APPLIED GIS AND SPATIAL DATA ANALYTICS

GROUP ASSIGNMENT

NATIONAL RETAILER SALES AND OPERATION PROJECT

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Contents

EXECUTIVE SUMMARY

To improve the company's performance in terms of sales and expand their market share, this report analysed the sales and marketing of existing stores, and build a linear regression model to predict some appropriate locations for opening a new physical store and internet presence. In addition, by applying network analysis to reduce its logistics relevant costs, the optimised distribution centres across Australia and vehicle routing plan in New Souths Wales are solved in ArcMap.

Based on the historical sales data, the methods of analysis of sales and marketing part was EDA (Exploratory Data Analysis) and Linear Regression Modelling. EDA was used to analyse the data from the outliers, the skewness (Histogram), the error term normality (Q-Q plot) and the correlation matrix (correlation heatmap). Linear Regression Modelling was used to analyse the sales of existing stores, and then use the significant factors to predict the sales of other locations without stores. The significant factors include gender, age, income and educational level.

From the analysis above, our group recommend St Kilda in Victoria as the best location to open a new physical shop, and Pyrmont Ultimo in New South Wales as the area to use internet presence to increase the company's market share.

The second part is planning to find the optimal number and new locations of distribution centres and design the relevant vehicle routes.

Firstly, as the foundation of network analysis, a network with the travel time of all Australian roads are created.

And then, for filtering the areas where are suitable to set distribution centres across the whole country, an index Y is calculated. It is a composite index that involves shops' sales, local labour forces, the total number of manufacturers, the total number of transport companies, and building values. At the next step, the top 35 areas with best Y in Australia are sorted out as the candidate location to set national distribution centres. In terms of the optimal number and location, network analysis is used. According to the result, 7 distributions which separately located in the following area: Perth city, Tea Tree Gully, Whittlesea - Wallan, meander valley - west Tamar, Blacktown, Maroochy, Townsville. And the result of service area buffers shows most shops in Australia can be served within 3 hours. It fits the target to use the least number of distribution centres to serve all shops effectively and efficiently.

In terms of the chosen distribution centre and shops in New South Wales, the Vehicle Routing Problem (VRP) is conducted in ArcMap. In this function of ArcMap, we process the sales data and use its location as 'orders' in VRP. The top four shops which have the most excess stock and the location of the distribution centre in NSW are loaded as 'depot'. As for the 'routes', three types of vehicles with enough numbers are loaded within appropriate constraints including open time, service time, capacity, fuel cost, drivers' salary and work time. All these routes are set to be able to reload toys in excess stocks shops. After setting the route renewals, the VRP will solve the optimised numbers and routes of vehicles to deliver the toys for one distribution plan, considering the redistribution from excess stocks shops.

Two distribution plans are proposed regarding the demand of each shop. Plan A is to deliver toys daily so that the intensive demands around Sydney can be satisfied. Plan B is to deliver toys weekly which may cause more trucks initial purchase and mismatch with the extremely intensive demand in CBD's shop. Regarding the issues of mismatch of demand, it is suggested that the company could set separately route to deliver toys to remote area weekly in Plan A and to deliver toys to CBD area daily in Plan B. Eventually, the optimised numbers and routes of these plans are solved by VRP.

Based on the computed results of Plan A and Plan B, we gained each route's arrangements and costs. We will compare the total costs and choose the optimal routing plan.

For Plan A, two small trucks, one large truck and two articulated trucks should be purchased with $630,000 fixed costs, and $7,318.54 variable costs per week as drivers' salary, fuel costs and so on. For Plan B, fixed costs are complex. Company will use one small truck, one large truck and four articulated trucks per week. While in practical, same trucks can be used in different days in a week, which means the company can only purchase one articulated truck and one large truck (small truck can be replaced by large truck with lower fixed costs and higher fuel costs), and if the company prefers long-run strategy, it can purchase one articulated truck, one large truck and one small truck with $360,000 fixed costs. Plan B will also require $3,388.58 in variable costs per week.

Since comparison on fixed and variable costs of two plans clearly shows that Plan B always have lower costs, so we recommend Plan B. In Plan B, 6 routes are arranged, they are showed in Table A:

Table A

Route	Truck Type	Frequency	From	Via (Shops)	Via (Renewals Shops)	To
1	Articulated	Weekly	DC	280, 204, 215, 384, 222, 220	384	DC
2	Articulated	Weekly	DC	207, 203, 202, 271, 209	202	DC
3	Articulated	Weekly	DC	212, 208, 237, 211, 216, 278	No	DC
4	Articulated	Weekly	DC	214, 236, 238	No	DC
5	Small	Weekly	DC	233	No	DC
6	Large	Daily	DC	219	No	DC

TECHNICAL REPORT

1. SALES AND MARKETING

1.1 DATASET

- shoplocation.csv
- shopsales.csv
- AusCapitalCBDs.shp
- Econ_ind_2011_16.csv (Australian economic indicators from 2011 to 2016)
- industryInnovation2009_2016.csv
- SA2_AgeSex layer in AustraliaSA2Data.gdb
- SA2_EmploymentStatus layer in AustraliaSA2Data.gdb
- SA2_PersonalIncome layer in AustraliaSA2Data.gdb
- AgeBySA2ByIncomeAllAustralia.csv
- eNSWroadlink
- MetroArea
- Econ_IndABS
- Industryinniovation
- GEODATA TOPO 250K Series 3 (Retrieved from https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search?node=srv#/metadata/63999)
- SA3_2016_AUST (Retrieved from: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1270.0.55.001July%202016?OpenDocument)

Dataset Assumptions:

The shop location dataset contains 69 observations, including one online shop. Due to the location of an online store is missing, we only discuss 68 entity stores in the rest of the analysis. We assume the shop number is unique as identity. In shop sales set, each GTIN is assumed to represent a unique item across various stores. To be consistent with shop locations handling, data related to the online shop is excluded. Additionally, the sold quantity is more likely to decide sales performance, compared to the total quantity in-shop and on order. In economics indicator set, "Building Approvals - Value of total non-residential building ($m)" is assumed to reflect the commercial building rental price. We assume that the column "Total" in AgeSex layer refers to the total population in each SA2. And the total number of all ages, genders equals the total population respectively. In the same SA2 geodatabase, the total number of all employment status is assumed to equal the total population in SA2_AgeSex layer. For the convenience of analysis, employment status is aggregated into “employed” and “unemployed” groups. The total number of various personal income levels is assumed to be the total population in age-sex shapefile. The assumption of personal income by age dataset is similar to previous datasets. By summarizing the data, we found that the total number of the population without applicable income equals the total number of children under 15 years old. So, age levels are divided into three groups: children (0-14 years), working population (15-64 years), and aging population (over 65 years). Income levels are grouped into low income (weekly income from $1 to $599), medium-income (weekly income from $600 to $1249) and high income (weekly income from $1250 to $1999). The division methods of ages and income levels are applied to “AgeSex” and “PersonalIncome” layers.

1.2 GENERAL ANALYSIS

After data processing, this part will focus on exploratory data analysis and modelling. As described in the previous section, the total sold quantities are selected as the target variable from the three sales-related variables in shop sales set. As shown in Figure 1 and Figure 2, the distribution of sold quantities is right-skewed, ranging from -2,500 to 15,000. The average sold quantity is approximately 3,274 with a standard deviation 2244.28.

Based on domain knowledge, certain factors can affect sales, such as demographics, economic factors and business indicators. In order to explore the correlation between the target variable and the explanatory variable, a correlation heatmap is drawn, as shown in Figure 3. In the correlation heatmap, only the nine most correlated

features are displayed. Although there is no strong relationship between variables and sold quantities, the most relevant features among selected features are educational levels, postgraduate and graduate level, followed by high income.

