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ABSTRACT

McDonald's is an extremely large company, which has outlets all over the world and has become a household name over the years. It is believed to be the top fast food restaurant company in the world. Kentucky Fried Chicken (KFC), Burger King and many other fast food companies follow this. There are many factors that contribute to this booming business of McDonald's. The one thing that we do not normally see people thinking about is the seating arrangement – questions like "Can we place the tables in this way instead of the present way?".

So here, we have decided to study the seating arrangement of McDonald's and see if we can improve it. To simplify the matter, we have decided to focus on the McDonald's outlet at Kovan, at Hougang Street 21. While doing this project, we have read up on some theorems that we thought were applicable. In this report, we have included two of these theorems – the Marriage Theorem and the Pigeon Hole Principle. At the end of it all, we have come up with an improved version of the seating layout.

To begin with, we will take a deeper look into the problem and find out more about the factors. To support some of the statements in this report, we have included some data that we have collected from the McDonald's outlet.

ACKNOWLEDGEMENTS

The students involved in this report and project thank the school for this opportunity to conduct a research on the seating structure of McDonald's.

They would like to express their gratitude to the Accelerated Mathematics Programme teacher, Ms Kok Lai Fong and mentor, Zulfiqar Ali for their guidance in the course of preparing this project.

This report was done by:

Literature Review	Sharon Cho Crystal Tan Janel Lee
Research	
New layout	

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Overview

In all fast food restaurants, the companies always aim to get as many consumers as they can to purchase their food and hence, increasing their sales and revenue. However, in doing so, they have many factors to consider, for example advertising to get the people's attention to purchase their food and also the service that they provide. The service has to be of high standards and it makes the customer feel comfortable and relaxed.

However, many a times, it is seen that some or most companies put their focus on the skills of their counter staff, the service that they provide and also on the items in their menu. The one thing that we seem to see neglected is the seating structure

The Problem, Observation and Idea

We have observed at fast food outlets like McDonald's that customers will leave upon seeing that all the seats are being taken up. In this way, McDonald's outlets are losing their customers to their other competitors like Burger King, Kentucky Fried Chicken or even Subway, which are less crowded and are nearby.

We looked into the problem and discovered that actually, one contributor to this problem of having a lack of seats could be their seating structure. Hence, we decided to do our project on trying to find suitable seating arrangements to accommodate as many tables and chairs in a limited space and also to make it look neat and appealing to the consumers' view.

An example of this problem would be similar to the one below. A single customer enters the outlet and sits at a 4 seater table. Later on, a group of 4 enters the outlet but the singles customer has already taken up the whole table. Assuming that the customers do not like to wait for seats and that the entire outlet is occupied, the group of 4 would definitely leave the outlet. Hence, McDonald's will lose customers which is to their disadvantage.

Factors and Assumptions

To come up with various solutions, we have to first look into some of the contributing factors. Firstly, it would be concerning the tables and chairs. The dimensions and the types would affect the number of consumers the place can accommodate. The types of tables and chairs are referring to them being either fixed or movable.

Secondly, it is the size of the outlet itself. It is important to remember that the amount of space that fast food restaurants have is limited, and yet they have to cater to a large number of consumers patronising them. With this, we also have to consider the size of the kitchen, counter area and maybe a McCafe.

Thirdly, it is the timing, such as morning, afternoon or evening. This affects the outcome because the number of customers coming in a period of maybe five minutes in the afternoon may be very different compared to the number of customers coming in a period of five minutes during the evening. Also, the number of people coming in as a group and ordering at the same time might be affected.

Fourthly, it is regarding how long the customers plan to stay in their seats. Some of

them might be in a rush and have a quick meal. However, for others, they might like to stay on for a bit maybe to chat and relax or to use the laptop to access the Internet there.

Due to the fact that many of these factors are different in different outlets, hence, assumptions have to be made. These assumptions are meant to help us standardise certain important factors and hence, reducing our scope and complexity to come up with solutions. For example, an assumption could be that each person finishes their meal in 30 minutes and leaves immediately. This could help us to come up with a solution that is and based on the majority of the consumers.

Associations

To further understand this problem, we have also associated it to the game Diner Dash. Diner Dash is a computer online game that is based on serving customers in the shortest time possible in a restaurant environment. In each game level, we are given a limited number of seats and only two types of tables, 2 seaters and 4 seaters. The number of customers waiting in a line will be never ending. This scenario is quite similar to the ones seen in real life and hence, we feel that this game can be closely related to our project and might serve useful as a reference.

Applications of Mathematics

Some simple applications that we have applied to write this research report are statistics and ratio. Under statistics, we need to collate the results and compare it with one another. To do this, we calculated the mean, median and mode. We used ratio to compare the number of the different types of seats. We have also taken an example of

the Marriage Theorem to help us visualize the situation better.

CHAPTER 1: INTRODUCTION

1.1 Objectives

The aim of this project is to study the seating arrangement of the McDonald's outlet at Kovan and come up with an improved seating arrangement. We also want to draw some conclusions at the end of the project.

1.2 The Problem

This problem was actually brought up after we had done some observations for our previous project. While we were in McDonald's, we noticed that quite a number of customers left the outlet due to the lack of seats. Upon closer observation, we noticed that it was mostly because some customers took up the tables, which had seats they did not need.

One example would be to have a single customer eating at a table suited for four. A group of four soon enters and finds that all the other tables are unavailable. They are in a rush and they need to have a quick lunch. So, they would seek an alternative choice, which could be a nearby fast food restaurant. Hence, in this way, McDonald's would lose their customers to the other competitors in the neighbourhood.

We think that this is a good problem to solve because from what we see and know, McDonald's has mainly focused on the food and customer service. Hence, through this project, we would like to find out if there is a better solution to the seating arrangement or is the already the best.

1.3 Factors

The first factor is the tables and the chairs. As we see from some outlets, the tables and chairs are not fixed and can be moved freely. We think that this is one way that McDonald's does to let consumers have sufficient seats. However, this can backfire too - in the case where new consumers do not have seats as the chairs have already been moved to another table. From this, we have decided to make the tables and chairs fixed. In this way, we think that it would further reduce the chances of the consumers leaving to another fast food restaurant. The dimensions of the furniture will be kept the same as in a normal McDonald's outlet. We decided on this because we thought that it was best to follow McDonald's structure, but just improve on their seating plan.

The second factor is the size and shape of the outlet. We considered this as a factor because if it is a small outlet, the seating space would definitely be smaller and we cannot include as many tables as compared to a larger outlet. Besides the size, the more important thing is the shape of seating area. Different outlets would have different shapes. Some examples are like the U shape, Z shape or just the usual rectangle. Later on in the report, we will be discussing more on this as to if it has any significance.

The third factor is the time of the day. We had gone down to the outlet at Kovan and observed during 2 different times of the day – afternoon and evening. During these 2 periods of time, the size of the groups entering and eating at the outlet is relatively different. This would serve as a problem in cases such as the one stated below.

Let us say that in the afternoon, there are more groups of 4 entering the outlet and hence, there are more 4 seater tables in the outlet. However, as it approaches to become evening, there are more single customers entering. If there were an overwhelming number of a single consumer entering the outlet in the evening, there would soon be no space for others to sit.

