

Table 3.2 Sample Data of the System

Citymart Distribution Centre	Citymart Branch ID	Delivery Time of Ways	Distance (km)	Path	Best Time
Citymart Distribution Center	Marketplace by Citymart Supermarket (6.5 mile)	33 min	17 km	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. → Lay Daung Kan Rd. → E Horse race Course Rd. → New Univeraity Ave Rd. → Inya Rd. → Pyay Rd.	33 min
		34 min	17 km	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. → Upper Pazuntaung Rd. → Kabar Aye Pagoda Rd. → Dhammazedi Rd. → U Wisara Rd. → Pyay Rd.	
		34 min	17 km	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. → Gan Da Mar Rd. → Kabar Aye Pagoda Rd. → Pyay Rd	
Citymart Distribution Center	Citymart Supermarket Aung San Stadium	39 min	18 km	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. → Upper Pazuntaung Rd. → Ar Thaw a St. → Thadi Pahton St. → Kyaik Ka San Rd. → Nat Mauk Rd. → Kan Yeik Thar Rd. → Upper Pansodan Rd. → Gyo Phyu Rd.	39 min
		40 min	15 km	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. → Myin Taw Tar Rd. → Yammonar Rd. →St Yone Rd. → Bo Min Yaung St. →	

				Myanma Gone Yi St. → Upper Pansodan Rd. → Gyo Phyu Rd.	
		41 min	15 km	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. →Min Nandar Rd. → Yammonar Rd. →St Yone Rd. → Bo Min Yaung St. → Myanma Gone Yi St. → Upper Pansodan Rd. → Gyo Phyu Rd.	

Traffic in Yangon can be a real problem. The rush hour times are being gathered as the information of the system from trip advisor websites [27], the commercial district of banks, universities, trading corporations, and offices. The rush hour is being assumed from 6:30-9:30 am and in the evening 15:30-18:30 pm. Table 3.3 displays the information is assumed for traffic in Yangon.

Table 3.3: Traffic Information in Yangon

Sources	**AM**		**PM**	
	From	**To**	**From**	**To**
www.tripadvisor.com	6:30	9:30	4:00	6:30
www.tripadvisor.com	7:00	9:00	5:00	8:00
School/Universities/Offices		9:00	4:00	
School/Universities/Offices		8:00	3:00	
Most Companies		9:00	5:00	
Google Map	8:00	9:30	3:00	6:00

The delivering time with traffic are gathering from Google Maps that has a feature called "Popular times" that shows how long one can expect to wait at places like restaurants and supermarkets for weekdays and weekends. By knowing how busy somewhere is, and how long it takes than expected, the user can save time by planning to go on another day or at a different time. Figure 3.1 represents the traffic rules for Yangon, Myanmar and these rules are added the RB-ACS Algorithm.

```
Calculating Weekday and Traffic
If (Day is Saturday or Sunday)  then
        Weekday=off;
Else Weekday=on;
If (Start time is between 6:30-9:30 am  and between 15:30-18:30)  then
        Traffic=on;
Else Traffic=off;

The proposed rules based on traffic information
If (Weekdays==on and Traffic== on) then
       Takes delivery times based on traffic for Weekday
If (Weekdays==on and Traffic== off) then
       Takes delivery times based on non_traffic for Weekday
If (Weekdays==off and Traffic== on) then
       Takes delivery times based on traffic for Weekend
If (Weekdays==off and Traffic== off) then
       Takes delivery times based on non_traffic for Weekend
```

Figure 3.1 The proposed traffic rules

3.3 Improved Red-Black Ant Colony System

The following Red-Black Ant Colony System (RB-ACS) algorithm was used to implement the proposed system. RB-ACS utilize the fundamental idea of ant colony system, it has a few significant changes. The progressions that are made to the ACS are as follows:

Separate nearby ways: In ACS, just a single gathering of ants is utilized to look and the ants might utilize the way of different ants. Consequently, the pursuit isn't quickly enough for huge most brief way issues. Thus, rather than utilizing one gathering, the proposed framework utilizes two gatherings of ants, specifically the black gathering and the other is red gathering.

Different boundary values: In the proposed RB-ACS, the two gatherings have separate qualities. There are various gatherings of ants; every one of which has different nearby update values. In this way, the proposed RB-ACS involves separate qualities for the boundaries in neighborhood refreshing.

Worldwide refreshing: When every one of the ants has made their visits, then worldwide refreshing is applied. In ACS, unquestionably the best subterranean insect is permitted to store pheromone on its way. Be that as it may, in RB-ACS, two best subterranean ants from each gathering are permitted to store pheromone. This makes the worldwide refreshing equal.

3.3.1 Red-Black Ant Colony System Algorithm

Figure 3.2 represents the improved Red-Black Ant Colony System Algorithm and we add the calculation of traffic and choose the paths with the proposed traffic time rules in the step 2. So, the improved Red-Black Ant Colony System Algorithm presents Route Planning mechanism based on traffic information to apply supermarket delivery business.

Algorithm: Improved Red-Black Ant Colony System Algorithm

Input Data: Delivery Date, Start time, End time and the List of Citymart Supermarket Branches to deliver the stock.

Output: The Shortest Path for the user-desired Citymart Supermarket Branches.

Start

- **Step 1:**

  Check weekday or weekend

  Place the ants of each group (Red group and Black group) randomly in each supermarket

- **Step 2 :**

  For each supermarket do

      For each ant of the two groups do

      Check traffic

      ***Choose the paths* with the proposed rules**

      Choose the next supermarket according to the state transition rule

      if(every supermarket is visited) then

          place the ants in their starting supermarkets respectively

      Update the visited edges using local updating rule.

- **Step 3:**

  For each group of ants do

      Compute the best paths of each group

  Update the paths

- **Step 4:**

  If (End_condition = True) then

      Print shortest path

  else

    Go to Step 2

End

Figure 3.2 General Flow of Improved Red-Black Ant Colony System Algorithm

3.4 System Overview

Figure3.3 shows the transaction of the presented system. Firstly, the user chooses the desired branches to deliver the stock. The system will send the desired locations to the system database. The system will execute the random start place from the distribution system for both groups (red & black ant group). The system processes the shortest route for all user desired branches. If the total delivery time exceeds the user desired start and end time, the system shows the shortest route for all and the list of branches to deliver between desired times. If the total time is enough, the system will display the shortest route for the way of delivery and route detail between branches to the user.

