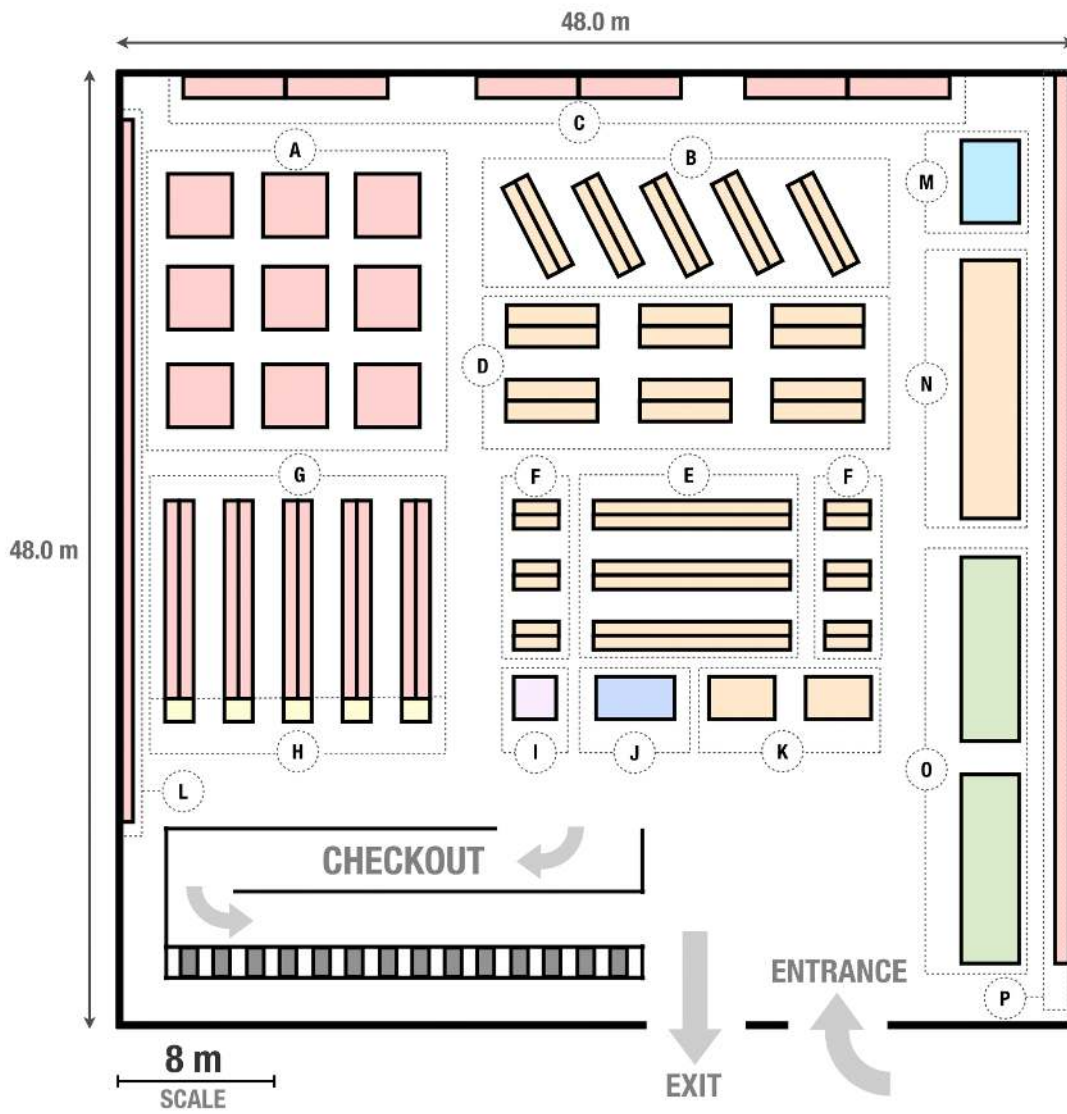Summary

Flash sale event is a promotion offered by a plenty of company for a very short period of time, which was organized for several reasons. A lot of companies use this event as the marketing strategy. Since the customers tend to purchase a lower-price item quickly, flash sale can be effective method for unloading out of season stock. Also, this event use to promote the store. Due to the customer are quickly purchase this flash sale event, the product in the flash sale can be damaged during the flash sale event.

In flash sale event, many accidents can happen due to carless of customer or even store layout. These accidents cause the product damaged that both effect to the seller and customer. The accident can happen in various way—drop from hand, drop from shelf, scratch, hit, and split. The higher rate that the accident will occur depend on the product popularity, so the mathematics model was built to determine the popularity of product. From the model, the most popular product is DSLR Camera, Body Only, Black. Not only product popularity that cause the product damage, but also the probability of damage which are surface area, high per base area, and weight. These factors have been weighted and the model was created to determine the level of damage. Then the product was arranged in store follow the diagram. Lastly, the new layout of store was designed in the form of Archimedes spiral.

The program is a method to find the layout of the product from 2 cases, the first case is not from the diagram, as the problem is given with the second case, which can be designed from the layout in any form. The organizing team used the program to try every possible thing, and the result was shown as a map. After that, the problems caused by creating the first map were concentrated. The conclusion is that by creating a spiral which has the ability to flow better customer also can be of value as EDGE high. Popular bricks with a high y exterior to reduce frustration and chaos too

48.0 m · 48.0 m · 8 m SCALE · CHECKOUT · ENTRANCE · EXIT

Type	Dimension (m) Width	Length	QTY	TotalArea cm²	m²	Category
A	3.5	3.5	9 ea	1102500	110.25	TV&Home Theater
B	0.8	5.3	10 ea	424000	42.4	Appliances
C	1.2	5.0	6 ea	360000	36	TV&Home Theater
D	1.2	5.5	12 ea	792000	79.2	Appliances
E	0.8	10.5	6 ea	504000	50.4	Appliances
F (LEFT)	0.8	2.5	6 ea	120000	12	Appliances
F (RIGHT)	0.8	2.5	6 ea	120000	12	Appliances
G	0.8	9.5	10 ea	760000	76	TV&Home Theater
H	1.2	1.6	5 ea	96000	9.6	Cameras
I	2.3	2.3	1 ea	52900	5.29	Audio
J	2.3	4.2	1 ea	96600	9.66	Video Gaming
K	2.3	3.5	2 ea	161000	16.1	Appliances
L	0.9	36.4	1 ea	327600	32.76	TV&Home Theater
M	3.1	4.5	1 ea	139500	13.95	Cell Phones
N	3.1	13.5	1 ea	418500	41.85	Appliances
O	3.1	10	2 ea	620000	62	Computer&Tablets
P	1.0	45.0	1 ea	450000	45	TV&Home Theater

Category	TotalArea cm²	m²	AdjustedArea
Appliances	141774	141.777	184.311
Audio	273	0.0273	0.035
Cameras	37667	3.767	4.90
Cell Phones	72141	7.214	9.38
Computer&Tablets	457182	45.718	59.44
TV&Home Theater	1043411	104.341	135.643
Video Gaming	12351	1.265	1.645

48.0 m

48.0 m

10°
20°
10°
10°
10°
10°
10°
20°
10°

CHECKOUT

ENTRANCE

EXIT

8 m
SCALE

TABLE OF CONTENTS

1. **Introduction**

A flash sale is a promotion offered by a plenty of company for a very short period of time, which was organized for several reasons. A lot of companies use this event as a valuable marketing strategy. Since customers tend to purchase a lower-price item quickly, flash sale can be an effective method for unloading both surplus stock and the items that are either out of season or sit in a storage for a long time and restocking with a new collection of the products. Furthermore, the most important point is that flash sale provides a great opportunity to promote brand awareness. Some brands can advertise their names through this event leading people to set their eyes on. Although flash sale is only a short-term impulse, it allows companies to tell customers about their other non-sale products and value proposition.