The fourth factor is the length of time the consumers are planning to stay in their seats. This factor is extremely unpredictable. With the new services provided like wireless network, more consumers would like to bring their laptops with them and access the Internet for quite some time. This happens even if they have finished their meals, leaving others with no seats. On the other hand, McDonald's aims to provide fast service for their customers and so, quite a number of people enter the outlet with the idea of having a quick meal and leaving immediately after finishing it.

As you can see from the above 2 examples, they are both opposites which can happen during anytime of the day. Hence, it is important to put this factor into consideration.

1.4 Assumptions

As pointed out in the Literature Review, assumptions are important in this project as they will reduce the complexity of the problem and standardize things. For the above factors, we made some assumptions, which have helped us during the progression of this research project. These assumptions will be stated in the relevant chapters.

CHAPTER 2: OUTLET AT KOVAN

In this chapter, we will be reviewing the necessary information that we have got from the outlet at Kovan. These data are important in the planning of the seating arrangement for that particular outlet.

2.1 Present Seating Plan

We made a number of trips to the McDonald's outlet at Kovan as we needed to obtain the current seating plan that they were using. At first, we approached the manager there and requested for it, however, this failed when he told us that we needed to ask it from the Headquarters. To make it simple, we drew the outlet out by means of observing.

The main things we were looking out for were the positions of the different table sizes, the dustbins, facilities, walls and so on. Besides the positioning, we were also looking out for the dimensions of those things. Below is the seating plan, which also includes the dimensions of the furniture…etc.

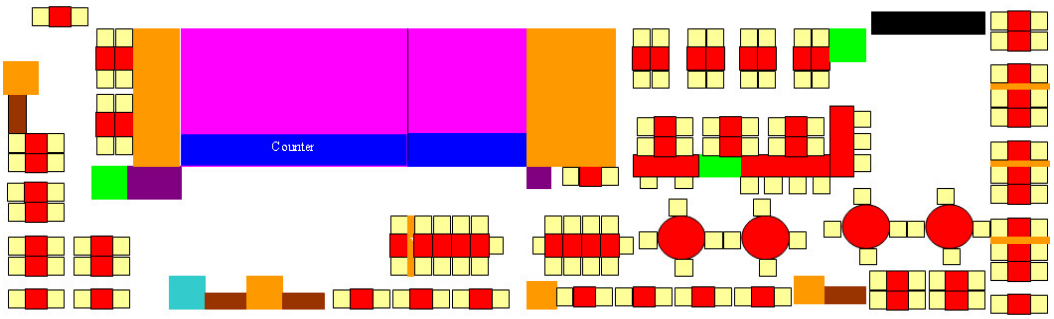

Figure 2.1 Present seating plan of McDonald's outlet at Kovan

In the above diagram, the colours represent different things. The table below shows what the colours represent. It is important to keep in mind that the diagram is not drawn to scale.

Colour on diagram	Item it represents
Orange	Walls
Brown	Door
Pink	Kitchen
Blue	McCafe Counter & McDonald's Counter
Black	Rest rooms
Green	Dustbin
Purple	Sauces and Tissue
Light Blue	Machine

Figure 2.2 Table to show what the different colours represent

Furniture	Width (cm)	Length (cm)
1 seat	48	48
2 seater table	50	60
4 seater table	100	60
2 seater table (inclusive of seats)	50	156
4 seater table (inclusive of seats)	100	156
Long table	64	Depends on layout
Long table (inclusive of seats)	102	Depends on layout
Circular tables	Diameter is 69.5	
Dustbin	64	64
Sauce area	80	128
Machine	80	80
Door	-	112
Main counter	-	640
McCafe counter	-	272

Figure 2.3 Table showing the dimensions of the furniture

2.2 Groups of people

Besides the layout, we researched on the sizes of the groups entering the outlet from 2 pm to 3 pm for the first shift and from 6 p.m. to 7 p.m. on the next. We carried out these observations twice for each of the timings. Below is the data that has been collated.

For each set of data, we have calculated the mode and the median. For each of the different timings, we have 2 different readings, and thus, we have calculated the average using the data collected. At the end of it all, there is a comparison between the averages of the 2 different timings.

In between the reviewing, we have included graphs to make comparison of the sets easier.

2.2.1 Data from 2 pm to 3 pm

Day 1

No. of groups of…	1	2	3	4	5	6	7	8
	5	17	5	3	3	-	1	1

Total number of groups = 35

Figure 2.4 Table of data collected on Day 1 from 2-3pm

Day 2

No. of groups of….	1	2	3	4	5	6	7	8
	20	9	7	3	1	1	-	1

Total number of groups = 42

Figure 2.5 Table of data collected on Day 2 from 2-3 pm

For Day 1:

Using the above data collected, we can calculate the mode of customers.

Mode = Groups of 2

The middle point is the 18^{th} term; hence, we can find the median.

Median = 2

For Day 2:

Using the above data collected, we can calculate the mode of customers.

Mode = Groups of 1

The middle point is the 21^{st} term; hence, we can find the median.

Median = 1

2.2.1.1 Average of Data from 2 pm to 3 pm

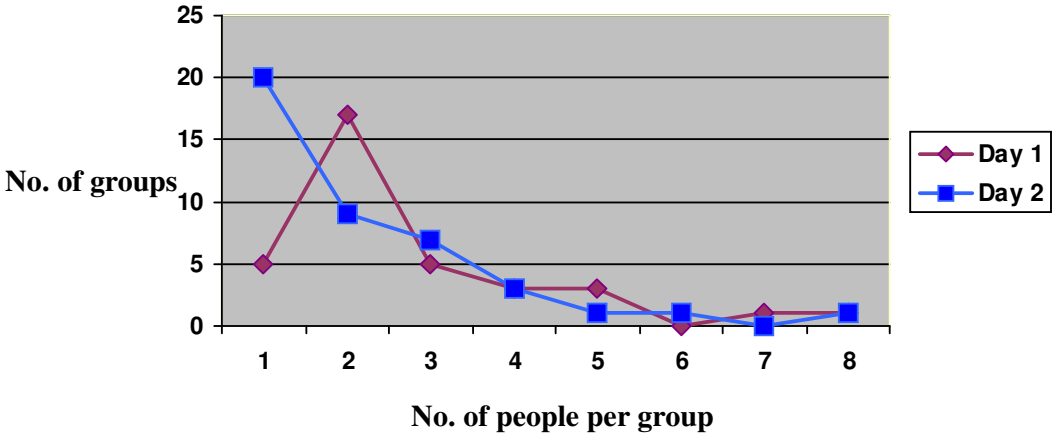

Figure 2.6 Line graph of number of customers from 2-3 pm on Days 1 and 2

Using the data, calculate the average for both Day 1 and Day 2 for a rough estimation of the number of customers coming into McDonalds in a specific number of people per group.

Here are the results:

Groups of 1 = (5 + 20) / 2 = **12.5**

Groups of 2 = (17 + 9) / 2 = **13**

Groups of 3 = (5 + 7) / 2 = **6**

Groups of 4 = (3 + 3) / 2 = **3**

Groups of 5 = (3 + 1) / 2 = **2**

Groups of 6 = (0 + 1) / 2 = **0.5**

Groups of 7 = (1 + 0) / 2 = **0.5**

Groups of 8 = (1 + 1) / 2 = **1**

Average of Day 1 and Day 2

No. of groups of….	1	2	3	4	5	6	7	8
	13	13	6	3	2	1	1	1

Total number of groups = 40

Figure 2.7 Table of data for the mean of Days 1 and 2 from 2-3 pm

Using the above data collected, we can calculate the mode of customers.

