Route planning of China Tobacco
Guiyang Branch Office

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Bachelor’s Thesis in Logistics and Innovation Management

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Route planning of China Tobacco Guiyang Branch Office

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Summary: This report focuses on solving a practical rout planning problem. It takes China Tobacco Guiyang Branch Office as an example. We trying to analysis and evaluating the route of distribution, optimizing the route of distribution. In this report, we want to break the region limitation of the present route of distribution, and we focus on six towns that located near the boundary. We optimize the route of distribution through these steps: fist find out some alternative routes; then use Google map to get their distances; consider the capability of the shortest distance route and discuss the route can be success or not; at last calculate the distance, time, gasoline and cost the new route can save after optimized. After the calculation and analysis, we get an optimized route of distribution. The optimized routes of distribution reduce the logistics time and cost; improve operational efficiency and decrease the environmental pollution compared with present route of distribution. Even we have not covering all stops of the routes, and we did not map the detail streets into the routes; we believe this optimized method can help Guiyang Branch Office to own more efficient routes of distribution, increase its commercial efficiency, and improve the rationality of the layout of the regional distribution.

Keywords: Route planning, logistics, region limitation
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Our sincere thanks are also given to all our teachers in University of Gavle, your great knowledge, wisdom and life philosophy influenced us a lot.

Last but not least we owe much to all of our friends and classmate for their valuable suggestions and advices to help us improve.
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1. Introduction

The head office of China Tobacco was founded in 1982. In 1983, the state department published “THE REGULATIONS ON MONOPOLY SALES OF TOBACCO” and established the National Tobacco Monopoly Institution formally. In January 1984, the national tobacco monopoly administration was established. Today, China Tobacco owns 33 provincial tobacco monopoly administrations, 16 industrial companies, include 57 brands, the number of employees in China Tobacco is 510,000.¹

China Tobacco as the national tobacco monopoly administration, it implements unified leadership, vertical management and monopoly management system. The production part and sell part are separate, and the competition is only exists in production part, they have to try to occupy more market share. As for sell part, different provincial administrations just need to distribute cigarettes to different retailers in their regions.

In recent years, the company constantly strives to complete institutional mechanisms, optimize resource allocation in order to improve quality of service and company efficiency. Trough the project of route planning of Guiyang Branch Office, we want to offer some suggestions for the company to help them optimize their route of distribution.

2. Purpose

This report is a bachelor’s thesis. Our study program industrial management and logistics that includes a lot of knowledge about distribution. In recent years, the development and changes in China is rapid, and this requires the distribution logistics need to be adjusted to catch the speed of change. China tobacco Guiyang Branch Office is a typical company with distribution logistics. This branch office divides distribution regions according to the deviation of political regions, but this maybe cause some inefficient distribution route. As we learned some knowledge about route planning during our bachelor study, and we are very interested in this region, so we

¹ China’s Tobacco industry overview
want to go deep into this area and apply the knowledge to solve an actual problem during the thesis work. In the report, we trying to analysis and evaluating the route of distribution of China Tobacco Guiyang Branch Office; optimizing the route of distribution for the purpose of reducing logistics cost; improving operational efficiency; and increasing service quality.

3. Methodology

The logistics distribution system of cigarettes in Guiyang Branch Office is a complex system. Its typical characteristics are huge numbers of customers, extensive distribution, big difference of road condition, unstable demands of cigarettes from retailers and long transport distance.

Under this circumstance, a complex theoretical modal can not be applied into a distribute practice, and can bring a big probability of deviation. In the meantime, a complex modal need to have a strict requirement on data and the present reality can not satisfy this requirement.

So, we decide to use another way to simplify this route problem, and optimize the distribution route. We consider all the distribution routes as single vehicle route problems (SVRP)\(^2\). Single vehicle route problem (SVRP) means disintegrate the whole distribution network as many small single vehicle routes, those routes have definite number of retailers, retailers locations and amount of cigarettes to deliver.\(^3\) Then we solve the route problems step by step as blow:

1. Choose some routes which deliver good to some retailers located near the boundaries;
2. Use Google map to find the routes and distance;
3. Calculate the total distance of all the possible ways to deliver goods, and decide the most efficient ways, the formula we use is:
   \[
   \text{Total distance} = (l_{r1} + l_{s2} + l_{r3} + l_{rT1}) + (l_{r2} + l_{r4} + l_{s6} + l_{rT2})
   \]
4. Consider about the capability of the shortest route we calculated to make sure

\(^2\) CHEN Zixia, YE Qingtai, 2005
\(^3\) CHEN Zixia, YE Qingtai, 2005
the route can be success or not, the formula we use is

\[
\text{Capability} = \left( \frac{\text{total order quantity}}{\text{the full load of the truck}} \right) \times 100\%;
\]

If the capability exceed 100%, the route is untenable, if not, the route is tenable;

5. Calculate the save in distance, time, gasoline and cost of the new route.

- \[
\text{Saving distance} = \text{primary distance} - \text{optimized distance}
\]
- \[
\text{Saving time} = \text{primary cost of time} - \text{optimized cost of time}
\]
- \[
\text{Saving gasoline} = \text{primary oil consumption} - \text{optimized oil consumption}
\]
- \[
\text{Saving cost} = \text{primary cost} - \text{optimized cost}.
\]

We learned and practiced this method during our learning process, and we got this method from our supervisor during the lecture. Even this method didn't be documented, but we also think it is useful and suit for our thesis work.

4. Theoretical Framework

4.1 Definition of route planning

Route planning takes responsibility to choose the most efficient routes which involves several nodes. It is an outstanding method to minimize the driving distance and time, also decrease oil consumption. Route planning is an exercise which can make improvement in financial and organization and regulate the climate. But there are also some disadvantages of route planning:

- Firstly, as a part of process of route planning or even more are fulfilled by computer, it inevitably exist deviation and errors.
- Secondly, before the company saves money from route planning, they need to spend more to complete necessary equipments or pay to 4PL (Fourth Party Logistics).