According to huge discounts and promotions, a limited selection of sale products and a short time span, a numerous number of people are coming for this big sale. At the start of the sale, huge crowd who leave their home for grabbing this golden opportunity of purchasing super discounted items gather at the entrance of the store. They then rush in the store, scramble for their desired products, and hasten to the cashier. These hastes build up a human traffic jam, which causes products' damage and people' hurt.

This project is working on a flash sale that mainly sells an electronic and appliance retail store. In order to run a successful flash sale, the organization has to be planned to reach a flash sale's goal and avoid products' damage as much as possible. In point of fact, Improvement of this sale can be operated by several ways. However, this project will be focusing on the plan to create the best management of the layout of the store.

2. **Restatement of problem**

   2.1 The Event
   - Describe the way that customers may damage the product during the sale event.
   - For the information given, what is the most popular product by the shopper and why?

   2.2 Store layout
   - From the event, identify the store layout factors that cause damage to the product and other factors that you think are important during the flash sale.
   - Use the factor that will damage to the product due to the customer to develop the mathematical models to qualitatively predict both the behaviors of customer result in products in the store products and the level of damage.
   - Base on the model, discuss the optimal locations of the product and label the various area of floor plan for the location of departments and displays of the most popular sale products.
   - Using your analysis and the model to develop a new better floor plan layout for this flash sale scenario.

   2.3 Letter
   - Write a one-page letter to the store manager supporting your floor plan layout discussing any additional strategies for a successful flash sale.

3. Assumption

3.1 The number of customers who come to this flash sale is massive enough to create predictable average value from the mathematical model.

- Since the demand of individual customers is literally unequal, the calculated customers' demand from the model is not able to predict the actual customers' demand of each person. Nevertheless, during the flash sale, tons of people come to the event.

3.2 Every people in the same condition have the same chance to damage in the same condition

- It is hard to consider that every person has a different physical appearance which affects the chance that he or she will damage the product. For example, a weaker person has more chance to break down the product. This can be hard to bring in the calculation of the level of damage.
- The damage will happen from the outer condition – too many people in an area and so on. All conditions can occur to a person with the same chance.

3.3 The behavior of customer that will damage is from motivation (customer demand rate)

- It difficult to consider the mood of costumer that effect to the chance to breakdown the product – costumer that get annoying other can affect more chance to damage the product – because of it hard to average the customer negative mood
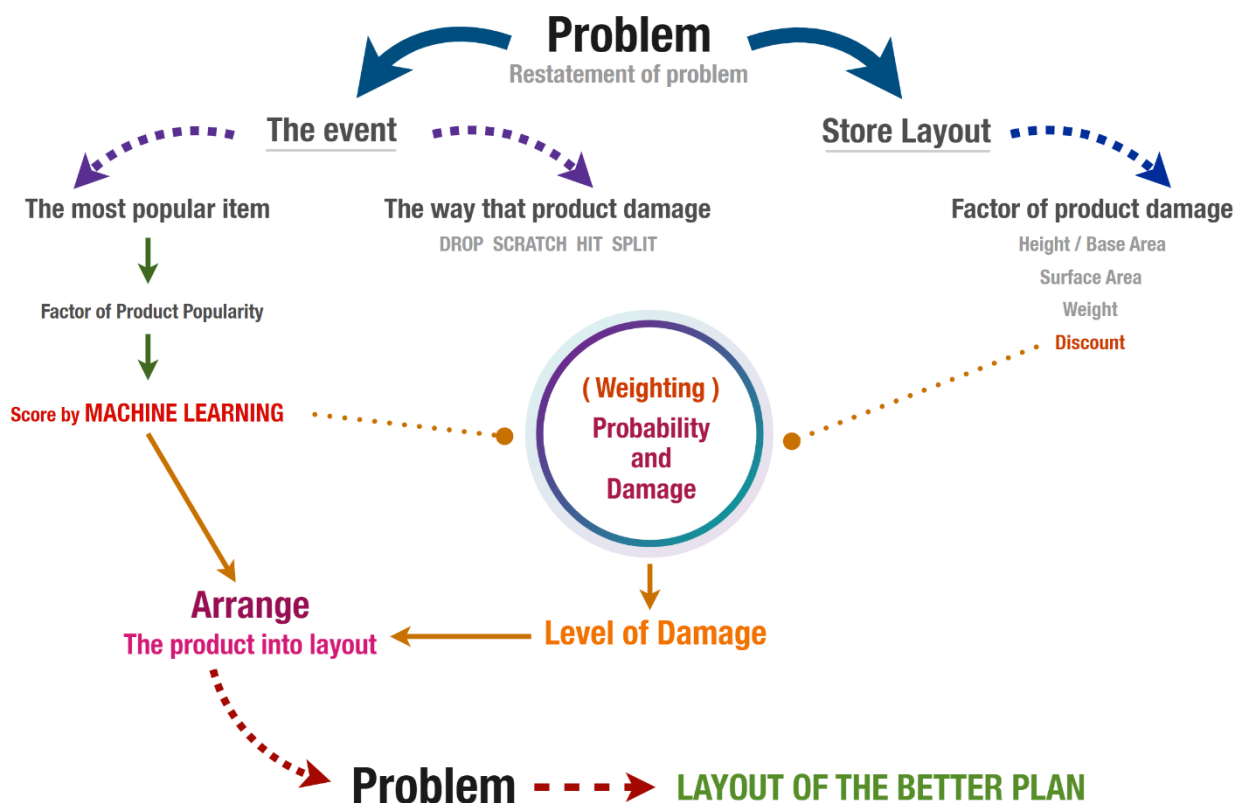
4. Overview Procedure

Figure 1 Overview Procedure Chart of this report

5. Data preparation

To make the model more accurate and realizable, the information was collected more from internet. The additional data consist of height, width, and length of each product. The data was searched follow the information of product given.

6. The event
6.1 The various ways that products might be damaged during the flash sale

Since store of flash sale usually contains tons of people, they gather massively causing customer's carelessness and hastiness. Hence, products could be damaged during flash sales by careless actions of customers. There are four cases that products can be damaged:

Drop - Products can be dropped during carrying by slipped out of customers' hand which was considered as "drop from hands" case. Another case is that they can be dropped from shelf or table by being hit by surroundings.