Mode(s) = Groups of 1 and 2

The middle point is the 20th and 21st term; hence, we can find the median.

Median = (2+2)/2

= 2

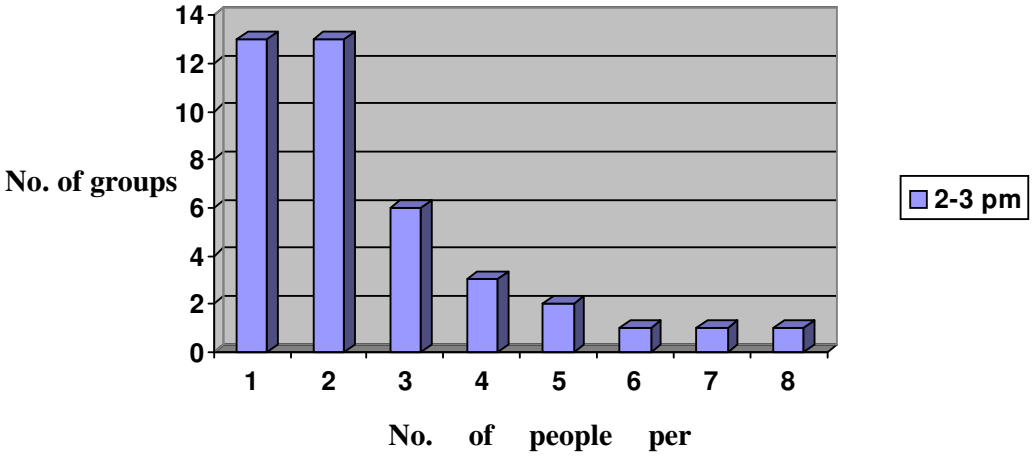

Figure 2.8 Bar graph for the mean of Days 1 and 2 from 2-3 pm

2.2.2 Data from 6 pm to 7 pm

Day 1

No. of groups of…	1	2	3	4	5	6	7	8
	17	21	7	1	-	-	-	-

Total number of groups = 46

Figure 2.9 Table of data collected on Day 1 from 6-7 pm

For Day 1:

Using the above data collected, we can calculate the mode of customers.

Mode = Groups of 2

The middle point is the 23rd and 24th term; hence, we can find the median.

Median = (2+2)

= 2

Day 2

No. of groups of…	1	2	3	4	5	6	7	8
	29	17	8	1	-	-	-	-

Total number of groups = 55

Figure 2.10 Table of data collected on Day 2 from 6-7 pm

For Day 2:

Using the above data collected, we can calculate the mode of customers.

Mode = Groups of 1

The middle point is the 28th term; hence, we can find the median.

Median = 1

2.2.2.1 Average of Data from 6 pm to 7 pm

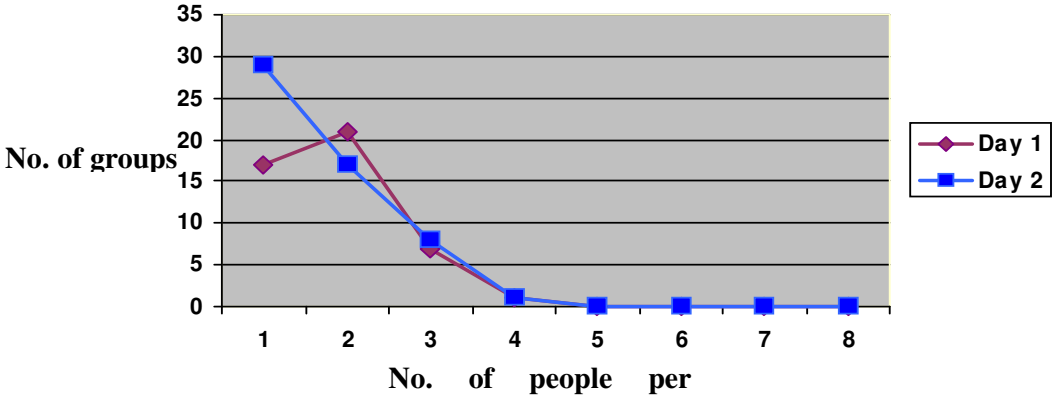

Figure 2.11 Line graph of number of customers from 6-7 pm on Days 1 and 2

Using the data, calculate the average for both Day 1 and Day 2 for a rough estimation of the number of customers coming into McDonalds in a specific number of people per group.

Here are the results:

Groups of 1 = (17 + 29) / 2 = **23**

Groups of 2 = (21 + 17) / 2 = **19**

Groups of 3 = (7 + 8) / 2 = **7.5**

Groups of 4 = (1 + 1) / 2 = **1**

Groups of 5 = **0**

Groups of 6 = **0**

Groups of 7 = **0**

Groups of 8 = **0**

Average of Day 1 and Day 2

No. of groups of….	1	2	3	4	5	6	7	8
	23	19	8	1	-	-	-	-

Total number of groups = 51

Figure 2.12 Table of data for the mean of Days 1 and 2 from 6-7 pm

Using the above data collected, we can calculate the mode of customers.

Mode(s) = Groups of 1

The middle point is the 20th and 21st term; hence, we can find the median.

Median = 2

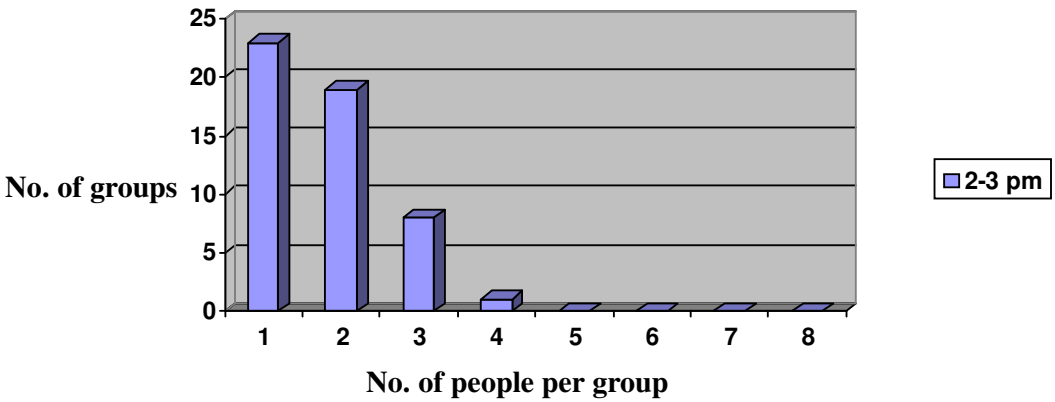

Figure 2.13 Bar graph for the mean of Days 1 and 2 from 6-7 pm

2.2.3 Data of 2-3 pm versus 6-7 pm

Using the calculated average results of timings 2-3 pm and 6-7 pm, we will start comparing the two different timings.

2-3pm

No. of groups of….	1	2	3	4	5	6	7	8
	13	13	6	3	2	1	1	1

Total number of groups = 40

Figure 2.14 Table of data for the mean of Days 1 and 2 from 2-3 pm

From the results in the earlier part of the report:

Mode(s) = Groups of 1 and 2

Median = 2

6-7pm

No. of groups of….	1	2	3	4	5	6	7	8
	23	19	8	1	-	-	-	-

Total number of groups = 51

Figure 2.15 Table of data for the mean of Days 1 and 2 from 6-7 pm

From the results in the earlier part of the report:

Mode(s) = Groups of 1

Median = 2

The above results are then collated into a line graph for easier further observations.