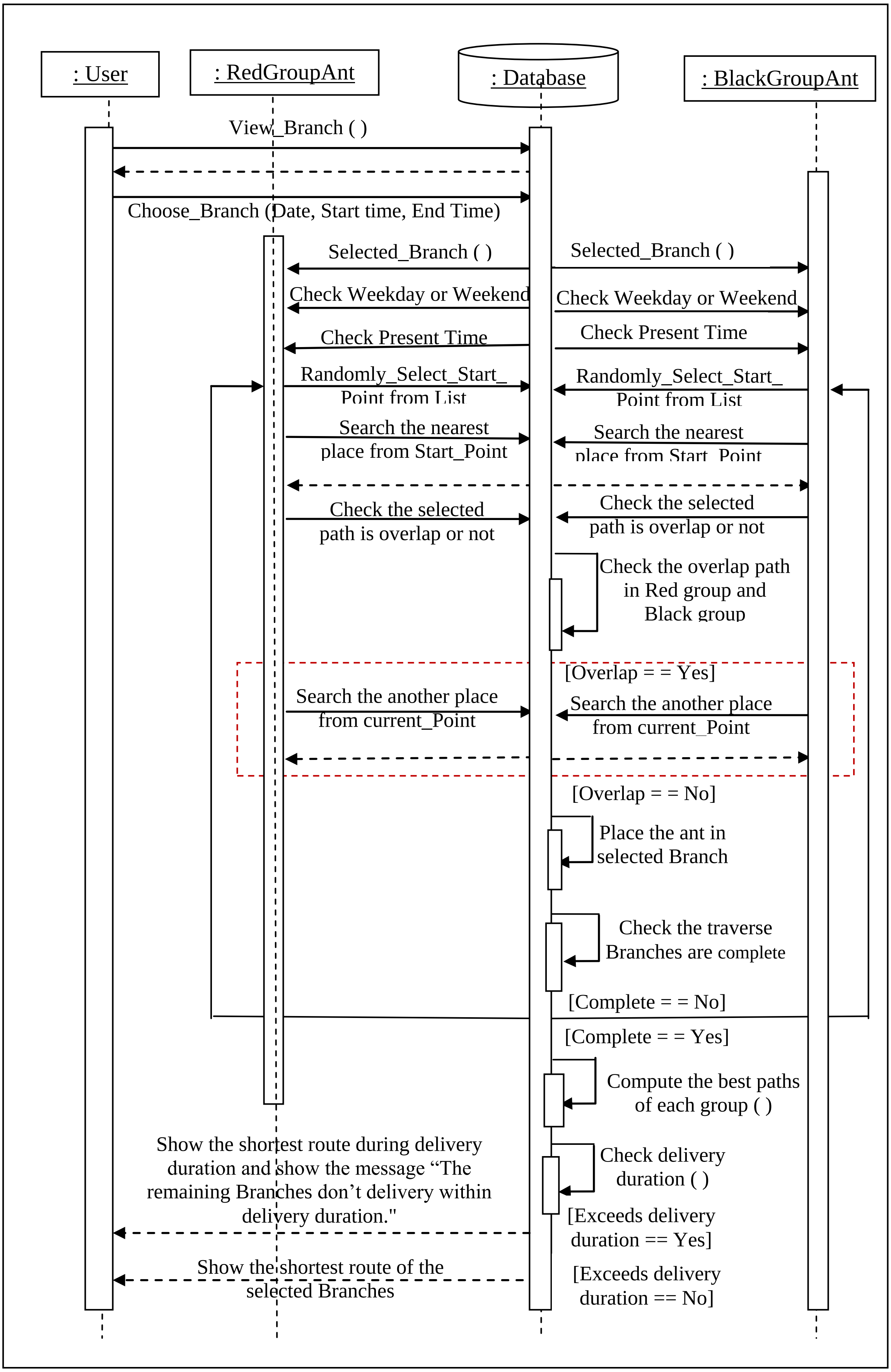


Figure 3.3 Sequence Diagram

In the case of figure 3.4, it shows the system flow of the proposed system. The system displays the Delivery Date, Start time, End time, and the List of Citymart Branches which retrieve from the system database. The user imports the above data to the system for computing the shortest delivery route .Then, the system will process the user desired data by depending on the start time and end time. After executing the process, the system will show the shortest delivery route of the system. The presented system will show the most limited course for all client characterized places. Assuming that the complete cross time surpasses the client characterized trip term, the system will print the message to the client "It isn't sufficient opportunity to send in one day". Then, the system displays the list of supermarket to send the stock in one day. If the duration is enough, the system will also display the shortest route of user desired Citymart branch to deliver the stock. This system presents delivery date and the list of Citymart Supermarket branches in the Yangon Region. Red-black ant colony algorithm depends on four time-interval (weekday traffic time, weekday non-traffic time, weekend traffic time, weekend non-traffic time).

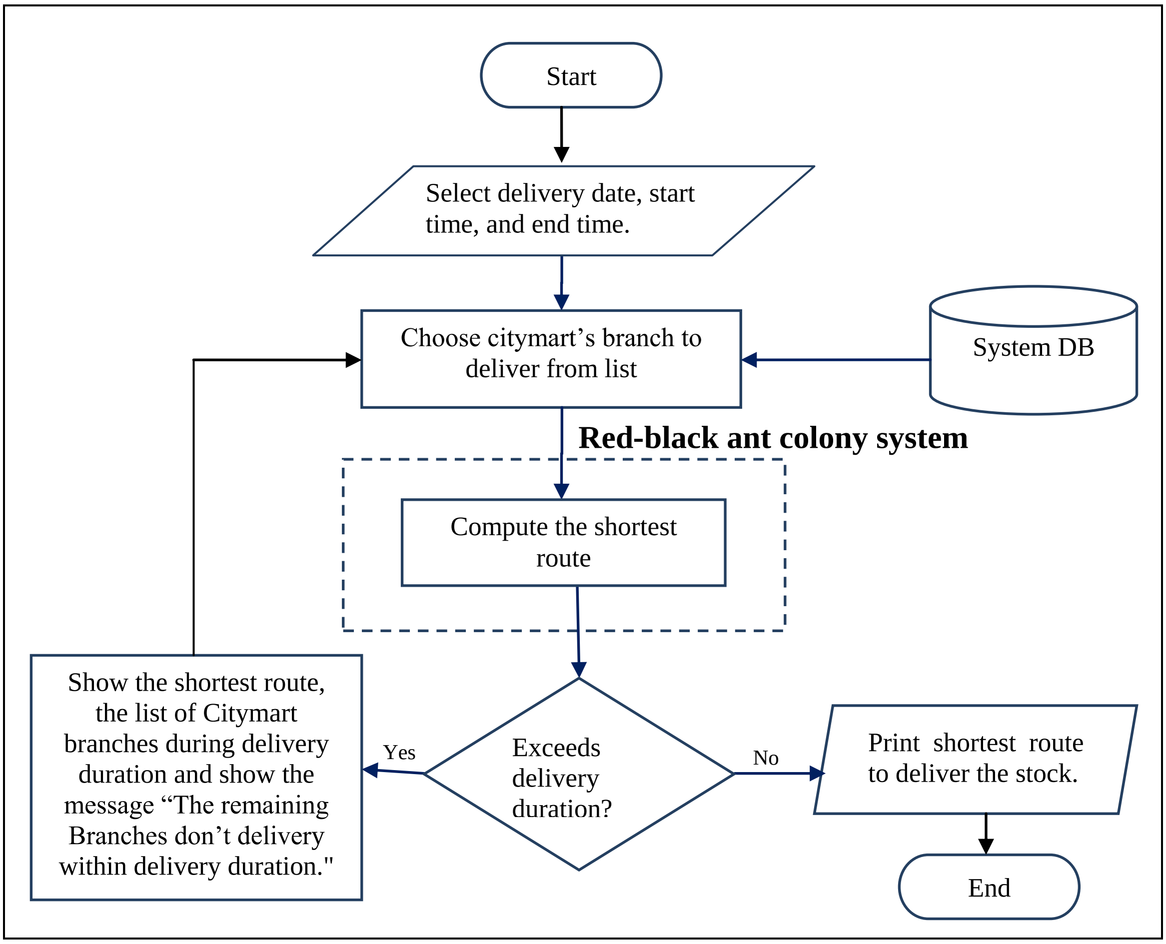


Figure 3.4 System Flow of the Proposed System

The next figure 3.5 is the flow of the red-black ant colony system algorithm. The user puts the inputs to the system. After that, the system check the weekday or weekend for the user desired date. The algorithm randomly places two ant groups as two start points. The works of the two groups are same but they work in parallel. The system checks the present delivery time to take the respective data from the dataset. Then, the system chooses the next shortest branch. At the time, if the choices of the next branch for two groups are same, the work of this algorithm checks the time taken of selected branch. After checking, the system gives the path of this branch to the group of early selection. The other group chooses the other shortest branch again. If the choices are difference, the system continuously chooses the next shortest branches to get the whole shortest path of all user desired Citymart branches. If the system does not have any branch to choose, the system ends the procedures of this algorithm.