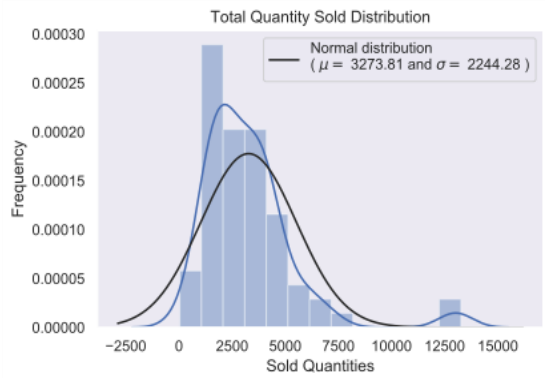


Figure 1 Total Quantity Sold Distribution

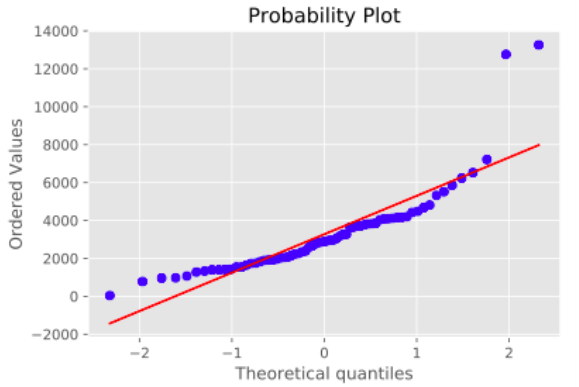


Figure 2 Probability Plot

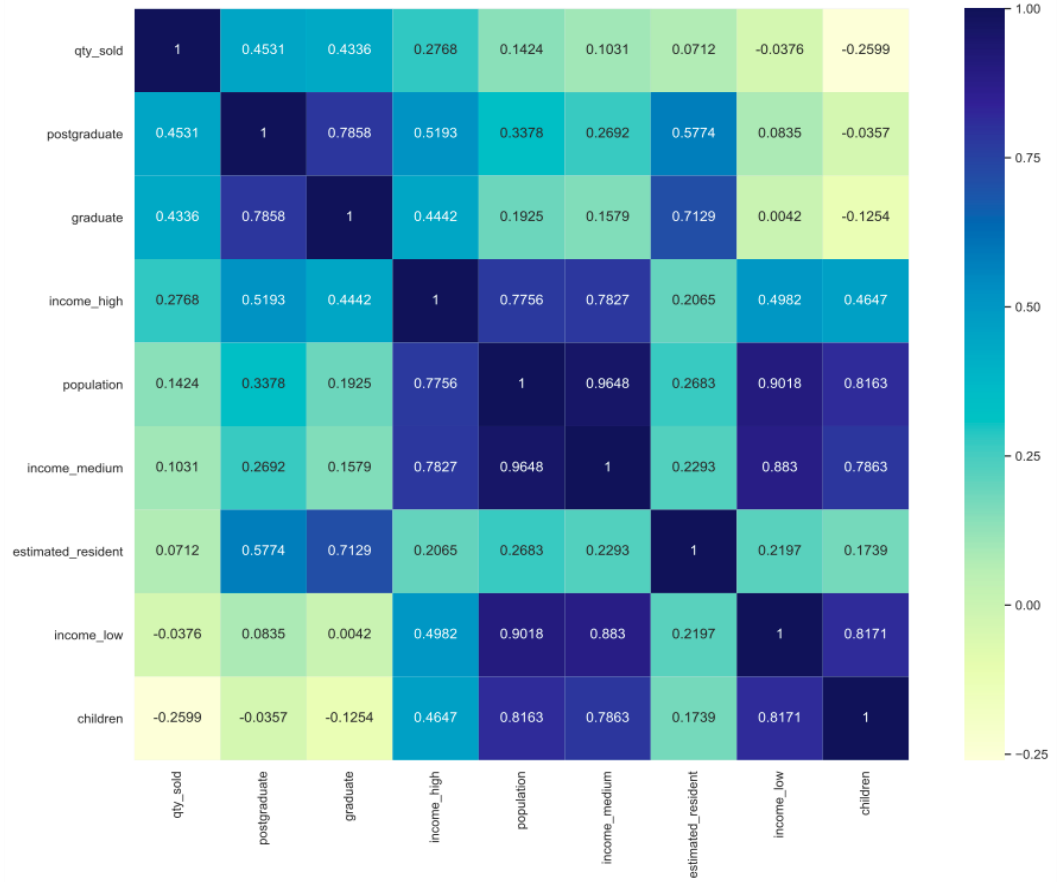


Figure 3 Correlation Heatmap

Thus, explanatory variables were chosen, including postgraduate, graduate, high income, medium income, low income, children, and population. Linear regression is fitted to predict sales, and an OLS (Ordinary Least Squares) summary is shown in Figure 4. The linear model can be expressed as follows:

$$\text{Sold}_{\text{quantities}} = 0.9885 * \text{Population} - 1.8102 * \text{children} + 1.3237 * \text{graduate} - 0.2173 * \text{postgraduate} - 1.3361 * \text{Income}_{\text{low}} + 0.3696 * \text{Income}_{\text{medium}} - 2.4139 * \text{Income}_{\text{high}}$$

The formula shows that population, graduates, and middle income are positively correlated with sales, while others are negatively correlated. Except for medium income, the p-values of other variables are all below 0.05, which rejected the null hypothesis. Among these seven features, high income has the most significant impact on sold quantities. When a person was added to the high-income group, the number of sales decreased by 2.4139. The

adjusted R-squared of the linear model is 0.829, indicating that the model's prediction effect is not bad. Furthermore, the residuals plot of the model is shown in Figure 4. We can see that the points are roughly evenly distributed around the zero line.

OLS Regression Results

Dep. Variable:	qty_sold	R-squared:	0.847
Model:	OLS	Adj. R-squared:	0.829
Method:	Least Squares	F-statistic:	48.23
Date:	Tue, 05 Nov 2019	Prob (F-statistic):	1.62e-22
Time:	01:39:03	Log-Likelihood:	-596.13
No. Observations:	68	AIC:	1206.
Df Residuals:	61	BIC:	1222.
Df Model:	7		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
population	0.9885	0.196	5.045	0.000	0.597	1.380
income_low	-1.3361	0.361	-3.704	0.000	-2.057	-0.615
income_medium	0.3696	0.592	0.625	0.535	-0.814	1.553
income_high	-2.4139	0.693	-3.485	0.001	-3.799	-1.029
children	-1.8102	0.293	-6.186	0.000	-2.395	-1.225
graduate	1.3237	0.294	4.504	0.000	0.736	1.911
postgraduate	-0.2173	0.083	-2.625	0.011	-0.383	-0.052

Omnibus:	0.189	Durbin-Watson:	1.839
Prob(Omnibus):	0.910	Jarque-Bera (JB):	0.370
Skew:	-0.081	Prob(JB):	0.831
Kurtosis:	2.677	Cond. No.	82.6

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Figure 4 OLS Summary

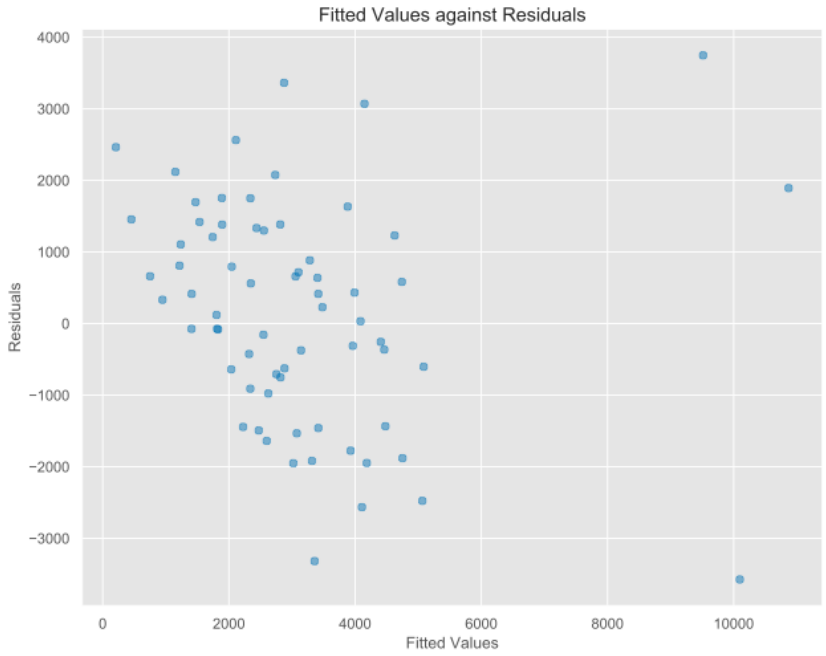


Figure 5 OLS Residuals Plot

1.3 TREND

To analyse the trend of sold quantities, sales data are aggregated by month and product type. In the sales dataset, products can be divided into four categories, educational toys, health and beauty, home decorations and toys. In Figure 6, it can be seen that from November to December, sales of all four products have increased.