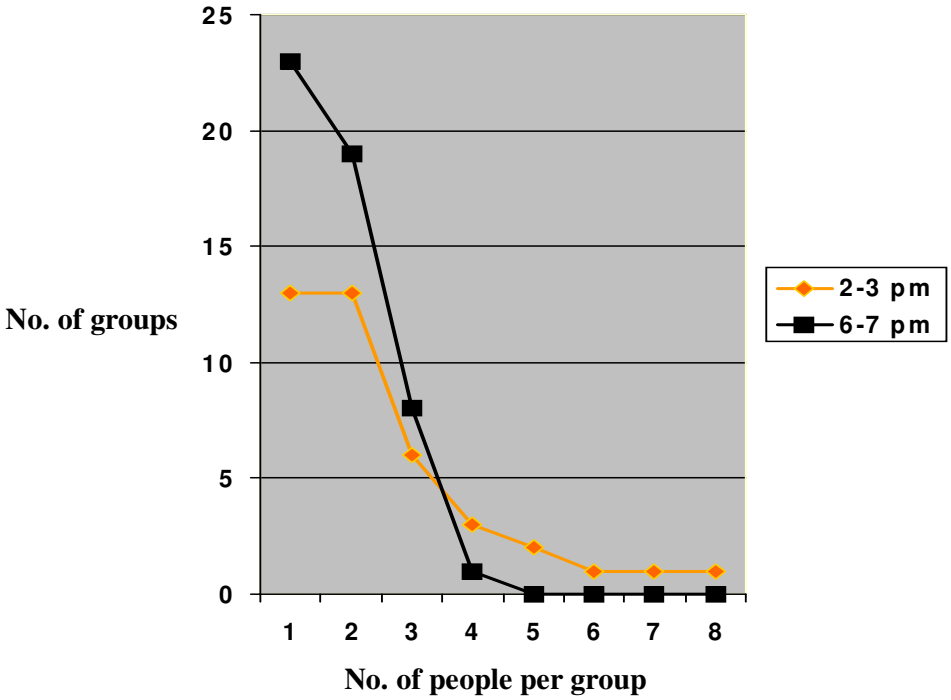

Figure 2.16 Line graph for the mean from 2-3 pm and from 6-7 pm

Using the data, we can calculate the average for 2-3 pm and 6-7 pm for a rough estimation of the number of customers coming into McDonalds in a specific number of people per group.

Here are the results:

Groups of 1 = (13 + 23) / 2 = 18

Groups of 2 = (13 + 19) / 2 = 16

Groups of 3 = (6 + 8) / 2 = 7

Groups of 4 = (3 + 1) / 2 = 4

Groups of 5 = (2 + 0) / 2 = 1

Groups of 6 = (1 + 0) / 2 = 0.5

Groups of 7 = (1 + 0) / 2 = 0.5

Groups of 8 = (1 + 0) / 2 = 0.5

Total average for both timings

No. of groups of….	1	2	3	4	5	6	7	8
	18	16	7	4	1	1	1	1

Figure 2.17 Table of data for the mean of data from 2-3pm and 6-7 pm altogether

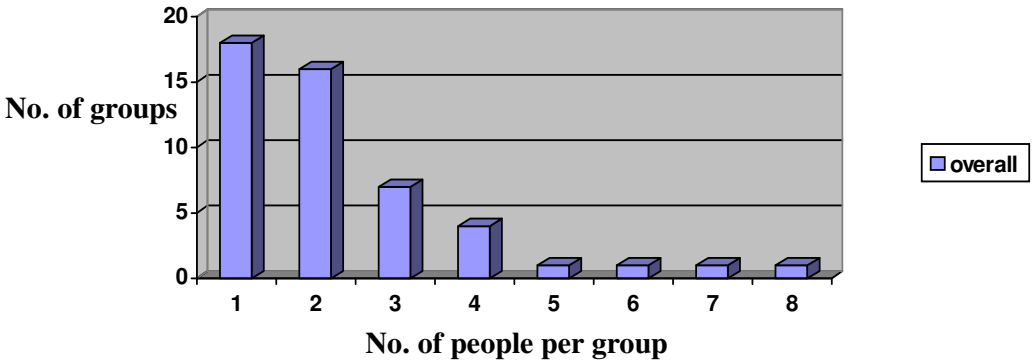

Figure 2.18 Bar graph for the mean of both timings

2.2.4 Overall analysis

For the overall results, we observed that

1. Most of the customers are either come alone or they come with one more person (1 or 2 customers per group).
2. From 2-3 pm, there are bigger groups coming in (groups of 4, 5, 6, 7, and 8).
3. From 6-7pm there are more small groups coming in (groups of 1, 2, and 3).
4. The largest group of people coming in is 8.
5. Even from 2-3 pm where there are supposed to be more bigger groups, they are extremely few. (Only 1)
6. The data collected on the 2 days for the different period of time are relatively accurate. Most of the data match.

However, we must take into consideration that this might not be very accurate as we only have 4 different sets of data taken to analyse.

CHAPTER 3: ANALYSING

In this chapter, we will be looking at some examples and theorems that we can try to apply to our problem, or at the least, give us an illustration of the problem.

3.1 Pigeonhole Theorem

To think of how to apply this theorem, we have to assume first that the outlet can have *n* groups of people in the outlet. Let us assume that the outlet is full and hence *n* number of groups in the outlet. The term 'full' here means that each table, and not each seat, is taken up. If one more group enters, there might not be enough space. We take it that each table is a pigeonhole and the customers, the pigeons.

The pigeonhole theorem states that if there are *(n + 1)* or more pigeons in n holes, some holes will inevitably have 2 or more pigeons. This is actually the sharing of holes. However, in our situation, if we were to apply the theorem into this scenario, it would mean that customers have to share the tables. The reasons are as shown in the table below.

Additional group is a group of:	**Option 1**	**Option 2**
1	Share seats	Leave
2 and more	Split up / share	Leave

Figure 3.1 Choices for the different groups

In the above table, it shows the 2 different numbers of people that the additional group could be made up of and the scenarios that could happen. For both scenarios, option 1 has definitely a higher chance of happening rather than Option 2 as they might have

chosen McDonald's because they want a quick meal. Through our experience, we see a minority of groups sharing tables. In addition to that, the staff will ask those who are studying to leave as customers who want to eat have no seats. This usually happens during peak times.

The Pigeonhole theorem could not be applied as we do not know exactly how large the extra group entering the outlet is. If the group is too large, the pigeonhole principle cannot be applied.

3.2 Marriage Theorem

The Marriage Theorem is basically about matching couples together, that is each woman can be matched with a compatible man and vice versa. The word compatible here refers to both the men and the women are willing to be matched.

To make this scenario seem more realistic, we can view the men and the women in a dance room. The women are in one corner of the room and the men in the other. If we were to view this as an illustration, it would look something like the one below.