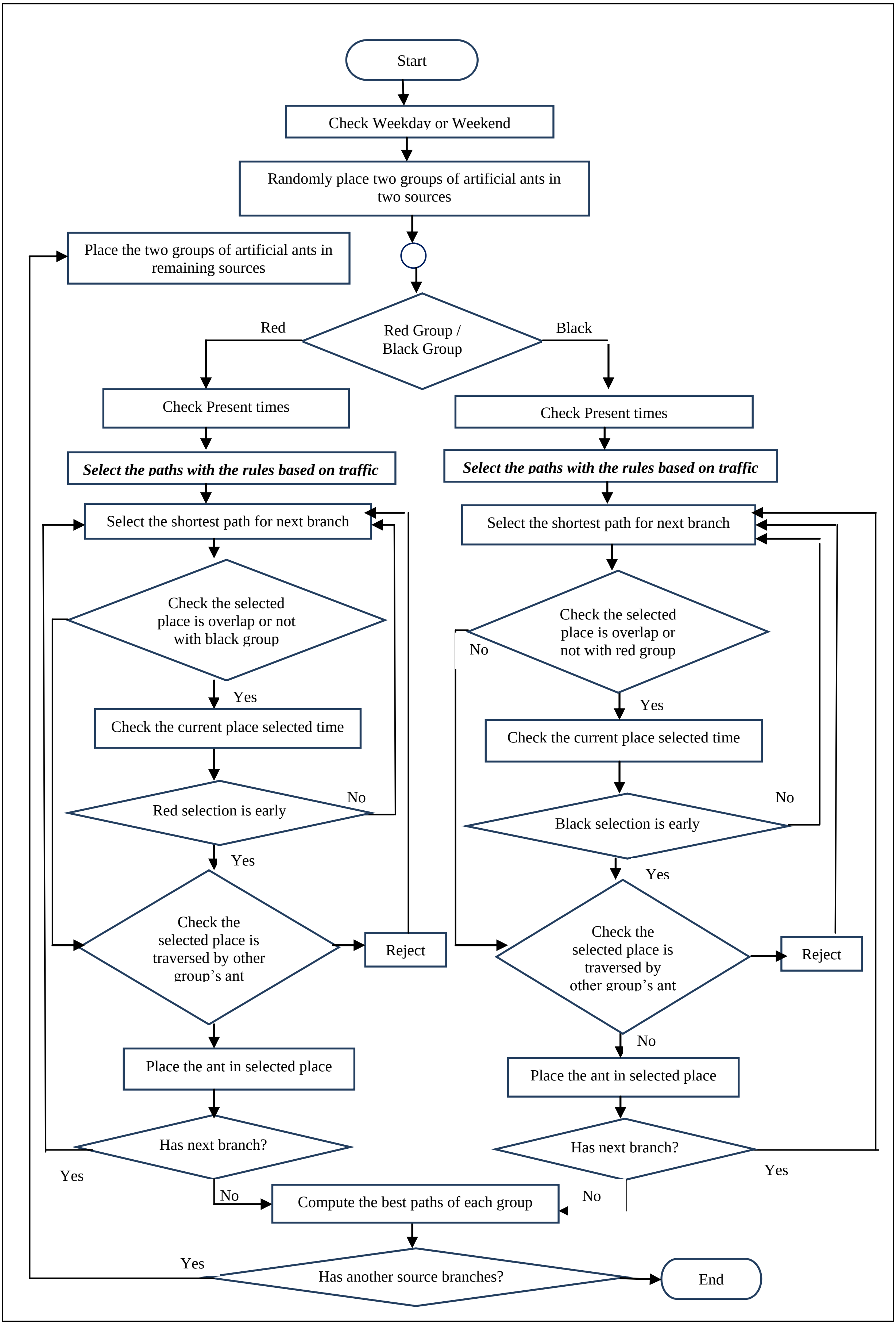


Figure 3.5 Algorithm Flow of the System

3.5 Implementation with Examples

This section implements the case study of the proposed system. In this section, how data is taken from the dataset and the runtime calculation process of each step is presented. The following case study is the sample calculation and sample result of our system. The user imports the inputs to the system are as follow:

- Date : 2-12-2021 (Tuesday)
- Start time : 9:00
- End time : 16:00
- Work time: 30 min (default by System)

Table 3.4 shows the list of Citymart Suprmarket Branches that the user is selected.

Table 3.4 User Desired Citymart Branch's Name

User Desired Citymart Branch's Name	**ID**
Marketplace by Citymart Supermarket (6.5 mile)	1
Citymart Supermarket Aung San Stadium	2
Citymart Supermarket (47 St.)	3
Citymart Supermarket Pawt Kan	4
Citymart Supermarket (Haing Thar Yar)	5
Citymart Supermarket AKK	6
Citymart Supermarket North-Okkalpa	7
Citymart Supermarket Thanlyin Kyauk Kaut	8

The proposed system uses two groups of ants, namely the black group and the other is red group. The two groups process in parallel. The system is defined the work time 30 minutes as default. If the user should change the work time, they can change the work time by editing in the Branch Information Page. Firstly, the system randomly places the two branches as the start places from the user-desired branches. The red group starts at Marketplace by Citymart (6.5 miles) and the black group places Citymart Supermarket AKK. The time starts at 9:00 am. So, the system takes the data of the weekday traffic time from the dataset. In step1, the total traverse time are added the weekday traffic time from the Citymart Distribution Center to the Marketplace by Citymart (6.5 miles) for the red group. Then, the system chooses the next shortest place. Then, the total traverse time are added the total time in the previous step, the weekday non-traffic time from Marketplace by Citymart (6.5 miles) to next shortest branch and the work time. Table 3.5 shows the weekday non-traffic time from Marketplace by Citymart (6.5 miles) to all other user desired branches for red group. Then, the system calculates the available time to go the next branch for the red group. The black group also calculates the same way of the red group. In the black group, the current branch is the Citymart Supermarket AKK. Therefore, the black route starts Citymart Supermarket AKK. Table 3.6 shows the weekday non-traffic time from Citymart Supermarket AKK to all other user desired branches for black group. After calculation of two groups, the red group's path is from Marketplace by Citymart (6.5 miles) to Citymart Supermarket North-Okkalpa. The route of the black group is from Citymart Supermarket AKK to the Citymart Supermarket Aung San Stadium. After that, the system calculates the total time and available time to take the next data from the dataset.

Table 3.5: Weekday Non-Traffic Time for Marketplace by Citymart (6.5 miles) in Step1

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
1	2	21 min	21 min	1 → 7
		23 min		
		23 min		
1	3	23 min	23 min	
		25 min		
		26 min		
1	4	22 min	22 min	
		23 min		
		24 min		
1	5	19 min	19 min	
		22 min		
1	6	22 min	22 min	
		25 min		
1	7	15 min	15 min	
		16 min		
		20 min		
1	8	42 min	42 min	
		47 min		
		53 min		

Table 3.6: Weekday Non-Traffic Time for Citymart Supermarket AKK in Step1

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
6	1	22 min	22 min	6 → 2
		25 min		
6	2	19 min	19 min	
		21 min		
6	3	22 min	22 min	
		24 min		
6	4	38 min	38 min	
		41 min		
		43 min		
6	5	35 min	35 min	
		39 min		
		42 min		
6	7	38 min	38 min	
		41 min		
		43 min		
6	8	35 min	35 min	
		39 min		
		42 min		

In step2, the system extracts data to choose the next shortest place from the dataset. Table 3.7 shows the weekday non-traffic time from Citymart Supermarket North-Okkalapa to next user desired branches for red group. Table 3.8 shows the weekday non- traffic time from Citymart Supermarket Aung San Stadium to the next user desired branches for the black group. The next branch for the red group is Citymart Supermarket Pawt Kan and the branch for the black group is Citymart Supermarket (47 St.). After choosing the next shortest branch for two groups, the system calculates the total time and available time to process the next step.

Table 3.7: Weekday Non-Traffic Time for Citymart Supermarket North- Okkalapa in Step2

Source	Destination	Delivery time of ways	Best time (Ants travel using State Trasition Rule)	Selected Route
7	2	45 min	45 min	7 →4
		50 min		
		58 min		
7	3	40 min	40 min	
		49 min		
		50 min		
7	4	20 min	20 min	
		22 min		
		23 min		
7	5	22 min	22 min	
		23 min		
		30 min		
7	6	38 min	38 min	
		41 min		
		43 min		
7	8	39 min	39 min	
		40 min		
		42 min		

Table 3.8: Weekday Non-Traffic Time for Citymart Supermarket Aung San Stadium in Step2

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
2	1	18 min	18 min	2->3
		19 min		
		19 min		
2	3	10 min	10 min	
		11 min		
		12 min		
2	4	31 min	31 min	
		33 min		
		35 min		
2	5	25 min	25 min	
		27 min		
2	7	45 min	45 min	
		50 min		
		58 min		
2	8	32 min	32 min	
		35 min		

In the next step, the system also extracts data to choose the next shortest place from the dataset. Table 3.9 shows the weekday non-traffic time from Citymart Supermarket Pawt Kan to remaining user desired branches for red group. Table 3.10 shows the weekday non- traffic time from Citymart Supermarket (47 St.) to remaining user desired branches for black group. The next branch for the red group is Citymart Supermarket Hlaing Thar Yar and the branch for the black group is Marketplace by Citymart (6.5 miles). After choosing the next shortest branch for two groups, the system calculates the total time and available time to execute the next step.