Scratch - Due to mass gathering of people, products, while holding, might be scratched by either customers or other stuff.

Hit - They might be hit by other customers or other products. This case included of any case that the product is distorted by being hit.

Split - Since most of customers try to scramble for their desired items, some items might split out by tussle. The item may be disassembled.

6.2 The factor of Product popularity during the flash sale

- **Regular Retail price:** the base retail price of an item before the discount. In economic theory, price relates to demand in a function called demand curve function assumes that the quantity of consumer demand varies with price along a downward slope – as a price increase, the consumer product's popularity falls. On the other hand, if the price declines, the product product's popularity increases.
- **Price during the flash sale:** the discounted price of an item during the flash sale. Discount price relates to demand in the flash sale; as the price decrease from normal, form demand curve, more customer product's popularity increase. In detail, discounts can suggest a better value proposition, because the customer pays less than he would he previously for the same product or at the same price, he can afford a higher quality of a product.
- **Discount Percent:** the percentage of discount compared to an item's normal price lowering the price of the product can stimulate sales. More discount percent can draw more consumer product's popularity because the customer will feel that they get the product with more worthiness.
- **Quantity during Flash sale:** the number of a particular item at the store and available for sale when the flash sale begins. The number of products might affect product demand during the flash sale by visualization of products' quantity. The products that have a large amount on sale can draw more or less costumer depend on each individual decision; some think that a small amount may popular or some think not.
- **The number of choices of a category of the product:** the number of items which in the same major category either having the same brand or not. In the same category of product or even the same item but different features make customers have more choice to choose. Therefore, when having more choices, the chance to choose each

item of customers will be divided and other factors will be related indecision, so the product's popularity will be divided into other brands that sell the same item.

6.3 Model of product popularity

6.3.1 Software and instrument

1. Software
   a. Scikit-learn
   b. NumPy
   c. SciPy
   d. Pandas
   e. Matplotlib
   f. Statsmodels
   g. PyCharm
2. Instrument
   a. Portable Laptop
   b. High Performance Computer Cluster

6.3.2 Background Reseach

Machine learning is a modern tool used to analyze and search for data patterns by understanding the relationship between input and output data until it can predict the results (Ballester & Mitchell, 2010). The three different types of Machine Learning are Supervised Learning, Unsupervised Learning, and Reinforcement Learning where choosing the choice of Machine Learning depends on the data that putting into a computer. Herein, the Computer was loaded with both the input and the output data which is suitable for use Supervised Learning.

There have several machine learning models that can do the regression task such as Random Forest (RF), Support Vector Machine (SVM), Decision Tree (DT), and Gradient Boosting. Because this work solved the low-input and low-feature regression problem so that is better to use Support Vector Machine (Chi et al,2008). In Support Vector Machine, There is important to choose the optimal hyperparameter values for it (Duan et al, 2003). Hyperparameter Tuning technique is the solution that finding the most appropriate hyperparameter values for the model (Claesen et al, 2014). The technique was applied to the model. The hyperparameter that was used in this technique shows below.

C : 1.0, 2.0, 3.0, 4.0, and 5.0
Epsilon : 0.1, 0.2, 0.3, 0.4, and 0.5
Degree : 2, 3, 4, and 5
Verbose : False and True
Shrinking : False and True
Kernel : 'rbf', 'linear', and 'sigmoid'

6.3.3 Assumption of Model

Rate of Product Popularity depends on Regular/ Suggested Retail Price (USD), Price During Flash Sale (USD), Quantity Available During Flash Sale, Discount During Flash Sale (%), and Number of choices of category. and the output data is Customer Rating (1-5) due to most of the customers know about these product details before they buy something. However, Customer Rating has come after they use the product but it can indicate the Product Popularity well because the social can shape the individual attitude of the product.

6.3.4 Model

Our dataset: $D = \{(x_i, y_i) \mid x_i \in \mathbb{R}^5, y_i \in \{-1,1\}\}_{i=1}^{134}$ such that each x_i are of 5 dimension and each have labels of either $y_i = +1$ or $y_i = -1$ class. We have 134 data points, but the result after plot the graph is not well separable data point. The Kernel trick come handy by using the Kernel function to make non-linearly separable data point to linearly separable data point. So, we use the RBF kernel that is

$$K(x_i, x_j) = e^{-\gamma(x_1 - x_j)^2}$$

Consider, the linearly hyperplane can be written as $y = ax + b$ and let vector $X = (x, y)$ and $W = (a, -1)$ then, we can write the hyperplane in vector form.

$$W \cdot X + b = 0$$
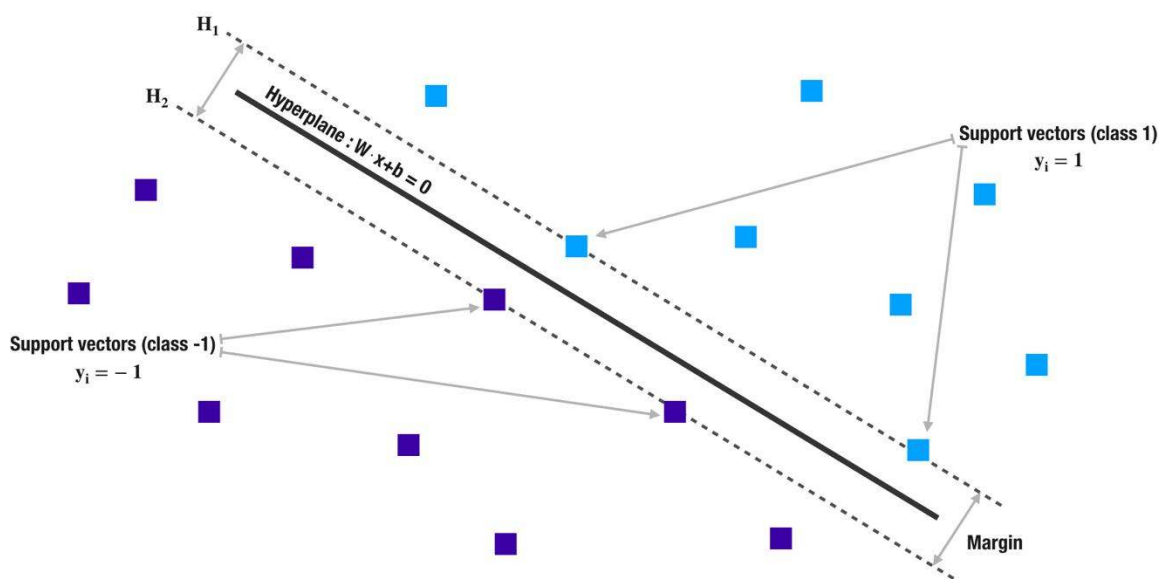
Figure 2 The H_1 and H_2 hyperplane, which passing through nearest data points.