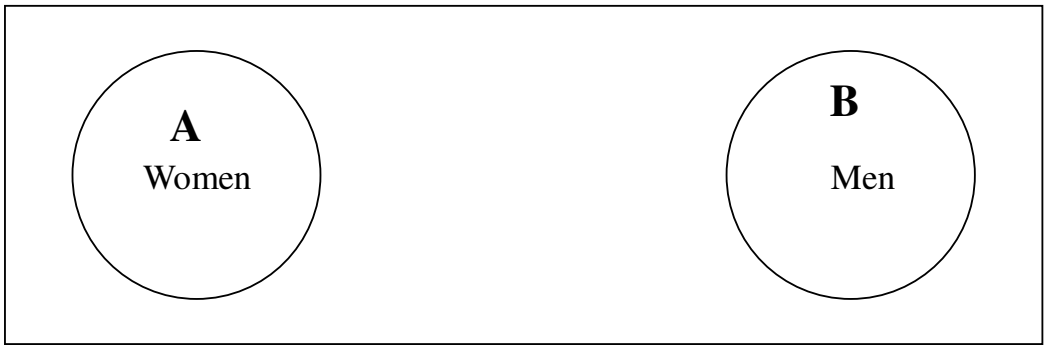

Figure 3.2 Illustration of Marriage Theorem applied to dance room

In the above diagram, set A, has k women ($x_1, x_2,\ldots x_k$) and there are n men in set B ($y_1,$

$y_2, y_3, \ldots y_n$). The Marriage Condition states that the number of men must be equal to or more than the number of women present. Hence, in the case of $k = 1$, thus $x_k = x_1$. In the situation, it would be one woman in set A and n men in set B now. In this situation, the woman would have a chance to find a compatible partner for the dance.

However, if there are fewer men than women in the dance room, then there will be left over women who will not be able to join in the dance. We will then see this as the Marriage Condition has failed.

3.2.1 Applying

Considering the above scenario, if we were to apply the situation to the problem, we can substitute the women as the customers and the men as the seats. 2 scenarios could turn out as the following:

(a)Seats (tables) > customers

(b)Seats (tables) < customers

In scenario (a), if there are more seats (tables) than customers, it is reasonable to suggest that there will be sufficient seats for the customers. On the other hand, in scenario (b), there are fewer seats (tables) than customers. In this case, logically, customers will not have enough seats and hence, McDonald's will lose customers.

However, the Marriage Theorem can only be used to visualise, and we are unable to apply fully. This is due to the fact that the theorem focuses on perfect matching, which is highly impossible in our situation. We do not know where the customers will

exactly sit as different people have different choices. Hence, here is the assumption that we have made. The following table shows the different types of tables, ranked from the most probable to the least, that different groups of customers will choose to sit at.

Customers per group	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5
1	2 seater tables	Others	4 seater tables	9 or 10 seater tables	Leave
2	2 seater tables	4 seater tables	Others	9 or 10 seater tables	Split / leave
3	4 seater tables	Others	9 or 10 seater tables	Split	Leave
4	4 seater tables	Others	9 or 10 seater tables	Split	Leave
5 / 6	9 or 10 seater tables	Others	Split	Leave	-
7 / 8	9 or 10 seater tables	Others	Split	Leave	-
9 / 10	9 or 10 seater tables	Others	Split	Leave	-

Figure 3.3 Table of quantities of different types of tables

From here, we can make some observations. We can see that customers would very much stay in their groups rather than splitting. Hence, we always see the 'others' type of seat for either choice 1 or 2. The 'others' type of table refers to the long tables.

We also observed that as the size of the group increases, the fewer the choices they have. The customers would also rather split than leave. This assumption was made because fast food was made for people who needed a quick meal. Hence, they would still rather eat at the outlet than leave for another, as that would waste some time.

3.3 Diner Dash

Diner Dash was first released in 3 December 2003. It was developed the a the New Yourk game development studio GameLab and published by PlayFirst. It has since produced Diner Dash 1, 2 and 3. Diner Dash is in face an action strategy game in which the player takes the role of a stockbroker who quits her job to run her own diner. The character's name is known as Flo.

The game involves seating customers and guiding Flo around the restaurant to serve customers. The objective is to earn enough money to proceed to the next level with newer upgrades. It also centres on catering to customers within a time limit in order to gather as much money as possible. In the game, certain quantities of different number of seaters are provided, with the aim of serving customers as fast as possible in mind. To add to the challenge, new customers are constantly entering the restaurant. The player has to provide quick service so as to prevent customers from leaving.

On our own part, there might be some conditions and scenarios where seats are wasted due to lack of proper planning and space. For example, there is a 2 seater and a 4 seater. The 4 seater is empty while the 2 seater is taken up. A group of 2 then enters the diner and is forced to be seated at the 4seater table, thus wasting space for future groups of 4 coming in. So, the question is, what if a group of 4 comes in next?

Hence, with this example, it links us to our situation in McDonald's. From here, we can see one example of how the tables and seats are wasted.

Figure 3.4 Screen shot of Diner Dash

CHAPTER 4: PREPERATION FOR NEW LAYOUT

In order to come up with a suitable improved seating plan, we have to first study the present seating layout and come up with some information to start on. Some things that we need to consider are the ratio of the tables and the groups of people, the shape of the tables and so on. More detailed explanations and diagrams will be included in the next chapter. This chapter aims to give readers a better understanding of what is going to come in the next chapter.

4.1 Comparing number of tables with the customers

Using the ratio of the different tables in the existing layout of McDonalds', we will compare it with the statistics in Chapter 2. This is to see whether McDonalds' is having a lack of tables.

	2 seater	**3 seater**	**4 seater**	**9 seater**	**10 seater**
Tables	16	-	22	1	1
Others	1	1	1	-	-

(Others refers to the long tables)

Figure 4.1 Table of quantities of different types of tables

No. of groups of….	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	18	16	7	4	1	1	1	1

Figure 4.2 Table of number of different groups entering on average

Customers per group	Choice 1	Choice 2	Choice 3	Choice 4	Choice 5
1	2 seater tables	Long tables	4 seater tables	9 or 10 seater tables	Leave
2	2 seater tables	4 seater tables	Long tables	9 or 10 seater tables	Split / leave
3	4 seater tables	Long tables	9 or 10 seater tables	Split	Leave
4	4 seater tables	Long tables	9 or 10 seater tables	Split	Leave
5 / 6	9 or 10 seater tables	Long tables	Split	Leave	-
7 / 8	9 or 10 seater tables	Long tables	Split	Leave	-
9 / 10	9 or 10 seater tables	Long tables	Split	Leave	-

Figure 4.3 Table of options for the different size groups

Comparing Figures 4.1 and 4.2, we can conclude that the McDonald's outlet needs more 2 seater, 4 seater and 6 seater tables. More 4 seater tables are needed because from our assumption above in Figure 4.3, we assume that all groups of 3 will choose to go to a 4 seater table as their first choice. Besides this, if the bigger groups (5 and above) decide to split because of the lack of tables, many of them would rather sit at 4 seater tables rather than the 2 seater tables as they would want to sit with as many of their friends.

4.1.1 Planning of number of tables

Previously, we had actually wanted to use the average data to come up with the improved seating layout. However, after further consideration, we decided to use the maximum number of customers instead. We thought that if we were to use the maximum number of customers, we would then be more prepared. Although the number of customers entering the outlet might not be the same number, we still treat

the data as a goal for us to reach. It is extremely difficult to be able to make it suitable for the maximum, as the space is limited. Thus, we have tried our best to put in as many tables as possible to suit the customers' needs.