During the transportation, vehicles use gasoline for moving. After gasoline burning, there will come out some gases and micro granules. These gases and micro granules are harmful to human health and environment. Route planning plans the shortest route.

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4 Kenth Lumsden, 2004
5 Talking the most Efficient Route from A to B
Reduce the distance means less gasoline will be used. Route planning is a way to protect environment and human health.\textsuperscript{6}

### 4.2 Data collection

“Both manual methods and computer-based methods can be used to solve route planning problems. Manual methods have a limitation on number of customers, but it will be not too complex. Computer-based methods can solve route planning problems with large number of customers, and even can handle the stochastic variables, but it comparatively become more complex then manual methods.

The data are needed in the methods are:

1. The location of customers in relative to distribution centre or channels.
2. The number of customer needs.
3. Distance between distribution centre/ channels and customers, and distance between customers.
4. The transport times for each transport route.
5. Other restrictions like the carrying capacity of vehicles and the roads.”\textsuperscript{7}

### 4.3 Methods

Usually, there are two main common solution methods to solve route planning problem, exact algorithms and heuristic algorithm. As the calculated amount of exact algorithms will be increase exponentially with the growing dimensions of questions, thus its application scope is limited in practice. Due to VRP (vehicle routing problem) is a tough problem, try to find an approximation algorithms (heuristic algorithm) is necessary and realistic. At present, two-phase algorithm is the mostly used method in heuristic algorithm. In two-phase algorithm, we mainly have two algorithms: Route-First/Cluster-Second Method and Cluster -First/ Route -Second Method.\textsuperscript{8}

\textsuperscript{6} N Künzli, R Kaiser, S Medina, M Studnicka, O Chanel, P Filliger, M Herry, F Horak Jr, V Puybonnieux-Texier, P Quéné, J Schneider, R Seethaler, J-C Vergnaud, H Sommer, 2000
\textsuperscript{7} Göte Olsson, 2007
\textsuperscript{8} Discussion about Tobacco Distribution route optimizing, 2009
As Guiyang branch office already divided its market into five regions based on the boundaries among districts, and the distribution routes also exist, it is not necessary for us to divide the regions and routes newly. But we can also try to dabble a method to partition the regions and routes. A useful algorithm is called K-MEANS algorithm. The basic tendency of K-MEANS algorithm is:

1. Choose K nodes from all the nodes in an area as the initial clustering centers;
2. Based on the distance between the other nodes and centers to cluster those nodes;
3. Repeat the process continually until all centers are not change any more, ensure each clustering itself compact as much as possible; and as possible keep away from other clustering.9

Those methods often use some algorithms as a basic form to solve the problems. During this report, as the number of customers we choose will be less, it is easily for us to associate the common formula below to solve the route planning problem:

$$S_{ij} = (2loi + 2loj) - (loi + loj + li) = loi + loj - lij$$

10

The saving distance of this formula is equal to the total distance of the round trip from distribution channel to each node minus the total distance after optimizing. But the formula is not suitable for this research, because the routes we chose are already exist, we can not calculate the original total distance as the round trip from distribution channel to each node.

5. Present situation

5.1 Company profile

China Tobacco Guiyang Branch Office was founded in August 2001 11, it is the last tobacco commercial unit in provincial capital which was approved by the state. It is responsible for tobacco monopoly administration, tobacco production, and cigarette sales work in the provincial capital. China Tobacco Guiyang Branch Office is working as ordering the cigarettes from different manufacturers, and then sells them to

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9 Discussion about Tobacco Distribution route optimizing, 2009
10 Kenth Lumsden, 2004
11 Guizhou Tobacco Company Overview
different retailers. Guiyang Branch Office totally includes four County tobacco monopoly bureaus which are Xiuwen county, Xifeng county, Kaiyang county, Qingzhen city, and 6 District tobacco monopoly bureaus of Nanming, Yunyan, Xiaohe, Huaxi, Wudang and Baiyun. The area of Guiyang is 8034 km², and the population is 3967900. The distribution center of China Tobacco Guiyang branch office owns 272 employees, 55 delivery vehicles and 272 routes of distribution.

5.2 Distribution center and distribution channels

The scope of the company's market is includes Guiyang city, Qingzhen city, Xifeng county, Xiuwen county and Kaiyang county. The company divided its market into five regions based on the boundaries among districts. The distribution center is the Guiyang city one. Guiyang distribution center is not only delivery goods to retailers in Guiyang city; but also takes the responsibility of delivering goods to other four distribution channels. The Guiyang distribution center have four trucks to delivering goods once a week; and the full load of a truck is 31 boxes of cigarettes, and one box has 250 cartons of cigarettes. So the full load of a truck is 7750 cartons of cigarettes.

Each region owns a distribution channel that has their respective employees, delivery vehicles and storehouse. We make a figure to show the basic information of those cities and counties in Guiyang, and it includes the situation of area, population, income per capita, number of customers and number of cigarette of those regions.