Table 3.9: Weekday Non-Traffic Time for Citymart Supermarket Pawt Kan in Step3

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
4	2	31 min	31 min	4->5
		33 min		
		35 min		
4	3	40 min	40 min	
		41 min		
		43 min		
4	5	16 min	16 min	
		18 min		
		21 min		
4	6	38 min	38 min	
		41 min		
		43 min		
4	8	60 min	60 min	
		62 min		
		74 min		

Table 3.10: Weekday Non-Traffic Time for Citymart Supermarket (47 St.) in Step3

Source	Destination	Delivery time of ways	Best time (Ants travel using State transition Rule)	Selected Route
3	1	21 min	21 min	3→1
		23 min		
		24 min		
3	4	40 min	40 min	
		41 min		
		43 min		
3	5	35 min	35 min	
		37 min		
		40 min		
3	7	40 min	40 min	
		49 min		
		50 min		
3	8	31 min	31 min	
		43 min		

In step4, the system also takes data to choose the next shortest place from the dataset. Table 3.11 shows the weekday non-traffic time from Citymart Supermarket Hlaing Thar Yar to remaining user desired branches for red group. Table 3.12 shows the weekday non- traffic time from Marketplce by Citymart Supermarket (6.5 miles) to remaining user desired branches for black group. The next branch for the red group is Citymart Supermarket AKK and the branch for the black group is Citymart Supermarket North-Okkalapa. After selecting the next shortest branch for two groups, the system calculates the total time and available time to run the next step.

Table 3.11: Weekday Non-Traffic Time for Citymart Supermarket Hlaing Thar Yar in Step4

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
5	2	25 min	25 min	5→6
		27 min		
5	3	28 min	28 min	
		35 min		
5	6	18 min	18 min	
		21 min		
		35 min		
5	8	29 min	29 min	
		30 min		

Table 3.12: Weekday Non-Traffic Time Marketplace by Citymart (6.5 miles) in Step4

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
1	4	19 min	19 min	1→7
		20 min		
		22 min		
1	5	17 min	40 min	
		19 min		
1	7	15 min	15 min	
		16 min		
		20 min		
1	8	42 min	42 min	
		47 min		
		53 min		

In the step5, the system also takes the data as the previous steps. Table 3.13 shows the weekday non-traffic time from Citymart Supermarket AKK to remaining user desired branches for red group. Table 3.14 displays the weekday non- traffic time from North-Okkalapa to remaining user desired branches for black group. The next branch for the red group is Citymart Supermarket Aung San Stadium and the branch for the black group is Citymart Supermarket Pawt Kan. After then, the system also calculates as the above steps.

Table 3.13: Weekday Non-Traffic Time for Citymart Supermarket AKK in Step5

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
6	2	20 min	20 min	6→2
		21 min		
6	3	22 min	22 min	
		24 min		
6	8	35 min	35 min	
		39 min		
		42 min		

Table 3.14: Weekday Non-Traffic Time for Citymart Supermarket North-Okkalapa in Step5

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
7	4	20 min	20 min	7→4
		22 min		
		23 min		
7	5	22 min	22 min	
		23 min		
		30 min		
7	8	39 min	39 min	
		40 min		
		42 min		

In step6, the system also takes the data as the previous steps. Table 3.15 shows the weekday non-traffic time from Citymart Supermarket Aung San Stadium to remaining user desired branches for red group. Table 3.16 descibes the weekday non-traffic time from Citymart Supermarket Pawt Kan to remaining user desired branches for black group. The next branch for the red group is Citymart Supermarket (47 St.) and the branch for the black group is Citymart Supermarket Hlaing Thar Yar. After then, the system also calculates as the above steps.

Table 3.15: Weekday Non-Traffic Time for Citymart Supermarket Aung San Stadium in Step6

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
2	3	10 min	10 min	2→3
		11 min		
		12 min		
2	8	32 min	32 min	
		35 min		

Table 3.16: Weekday Non-Traffic Time for Citymart Supermarket Pawt Kan in Step6

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
4	5	16 min	16 min	4→5
		18 min		
		21 min		
4	8	60 min	60 min	
		62 min		
		74 min		

In step7, the system also executes the data as the previous steps. Table 3.17 shows the weekday non-traffic time from Citymart Supermarket (47 St.) to remaining user desired branches for red group. Table 3.18 represents the weekday non- traffic time from Citymart Supermarket Hlaing Thar Yar to remaining user desired branches for black group. The next branch for the red group is Citymart Supermarket Thanlyin and the branch for the black group is Citymart Supermarket Thanlyin. After then, the system also processes as the previous steps.

Table 3.17: Weekday Non-Traffic Time for Citymart Supermarket (47 St.) in Step7

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
3	**8**	31 min	31 min	5 → 4
		43 min		

Table 3.18: Weekday Non-Traffic Time for Citymart Supermarket Hlaing Thar Yar in Step7

Source	Destination	Delivery time of ways	Best time (Ants travel using State Transition Rule)	Selected Route
5	**8**	29 min	29min	5 → 8
		30 min		

After traversing all user desired branch, the system produces two shortest routes for the two groups (the red group and the black group). And then, the system produces the better route for the user among these two routes. Table 3.19 displays the two routes of the user desired branches.

Table 3.19: Two Shortest Routes For Two Groups (Red and Black Group)

Ant Group	**Path**	**Total Time**	**Required Time**	**The Shortest/ Best Path**
Red Group	DC→1→7→4→5→6→2→3→8	9:00→15:43	9:00→16:00	City Mart Distribution Center → Marketplace by Citymart Supermarket (6.5 mile) → Citymart Supermarket North-Okkalapa → Citymart Supermarket Pawt Kan → Citymart Supermarket (Haing Thar Yar) → Citymart Supermarket AKK → Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) → Citymart Supermarket Thanlyin Kyauk Kaut

Ant Group	Path	Total Time	Required Time	The Shortest/ Best Path
Black Group	DC→6→2→3→1→7→4→5→8	9:00→15:26	9:00→16:00	City Mart Distribution Center → Citymart Supermarket AKK→ Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) → Marketplace by Citymart Supermarket (6.5 mile) → Citymart Supermarket North-Okkalapa → Citymart Supermarket Pawt Kan → Citymart Supermarket (Haing Thar Yar) → Citymart Supermarket Thanlyin Kyauk Kaut

According to the above table, the route of the black group is better than the red group. Table 3.20 describes the detail road paths between these user desired branches. This table shows the names of roads between the user-desired Citymart branches in Yangon.

Table 3.20: Detail Road Path between the User Desired Branches

Sr. No.	Name of Citymart Branches	Path
1	CityMart Distribution Center	Ta Taing Hmw St. → Padauk St. →Ayer Wun Main Rd. → Lay Daung Kan Rd. →Lay Daungkan Rd.
2	Citymart Supermarket AKK	Lay Daungkan Rd. → Shwe Gon Taing Rd. → Bahan Rd. → Zoological Garden Rd. → Go Phyu St.
3	Citymart Supermarket Aung San Stadium,	Go Phyu St. → Zoological Garden Rd. → Alan Pya Pagoda St. → Bo Gyoke Rd. → Bo Myat Htun Rd. → Anawrahta Rd. → 47th St.
4	Citymart Supermarket (47 St.),	47th St. →Anawrahta St. → Bo Myat Tun St. → Shwedagon Pagoda St. → U Wisara Rd. → Pyay Rd. →

Sr. No.	Name of Citymart Branches	Path
5	Marketplace by Citymart Supermarket (6.5 mile),	Pyay Rd. → Kabar Aye Pagoda Rd. → Swae Taw MyRd. →Thudhamma Rd.
6	Citymart Supermarket North-Okkalpa	Thudhamma Rd. → Radio Station Rd. → Oakkala Rd. → Pyay Rd. → Thiri Mingalar Rd. → Lower Mingalardon Rd. → Bawdi Naung Pin St.
7	Citymart Supermarket Pawt Kan,	Bawdi Naung Pin St. → Lower Mingalardon Rd. →Bayint Naung Rd. → Hlain River Rd. → Ka Naung Mn Thar Gyi Rd. → Yangon-Pathein Rd.
8	Citymart Supermarket (Haing Thar Yar),	Gan Da Mar St. → Padauk War (1) St. → Kan Thar Yar Rd. → Yangon-Pathein Rd. → Bayint Naung Bridge 2 → Gan Da Mar Rd. → Wai Za Yan Tar Rd. → Thanlyin Chin Kat Rd. → Kyaik Kyauk Pagoda Rd.
9	Citymart Supermarket Thanlyin Kyauk Kaut	End the Shortest Path

CHAPTER 4

IMPLEMENTATION AND EXPERIMENTAL RESULTS

In this chapter, the implementation of the system and experimental results of the system are described. The experimental results show the comparison of the red-black ant colony algorithm (RB-ACS) and the ant colony algorithm (ACS).