This trend is mainly influenced by Christmas and New Year holidays. The number of toys sold has almost tripled from 8k to about 24k. The sales of home decorations and educational toys also reached its peak in December. However, health and beauty are best sold in February of the year.

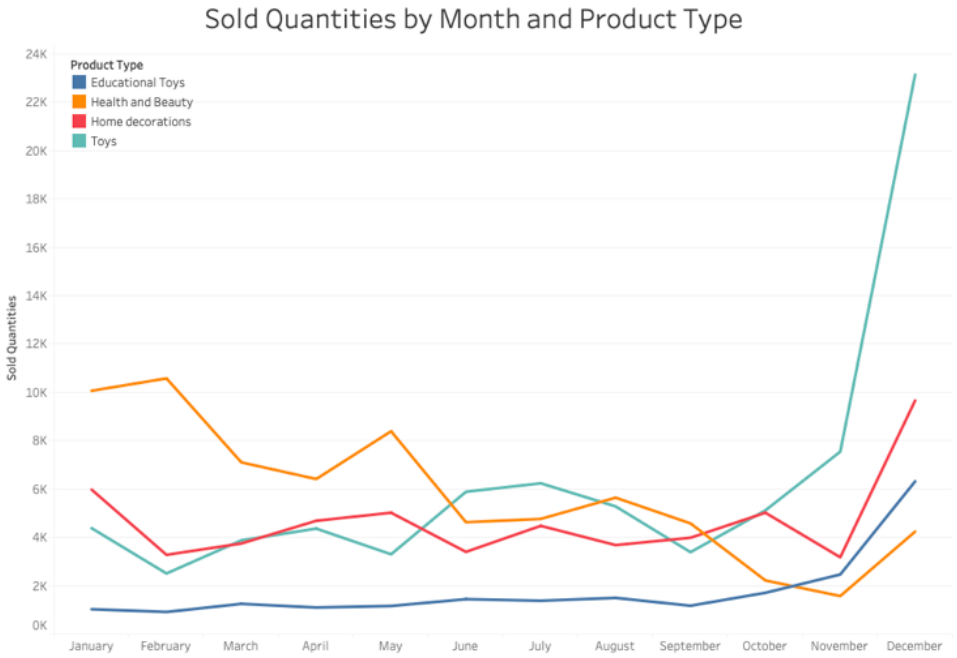


Figure 6 Sold Quantities Trend by Month and Product Type

Apart from trends regarding the month and product type, there is another significant trend in different states (Figure 7). In most cases, CBD sales are higher than in other stores in the state, while Perth, CBD in Western Australia, is worse than Booragoon. It is worth mentioning that this graph does not cover Northern Territory because even its CBD Darwin City did not open a store. Among the seven CBD stores, Melbourne has the highest sales, followed by Sydney. However, 25 out of 68 stores opened in New South Wales have opened stores, which lead to the highest selling in NSW.

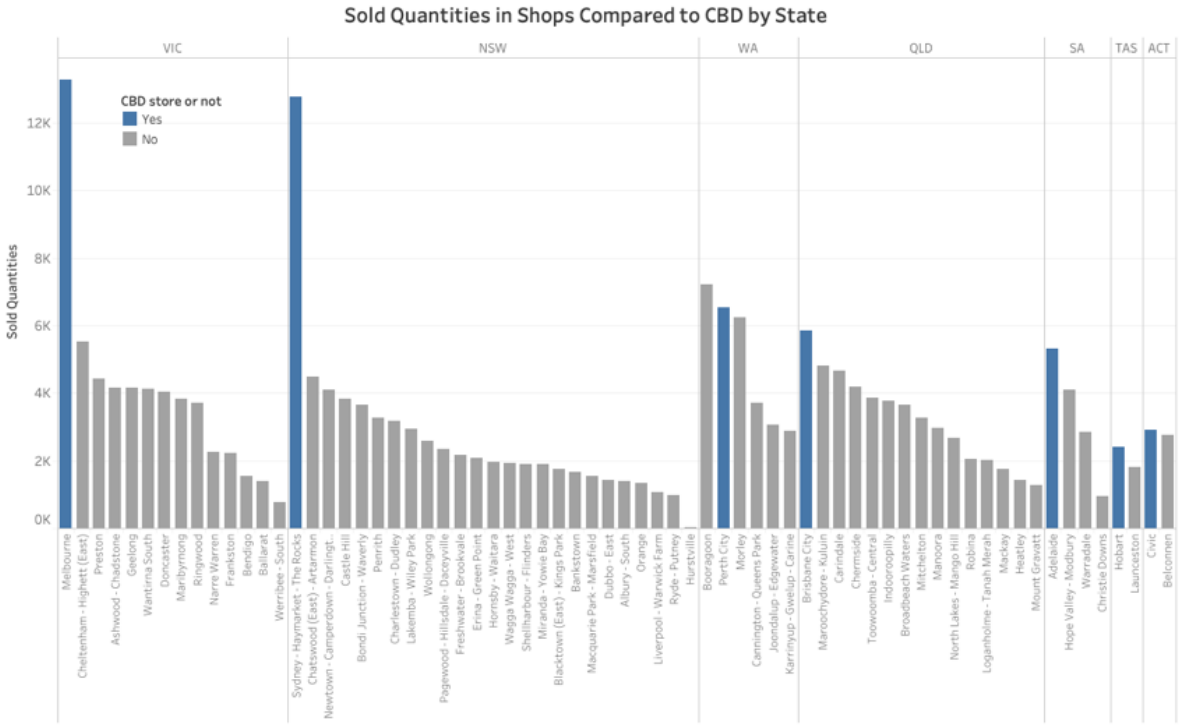


Figure 7 Sold Quantities in Shops Compared to CBD by State

1.4 NEW STORE

According to the analysis and predicted result above, our group identified Top four candidate locations (SA2) for opening a new shop, Sydney - Haymarket - The Rocks, Perth City, Melbourne and St Kilda. As the first three locations are CBD of New South Wales, Western Australia and Victoria, and all of these three already have stores, they all not a great place to open a new shop. Therefore, the best location is St Kilda in Victoria to open a new store. From the result of Linear Regression, Population, Children, Income, Education Level are important factors which will influence sales. And from the analysis of these important factors, Figure 8 will explain the reasons to choose St Kilda in Victoria to open a new physical store.