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12 Economic and social development statistical communiqué of Guiyang City in 2009
13 Guiyang Overview
14 The story of JIANG Yongning in Guiyang distribution center
15 Distribution route
<table>
<thead>
<tr>
<th>Item</th>
<th>Area/km²</th>
<th>Population</th>
<th>Income per capita in town/RMB</th>
<th>Income per capita in county/RMB</th>
<th>Number of retailer</th>
<th>Number of cigarettes Box/year (1 box=250 cartons of cigarette)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guiyang</td>
<td>2577.54</td>
<td>2140871</td>
<td>12781</td>
<td>4088</td>
<td>18000</td>
<td>130000</td>
</tr>
<tr>
<td>Qingzhen</td>
<td>1492</td>
<td>516500</td>
<td>11060</td>
<td>3549</td>
<td>8000</td>
<td>12000</td>
</tr>
<tr>
<td>Xinguo</td>
<td>1075.5</td>
<td>311300</td>
<td>9761</td>
<td>2997</td>
<td>5000</td>
<td>9600</td>
</tr>
<tr>
<td>Xifeng</td>
<td>1036.5</td>
<td>258000</td>
<td>1068</td>
<td>2670</td>
<td>3000</td>
<td>10800</td>
</tr>
<tr>
<td>Kaiyang</td>
<td>2026</td>
<td>420000</td>
<td>7883</td>
<td>2627</td>
<td>6000</td>
<td>12000</td>
</tr>
</tbody>
</table>

(Table 1 Basic information of each region\textsuperscript{16})

5.3 Order and delivery

Causes of the retailers are constant, and if new retailer wants to order goods, he should go to the China Tobacco Guiyang Branch Office for application. So the distribution channel divided retailers into five groups based on the locations now. Each group has an order day in each week that the retailers decide the quantity of goods through internet, phone or onsite interview. On the next work day, distribution channel will delivery goods to the retailers. This delivery way makes the distribution channel easier to get an optimal route of distribution in their responsible region\textsuperscript{17}.

The main transport is trucks. The full load of a truck is 10 boxes of cigarettes, and one box has 250 cartons of cigarettes. So the full load of a truck is 2500 cartons of cigarettes. The average fuel consumption is 12.5L/100km, and the average speed is 30km/hour\textsuperscript{18}.

\textsuperscript{16} Guiyang Overview
\textsuperscript{17} SHI Dezhi (Interview)
\textsuperscript{18} CHEN Lin (Interview)
5.4 Present routes of distribution
No matter what kind of distribution, there are two aspects need to be consider. One is divide the optimal distribution area, another one is choose of distribution routes. During the distribution, transportation cost is one main factor of total cost. Make the distribution distance shorter is the most important aspect in route planning.\(^{19}\) In this case, we do not consider about change the locations of distribution center and channels. There are two main reasons,

- These center and channels have been well building. Change their location will cost too much.
- The preview region division was divided by political region, and distribution channels have planed their distribution routes with optimal one in their responsible regions. Change all the routes will be a complex work and cost too much.

Do not change the location of distribution and center does not mean do not change the region division. From a whole view of this distribution model which divided by districts, in fact it could not get the optimal routes planning. Because the region limitation will result in a route of distribution which has high efficiency can not be implementing. In order to improve service quality and efficiency, the route planning should break the region limit. Cause of the distribution channel has about 272 routes\(^{20}\), in the following analysis we focus on the routes which retailers are cross-border. There are two main reasons that we choose those places located near the boundaries;

- The current route is not the shortest one even it belongs to the responsible distribution channel;
- There may come out two distribution channels delivery to the same place because of responsibilities is not divided specifically.

We picked out several places that retailers are cross-border to checking if the route of distribution is optimal. Then we draw a map to show the routes of distribution visualized, clear and easy to understand.

\(^{19}\) CHI Jie, LI Li, 2003
\(^{20}\) The story of JIANG Yongning in Guiyang distribution center
From the map above, the routes of each distribution channels have been illustrated, by considering cross-border retailers. We focus on analyzing these six towns; Shidong, Shuangliu, Jiuchang, Wuchang, Eqingchong, Shicao. Based on the information we gather from Guiyang Branch Office, we find out the current existing problems.

(a) Shidong
Now there are 11 retailers in Shidong, out of which 8 retailers are in the charge of Xifeng distribution channel, and the rest 3 retailers are in the charge of Xiuwen
distribution channel\textsuperscript{21}. This causes a repetitive delivery, and creates needless waste.

(b) Shuangliu
Shuangliu is located in the boundary between Kaiyang county and Xifeng county, and it retailers is in charge of Kaiyang distribution channel. There are not having other retailers on the transportation between Xifeng channel and Shuangliu County. And from the map, Xifeng channel seems be more close to Shuangliu.

(c) Jiuchang
Jiuchang is located in the boundary between Xiuwen and Xifeng, and is in charge of Xiuwen distribution channel. But from the map, it seems that Shuangliu is in the middle of Xiuwen and Xifeng, we are not sure which distribution channel take charge of Jiuchang will be more efficient.

(d) Wuchang
Wuchang is located in the boundary between Xiuwen and Guiyang, and it is in charge of Guiyang distribution centre. In order to deliver cigarettes to Wuchang, Guiyang distribution centre have to via Xiaoqiao to Ejingchong. The map shows Xiuwen channel has a distribution route to Houba, and Wuchang seems to be more close to Houba than Xinchang.

(e) Ejingchong
Xiuwen distribution channel is responsible for a part of retailers in Ejingchong, the rest are in charge of Guiyang distribution centre. It has the same problem with Shidong.

(f) Shicao
Because of traffic inconvenience and road limitation, the Qingzhen distribution channel delivers cigarettes to Shicao from Pingqiao need via Zhuchang. After that they have to go back in the same way, it seems a bit detour.

\textsuperscript{21} Detail file of customer order 2009
6. Results

There are many different functions that can be used to implement route planning. There are many free route planners on the internet. Those route planner software like Google Map, RAC route planner, Via Michelin, Bing maps & Directions are invented to help people find a suitable route from a geographical position to another easily through a journey planning engine.

There has two technologies for positioning, GPS and GMS. GPS is used for vehicle positioning, trace scheduling and transportation management in logistics. It has these characteristics;

- More functions, higher precision, large area coverage.
- Effective location. This can improve the company’s reaction speed and reduce operation cost and the vacancy rate of vehicle.
- Information transfer with high confidentiality, high capability and good anti-interference ability\textsuperscript{22}.