Let's assume H_1 and H_2 is some hyperplane, which passing through nearest data points that show in Figure 1. the closest data point is known as support vectors. The margin is an area which don't contain any data points. We can write the inequalities represent the data points which are above H_1 and below H_2.

$W \cdot x_i + b \geq 1$ for $y_i = +1$ represents the data points above H_1 ; $W \cdot x + b = 1$

$W \cdot x_i + b \leq -1$ for $y_i = -1$ represents the data points below H_2 ; $W \cdot x + b = -1$

Combining above two equation, it can be written as

$$y_i(W \cdot x_i + b) - 1 \geq 0 \text{ for } y_i = +1, -1$$

Consider, the margin between H_1 and H_2 is $M = \frac{2}{||W||}$. The optimal hyperplane was determined by maximizing the margin, that is the same things as minimizing the norm of W that is $\min \frac{||W||^2}{2}$

So, using Lagrange multiplier with constrain λ_i

$$L = \frac{||W||^2}{2} - \sum \lambda_i (y_i(W \cdot x_i + b) - 1)$$

and then, we use basic optimization algorithm to find the optimal value of W and b. Let's the optimal value of W be W_o and b be b_o. The optimal hyperplane that can separates the data points can be written as

$$W_o \cdot x + b_o = 0$$

Clustering Method is the way to identify groups of similar object in multivative datasets. There has several type of clustering methods; However, SVM-based clustering algotithm is one of methods which was used in the model and proper to the datasets which finding the relative properties and knowledge of input datas. It can improve the model performance over parametric approaches especially for supervised machine learning (Winters-Hilt et al, 2007).

Customer Rating which was given in this problem was collected after a customer brought that product resulting in a bias rating if using to predict Customer Demand Rate. Therefore, Machine Learning was used to let the Factor of product demand be part of Customer Demand Rate by giving Customer Rating as output into a model. Then, the model will find the relationship between Factor of product demand for predicting the output. Causing the output that came from was not Customer Rating but it is Customer Demand Rate because of variance coming from Factor of product demand.

In this case, the input data consists of Regular/ Suggested Retail Price (USD), Price During Flash Sale (USD), Quantity Available During Flash Sale, Discount During Flash Sale (%), and Number of choices of category. and the output data is Customer Rating (1-5).

6.3.5 The most popular items
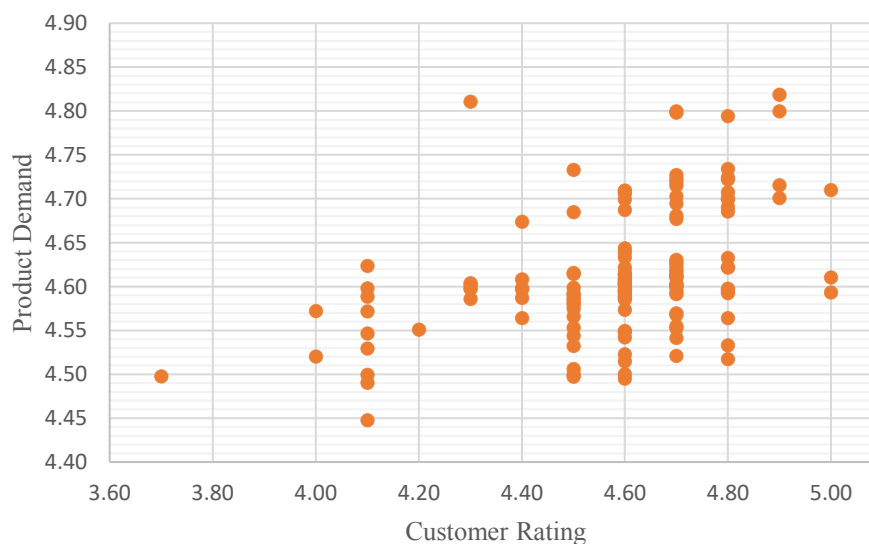
Figure 3 Scatter plot between Customer Rating and Product Demand

It can be seen that, Customer Rating value is not continuous showing on x-axis because the data that come from *StoreData_IMMC* file is not continuous. However, Product Demand showing on y-axis is continuous due to the variance of data come from Factor

of Product Demand. Therefore, the output of the model as known as Product Demand are now depends on both Factor of Product Demand and Customer Rating (After using that product).

According to our model, the result from machine learning give us the popular score of each product called "Product popularity". The product popularity rank in score between 0-5; the higher score shows that product is more popular. Therefore, the most popular item is DSLR Camera, Body Only, Black which has Product popularity equal 4.82. To explain this result from data given, because the customer rating of product is equal 4.9 which is very high when compare to other items, even though their price is high but when the product has discount which will draw the customer to buy the product.

7. Store layout

7.1 Factors of product damages
- **Product popularity** – Since more people are likely to gather at an item with high Product popularity, there is more chance that it is damaged by a careless action of those customers. Consequently, Damage Level of a product that has a high probability to be surrounded by lots of people must be significantly high.
- **Discounted price** – It was estimated as a value of the products which is assumed to be a cost that we lost from their damages. Additionally, we assume that a real outlay that was lost is approximately close to discount price, due to the lack of data.
- **Damage Probability** – It was determined by the probability to be damaged by several ways: dropped from hands, dropped from shelf, scratched, hit, and split. These types of damage were explained in detail in page 10. A probability that these several types of damage will be occurred was considered to depends on three factors:
- **Height per base area** – If the product's height that is compared to the base area is high, we assume that it has more chance to be dropped from shelf. Therefore, Damage Level of products with high Height per base area are more likely to be high.
- **Surface area** – surface area of the item was assumed to represent size of product and the difficulty of carrying it. For instance, laptops are carried more difficult than earphones because of its size which surface area was used for indicating its size by our assumption. In addition, surface area also represents the probability of being damaged. We assume that more surface area leads more area that can be damaged. For instance, if the cube box $5*5*5$ cm^3 and the box with the shape of $25*5*1$ cm^3 was compared, an item that can be damaged easier is the second shape, although the volume of these two objects are equal, so we use the surface area instead of volume. To sum up, high surface area creates higher chance to be damaged with surroundings and to be dropped from carrying.
- **Weight** – weight was assumed to be one of factors causing difficulty of carrying. Since heavy items can be easier dropped due to more obstacles of carrying, they have more chance to be damaged by dropping.

7.2 Other measures that is important during a flash sale event

Customer flow—there is another important factor during flash sale event the rate of customer that go inside the store in a time should be appropriate with the customer that check out the store, even if the rate of customer go inside the store is higher than rate of customer check out, the customer will gather then the density of customer is higher result in higher rate of accident.

7.3 Model level of damage

7.3.1 Assumptions

- Customers do not carry some types of products by themselves: dryer, washer, refrigerator, and oven. Therefore, we decide to assume that these kinds of products have no chance to be dropped when carrying, but they can be dropped by their turning over.
    - All types of damage have the same probability to be occurred and the same level of damage.
    - Products' material which is important for considering the strength of products is regardless.
    - People always carry their products by hands. There is no machinery that helps carrying, such as shopping carts or hand baskets.
    - Difficulty of carrying depends on surface area and weight of products.