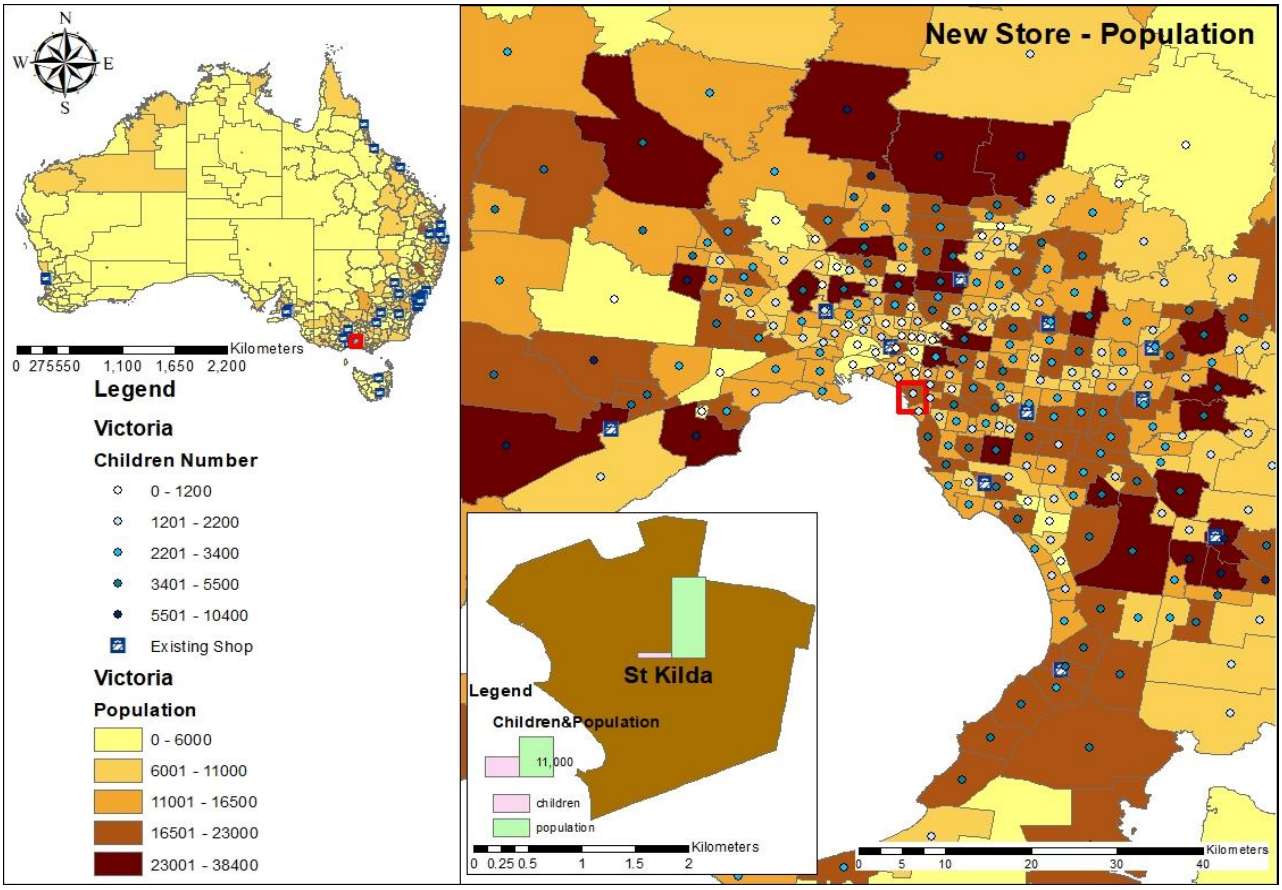


Figure 8 New Store - Population

From the analysis of population from existing stores' locations and compared with the new shop location, the population in St Kilda is about 22,551, which is very high compared with other locations, and the proportion of numbers of children is 6.9% of the total population. As the children who do not have fixed income and do little contribution to consumption. According to the result of linear regression modelling, the small proportion of children and large population in St Kilda provides a great environment for building a new shop.

From figure 9, both Educational Level and Medium Income Population in St Kilda are very high, which indicates this area has a big potential market to increase the company's total sales. Also, compared to the population of high-income and low-income, the population of medium-income is higher in St Kilda. From the result of Linear Regression analysis, the population of medium-income will increase the predicted total sales, as the coefficient is positive. Education level is also an important factor for the scale of total sales, figure 9 shows postgraduate and graduate level in St Kilda are very high which means the higher education level, the higher numbers of potential customers this area will have.