4.1 Implementation of the System

` The proposed system presents delivery date, start time, end time and the list of Citymart Supermarket branch in the Yangon Region. The user can choose Citymart branch to send the stock from the Citymart Distribution Centre from the list. After accepting the user defined locations, the shortest traverse time between these locations will be calculated. The traverse time depends on four time-intervals (weekday traffic time, weekday non-traffic time, weekend traffic time, weekend non-traffic time). Then, the system will execute the possible ways to reach all destination location. The system will display the shortest route for all user defined places. If the total traverse time exceeds the user defined trip duration, the system will print the message to the user "It is not enough time to send the stock in time". Then, the system displays the shortest route for the delivery way and the list of supermarket to send the stock in user-defined time. If the duration is enough, the system will also display the shortest route of user desired Citymart branch to deliver the stock.

4.1.1 Main Page of the System

The main page of the system includes four menu items. The "Home" menu item is the main page of the system. It displays the user to choose the date, time and the list of Citymart branches to deliver the stock. The "Citymart Branches" menu item shows the information of the Citymart Branches in Yangon. The "Trip Time" menu button shows the trip time between Citymart Branches. The "About" buttton displays about the Citymart Supermarket. Figure 4.1 shows the main page of the proposed system.

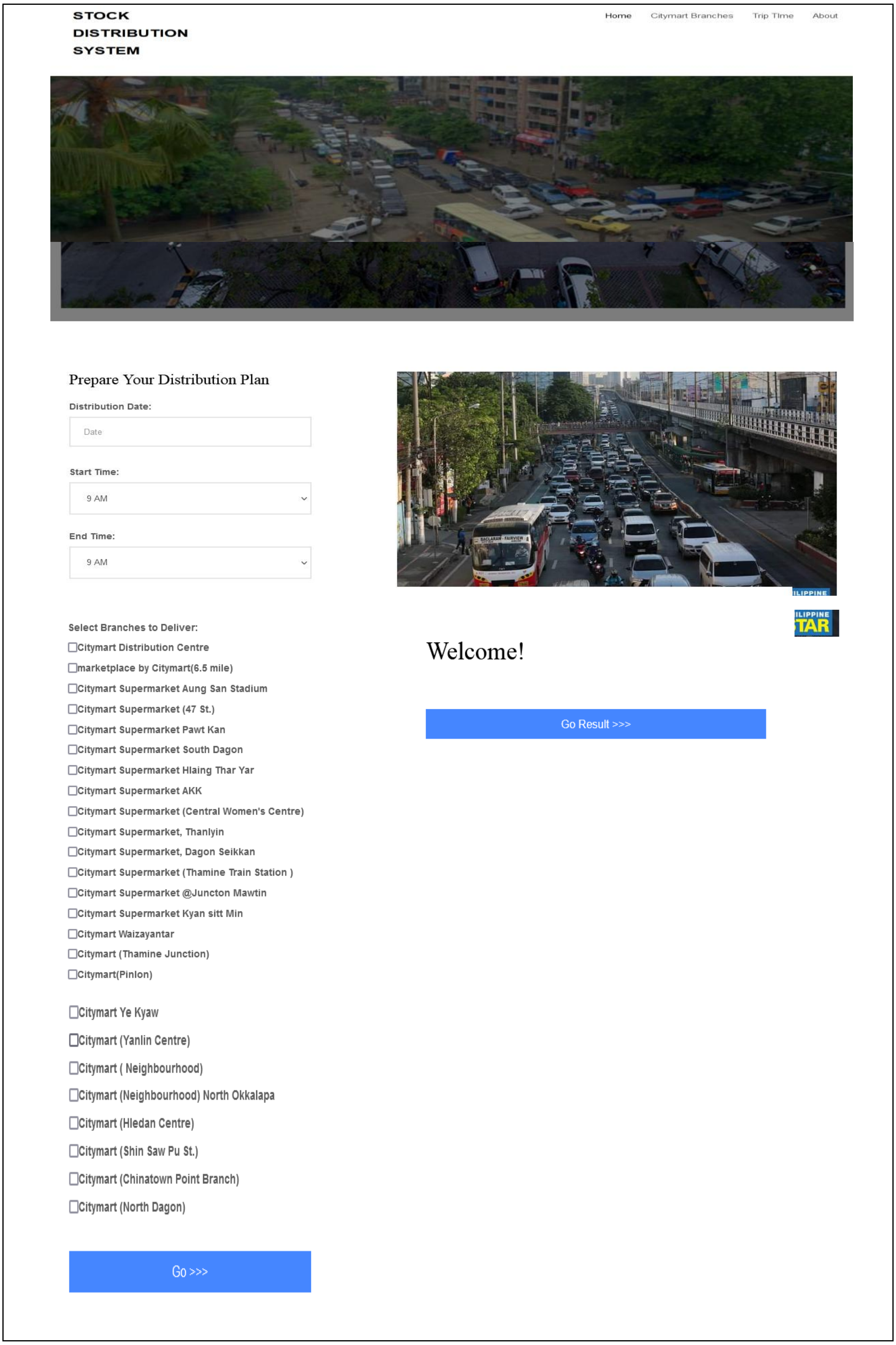


Figure 4.1: Main Page of the System

4.1.2 Citymart Branches Information Page

This page shows all the information of the Branches of Citymart in Yangon. If the user update the work time, he can change the data to enter changing data in the below textbox. Then the user click the “Edit” link. After clicking “Edit” link, the entering data will be changed in the system database. Moreover, the user can view the Trip time between Citymart Branches by clicking the “Distance” page link. If the user can insert the new data, he can click the “Save” button after filling the new information in the textboxes.

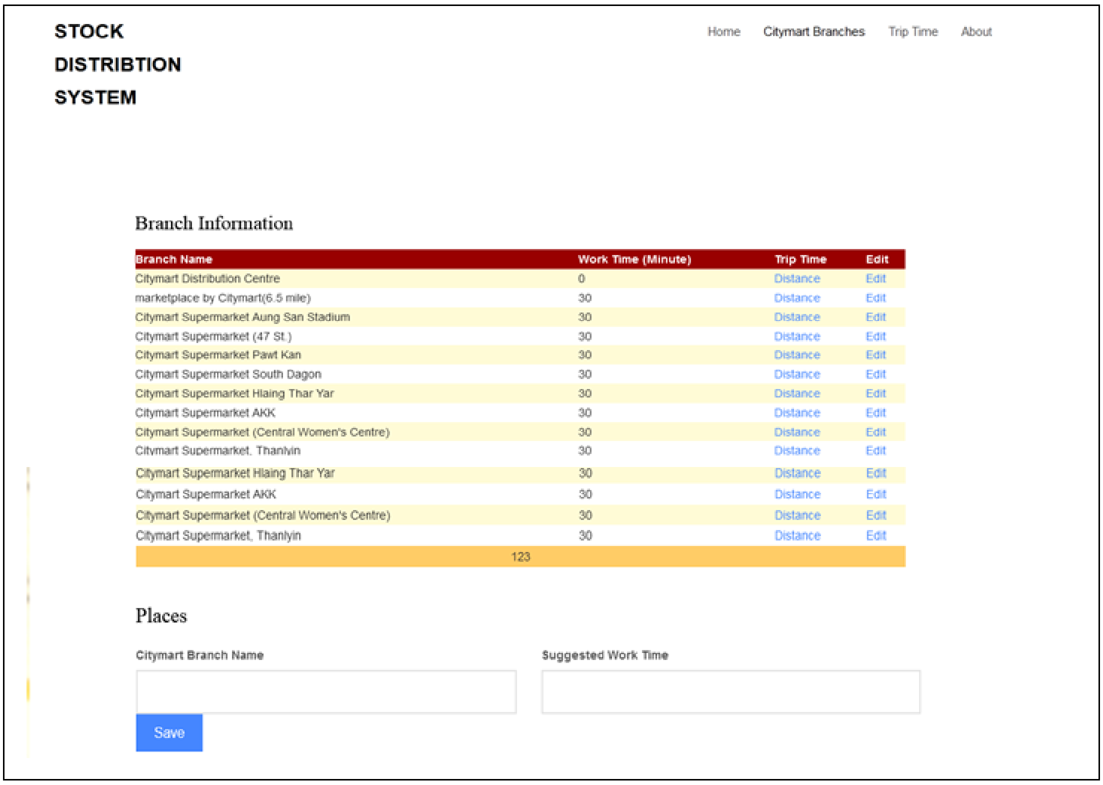


Figure 4.2: CityMart Branches Information Page

4.1.3 Deliver Time Information Page

In the Deliver Time Information Page, it shows the information of the trip time between the Citymart Branches and the trip time from the Citymart Distributin Center to the Branch in Yangon. The Trip Time depends on four time- intervals (weekday traffic time, weekday non-traffic time, weekend traffic time, weekend non-traffic time). The user can insert the new data of the deliver time information by clicking “Save” button.