4.2 Shape and size of furniture

We have decided to keep the size and shapes of the furniture like the counter, machine and door as our focus is only on the seating arrangement. In the McDonald's outlet, there are four circular tables, which are suited for four people. However, there is not enough space to put a total of four trays there comfortably. And so, we decided to remove these circular tables and stick to the usual rectangular ones instead.

The size of the tables would be roughly the same. We measured the outlet by measuring a tile on the floor and counting the number of squares around the sides. This may not be exact, however, it is still quite close to the real thing.

4.3 Wireless Internet connection

McDonald's has enabled every outlet with wireless Internet connection. By observation, we have seen many customers bringing their laptops along with them into the outlet with the idea of having a meal and surfing the Internet at the same time. They would want to sit at tables with an electric socket by the wall so that they are able to charge their batteries. Most of the time, these customers come as 1 to 2 people in a group and they would stay there for quite some time.

This adds to the problem of wasting space as it prevents bigger groups to sit at these tables. Hence, we have decided to create separate tables for these laptop users. In this

way, it would reduce the chances of McDonald's losing customers.

4.4 Wall idea

McDonald's has taken up an idea that saves space. In between the tables, instead of a walking space, there is a thin wall that separates the tables. We feel that this is and interesting idea. However, we see that the outlet does not really know how to apply this idea. Thus, we have decided to include it more into our new seating layout.

4.5 Sofa chairs

Sofa chairs are, in our opinion, more useful than single chairs, reason being that there is no limit to where the customer can sit. One example is, if there are 4 single seats, only 4 people can sit. However, if a sofa of the same area as the 4 single seats were to replace the seats, more people will be able to sit as they can squeeze if they want to. Besides, the sofa chairs provide more comfort for customers rather than the normal single seats.

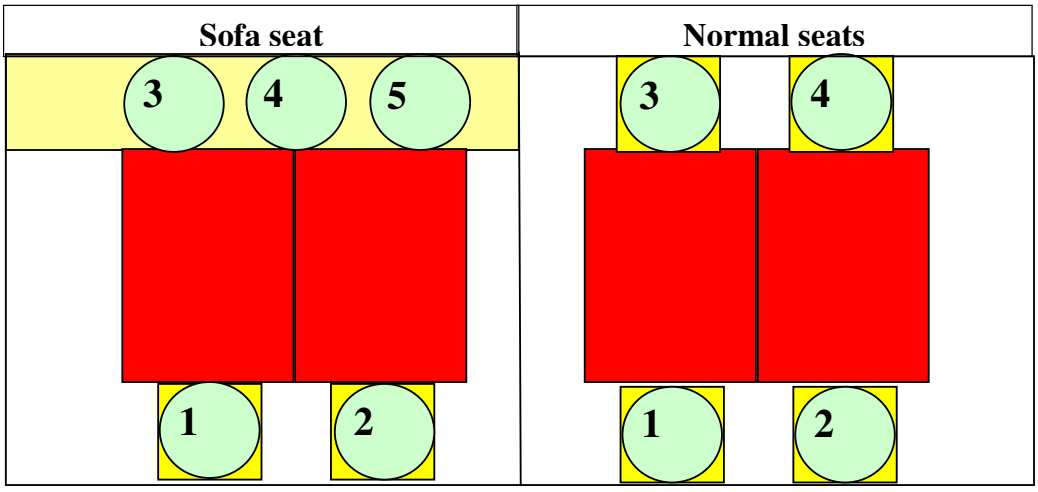

Figure 4.4 Sofa seats versus normal seats

CHAPTER 5: DETAILS OF NEW LAYOUT

For the new layout, we had to look into some matters as stated in Chapter 4. In this chapter, we will be taking a deeper look into these problems individually.

5.1 Maximum number of customers

Figures 5.1 to Figure 5.4 is actually data taken from chapter 2, that are information of customers entering on days 1 and 2 from 2-3 pm and 6-7 pm. Figure 5.5 shows the maximum number of customers in each group of customers.

No. of groups of…	1	2	3	4	5	6	7	8
	5	17	5	3	3	-	1	1

Figure 5.1 Table of data collected on Day 1 from 2-3pm

No. of groups of….	1	2	3	4	5	6	7	8
	20	9	7	3	1	1	-	1

Figure 5.2 Table of data collected on Day 2 from 2-3 pm

No. of groups of…	1	2	3	4	5	6	7	8
	17	21	7	1	-	-	-	-

Figure 5.3 Table of data collected on Day 1 from 6-7 pm

No. of groups of…	1	2	3	4	5	6	7	8
	29	17	8	1	-	-	-	-

Figure 5.4 Table of data collected on Day 2 from 6-7 pm

	Groups of 1	Groups of 2	Groups of 3	Groups of 4	Groups of 5	Groups of 6	Groups of 7	Groups of 8
No. of groups	29	21	8	3	3	1	1	1

Figure 5.5 Maximum number of different groups of customers

5.2 Shape of tables

As stated before, we have decided to replace the circular tables with the rectangular ones. This is because we find that the circular tables take up too much space. Below illustrates how much excessive space the circular table takes up.

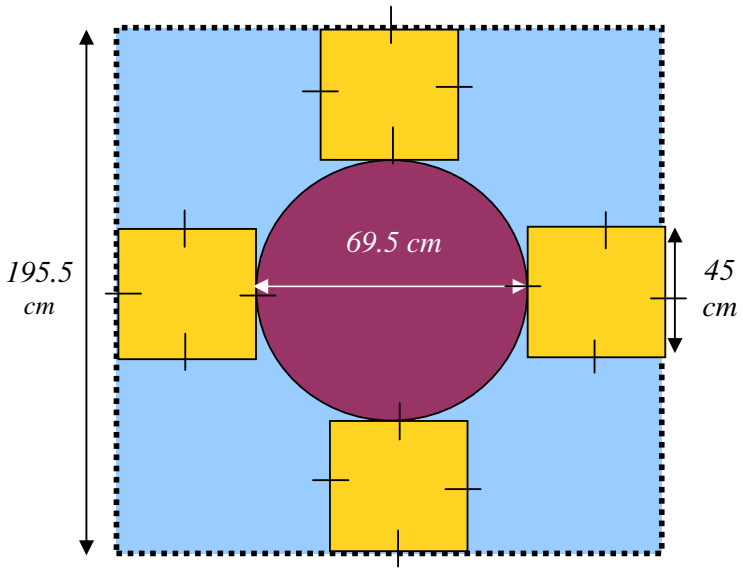

Figure 5.6 Imaginary rectangular box around circular table

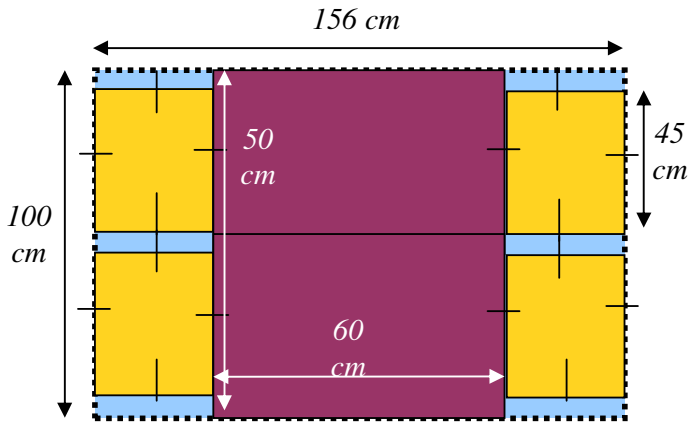

Figure 5.7 Imaginary rectangular box around rectangular table

Replacing the 4 seater circular table with a rectangular 4 seater table, we can now compare the difference in size of the imaginary rectangle box. First of, we calculate the area covered by the imaginary rectangular box for the circular table.