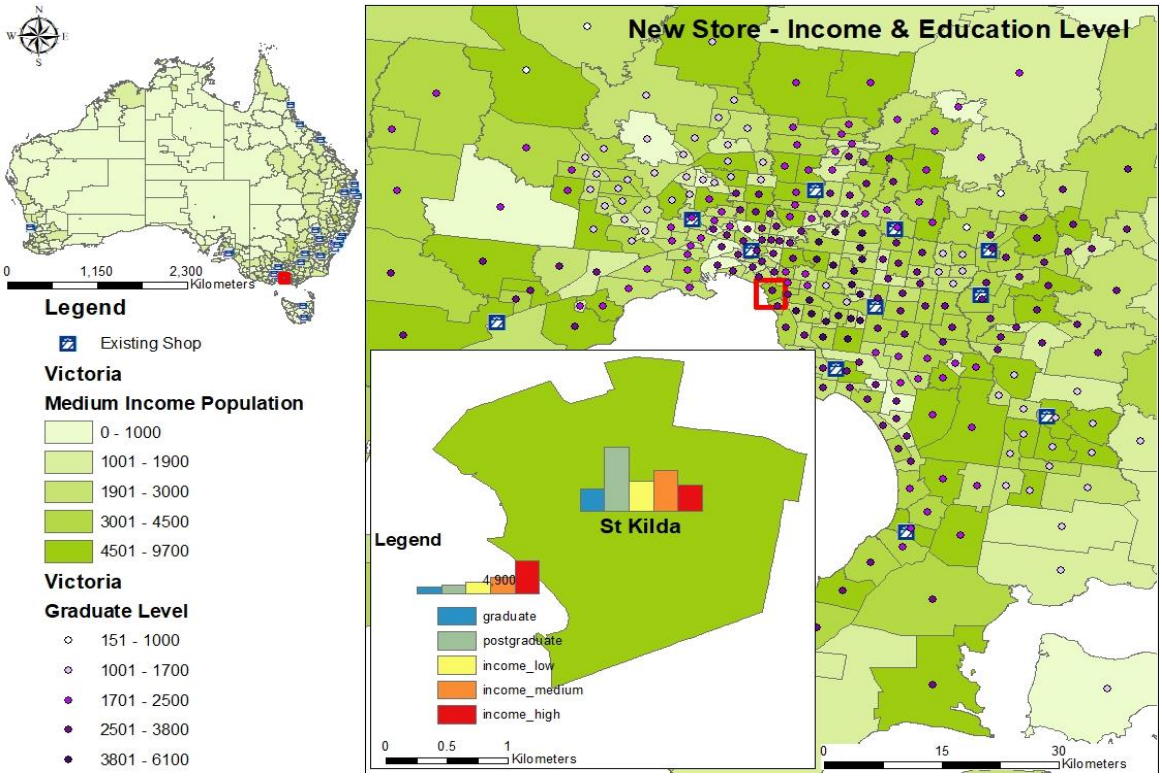


Figure 9 New Store – Income & Education Level

1.5 INTERNET PRESENCE

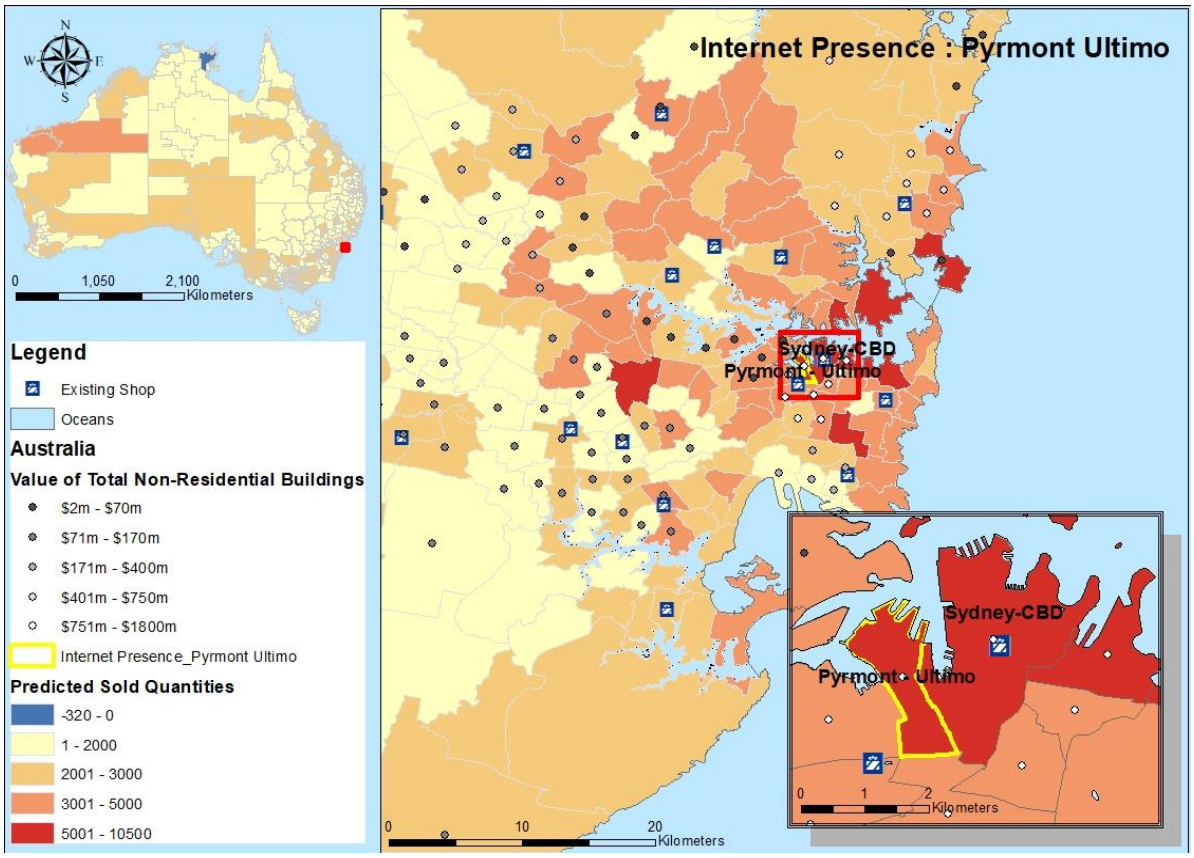


Figure 10 Internet Presence: Pyrmont Ultimo

From the analysis of the top ten predicted best locations for expanding sales, Pyrmont Ultimo in New South Wales is the best area (except CBD areas and St Kilda) for the company to use its internet presence to increase their market competitiveness. According to predict the total quantities sold in Australia, as the result shows in the map above, the predicted sales will be very high in state: New South Wales and Pyrmont Ultimo is the area has highly predicted sales with big population (from the regression modelling result), which means there would have a big potential market. However, there are many existing stores around Pyrmont Ultimo, and this area is near to Sydney CBD, and the high business rental cost on this location will not be appropriate to open a new physical store here. Therefore, applying internet presence at Pyrmont Ultimo is a great way to expand the company's market share.

2. LOGISTIC AND DISTRIBUTION

2.1 ASSUMPTIONS:

The following items are all assumptions which have been involved in this report:

- Distribution centres are open from 05:00 to 16:00
- Retail shops accept deliveries between 07:00 and 17:00 unless they are in the CBD where deliveries can only be made between 05:00 and 07:00 and from 13:00 to 15:00
- Average vehicle speed: 70 km/h outside metropolitan areas, 40 km/h in metropolitan areas, and 25 km/h inside the CBDs.
- Fuel cost 160 cents/Litre for Diesel
- Fixed time: 12 minutes
- Unit time: 0.3 minutes per unit
- To reduce maintenance and training costs only three types of vehicles are available to make deliveries with the following characteristics, note that the capacity listed is the capacity allocated for the products included in this dataset:

Type	Capacity (units)	Purchase Cost	Fuel efficiency (L/100km)
Articulated	250	$200,000	55
Large Rigid	75	$90,000	32
Small Rigid	40	$70,000	22

- It is assumed that driver cost is $30 per hour (Living in Australia, 2018), and one driver cannot drive continuous more than 6 hours and total drive time is no more than 8 hours. (National Heavy Vehicle Regulator, 2019)
- It is assumed that only truck purchasing fee, driver costs, fuel costs will be considered, Truck insurance, maintenance fee and other related fees will not be considered.
- It is assumed that shop quantity excess = quantity in shop - quantity in sales, the shops have ranked top three quantity excess will be selected as "Renewal shops with excess stocks".

2.2 NETWORK ANALYSIS

Firstly, for doing network analysis, a network that includes the travel time of all of the roads in Australia is created and the travel time is calculated according to the following formula (considering the different transport conditions between different city areas, this report assumes the vehicle speed outside metropolitan areas is 70 km/h, in metropolitan areas is 40 km/h, and 25 km/h inside the CBDs.):

$$\text{Travel time} = \begin{cases} \frac{\frac{distance}{1000}}{70} * 60 \text{ (outside metropolitan areas)} \\ \frac{\frac{distance}{1000}}{40} * 60 \text{ (in metropolitan areas)} \\ \frac{\frac{distance}{1000}}{25} * 60 \text{ (inside CBD)} \end{cases}$$

2.3 NEW LOCATION-ALLOCATION

Secondly, for finding suitable areas to set national distribution centres in Australia, the following important financial implications:

1. Shop sales: This is the most important element because the final target for distribution centres is to serve current shops.
2. Labour force: For keeping the management of the warehouse, a large quantity of staff is needed and hiring local workforces can save costs.
3. Manufacturing count businesses: As a retail company, building relationships with local manufacture is important and setting distribution centres nearby can reduce transport costs.
4. Building value: Whatever renting or building a new distribution centre, the cost of land use accounts for a very big percentage.
5. The number of transport industry: If an area has a lot of transport companies, it commonly has some advantages in the transport system or relevant workers.

For taking all of these implications into consideration, an index Y is created according to the below formula:

$$Y = \frac{\text{Shop sales}}{\text{ma}(nship\ sales)} * 50\% + \frac{(\text{Labour force})}{\text{MAX}(\text{Labour force})} * 12.5\% + \frac{(\text{Manufacturing count businesses})}{\text{MAX}(\text{Manufacturing count businesses})} * 12.5\% + \frac{(\text{Number of transport industry})}{\text{MAX}(\text{Number of transport industry})} * 12.5\% - \frac{(\text{Building value})}{\text{MAX}(\text{Building value})} * 12.5\%$$

(Considering the importance of shop sales, its weight is set to 50%)

Finally, get the top 35 areas with the best index Y and visualise these areas on the Australian map (Figure 11).

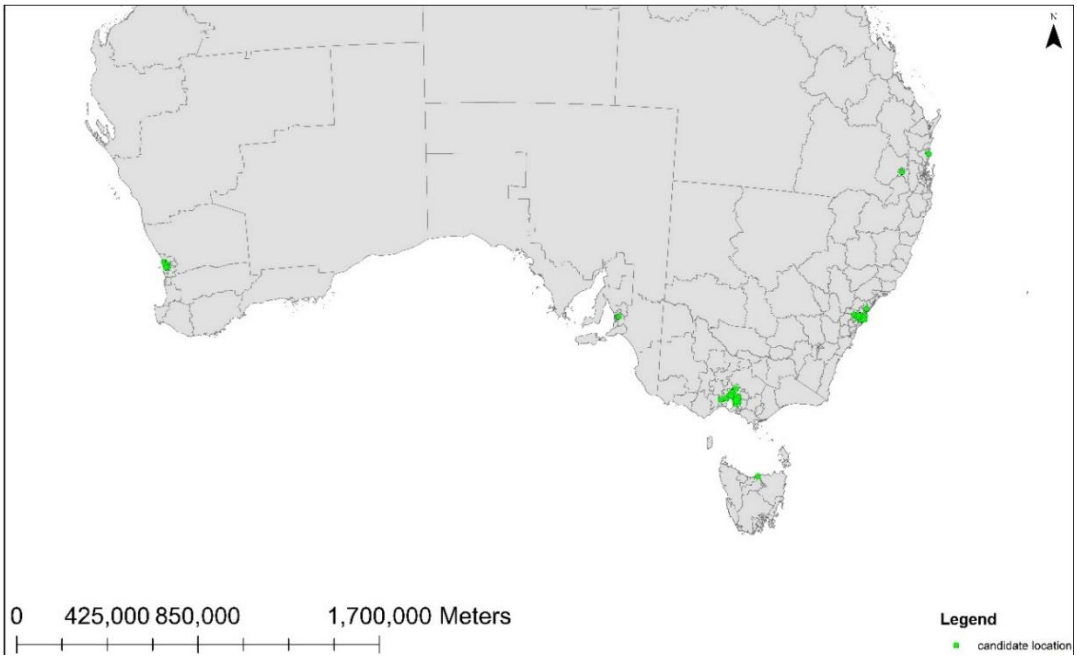


Figure 11 Candidate location

However, although all of these candidate locations are suitable to build distribution centres, the optimal number and location are still needed to do further evaluation.