GMS is a highly confidential system, has large capacity, has good performance with roaming, and it is the most widely used digital cellular system. Compared with GPS, GMS’s Accuracy of positioning is lower than GPS, and GMS could not find the location immediately, and it need GMS’s internet to support the operation. But GMS has no block or signal isolation problems. Wherever, GMS could be used as long as there has signal\textsuperscript{23}.

Guiyang Branch Office has already owned an electronic map before and they tried to use it to optimize their route of distribution. But as it turned out, GPS and GMS is not suitable to optimize the route of distribution of Guiyang Branch Office. There are two main reasons;

- The lacking of information. Many streets and places have not been marked in the map, especially for some small towns and counties.
- The slow update speed and lagging maintenance. In recent years, the rapid development and change in China made many places and streets remodel, renovate or

\textsuperscript{22} CAI Shaohua, 2002
\textsuperscript{23} XU Han-wei, 2003
rename, but the electronic map did not catch the speed to update.

These lead to the fail to use GPS and GMS as the guide and help the tracks find the most effective way. For those online route planner systems, most of them are developed by countries in Europe, there is no detail map of Guiyang, China, and we can not use these to find feasible ways for Guiyang Branch Office.

After we choose the six places located in the boundaries between different counties, we want to through calculations to check whether the current routes or the possible routes will be more effective. First, we calculate the total distance of each alternative route, and then calculate their capabilities of each route, through rational analysis and comparison, we choose one to be the most efficient way. The real distances between towns are different with the distance on map. Google Map is a system that could calculate the driven distance based on the road. So in the following calculation, the distance we collected are all from the Google Map.

### 6.1 Shidong town

Both Xifeng channel and Xiwen Channel are delivering goods to Shidong town now. Dashilianjiang town is located near the Shidong town, and Xiwen channel go through Dashilianjiang, then delivery goods to Shidong. We explore which channel take the responsible for the two towns' delivery will be more efficient; or we separate the delivery route of Dashilianjiang and Shidong to two channels will be more efficient.

<table>
<thead>
<tr>
<th></th>
<th>Xiwen</th>
<th>Xifeng</th>
<th>Dashilianjiang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xiwen</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xifeng</td>
<td>44.8 km</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dashilianjiang</td>
<td>45.2 km</td>
<td>29.6 km</td>
<td>-</td>
</tr>
<tr>
<td>Shidong</td>
<td>38.5 km</td>
<td>22.1 km</td>
<td>7.6 km</td>
</tr>
</tbody>
</table>

---

Google map
Original total distance = 2*(38.5+7.6+45.2) = 182.6 km

There are three alternative routes to choose;

(A) Xiuwen channel → Dashilianjiang → Shidong → Xiuwen channel

Route A means Xiuwen channel take charge of Dashilianjiang town and Shidong town. The vehicle starts from Xiuwen channel; go through Dashilianjiang, Shidong; then go back to Xiuwen channel.

Total Distance = 45.2+7.6+38.5 = 91.3 km

(B) Xifeng channel → Shidong → Dashilianjiang → Xifeng channel

Route B means Xifeng channel is responsible for both Dashilianjiang town and Shidong town. The vehicle delivery goods start from Xifeng channel; then go through Shidong and Dashilianjiang. After that, the vehicle goes back to Xifeng channel.

Total Distance = 22.1+7.6+29.6 = 59.3 km

(C) Xifeng channel → Shidong → Xifeng channel

Xiuwen channel → Dashilianjiang → Xiuwen channel

Route C means Xifeng channel take responsible for Shidong town; and Xiuwen channel is in charge of Dashilianjiang town. It seems that the calculation of Dashilianjiang is needless, because the route is focus on Shidong town. In order to make rational comparison of the three alternative routes, we have to consider all the towns we mentioned into the calculation.

Total distance = 22.1*2+45.2*2 = 134.6 km

Based on the calculation results, Route B is the shortest one, but we can not say it is the most efficient one. Capability should also be considered in the route planning. The average order quantity of Shidong town is 875 cartons per week, and Dashilianjiang is 168 cartons per week. The delivery time is once a week. \(^{25}\) The full load of a truck is 2500 cartons.

The capability of Route B = (168+875)/2500 = 0.42 = 42%  

\(^{25}\) Detail file of customer order 2009
The capability is less than 50%, we suggest this route change the delivery time from once a week to once every two weeks. The capability of a truck can improve into 84%. There is another important factor to decide the distribution route. We should try to arrange the queue of the stops in the route based on the deliver volume from high to low. The average order quantity of Shidong town is larger than Dashilianjiang town. So we choose Shidong as the first stop.

After the calculation and discussion, we suggest the final optimizing route should be Route B (Xifeng channel→ Shidong → Dashilianjiang → Xifeng channel). The delivery time is once every two week. Every two weeks Route B saves distance with 90.5 km; time with 3.01 hours; gasoline with 11.3 L that costs 68.93 Yuan (‘Yuan’ is the unit of Chinese currency) than the primary distribution route.

6.2 Shuangliu town

Now Kaiyang channel takes the responsibility for Shuangliu town. The distance between them is 13.4 km. From the map, Shuangliu town is in the middle between Xifeng channel and Kaiyang Channel. We want to check whether it is the most efficient way now through calculation.

<table>
<thead>
<tr>
<th></th>
<th>Kaiyang</th>
<th>Xifeng</th>
<th>Shuangliu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiyang</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xifeng</td>
<td>62.8 km</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shuangliu</td>
<td>13.4 km</td>
<td>49.6 km</td>
<td>-</td>
</tr>
<tr>
<td>Jiuchang</td>
<td>37.7 km</td>
<td>25.1 km</td>
<td>24.5 km</td>
</tr>
</tbody>
</table>

Original total distance = 2*13.4 = 26.8 km

There are two alternative routes to choose;

(A) Kaiyang channel → Shuangliu → Kaiyang channel

Route A means Kaiyang channel take responsible for shuangliu town. The vehicle starts from Kaiyang channel, go to Shuangliu town, and then go back to Kaiyang.
channel. This is the primary way.