Area of imaginary box around circular table = (195.5) (195.5)

= 38 220.25 cm^2

Now, we calculate the area covered by the imaginary rectangular box for the rectangular table.

Area of imaginary box around rectangular table = (156) (100)

= 15 600 cm^2

From here, we can see a visible difference in the 2 areas. The difference is as follows:

Area around circular table – Area around rectangular table = 38 220.25 - 15 600

= 22

620.25 cm^2

Furthermore, the tray is rectangular in shape and we are able to fit more trays on the rectangular table, at least, there is more comfort rather than the circular table. Hence, after coming up with the above results, it is absolutely right to replace the circular tables with the rectangular ones.

5.3 Wireless Internet Connection and electrical sockets

As we have observed, many customers using their laptops in McDonald's would very much prefer to sit at a table next to a wall with an electrical socket. In addition, these people usually come in groups of 1 or 2. Because of this, we have decided to create a corner where the long tables are all against the wall. We think that this is a good idea as the customers are able to use their laptops in peace and also it will reduce the chances of customers from sitting at 4 seater tables at the sides. The corner will look something like Figure 5.8 below.

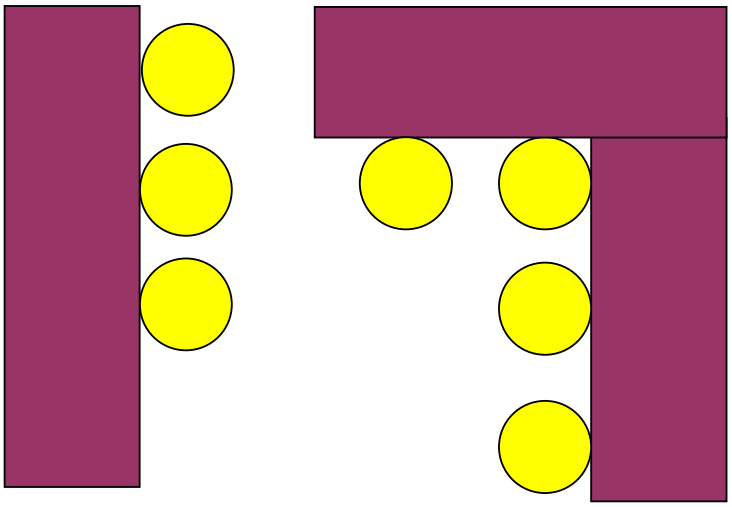

Figure 5.8 Corner of outlet with long tables and electric sockets

The reason for this implementation was that we thought that the long tables has an advantage. Firstly, it does not take up too much space and we are able to easily create

a big enough walking space for customers. Secondly, it appeals to both small and big groups. As compared to a 9 or 10 seater table, these long tables allow customers to sit at any chair they want. It would not be considered as sharing tables with other people that they do not know as it is treated as a common space.

5.4 Wall idea

By inserting a thin wall in between seats, we are able to separate the tables and to save space. Besides this, bigger groups who want to split up can sit near each other. For example, if a group of 6 enters an outlet that is full. However, there is still a 4 and 2 seater table separated by a thin wall, their first reaction would be to sit there as all of them can be near each other.

Below are some calculations to find out how much space we actually safe by using the wall idea instead of the usual 'walking space' method.

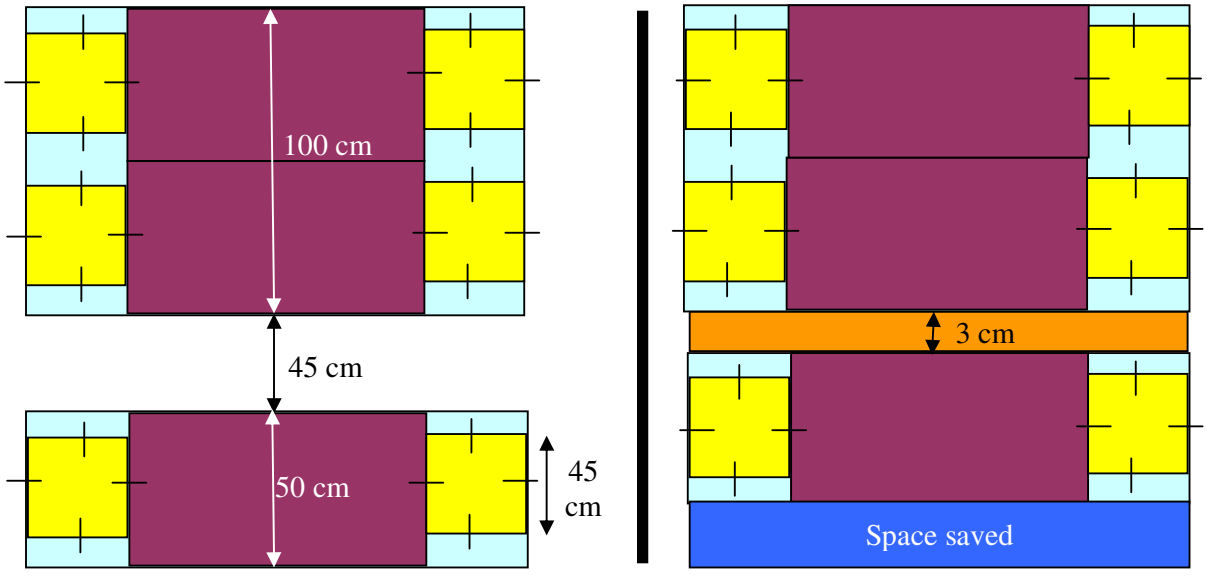

Figure 5.9 Tables with usual walking space versus wall idea

Area of space saved = [(156) (195)] – [(156) (153)]

= 30 420 – 23 868

= 6 552 cm^2

Previously, we have calculated that the amount of space a 2 seater table takes up is:

Area of imaginary rectangle around 2 seater = (50) (156)

= 7 800 cm^2

If we were to place five of such 2 seater tables consecutively using the wall idea, we would then be able to save an area of:

Area of space saved = (6 552) (4)

= 26 208 cm^2

Number of 2 seater tables can fit in = 26208 / 6 552

= 4 tables

In fact, from the above calculation, we can see that the extra space of 26 208 cm^2 can fit four of the same 2 seater tables. Thus, we can conclude that the wall idea is a useful way of saving space.

5.4.1 Wall idea used presently

At the McDonald's outlet at Kovan, the wall idea is applied. The diagram below depicts how part of the application looks like.