The logic this report involves is to use the least number of distribution centres to cover all shops across the country. The first assumption to the optimal number is 7. It means one distribution can cover one separate area in Figure 11.

The result of network analysis is:

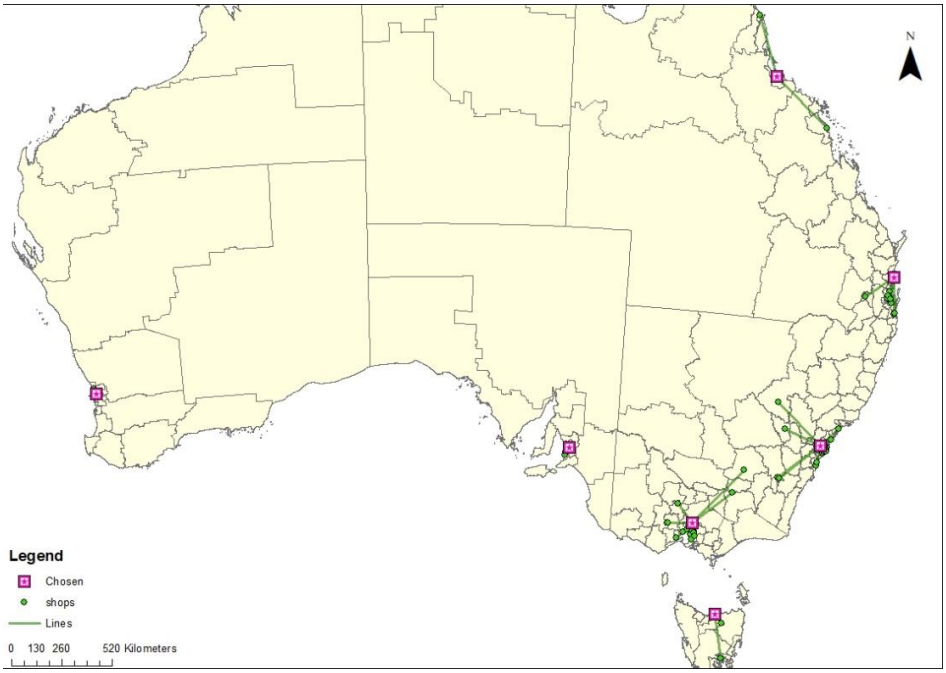


Figure 12 Optimal distribution centres

In Figure 12, for all distribution centres and shops which are connected by the green line, the travel time is lower than 5 hours. So, these 7 distribution centres are enough to serve all stores in Australia within 5 hours. And Table 1 is the detailed location of these 7 distribution centres:

Table 1 optimal distribution centres

States	Sa3 name
Western Australia	Perth city
South Australia	Tea tree gully
Victoria	Whittlesea
Tasmania	Meander valley – west Tamar
New south wales	Blacktown
Queensland	Maroochy
Queensland	Townsville

For further evaluating the effectivity of distribution centres, the service area buffers are created:

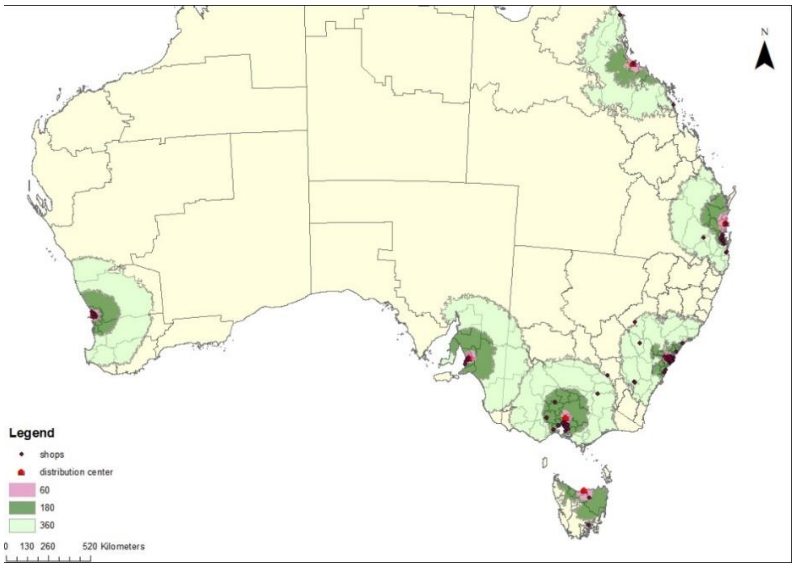


Figure 13 Service area buffer

Figure 13 shows most of the shops in Australia can be served within 3 hours. It fits the target: using the least number of distribution centres to cover all shop across the country. Therefore, these 7 distribution centres can be regarded as the optimal distribution centres setting plan.

2.4 ROUTING PLAN

Based on the chosen distribution centre and stores locations above in New South Wales, We will arrange optimal routes through network analysis.

2.4.1Methodology

Firstly, we solve the sales data of each shop to fit the Vehicle Routing Problem (VRP) in ArcMap. This is achieved by R that group by the shop number in sales data. Hence, we get the annual data of quantity in shops, quantity ordered by shop and quantity sold. In the routing plan, quantity ordered is used as the deliver numbers from distribution centre to every shop. Quantity in shop minus quantity sold is regarded as the excess stocks in this shop. Then the solved data is associated with the assumptions on retail shops open time, including the special delivery time limitation in CBD. Therefore, these shops' sale data are loaded into the orders in VRP, which means routing plan will deliver toys to these shops.

Secondly, the location of the chosen distribution in NSW is loaded as a depot where toys are loaded in trucks. This also considers the open time from 05:00 to 16:00. In the meantime, we choose the top four shops with the most excess stocks to be the renewals points. This means trucks can load the excess stocks in these shops and deliver to other shops. Hence, we got five depots to load toys.

Thirdly, the vehicles are set into VRP. There are three types of vehicle with different fix cost and fuel cost. Every Truck is set to start work from 5:00 AM and can delay the start time until 4:00 PM. Different types of trucks will have different service time regarding their capacity. Drivers of trucks are considered with reasonable travel time and salary ($30/hour). After setting one truck of each type, we give enough number of vehicles, and VRP will solve the optimised number of each type of vehicle and its routes.

Finally, we load the renewals depot on each truck, so that VRP will take into account the redistribution from excess stocks shops to other shops. Therefore, VRP will solve the final routing plan including the optimised number of vehicles for servicing shops in NSW.

2.4.2 Two Distribution Plans

Two distribution plans are assessed in this report. The Results of Plan A (Daily) and Plan B (weekly) are discussed following.

Plan A: Based on daily distribution

The first plan considers delivering toys to each shop every day. This way can satisfy the high demand especially demand in CBD's shop. However, it's not economical to deliver a few toys to remote shops every day. Therefore, we make the frequency of delivery for the only two remote shops to be weekly (there are two remote shops in NSW are covered by the distribution centre in VIC because of distance).

Load daily demand to shops with daily deliveries, and weekly demand to remote shops in VRP. As a result, the routes for the two conditions are solved by VRP. These routes are shown in Figure 14 and 15.