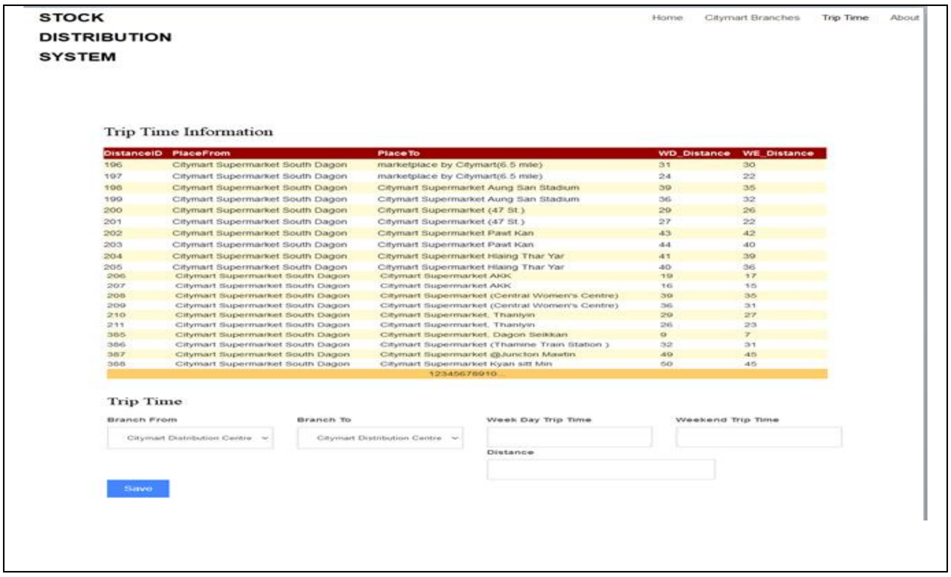


Figure 4.3: Deliver Time Information Page

4.1.4 System Informatin Page

Figure 4.4 is the About Page. It shows the abstract information of the proposed system.

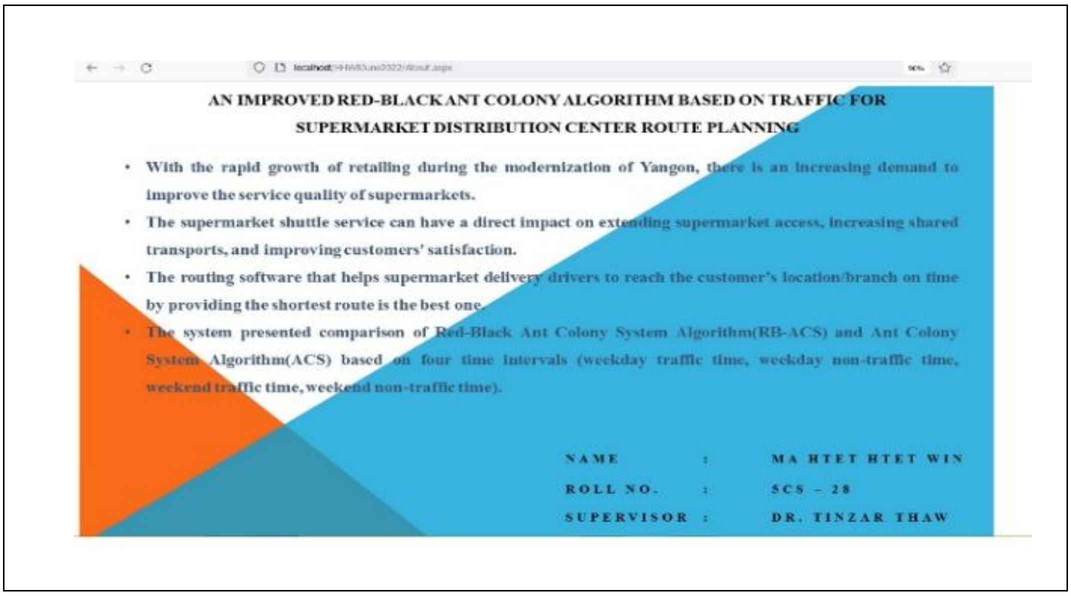


Figure 4.4 System Information Page

4.1.5 Shortest Route Page

This page displays the shortest route, total time, total kilometer and route detail between the user-desired Citymart Branches during the user desired start and end time. It shows two route plans (Plan A and Plan B) for the user. Finally, the system produces the shortest route among these two route plans.

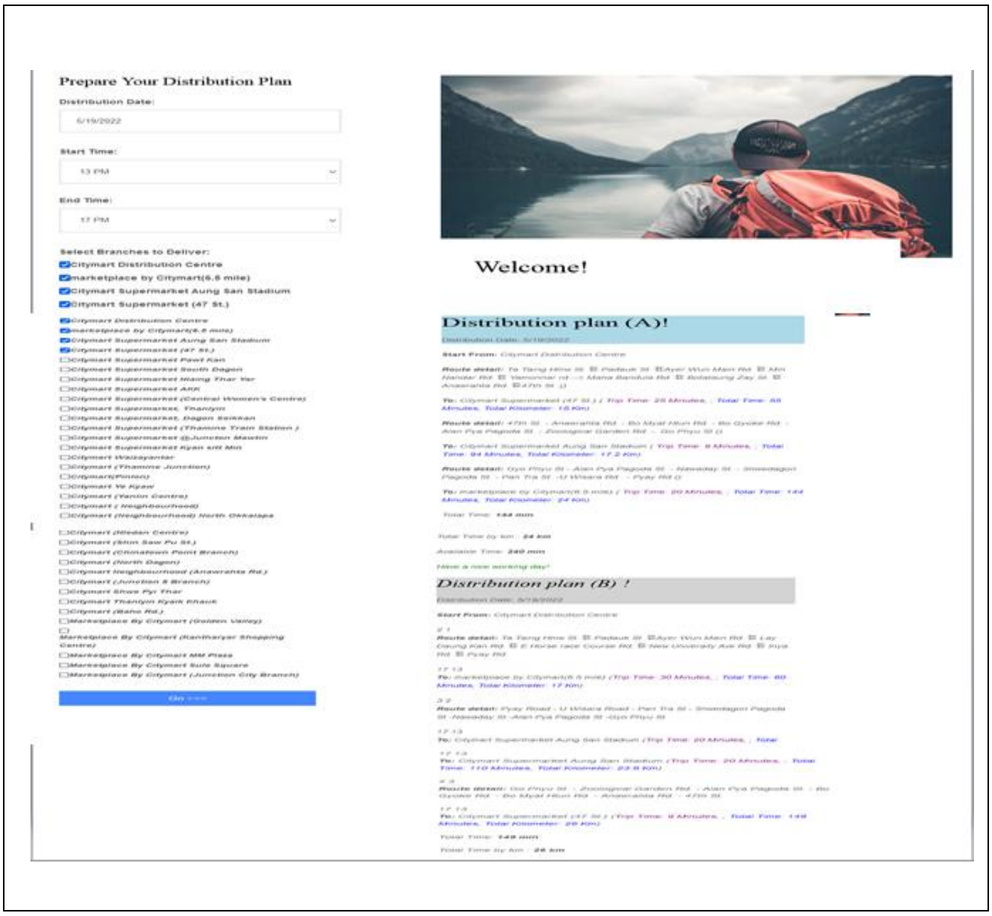


Figure 4.5: Shortest Route Page

4.1 The Database Design of the System

In the system database, there are three tables to compute the shortest route for the place. They are Branches, Distance, and DetailPath tables. The table of the "Branches" includes three attributes such as BranchID, Branch, and WorkTime. The "BranchID" uses the id of the branches to connect the other tables in the database. The "BranchID" is the primary key of the "Branches" table. The "BranchName" is the name of the Citymart Branches in Yangon region. The "Worktime" is the time of the work to send the stock. The "DeliveryTime" table is used to know the deliver time between Citymart Branches depending on four time intervals. The "DeliveryTimeID" is the primary key of the "DeliveryTime" table. The "SourceID" and "DestinationID" in this table are the "BranchID" of the "Branches" table. So, they are foreign keys of this table. The "WD_ DeliveryTime" is the deliver time for the weekday which is specified into traffic time and non-traffic time. The "WE_ DeliveryTime" is the deliver time for the weekend which is specified into traffic time and non-traffic time. The "DetailPath" table maintains the road path between branches and the distance (kilometer) between the branches to compute the shortest route. The "PathID" is the primary key of the " PathDetail " table. The "SourceID" and "DestinationID" in this table are the "BranchID" of the "Branches" table. So, they are also foreign keys of this table. Figure 4.5 shows the database design of the system.