7.3.2 Normalization

Normalization is the way to adjusting the value in datasets on a different scale to a common or similar scale for comparing on multiple dataset (Beeri et al,1989). There has several method to normalize the data. One of them is to let the value into 0 to 1 while keeping the data ratio still the same. Moreover, In Factor of Product Damage, the data of each factor is on entirely different scales. Therefore, to compare and weight altogether for gaining Damage Score, they must be normalized to a common scale.

For each Factor of Product Damage was be normalized to a common scale 0 to 1. where the order of the value keep remain the same to the value before normalizing. The normalization formular is shown below, where D_L is The lowest value in the dataset, D_H is the highest value in the dataset, D_I is the value of present data, and $D_{NormalI}$ is the normalized value of the present data.

$$D_{NormalI} = \frac{D_I - D_L}{D_H - D_L}$$

7.3.3 Model (Weighting)

To predict the behavior of the flash sale customer that result in damage of product and the level of damage, the factor that was considered in level of damage consist of product popularity, discount price and probability that product will damage (probability of product damage). To calculate probability of product damage, weighting method was used to weight the factor of product damage (height per base area, surface area and weight) due to the store layout that how much each factor effect to the level of damage. Therefore, the factor was weighted from the way that that factor can make an accident—drop from hand, drop from shelf, scratch, hit, split.

Table 1 Explanation of damage affected by each factors of damage

Factor of Damage	Way that the item will be damaged	Explanation
Surface Area	Drop from hand	Higher surface area makes the customer can carry harder so it has more chance that customer will slip the item.
	Scratch	When customer carry the item which high surface area it uses more area of walkway to take the item, so the item has more chance in scratching other surrounding item.

	Hit	When customer carry the item which high surface area it uses more area of walkway to take the item, so the item has more chance in hit by other customer
	Split	When customers try to scramble for their desired items, more surface area can be scram by many people and cause item be damaged.
Height per base area	Drop from hand	If the item has small base area, but has high height, it has high opportunity that item will fell down.
	Drop from shelf	
Weight	Drop from hand	If the item has high weight the chance that it will drop is higher.
	Drop from shelf	

After the way that the item will be damaged and Factor of Damage was matched, we give the percent to each Factor of Damage by assume that every way that item will be damaged all ways have same rate to damaged; it has 5 way to damage so each of way has the weight equal 20%. Therefore, each Factor of Damage will be weighed by the way that that factor can damage the item.

Table 2 Weighting score of each Factor of Damage

Factor of Damage	Way that the item will be damaged	Percent weight (%)	Overall weight (%)
Surface Area	Drop from hand	6.67%	66.67%
	Scratch	20%	
	Hit	20%	
	Split	20%	
Height per base area	Drop from hand	6.67%	16.67%
	Drop from shelf	10%	
Weight	Drop from hand	6.67%	16.67%
	Drop from shelf	10%	

After our team weight percent and normalize Factor of Damage, the probability of product damage can be determined by

Probability of product damage (PD)=(A*66.67+H*16.67+M*16.67)

Remarks: A : Normalized Surface area
H : Normalized Height per base area
M : Normalized Weight

However, some products can't be carried because of their weight, so they will not be damaged during transport. These items consist of dryer, refrigerator, washer, oven. Due to their weight that very heavy, so it very hard to drop even the value of high per base is high. Consequently, our team ignores the probability of damage from Hight per base area and Weight in the calculation.

Since the chance product will be damaged depending on the probability of product damage and the product popularity then, when the damage occurs the level of damage depend on the discount price so the level of damage can be determined by

level of damage=Product popularity*Normalize Discount price*PD

But, if the level of damage was calculated like this, the level of damage will almost depend on the Discount price more than a Factor of Damage. Hence, the Factor of Damage was powered by 2 and the damaged level can be determined by

level of damage=Product popularity*Normalize Discount price*PD ^{2}

7.3.4 Calculation

Product: 50" 4K UHD HDR Smart LED TV, 7 Series
    Product popularity: 4.614
    Normalize Discount price: 0.128
    Normalize Surface area: 0.315
    Normalize High per base area: 0.015
    Normalize weight: 0.14

Calculate Probability of product damage

Probability of product damage(PD)=(0.31*66.67+0.015*16.67+0.14*16.67)

Probability of product damage (PD)=23.20

Calculate level of damage

level of damage=4.61*0.128*23.20 ^{2}

level of damage = 317.62

7.4 Procedure to arrange the products into layout

After the level of damage was calculated in each department, the value was converted to be the ellipse's area as a damage area and we also multiply with the area of the product's location to make sure that the damage area totally covers the area of that product's location. So, we will convert the product popularity same as the level of damage. Next, we will arrange the location of department with the damage and product popularity area. It will occur the intersection area.

7.4.1 State of the categories on original floor plan

7.4.1.1 Mathematic for Program

Consider, area of intersecting ellipses has 5 cases.

1. **No intersection Points**

    One ellipse is contained strictly in the other, or the ellipses are separated.
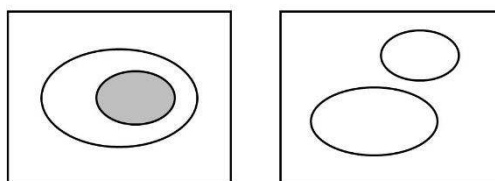
Figure 4 No intersection Points of two ellipse

2. **One Intersection Point**

    One ellipse is contained in the other but the two ellipses are tangent at the point of intersection, or the ellipses are separated except for a single point of tangency.
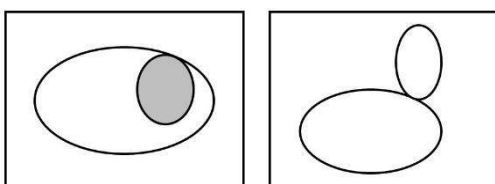
Figure 5 One intersection Points of two ellipse

3. Two Intersection Point

Two possible configurations are possible. Either one ellipse is contained in the other, but the two ellipses are tangent at the point of intersection, or the ellipses intersect at two distinct points.
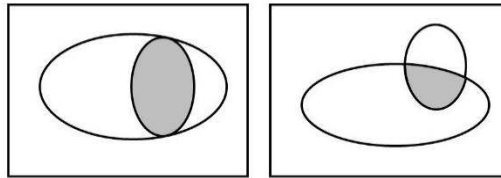
Figure 6 Two intersection Points of two ellipse

4. Three Intersection Point

The two ellipses intersect tangentially at one point and transversely at two points.
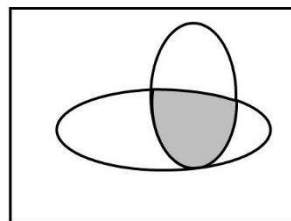
Figure 7 Three intersection Points of two ellipse

5. Four Intersection Point

The two ellipses intersect transversely at four points.
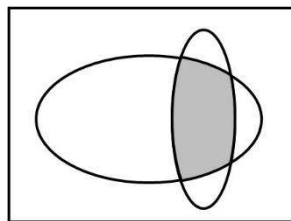
Figure 8 Four intersection Points of two ellipse

The optimal location of department is a arrangement of store's department which has the least intersection area of the damage and product popularity.