There are three trucks (one small, one large and one articulated) are used for near shops with daily deliveries. It is noted that the small truck reloads in shop 237 (Wollongong). In the meantime, two trucks are used for delivering toys to remote shops weekly. One articulated truck serves the shop 238 and one small truck is used for shop 233. In summary, five vehicles should be purchased in this scenario, and the optimised routes are solved by VRP showed in Figure 14 and 15.

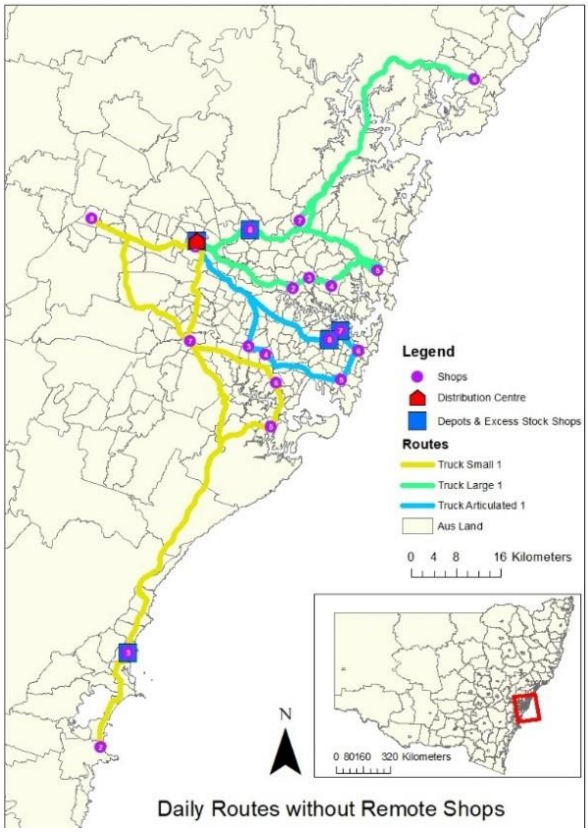


Figure 14 Daily Route without Remote Shop

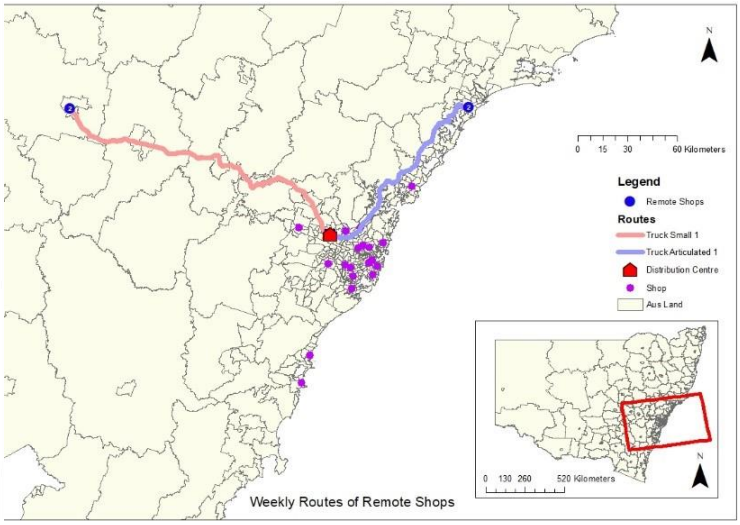
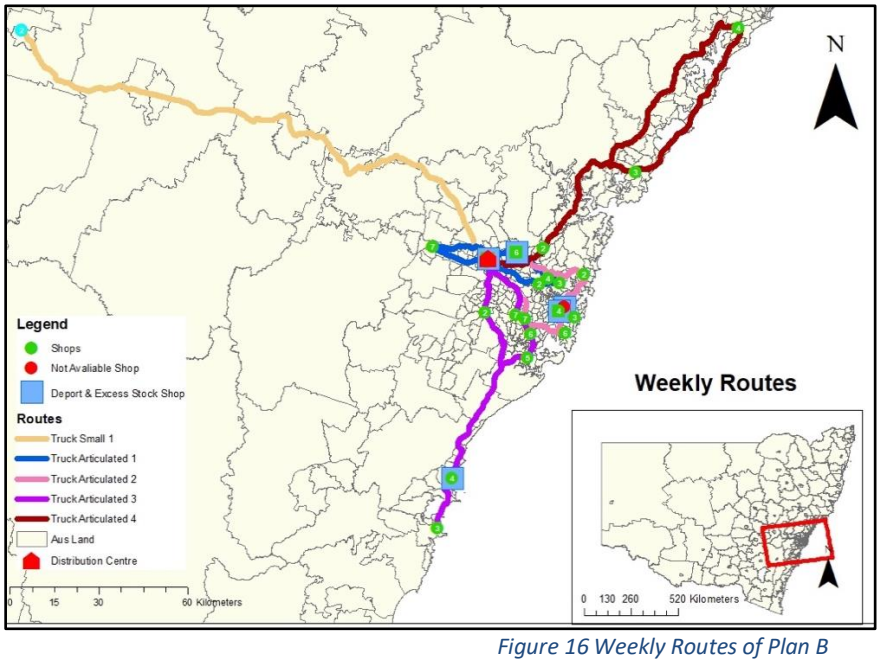


Figure 15 weekly Route of Remote Shops

Plan B: Based on weekly distribution

Plan B is based on weekly distribution. In this plan, 24 stores will be covered by one distribution centre in New South Wales (NSW) (2 of 26 shops in NSW will be covered by Victoria (VIC) distribution centre because shorter distance, so we will not route them).
In plan B, the average weekly ordered quantity of each shop is calculated from provided “sales summary data”. As shown in Plan A, the only weekly order number is changed, all other features in Plan A will be kept. From the Network Analyst, we gained a new map shown in Figure16.



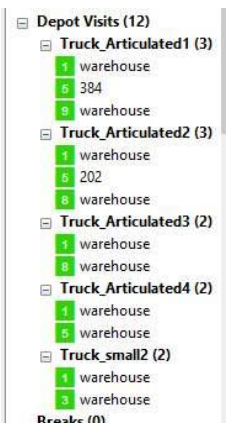


Figure 16 Weekly Routes of Plan B

From the map Figure, A provided by computer, 5 routes in a week is planned. Four routes of them use articulated trucks, and one route uses a small truck. In Figure 16, which shows the stops in each route, we can see: Route 1 with an articulated truck will stop at shop 384 as the renewals shop; Route 2 with an articulated truck will stop at shop 202 as the renewals shop, other routes will not stop at renewals shop in routes.

However, from the computer solution, one of the shops cannot be arranged, which is the CBD shop (Number 219). The reason is that this shop has much higher sold quantity and order quantity every week, and it is not enough to deliver goods from distribution centre to CBD shop once a week.

Therefore, based on the fact of CBD shop, we decide to distribute goods to the CBD shop once a day and separate CBD shop to arrange a route. Daily order quantity will be used in daily delivery for CBD shop. From the computer, we obtain the following route arrangement (Figure 17).