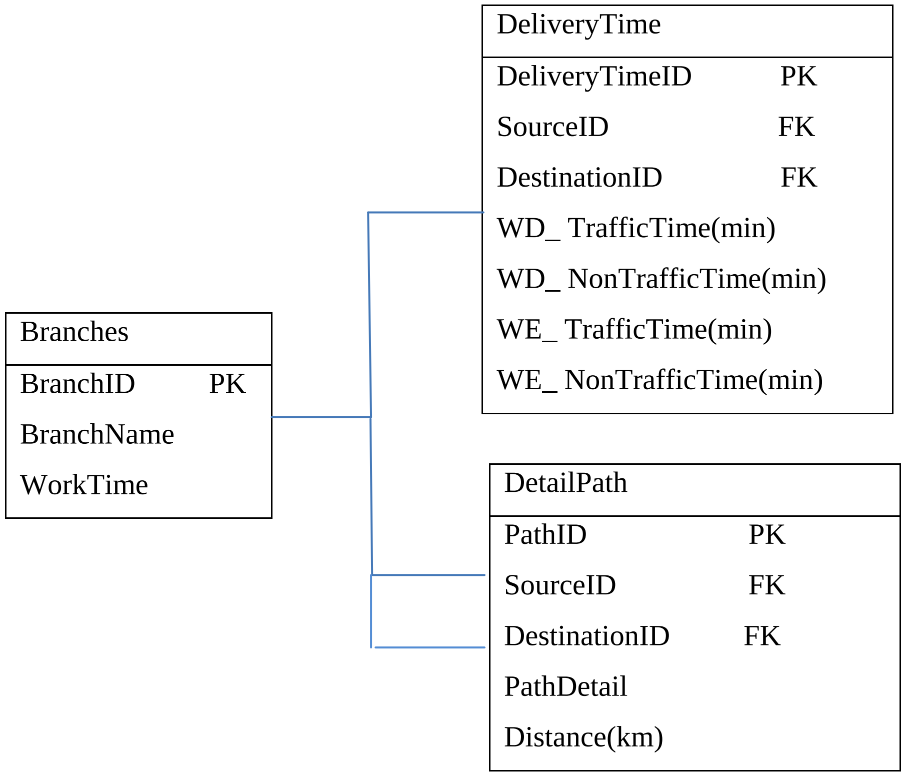


Figure 4.6: Database Design of the System

4.2 Experimental Results

The proposed system computes the shortest paths using Red-Black Ant Colony Algorithm (RB-ACS). RB-ACS uses the basic concept of ant colony system (ACS). But, it has some changes to calculate the shortest route. It uses two groups of ants, namely the black group and the other is red group. These two groups search in parallel. The proposed algorithm is compared with the existing ACS algorithm based on the randomly selected 35 paths from the distribution center. The following table shows the 35 random routes to compare these two algorithms.

Table 4.1: Thirty-Five Random Routes to compare ACS and RB-ACS Algorithms

Route ID	Names of Branches for Route
1	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium→ Citymart Supermarket (47 St.) → Citymart Supermarket Pawt Kan → Citymart Supermarket South Dagon
2	Marketplace By Citymart (6.5 miles)→ Citymart Supermarket (47 St.) → Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar) → Citymart Supermarket AKK
3	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium → Citymart Supermarket Pawt Kan → Citymart Supermarket South Dgon → Citymart Supermarket (Hlaing Thar Yar)
4	Citymart Supermarket Aung San Stadium → Citymart Supermarket Pawt Kan → Citymart Supermarket (Hlaing Thar Yar) → Citymart Supermarket AKK → Citymart Supermarket(Central Women's Center)
5	Citymart Supermarket (47 St.) → Citymart Supermarket (Hlaing Thar Yar) →Citymart Supermarke AKK → Citymart Supermarket Central Women's Center → Citymart Supermarket Thanlyin
6	Citymart Supermarket Aung San Stadium →Citymart Supermarket South Dagon →Citymart Supremarket AKK → Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin
7	Citymart Supermarket Pawt Kan → Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar)→ premarket AKK → Citymart Supermarket(Central Women's Center)
8	Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) →Citymart Supermarket Pawt Kan→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin
9	Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar)→ premarket AKK → Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin
10	Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min→ Citymart Waizayantar
11	Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar →

	Citymart (Thamine Junction)
12	Citymart Supermarket Dagon Seikkan → Citymart Supermarket Kyan Sitt Min → Citymart (Thamine Junction)→ Citymart Ye Kyaw→ Citymart (Neighbourhood)
13	Citymart Supermarket @ Junction Mawtin → Citymart Waizayantar → Citymart (Pinlon Road)→ Citymart (Yankin Center) → Citymart (Neighbourhood) North Okkalapa
14	Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
15	Citymart Supermarket Dagon Seikkan → Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Neighbourhood) North Okkalapa
16	Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar → Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood)
17	Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood)
18	Citymart Waizayantar → Citymart (Pinlon Road)→ Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
19	Citymart Supermarket Kyan Sitt Min → Citymart (Thamine Junction)→ Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
20	Citymart Supermarket Pawt Kan→ Citymart Supermarket Kyan Sitt Min → Citymart (Thamine Junction)→ Citymart Ye Kyaw → Citymart (Neighbourhood)
21	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) → Citymart Supermarket Pawt Kan → Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar)→ premarket AKK → Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin → Citymart Supermarket Dagon Seikkan
22	Marketplace By Citymart (6.5 miles) → Citymart Supermarket (47 St.) → Citymart Supermarket South Dagon → premarket AKK → Citymart Supermarket Thanlyin → Citymart Supermarket @ Junction Mawtin → Citymart Waizayantar → Citymart (Pinlon Road)→ Citymart (Yankin Center) → Citymart (Neighbourhood) North Okkalapa
23	Citymart Supermarket Aung San Stadium → Citymart Supermarket Pawt Kan

	→ Citymart Supermarket (Hlaing Thar Yar)→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Dagon Seikkan → Citymart Supermarket Kyan Sitt Min → Citymart (Thamine Junction)→ Citymart Ye Kyaw → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
24	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) → Citymart Supermarket Pawt Kan → Citymart Supermarket Thanlyin → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart (Neighbourhood)
25	Citymart Supermarket Aung San Stadium → Citymart Supermarket South Dagon → Citymart Supermarket(Central Women's Center)→ Citymart Supermarket @ Junction Mawtin → Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
26	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Pawt Kan → Citymart Supermarket (Hlaing Thar Yar)→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket @ Junction Mawtin → Citymart Waizayantar → Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood)
27	Citymart Supermarket (47 St.) → Citymart Supermarket Pawt Kan → Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar)→ Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar → Citymart (Thamine Junction)→ Citymart (Yankin Center)
28	Citymart Supermarket Aung San Stadium → Citymart Supermarket Pawt Kan → Citymart Supermarket (Hlaing Thar Yar)→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin → Citymart Supermarket @ Junction Mawtin → Citymart Waizayantar → Citymart (Pinlon Road)→ Citymart (Yankin Center) → Citymart (Neighbourhood) North Okkalapa
29	Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar → Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
30	Citymart Supermarket Pawt Kan → Citymart Supermarket (Hlaing Thar