Total Distance= 2*13.4= 26.8 km

(B) Xifeng channel → Jiuchang → Shuangliu → Jiuchang → Xifeng channel

Route B means Xifeng channel take responsible for Shuangliu. Cause of the road limitation, Xifeng channel delivery goods to Shuangliu must go through Jiuchang town.

Total Distance=2*(25.1+24.5) =109.2 km

Comparing Route A with Route B, Route A save nearly 80km. This makes Route A is the best choice, but we should also calculate the capability. Capability is an important factor to decide whether it is an efficient way or not. The average order quantity of Shuangliu is 839 cartons per week. In Route A, the truck departures from Kaiyang channel. The delivery time is once a week.

The capability of Route A= 839/2500=0.3366=33.66%

The capability is less than 50%, so we suggest this route change the delivery time from once a week to once every two weeks. The capability of a truck can improve into 67.12%.

After all, Route A has the same route with the primary distribution route. It seems there is no saving. But the delivery time is change in to once every two weeks. Route A saves distance with 26.8km; time with 0.9 hours; gasoline with 3.35 L that costs 13.51Yuan than the primary distribution route every two weeks.

6.3 Jiuchang town

From the map, Jiuchang seems have the same distances from Xifeng channel and Xiuwen channel. Now, Xiuwe channel take responsible for Jiuchang town because Jiuchang located in Xiuwen region. Through the calculation, we want to check whether it is the efficient route now.

25 Detail file of customer order 2009
<table>
<thead>
<tr>
<th></th>
<th>Xiuwen</th>
<th>Xifeng</th>
</tr>
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<tbody>
<tr>
<td>Xiuwen</td>
<td>-</td>
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<td>Xifeng</td>
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</tr>
<tr>
<td>Jiuchang</td>
<td>16.5 km</td>
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</tbody>
</table>

Original total distance= 2*16.5=33 km

There are two alternative routes to choose;

(A) Xiwen channel ➔ Jiuchang ➔ Xiwen channel

Route A means Xiwen channel take responsible for Jiuchang town. This is the primary way.

Total Distance= 2*16.5= 33 km

(B) Xifeng channel ➔ Jiuchang ➔ Xifeng channel

Route B means Xifeng channel is in charge of Jiuchang town.

Total Distance = 2 * 25.2 = 50.4 km

From the route it seems it is better to keep the primary way. Next, we will calculate the capability of routes. The average order quantity of Jiuchang is 913 cartons per week. The delivery time is once a week. The full load of a truck is 2500 cartons.

The capability of Route A=913/2500=0.3652=36.52%

The capability is less than 50%, so we suggest this route change the delivery time from once a week to once every two weeks. The capability of a truck can improve into 73.04%.

After calculation and discussion, Route A has the same route with primary one. But the delivery time has changed into once every two weeks. Route A saves distance with 33km; time with 1.1 hours; gasoline with 4.13L that costs 25.16 Yuan than the primary route every two weeks.

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25 Detail file of customer order 2009
6.4 Wuchang Town

Now Guiyang center delivery goods go through Yangchang and Xinchang, arriving Wuchang and then go back to Guiyang center. Houba is in charge of Xiuwen channel now. From the map, we find that Houba is more close to Wuchang than Xinchang. So we want to check if Xiuwen takes responsible to Wuchang, this route will be more efficient than primary one or not.

<table>
<thead>
<tr>
<th></th>
<th>Xiuwen</th>
<th>Guiyang</th>
<th>Wuchang</th>
<th>Houba</th>
<th>Xinchang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xiuwen</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Guiyang</td>
<td>29.2 km</td>
<td>-</td>
<td>52.1 km</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wuchang</td>
<td>18.3 km</td>
<td>52.1 km</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Houba</td>
<td>15.2 km</td>
<td>33.7 km</td>
<td>3.1 km</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xinchang</td>
<td>30.2 km</td>
<td>49 km</td>
<td>8.6 km</td>
<td>15.3 km</td>
<td>-</td>
</tr>
<tr>
<td>Yangchang</td>
<td>35.1 km</td>
<td>48.6 km</td>
<td>13.5 km</td>
<td>20.2 km</td>
<td>4.9 km</td>
</tr>
</tbody>
</table>

Original total distance= 2*(48.6+4.9+8.6+15.2)=154.6 km

There are two alternative routes to choose;

(A) Guiyang center → Yangchang → Xinchang → Wuchang → Guiyang center

   Xiwen channel → Houba → Xiwen channel

Route A is the present routes now. Guiyang center takes the responsible for Wuchang. And in order to get rational comparison, we also calculate the route of Houba. So the calculation result could compare with next alternative routes.

Total Distance=48.6+4.9+8.6+52.1+15.2*2=144.6 km

(B) Xiwen channel → Houba → Wuchang → Xiwen channel

   Guiyang center → Yangchang → Xinchang → Guiyang center

Route B is Xiwen channel takes responsible for Wuchang and this route go through Houba. We have mentioned the calculation should include all towns in the routes, so we could have rational comparison. The route B also calculates the distance of
Guiyang center to Yangchang and Xinchang.

Total Distance = (15.2+3.1)*2+ (48.6+4.9+49) =139.1 km

From the calculation result, the distance of Route B is shorter than Route A. The average order quantity of Wuchang is 615 cartons per week, Houba is 739 cartons per week, Yangchang is 631 cartons per week, and Xinchang is 897 cartons per week. The delivery time is once a week. The full load of a truck is 2500 cartons. There are two channels in Route B. One departure from Xiuwen channel, go through Houba and Wuchang, then go back to Xiuwen channel; another one departure from Guiyang center, go through Yangchang and Xinchang, then goes back to Guiyang center.