7.4.1.2 Algorithm of program

To arrange the depatment, first our team put the store floor plan in axis and track the point of each area that can lay the item.
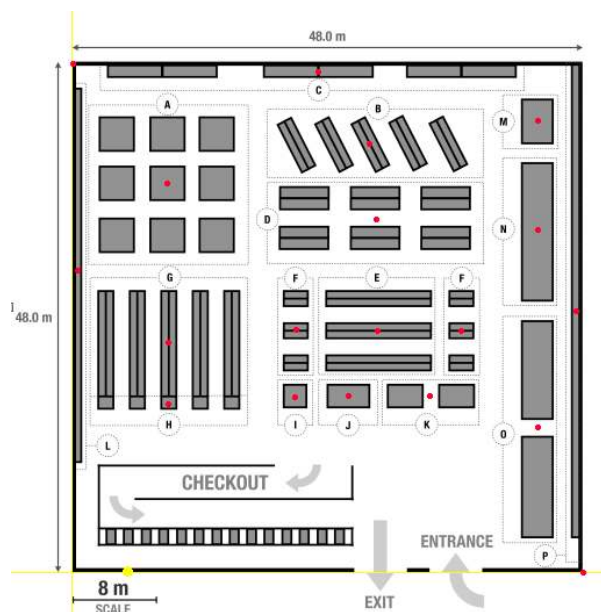
Figure 9 Tracking to find the center of each area

After we get the point of each area, these point will be the vertex of the ellipse in the future.

Second, the size of each area and each department which we add 30% area that will use in department was collect. Then, the program will put the department in an to area and build the the ellipse. To put the department into area, some department need to be fixed into the specific area first because it will cause high computation-cost. Therefore, our team fix Audio at area I because it use lowest area, Camera at area H because the apparence of the shelf is appropiate to show the product, Computer and Tablet at area O and Video gaming at area J because it is the second lowest area. The others department, the program was run every case by the algorithm above.

Table 3 Example case of program which has 3 category and 5 zone

RunTime	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	explanation
1	D1	D2	D3			Fix D1 and D2 at Zone 1 and Zone2
2	D1	D2		D3		
3	D1	D2			D3	
4	D1		D2	D3		Fix D1 and D2 at Zone 1 and 3
5	D1		D2		D3	
6		D1	D2	D3		Fix D1 and D2 at Zone 2 and 3
7		D1	D2		D3	

As per the table 3, showing how to organize with the department and the area. However, it doesn't not include other facter; in this case, it is area of each department and each zone. To use it, it need to be desired wheter each zone has enough area for each department or not, if yes, program will allocate area of next department, if not, the program will continue to allocate area for the department untill the whole department has enough space for it.

7.4.1.3 Problem of normal flash sale store

13

- **Location of product:** the product with more customer demand leads the customer to pick in the area. This makes the area around the location of the item will fill with the dense crowd. With more density of the people in an area will cause the customer to walk harder and more opportunity to have an accident such as crashing, when the accident occurs, the product that the customer is carrying, or the surrounding item may be damaged. Especially, if the popular items are near together, it will cause harder to walk and higher accidental rates due to the higher density of customers.

- **Too narrow walkway:** When the area that customers narrow causes more density of the customer. This affects a higher rate of an accident which makes the product damaged. Furthermore, if the walkway is narrow and the product or item is large—some of the product is not big but because of their surface area ie. LED can easily damage—it makes the higher chance that the item may crash with other customer or the product that in the shelf and the item are damaged.

7.4.1.4 Procedure to organize the products into floor plan layout

- Popularity must be distributed equally. By more density of the people in an area, the customers walk harder and there is more opportunity to have an accident such as crashing, when the accident occurs, the product that the customer is carrying, or the surrounding item may be damaged. Therefore, popular product should not be near each other.
- Department with more Damage Level must be placed at the location that people occupied area and is near the cashier the most.
- Total base area and quantity of products in that department must not exceed the total area of those locations
- Popular items must be distributed due to higher chance of product damage which is caused by poor dispersion of people.
- Popular items must be placed towards the inside of the room. Therefore, there is low chance that lots of people will gather at the front of the store which will block the walkway that is near the entrance and the exit of the store.