	Yar)→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Waizayantar → Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood)
31	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) → Citymart Supermarket Pawt Kan → Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar)→ premarket AKK → Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin → Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar → Citymart (Thamine Junction)→ Citymart (Pinlon Road)
32	Marketplace By Citymart (6.5 miles) Citymart Supermarket (47 St.) → Citymart Supermarket South Dagon → premarket AKK → Citymart Supermarket Thanlyin → Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar → Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
33	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium→ Citymart Supermarket Pawt Kan → Citymart Supermarket (Hlaing Thar Yar)→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar→ Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
34	Marketplace By Citymart (6.5 miles) → Citymart Supermarket Aung San Stadium → Citymart Supermarket (47 St.) → Citymart Supermarket Pawt Kan → Citymart Supermarket South Dagon → Citymart Supermarket (Hlaing Thar Yar)→ premarket AKK → Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin → Citymart (Thamine Junction)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa
35	Citymart Supermarket Aung San Stadium → Citymart Supermarket Pawt

	Kan → Citymart Supermarket (Hlaing Thar Yar)→ Citymart Supermarket(Central Women's Center)→ Citymart Supermarket Thanlyin → Citymart Supermarket Dagon Seikkan → Citymart Supermarket @ Junction Mawtin → Citymart Supermarket Kyan Sitt Min → Citymart Waizayantar→ Citymart (Thamine Junction)→ Citymart (Pinlon Road)→ Citymart Ye Kyaw → Citymart (Yankin Center) → Citymart (Neighbourhood) → Citymart (Neighbourhood) North Okkalapa

Figure 4.7 shows the results of two algorithms based on total traverse time. When the total traverse time of these two algorithms are compared, the result of the proposed RB-ACS algorithm is more optimize than the result of the ACS to save time because of considering traffic information. The results of the proposed algorithm are more effective than ACS. Although some results of these two algorithms are same, most results are more optimize than the ACS algorithm.

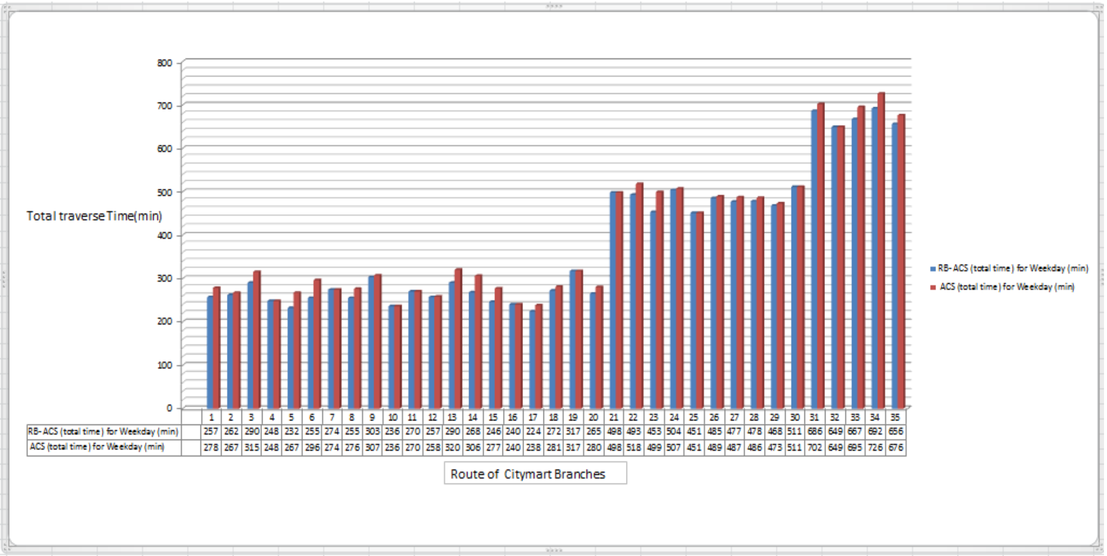
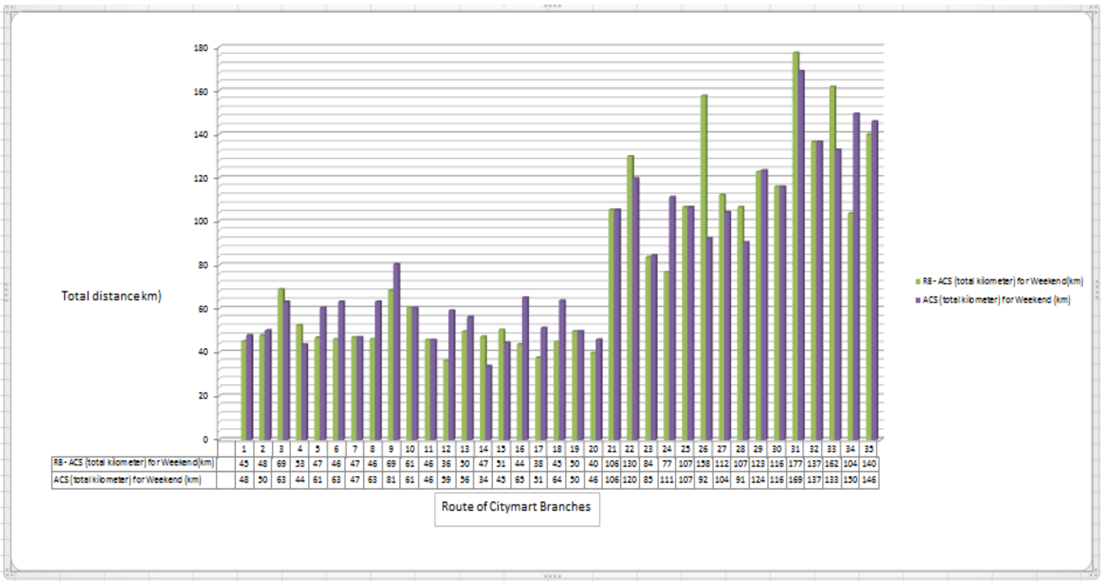


Figure 4.7: Comparison of ACS and RB-ACS Based on Total Traverse Time

The following figure 4.8 shows the comparison results of the proposed system and the ACS algorithm based on total distance (km). According to the comparison results, 20 out of 35 routs of the proposed algorithm are same or less distance than the ACS algorithm. This is because the traverse time does not direct ratio to the distance. The system is calculated the shortest paths based on traffic information. Therefore, the shortest route effects on the shortest time directly. Although the total distance is longer, the traverse time can be shorter. In spite of the total distance is shorter, the traverse time can be longer. Therefore, the results can change based on the traffic. Generally, the result distance of ACS is longer than the proposed algorithm.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
RB - ACS (total kilometer) for Weekend(km)	45	48	69	53	47	46	47	46	69	61	46	36	50	47	51	44	38	45	50	40	106	130	84	77	107	158	112	107	123	116	177	137	162	104	140
ACS (total kilometer) for Weekend (km)	48	50	63	44	61	63	47	63	81	61	46	59	56	34	45	65	51	64	50	46	106	120	85	111	107	92	104	91	124	116	169	137	133	150	146

Figure 4.8: Comparison of ACS and RB-ACS Based on Total Distance (km)

CHAPTER 5
CONCLUSION

This chapter presents the benefits of the system, the conclusion, limitation and further extension of the proposed system.

5.1 Conclusion

The improved Red-Black Ant Colony Algorithm based on traffic is used to find the best route of Supermarket Distribution Center to save time. The proposed system is compared to the existing ACS based on the randomly selected 35 routes. According to the experiments mentioned above, it provides a significant improvement for obtaining the shortest path's traverse time for the user-desired routes based on traffic during the user-desired start time and end time by comparing the Ant Colony System. It is simple and effective in finding very good solutions efficiently to various fields of difficult problems based on traffic.

5.2 Benefits of the System

The system finds the shortest path in easily with parallel processing of Red and Black ant based on traffic information.It saves time and money in the delivering problem between supermarket branches. It reduces the searching time by parallel running from different start points (dynamically). It produces a feasible solution to the user. It applies an improved Red-Black Ant Colony Algorithm based on traffic for Supermarket Distribution Center Route Planning.

5.3 Limitation and Further Extension of the Proposed System

The proposed system focuses on the finding of the shortest route based on four time intervals (weekday traffic time, weekday non-traffic time, weekend traffic time, weekend non-traffic time). In case of searching the shortest route, this system only concerned for these four time-intervals. The RB-ACS algorithm of this system searches the shortest path for the two groups which work in parallel. By working parallel, they are more convenience than ACS algorithm. This system can be extended for finding the best route based on dynamic time using the real network. This system can be better when the live traffic time is used, instead of applying these four-time intervals. The RB-ACS algorithm of this system searches the shortest path for two groups which work in parallel.

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