The capability of truck from Xiuwen channel = (615+739)/2500 =0.5416 =54.16%

The capability of truck from Guiyang center = (631+897)/2500 =0.6112 =61.12%

As we mentioned above, the delivery volume of each stops is a factor to decide the distribution route. There are two routes in Route B; Xiuwen channel → Houba → Wuchang → Xiuwen channel; and Guiyang center → Yangchang → Xinchang → Guiyang center. The delivery volume of Houba is larger than Wuchang, and the volume of Xinchang is larger than Yangchang.

After the calculation and analysis, Route B is Xiuwen channel → Houba → Wuchang → Xiuwen channel; and Guiyang center → Xinchang → Yangchang → Guiyang center. The delivery time is once a week. Route B saves distance with 5.5km; time with 0.18 hour; and gasoline with 0.69L that costs 4.2Yuan than primary route every week.

6.5 Ejingchong Town

Ejingchong town is located on the boundary between Guiyang and Xiuwen. Guiyang distribution channel delivery goods to Ejingchong and go through Xiaoqiao and Majia. From the map, we find there is a town 'Baimao' located near Ejingchong than Xiaoqiao, Baimao is in charged of Xiuwen distribution channel now.

25 Detail file of customer order 2009
Guiyang   Xiuwen   Ejingchong   Maijia   Xiaoqiao   Makou

<table>
<thead>
<tr>
<th></th>
<th>Guiyang</th>
<th>Xiuwen</th>
<th>Ejingchong</th>
<th>Maijia</th>
<th>Xiaoqiao</th>
<th>Makou</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guiyang</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xiuwen</td>
<td>28.7 km</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ejingchong</td>
<td>17 km</td>
<td>12.2 km</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maijia</td>
<td>10.5 km</td>
<td>18.3 km</td>
<td>6.5 km</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xiaoqiao</td>
<td>13 km</td>
<td>16.2 km</td>
<td>4 km</td>
<td>2.5 km</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Makou</td>
<td>21.4 km</td>
<td>7.4 km</td>
<td>4.4 km</td>
<td>10.9 km</td>
<td>8.8 km</td>
<td>-</td>
</tr>
<tr>
<td>Baimao</td>
<td>17.8 km</td>
<td>11 km</td>
<td>1.3 km</td>
<td>7.3 km</td>
<td>5.3 km</td>
<td>3.6 km</td>
</tr>
</tbody>
</table>

Original total distance = 2*(10.5+2.5+4+1.3+3.6+7.4) = 58.6 km

There are two alternative routes to choose;

(A) Guiyang center → Maijia → Xiaoqiao → Ejingchong → Guiyang center

    Xiuwen channel → Makou → Baimao → Xiuwen channel

Route A means all the customers in Ejingchong is in charge of Guiyang center. Guiyang center delivery goods go through Majia and Xiaoqiao, then arrive Ejingchong, finally go back to Guiyang center. For rational calculation, we also calculate another route from Xiuwen to Makou and Baimao.

    Total Distance= (10.5+2.5+4+17) + (7.4+3.6+11) = 56km

(B) Xiuwen Channel → Makou → Baimao → Ejingchong → Xiuwen Channel

    Guiyang Center → Maijia → Xiaoqiao → Guiyang center

Route B means Xiuwen channel is responsible for Ejingchong's customer. The route is start from Xiuwen Channel, go through Makou, Baimao and Ejingchong, and then go back to Xiuwen Channel. Guiyang Center is in charge of Majia and Xiaoqiao.

    Total Distance= (7.4+3.6+1.3+12.2) + (10.5+2.5+13) = 50.5 km

The distance of Route B is shorter than Route A. The average order quantity of Makou per mouth is 852 cartons per week, Baimao is 584 cartons per week, Ejingchong is 307 cartons per week, Xiaoqiao is 734 cartons per week, and Maijia is 382 cartons per
week.\textsuperscript{25} Guiyang center takes responsibility for Maijia and Xiaoqiao; and Xiuwen channel takes responsibility for Makou, Baimao and Ejingchong. The delivery time is once a week.\textsuperscript{25} The full load of a truck is 2500 cartons.

The capability of truck from Guiyang center = \((734+953)/2500=0.6748=67.48\%\)

The capability of truck from Xiuwen channel = \((852+584+307)/2500=0.6972=69.72\%\)

As we mentioned above, the delivery volume of each stops is a factor to decide the distribution route. Route B includes two routes; one is Xiuwen channel \(\rightarrow\) Makou \(\rightarrow\) Baimao \(\rightarrow\) Ejingchong \(\rightarrow\) Xiuwen channel; and another one is Guiyang center \(\rightarrow\) Maijia \(\rightarrow\) Xiaoqiao \(\rightarrow\) Guiyang center. The delivery volume of Makou is larger than Baimao, and Baimao is larger than Ejingchong. Xiaoqiao's volume is larger than Maijia.

After calculation and analysis, Route B is Xiuwen channel \(\rightarrow\) Makou \(\rightarrow\) Baimao \(\rightarrow\) Ejingchong \(\rightarrow\) Xiuwen channel; and another one is Guiyang center \(\rightarrow\) Xiaoqiao \(\rightarrow\) Guiyang center. The delivery time is once a week. Route B saves distance with 5.5km; time is 0.18 hours; and gasoline with 0.69L that costs 4.2 Yuan than primary route every week.