48.0 m

48.0 m

A
C
B
M
63
D
N
3
G
F
E
F
17
H
I
J
16
114
1
K
L
5
O
P

8 m
SCALE

CHECKOUT

ENTRANCE

EXIT
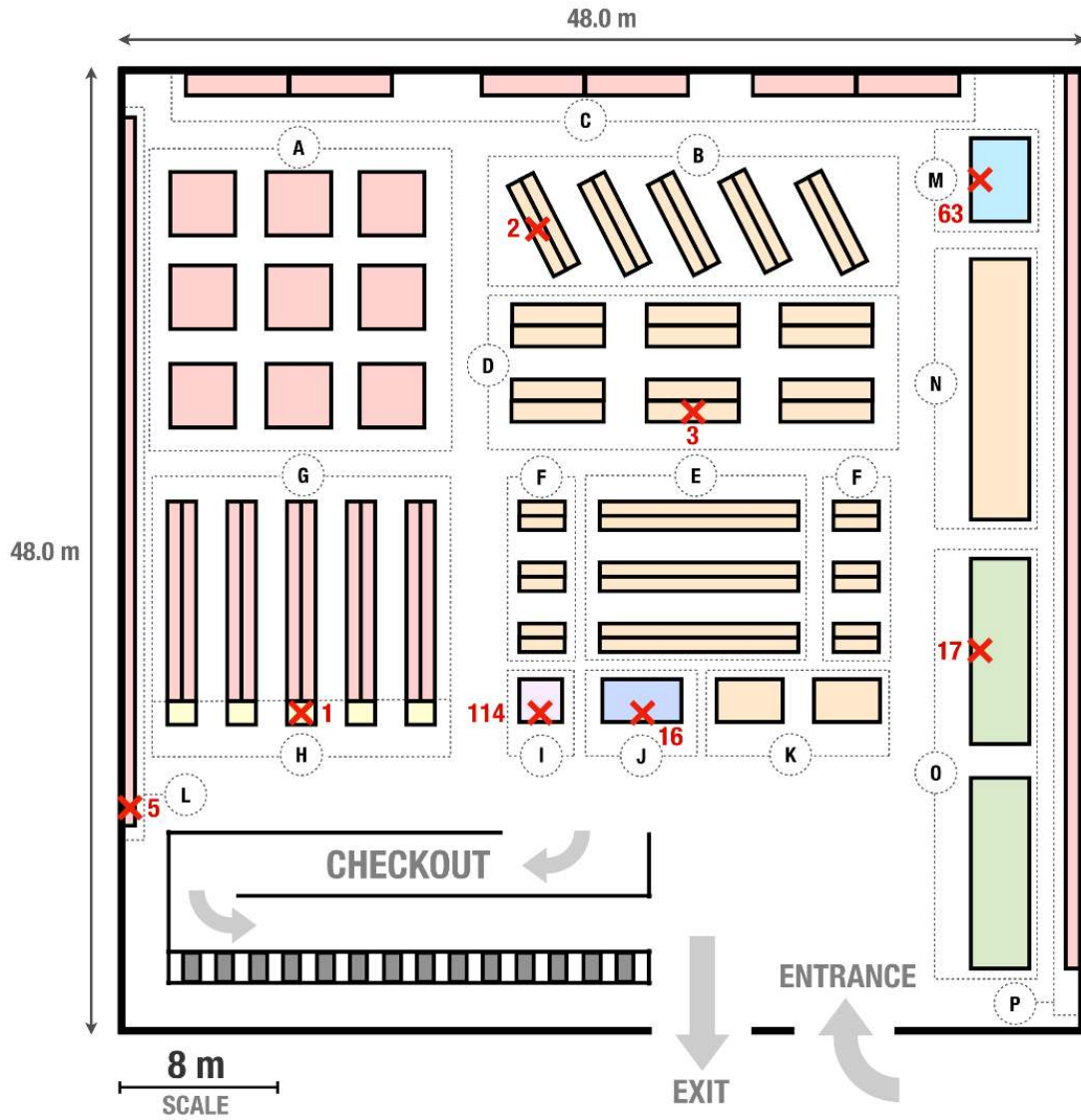
Type	Dimension (m) Width	Dimension (m) Length	QTY	TotalArea cm²	TotalArea m²	Category	Category	TotalArea cm²	TotalArea m²	AdjustedArea
A	3.5	3.5	9 ea	1102500	110.25	TV&Home Theater	Appliances	141774	141.777	184.311
B	0.8	5.3	10 ea	424000	42.4	Appliances	Audio	273	0.0273	0.035
C	1.2	5.0	6 ea	360000	36	TV&Home Theater	Cameras	37667	3.767	4.90
D	1.2	5.5	12 ea	792000	79.2	Appliances	Cell Phones	72141	7.214	9.38
E	0.8	10.5	6 ea	504000	50.4	Appliances	Computer&Tablets	457182	45.718	59.44
F (LEFT)	0.8	2.5	6 ea	120000	12	Appliances	TV&Home Theater	1043411	104.341	135.643
F (RIGHT)	0.8	2.5	6 ea	120000	12	Appliances	Video Gaming	12351	1.265	1.645
G	0.8	9.5	10 ea	760000	76	TV&Home Theater				
H	1.2	1.6	5 ea	96000	9.6	Cameras				
I	2.3	2.3	1 ea	52900	5.29	Audio				
J	2.3	4.2	1 ea	96600	9.66	Video Gaming				
K	2.3	3.5	2 ea	161000	16.1	Appliances				
L	0.9	36.4	1 ea	327600	32.76	TV&Home Theater				
M	3.1	4.5	1 ea	139500	13.95	Cell Phones				
N	3.1	13.5	1 ea	418500	41.85	Appliances				
O	3.1	10	2 ea	620000	62	Computer&Tablets				
P	1.0	45.0	1 ea	450000	45	TV&Home Theater				

Figure 10 Floor plan shading with each category given by the most efficiency case form
Code#2. The mark area shows the location of popular product with the rank of
popularity. In the diagram shows the top 3 of most popularity product and the most
popular item in each department.

7.4.1.5 Additional explanation of the most popular product(s)

Appliances: the second popularity product locate at zone B because the location is far from other popular product. Also, it doesn't block the main walkway. Another item is the third product popularity which is refrigerator is locate at zone N because has high base area.

Audio: the most popular product in department locating at zone I in the middle to prevent the customer block the main walkway.

Cameras: the most popular product locates at the middle of H to avoid the customer that is going to buy TV

Cell phone: the most popular product in the department locates at the middle of zone M to avoid blocking the customer that will go to shelf P

Computer and tablets: the most popular product in the department locates at zone O at the above shelf to avoid the customer from entrance and exit that will have other customer pass.

TV and Home Theater: the most popular product in department is located at the lowest part of zone L for customer for easily carrying and checkout because the product has high level of damage.

Video gaming: the most popular product in the department is located in the middle of zone J to avoid the customer from zone I and avoid the exit.

7.4.2 Layout of the better floor plan

7.4.2.1 Reason and introduction to new floor plan

According to the model from part 2C. it has some problems cause higher damage; because the walkway is narrow, so the distance between the department is low. When we put the level of damage into the ellipse and the distance between the vertex of each ellipse is low, these results in the area of some ellipse is overlap together. Furthermore, the customer flow of the store layout that was given is not suitable, because when we layout the product by the department, if the customer wants just only an item from the department that locates at the back of the store, it is hard to access and go back to cashier. Hence, our team solves these problems by the new layout.