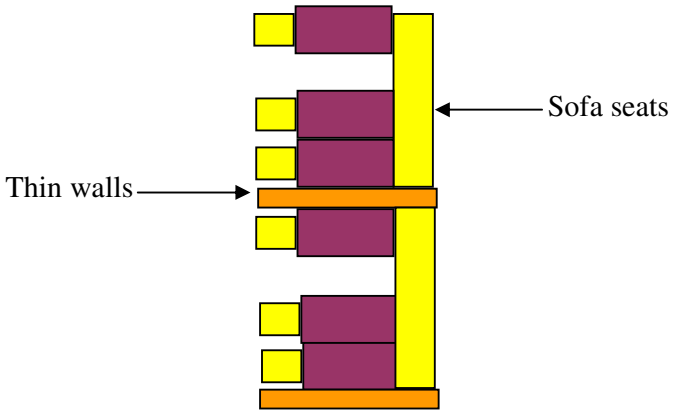

Figure 5.10 Usage of thin walls at Kovan outlet

From the above way the tables are grouped, we think that McDonald's chose this way most probably because they wanted customers to be able to sit as a group of 2, 3, 4, 5, 6 or 7. This is indeed an effective way of applying the thin wall.

5.5 Tables at the sides

We observed that the tables placed horizontally at the sides were mostly 2 seater tables. Was it possible to place more 4 seater tables at the sides? That was the question that could affect the new layout. Upon further consideration, we found out that if we were to do that, it would be difficult for the customers sitting right next to the window to get out from their seats. Hence, we continued to put majority of the 2 seater tables by the windows instead of the 4 seater tables.

CHAPTER 6: FINAL LAYOUT

We have come up with our new layout. In this chapter, we will be looking into how we came up with the layout by piecing together information from whatever we have collected so far.

6.1 Planning

To visualize the whole layout, we decided to draw it out on a scale of 1 cm: 16 cm. Our main aim is to actually just increase the number of tables and seats in the outlet, not forgetting to make the customers feel comfortable. One important thing to note while drawing was the walking space.

To understand it better, let us take the whole outlet as a drainage system. The doors are where the water flows through the whole system. There has to be a main route for the water to flow through the whole system. In our case, there must be a main route that leads from all the doors to the counter space. This 'main route' has to be the widest lane as most customers will walk through there. If the lane is too narrow, the customers will not be able to move around comfortably.

The second thing was the waiting space for the counter. This area is the most important of all. We decided to keep the same waiting space as the present one. We thought that the outlet had its reasons for doing so as they probably knew the number of customers entering the outlet better than us. Besides that, we also figured that the waiting space was reasonable enough.

6.2 Piecing together

We then continued to piece together the relevant information. For example, the corner with the long tables, the thin wall idea, the sofa seats and so on. At one point of time, we thought about introducing 6 seater tables into the layout. However, we thought that would only waste space. We still went on with the thin wall idea as we felt that that was a more worth idea.

Below is the new layout that we have come up with. The diagram is not drawn to scale.

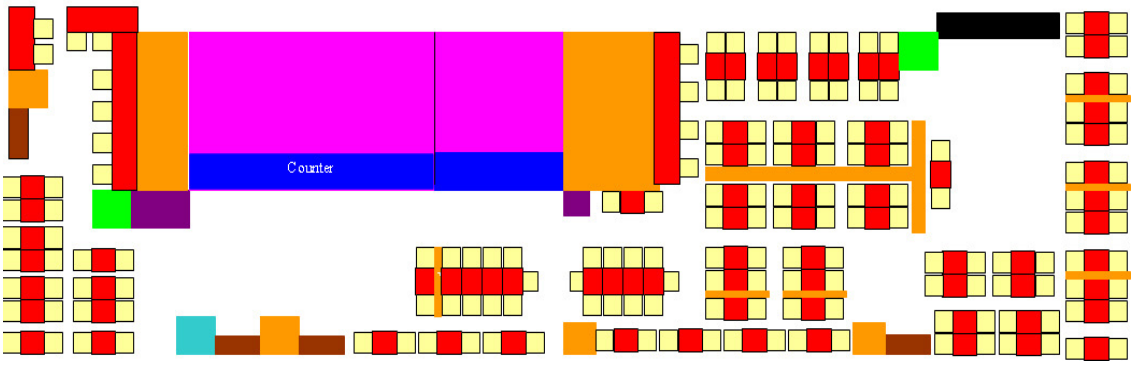

Figure 6.1 New seating layout

6.3 Results of new layout

	Present seating layout	New seating layout
2 seater tables	16	17
4 seater tables	22	24
9 seater tables	1	1
10 seater tables	1	1
Long tables	9	12

Figure 6.2 Results of new seating layout

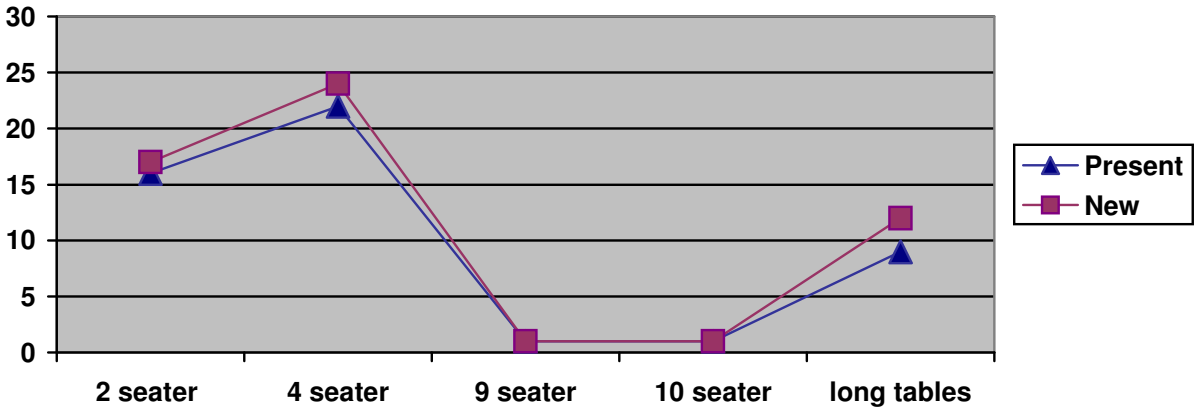

Figure 6.3 Graph of number of different tables in each layout

CHAPTER 7: CONCLUSION

7.1 Successful

Overall, we feel that our report is a success as we are able to reach our objective that is to come up with an improved seating layout. In this project, we made use of simple mathematics to make an improved layout. This is because if we apply theorems that are too complex, people may not comprehend it. What we have used is logical thinking, innovation and a bit of the architecture side. If given another opportunity, we would do it again and try to find a simple algorithm that we could apply and would be easily understood.

7.2 Conclusion

McDonald's has really considered the various factors and tried to suit their customers' needs. Our project on this seating arrangement is only based on one outlet and hence, cannot be applied to the others the same way. However, it is on the other hand possible, as there are a few ideas that we can apply. Taking the thin wall idea as an example. However, if given more time, we think that it is possible to find a similar pattern in all or at least most of the outlets in a certain district and find a solution from there.

7.3 Difficulties faced

Through this project, we faced difficulties like getting the measurements of the tables, chairs, counters and so on as the manager refused to let us see the layout of the outlet. Because of this, we had to think of ways to get the measurements using the quickest

way possible. We then went down to the outlet to measure and count the tiles on the floor.

We also had difficulties applying the two theorems, Pigeonhole principle and the Marriage Theorem as it was complex and had little time. We also found out that it is non-applicable in our context due to some constraints stated earlier..

7.4 Improvements to the project

If given a chance to improve on our project, we feel that we could improve on the report by enlarging our topic scope so that we are able to cover more common problems faced by fast food restaurants. In this way, we could even find out if the problems are linked and can solve it or at the least, find a solution to improve the situation.

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