\textbf{6.6 Shicao Town}

Qingzhen channel take the responsibility of Shicao town now. Qingzhen delivery to Shicao must go through Zhuchang town, but Zhucang town is charged of Guiyang distribution center.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
 & Guiyang & Qingzhen & Shicao & Zhuchang \\
\hline
Guiyang & - & - & - & - \\
\hline
Qingzhen & 23.7 km & - & - & - \\
\hline
Shicao & 21.6 km & 38 km & - & - \\
\hline
Zhuchang & 18.3 km & 33.2 km & 4.8 km & - \\
\hline
Pingqiao & 23.7 km & 27.9 km & 10.1 km & 5.3 km \\
\hline
\end{tabular}
\caption{Distance between places (km)}
\end{table}

\textsuperscript{25} Detail file of customer order 2009
\textsuperscript{26} Detail file of customer order 2009
Original total distance = $2 \times (27.9 + 5.3 + 4.8 + 18.3) = 112.6 \text{ km}$

There are three alternative routes to choose;

(A) Qingzhen channel $\rightarrow$ Pingqiao $\rightarrow$ Shicao $\rightarrow$ Qingzhen channel  
   Guiyang center $\rightarrow$ Zhuchang $\rightarrow$ Guiyang center

Route A means Qingzhen channel takes responsibility for Shicao and via Pingqiao and Zhuchang to Shicao. But Qingzhen channel doesn't take responsibility for Zhuchang town. Zhuchang town is in charge of Guiyang center. This is the primary route.

Total Distance = $(27.9 + 5.3 + 4.8 + 38) + 18.3 \times 2 = 112.6 \text{ km}$

(B) Qingzhen channel $\rightarrow$ Pingqiao $\rightarrow$ Zhuchang $\rightarrow$ Shicao $\rightarrow$ Qingzhen channel

Route B means Qingzhen channel takes responsibilities for Zhuchang, Pingqiao and Shicao. This route is start from Qingzhen channel, go through Pingqiao, Zhuchang and Shicao, and then go back to Qingzhen channel.

Total Distance = $27.9 + 5.3 + 4.8 + 27.2 = 65.2 \text{ km}$

(C) Guiyang center $\rightarrow$ Zhuchang $\rightarrow$ Pingqiao $\rightarrow$ Shicao $\rightarrow$ Guiyang center

Route C means Guiyang centre takes responsibility for Zhuchang, Pingqiao and Shicao. This route is start from Guiyang center, go through Zhuchang, Pingqiao and Shicao, and then go back to Guiyang center.

Total Distance = $18.3 + 5.3 + 10.1 + 21.6 = 55.3 \text{ km}$

(D) Guiyang center $\rightarrow$ Zhuchang $\rightarrow$ Shicao $\rightarrow$ Guiyang Center  
   Qingzhen channel $\rightarrow$ Pingqiao $\rightarrow$ Qingzhen channel

Route D means Guiyang centre takes responsibility for Shicao and Zhuchang. Qingzhen channel takes responsibility for Pingqiao.

Total distance = $(18.3 + 4.8 + 21.6) + 27.9 \times 2 = 100.5 \text{ km}$

From the calculation result, Route C is the shortest one. But we will consider the capacity later and decide the most efficient way. The average order quantity of Shicao is 188 cartons per week, Pingqiao is 1906 cartons per week, and Zhuchang town is
1328 cartons per week. The delivery time is once a week. The full load of a truck is 2500 cartons.

The capability of Route C = (188+1906+1328)/2500 = 1.37

The capability is larger than 1, it means that a truck can not delivery all the goods at one time. So the route C seems not a efficiency route. Route B is Qingzhen channel takes the responsibility for Pingqiao, Zhuchang and Shicao, the capability of the truck is same within Route C. So Route B is not an efficiency route too. In Route D, there are two channels. One truck departures from Guiyang center, then deliveries goods to Zhuchang town and Shicao town; and another one departures from Qingzhen channel and delivery goods to Pingqiao town.

The capability of truck from Guiyang center = (188+1328)/2500=0.6064=60.64%
The capability of truck from Qingzhen channel = 1906/2500=0.7625=76.25%

The delivery volume of Zhuchang zhen is larger than Shicao town. After these calculation and analysis, Route D is deciding as the most efficient routes among these several routes. Route D includes two routes, one is Guiyang center → Zhuchang → Shicao → Guiyang; another one is Qingzhen channel → Pingqiao → Qingzhen channel. The delivery time is once a week. Route D saves distance with 12.1 km, time with 0.4 hours, and gasoline with 1.51L that costs 9.23 Yuan than primary route every week.

6.7 Shuangliu and Jiuchang
Because of the low capability of these two towns, we have suggested Shuangliu and Jiuchang change their delivery time from once a week to once every two weeks. These two towns located nearby, and their primary capability are not large than 50%. In order to find the potential route which can be more efficient; we consider combining two routes as one, and discussing the feasibility.

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25 Detail file of customer order 2009
Original total distance = 2 * (13.4 + 16.5) = 59.8 km

There are three alternative routes to choose: (In order to get a rational calculation and comparison, the primary route is also mentioned in the following calculation.)

(A) Xiuwen channel → Jiuchang → Xiuwen channel
   Kaiyang channel → Shuangliu → Kaiyang channel

Route A is the primary way. Xiuwen channel takes the responsibility for Jiuchang town, and Shuangliu is in charge of Kaiyang channel.
Total distance = 16.5 * 2 + 13.4 * 2 = 59.8 km

(B) Xiuwen channel → Jiuchang → Shuangliu → Xiuwen channel
Xiuwen channel takes the responsibility for Jiuchang and Shuangliu's delivery.
Total distance = 16.5 + 24.5 + 41 = 82 km

(C) Kaiyang channel → Shuangliu → Jiuchang → Kaiyang channel
Kaiyang channel takes the responsibility for Shuangliu and Jiuchang's delivery.
Total distance = 13.4 + 24.5 + 37.7 = 75.6 km

Route A is the shortest one of three alternative routes, and it is the primary route. The calculation result means that the combination of these two routes is not more efficient than the separation one. So Shuangliu town and Jiuchang town are still be took charge separately by Kaiyang channel and Xiuwen channel. Their both delivery time are once every two weeks.
6.8 Jiuchang, Wuchang and Houba

As the result we got above, Houba, Wuchang and Jiuchang are all took charge by Xiuwen channel and the capability of those towns are not so high, so we discuss to combine the three towns into one route.