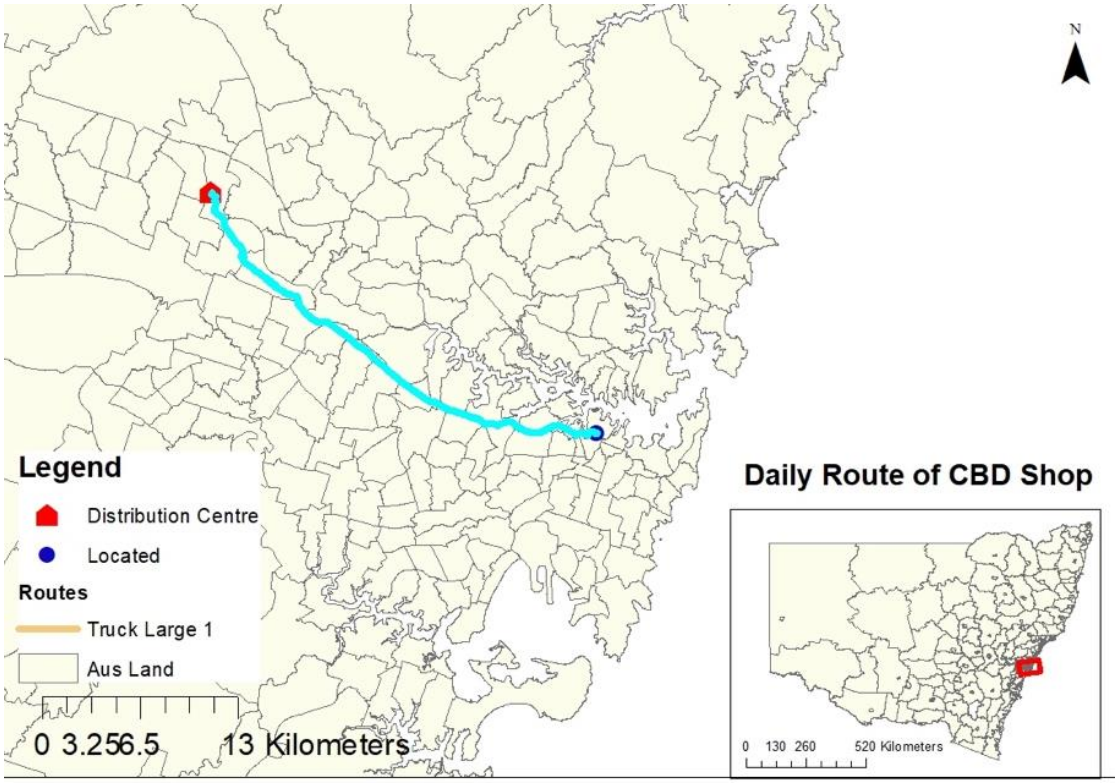


Figure 17 Daily Route of CBD shop in Plan B

In Figure 17, only routes from distribution centre to CBD shop is showed, and large truck will be used every day. Therefore, in Plan B, we have six routes. Five of them are weekly distribution, which means these routes will be practised once a week, shop 202 and 384 will be as renewals shops in this routing. One of them is daily distribution, in which one large truck will deliver goods to the CBD shop once a day.

Comparison: Based on the computed costs of each plan, we conclude Table 2 and Table 3, all number is at $:

Table 2

Daily Routes without remote shops			
	Total cost	**Variable Cost**	**Weekly Variable Cost**
Truck Large 1	90321.43772	321.43772	2250.06404
Truck Articulated 1	200262.6686	262.668624	1838.680368
Truck Small 1	70329.16201	329.162012	2304.134084
Weekly route of remote shops			
	Total cost	**Variable Cost**	**Weekly Variable Cost**
Truck Small 1	70418.14105	418.141045	418.141045
Truck Articulated 1	200507.5163	507.516321	507.516321
Truck Purchased			
Truck Small	2		
Truck Large	1		
Truck Articulated	2		
Total Weekly Variable Cost	Total Fix Cost		
7318.535858	630000		

Plan A: Based on Daily Distribution

Table 3

Weekly routes all shops			
	Total cost	**Variable Cost**	**Weekly Variable Cost**
Truck Small 1	70418.14105	418.141045	418.141045
Truck Articulated 1	200368.937	368.936968	368.936968
Truck Articulated 2	200378.4484	378.448433	378.448433
Truck Articulated 3	200455.0131	455.013052	455.013052
Truck Articulated 4	200546.7602	546.760159	546.760159
Daily Routes CBD shop			
	Total cost	**Variable Cost**	**Weekly Variable Cost**
Truck Large 1	90174.46854	174.468537	1221.279759
Truck Purchased			
Truck Small	1		
Truck Large	1		
Truck Articulated	4	→	1
Total Weekly Variable Cost	Total Fix Cost		
3388.579416	960000	→	360000

Plan B: Based on Weekly Distribution

Table 3 and Table 4 show the costs of plans.

In Plan A, five trucks (two small trucks, one large truck and two articulated trucks) should be purchased with $630,000 fixed costs, and variable costs per week (including driver costs, fuel costs, etc) is $7,318.53.
While in Plan B, six trucks should be purchased (one small truck, one large truck and 4 articulated truck) with $960,000 fixed costs, and variable costs per week are $3,388.58. However, Plan B is a weekly distribution plan, which means the company can use the same trucks on different days. In this case, the company can only purchase one articulated truck and large truck and one small truck with $36,000. If the company lacks fund in short term,

they can just purchase one articulated truck and one large truck (in which case fuel costs will be relatively higher, so this strategy is not suitable for the long run company).

From the comparison of two plans, Plan B has absolute superiority than Plan A in both fixed costs and variable costs. We would like to choose Plan B as optimal plan, in which case some shops (number 384, 202) with high excess stocks are treated as renewals shops, and one articulated truck, one large truck and one small truck should be purchased for company's long run.

REFERENCE:

Living in Australia (2018), Truck Driver Salary Australia. Retrieved from https://www.livingin-australia.com/truck-driver-salary-australia/

National Heavy Vehicle Regulator (2019), Standard hours. Retrieved from https://www.nhvr.gov.au/safety-accreditation-compliance/fatigue-management/work-and-rest-requirements/standard-hours

UNIT OF STUDY	ITLS	6	1	0	7	STREAM	
GROUP NAME		118					
STUDENT NAMES		480207519 Zhiyan Zhang 480276777 Xiaoshuang Su 480253848 Mingzhe Zhang 480322731 Mingyu Lian 480104171 Wen Zhang					

MARKING CRITERIA

ASSIGNMENT 2: 20 pages including title page, maps, tables and any appendices. Note: Pages in excess of the page limit will not be marked.

CATEGORY	CRITERIA	WEIGHT	MARK	COMMENTS
Executive Summary	Clear description of what you did, the important findings and recommendations	30%		
Sales and marketing	Analysis of the historical sales performance and economic indicators; selection and analysis of new locations and internet expansion	40%		
Logistics and distribution	Analysis of planning and placement of distribution centres and distribution routes and plans	20%		
Readability/Style	Report structure, extent to which it reads as one coherent document, spelling and grammar, page limits	10%		
TOTAL MARK		**100%**		**GRADE:**
Comments:				

Meeting Minutes – Group 118

Date	15/10/2019	**Location**	Fisher 3rd Floor
Time	10:00 am	**Duration**	3 hrs
Attendees			

Points discussed
Discussed main missions

Actions
Divided assignment into five parts

Date	20/10/2019	**Location**	Law Library
Time	11:00 am	**Duration**	5 hrs
Attendees			

Points discussed
Processing Data

Actions
Using R Studio to processing data to the form that can be used in following steps

Date	22/10/2019	**Location**	Home
Time	9:00 am	**Duration**	7 hrs
Attendees			

Points discussed
Processing Data and do linear regression to find trend of the data

Actions
Using R Studio to processing data to the form that can be used in following steps

Date	25/10/2019	**Location**	Fisher 3rd Floor
Time	10:00 am	**Duration**	10 hrs
Attendees			

Points discussed
Linear regression and find best optional shops locations

Actions
Using R and Python to do Linear Regression and analysis of goodness of fit

Date	27/10/2019	**Location**	Fisher
Time	2:00 am	**Duration**	3 hrs
Attendees			

Points discussed
Building network analysis

Actions
Review knowledge of workshop and build the network for following analysis

Date	29/10/2019	**Location**	Fisher
Time	10:00 am	**Duration**	5 hrs
Attendees			

Points discussed
Allocation of new distribution centre

Actions
Analysing the index for SA3 associated with allocation
Using ArcMap to analysis the optimised location of distribution centre

Date	2/11/2019	**Location**	Fisher
Time	9:00 am	**Duration**	5 hrs
Attendees			

Points discussed
Vehicle routing plan

Actions
Identifying two plans of distribution, taking into account of the excess stocks
Running VRP to get the optimised routes

Date	4/11/2019	**Location**	Fisher
Time	9:00 am	**Duration**	5 hrs
Attendees			

Points discussed
Finishing the final report and slides

Actions
Write report and check its format
Finish the slides and practice