<table>
<thead>
<tr>
<th></th>
<th>Xiuwen</th>
<th>Houba</th>
<th>Wuchang</th>
<th>Jiuchang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xiuwen</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Houba</td>
<td>15.2km</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wuchang</td>
<td>18.3km</td>
<td>3.1km</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jiuchang</td>
<td>16.5km</td>
<td>10.7km</td>
<td>13.8km</td>
<td>-</td>
</tr>
</tbody>
</table>

There are two alternative routes to choose: (In order to get a rational calculation and comparison, the primary route is also mentioned in the following calculation.)

(A) Xiuwen channel → Houba → Wuchang → Xiuwen channel
   Xiuwen channel → Jiuchang → Xiuwen channel

There are two trucks delivery good to Jiuchang; Houba and Wuchang separately.

Total Distance = (15.2 + 3.1) * 2 + 16.5 * 2 = 69.6km

(B) Xiuwen channel → Houba → Wuchang → Jiuchang → Xiuwen channel
Combine the three towns as one route and use a truck to take responsible for the route.

Total Distance = 15.2 + 3.1 + 13.8 + 16.5 = 48.6km

Route B is shorter than Route A, that means combine the three towns as one route will be better than they separate. So, we should use Route B to replace Route A.

Through the calculation result, we found Route B is better than Route A. But we still need to consider the capacity and check its feasibility. The average order quantity of Houba is 739 cartons per week, Wuchang 615 cartons per week, and Jiuchang town is 913 cartons per week. The delivery time is once a week. The full load of a truck is 2500 cartons.

The capability of Route B = (739 + 615 + 913) / 2500 = 90.68%
The delivery volume of Jiuchang is larger than Houba, and Houba is larger than Wuchang. So the Route B is Xiwen channel → Jiuchang → Wuchang → Houba → Xiwen channel. Route B saves distance with 21km, time with 0.7 hour, and gasoline with 2.63L that costs 16.01 Yuan RMB than Route A every week.

6.9 Optimized distribution route

From above calculation and analysis, the optimized distribution route is shown at the following diagram.

(Figure 3 Optimized distribution route)
(a) Shidong and Dashilianjiang
Now both Shidong town and Dashilianjiang town are responsible for by Xifeng channel. The delivery time is once every two weeks. The route starts from Xifeng channel, go to Shidong and Dashilianjiang, then go back to Xifeng channel.

(b) Shuangliu
Shuangliu is in charge of Kaiyang channel, and the delivery time is once every two weeks.

(c) Jiuchang, Wuchang and Houba
Xiuwen channel are responsible for Jiuchang, Wuchang and Houba. This route starts from Xiuwen channel, go to Jiuchang, Wuchang and Houba, and then go back to Xiuwen channel. The delivery time is once a week.

(d) Ejingchong, Makou and Baimao
These three towns are in charge of Xiuwen channel. This route starts from Xiuwen channel. This route starts from Xiuwen channel, go to Makou, Baimao and Ejingchong, and then go back to Makou and Xiuwen channel. The delivery time is once a week.

(e) Xinchang and Yangchang
Xinchang and Yangchang are in charge of Guiyang center. This route starts from Guiyang center, go to Xinchang and Yangchang, then go back to Guiyang center. The delivery time is once a week.

(f) Maijia and Xiaoqiao
Guiyang center takes responsible for Maijia and Xiaoqiao. Truck starts from Guiyang center, go to Maijia and Xiaoqiao, then go back to Guiyang center. The delivery time is once a week.
(g) Shicao and Zhuchang
Shicao and Zhuchang are been taken responsible by Guiyang center. Truck starts from Guiyang center, go to Zhuchang and Shicao, then go back to Guiyang center. The delivery time is once a week.

(h) Pingqiao
Pingqiao is in charge of Qingzhen channel. The delivery time is once a week.

7. Discussion
During this study we found that the huge number of retailers, scattered location of customers and zoning restriction complicated the distribution routes. A complex model is not suitable for this situation; even it can optimize the routes. If we break down the complex distribution route system into small parts, and use a simple method to simplify this problem, it will be more efficient than we using a complex model. Even there still have many deficiencies in our map and calculation, but the main purpose of the optimization is to show the opinion+ that the company can try to break down the zoning restriction to build more efficient routes of distribution.

There are two main limitations we found during this study:
1. As our main purpose is to improve the routes involving towns located in boundaries, and there are too many towns in Guiyang area, it will be really tough to calculate all the routes involving all the towns by hands, so we just picked out several towns to discuss, not covering all the stops.
2. The distance we calculated were the distance between towns and cities. But we did not map the detail streets into the routes.

8. Conclusion
After we optimize the routes of distribution, the optimizing distribution routes can totally save distance with 8554 km, time with 285.13 hours, and gasoline with 1069.25L that costs 6522.4 RMB than the primary routes every year. Reduce the use
of gasoline is not only reduce the operation costs, but also reduce the environmental pollution and protect human health.

Even through, there is a certain deviation between hypothesis and reality, but we believe this optimized method can help Guiyang Branch Office to own more efficient routes of distribution, increase its commercial efficiency, and improve the rationality of the layout of the regional distribution.

In the future, we suggest the company can aim at their complex distribution route situation to design a complete logistics and distribution system if they want to have a time proof system to help the company maximize the distribution efficiency, service quality and minimize the distance and distribution costs.

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Appendix

Work Breakdown Structure

1. Collect information
   1.1 Literature review
   1.2 Interviews
   1.3 Internet search

2. Report
   2.1 Structure
   2.2 Analysis present situation
   2.3 Optimize routes
   2.4 Calculation
   2.5 Review report
   2.6 Presentation

3. Project planning
   3.1 Mission and objectives
   3.2 Work breakdown structure
   3.3 Project schedule

4. Project administration
   4.1 Discussion with supervisor
   4.2 Group meetings
   4.3 Schedule project reviews
   4.4 Report preparation