Our new floor layout decided layout in the form of Archimedes spiral because people who want to shop all stores can walk follow the walkway through the core of spiral and walkout by cut the spiral in linear and the ones who already want to enough they can easily walk to the cashier. Our team decided to locate the popular item outside of the spiral, so the one who wants to buy just the popular item can buy and quickly bill and go out of the store. From these 2 factors, they can make the store has better customer flow even the walkway is narrow(but, our new model it also wide), thus the store won't have too many people in the store which can reduce that chance that the damage will happen(means that even the popularity of the product is high, but the customer doesn't go to the area in the same time it can reduce the chance of accident)
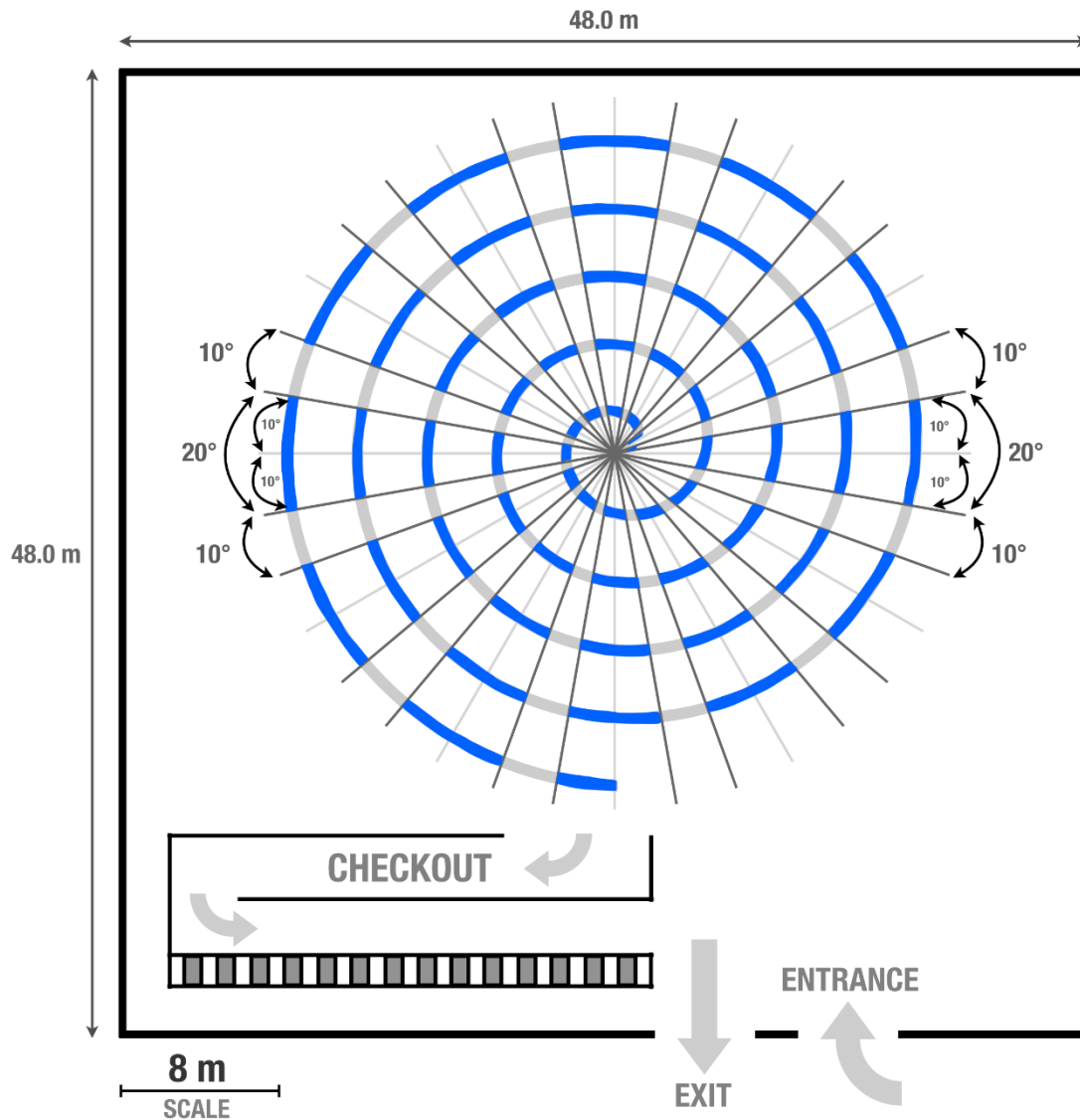
Figure 11 New Archimedes spiral floor plan. The blue area show the area of available zone for product and radian line show the walkway from the center to outer layer. The gray area can walk though its, it just show to shape of Acemedian Spiral.

To locate the product, the product with high popularity and high damage will locate at the outer layer of spiral to reduce damage that will happen during the customer carry the item to cashier.

7.4.2.2 Calculation of the location's area in Archimedean spiral

the location's area has $\pi/9$ rad length along the spiral line, 2.5 m. width, 4 m is the distance between the inner location and outer location, and $\pi/6$ rad is the angular distance between the center of a location and side locations.

We know that the Archimedean spiral's equation that is $r = b\theta$ in the polar coordinate system where b is constant. Let's assume the location's area is like a part of a ring with r_1 and r_2, where $r_2 > r_1$. It can be written as.

$$Area = \frac{1}{2}(r_2^2 - r_1^2)\theta$$

Using the integration with the condition of the location's area. Let's A be area of the location in Archimedean spiral. It can be written as

$$A = \frac{1}{2} \int_{\theta}^{\theta+\pi/9} (5b\theta + 6.25)d\theta$$

where $b = {}^{6.5}/_{2\pi}$ and $\theta = 0, {}^{\pi}/_6, {}^{\pi}/_3, \dots, {}^{n\pi}/_6$; $n = 1,2,3,\dots$

8. Memo of Model
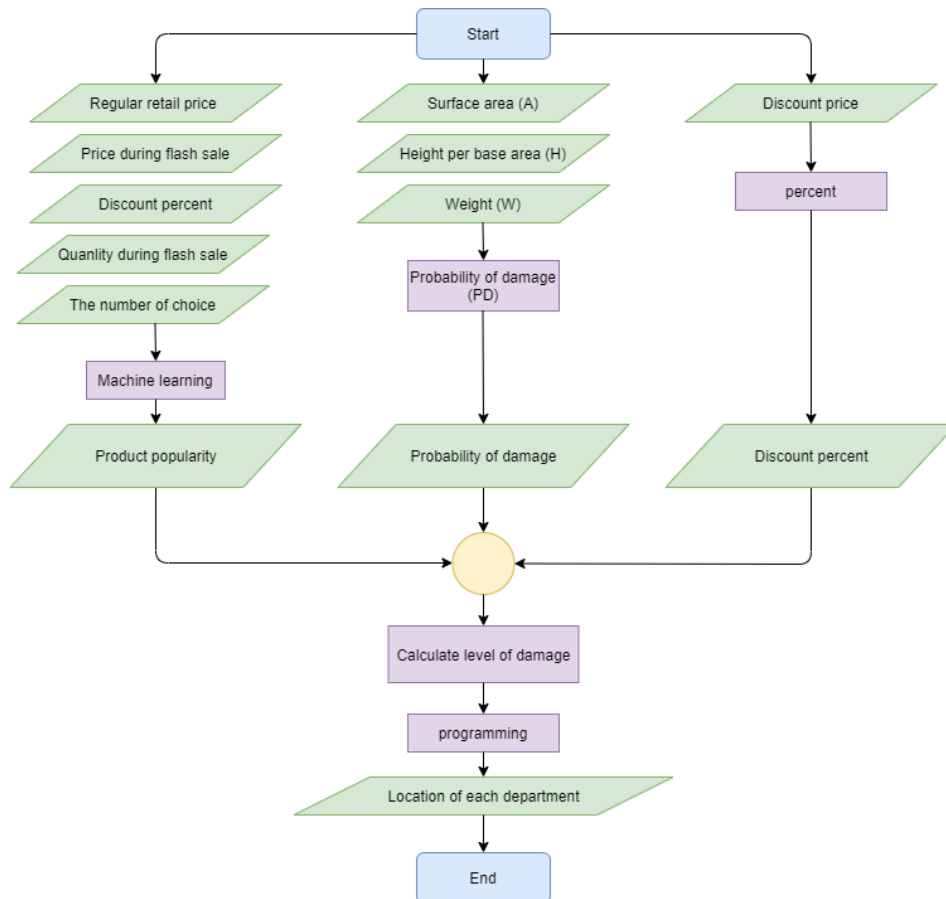
Figure 12 Overall this report model

9. Conclusion

In flash sale event, many accidents can happen due to carless of customer or even store layout. These accidents cause the product damaged that both effect to the seller and customer. The accident can happen in various way—drop from hand, drop from shelf, scratch, hit, and split. The higher rate that the accident will occur depend on the product popularity, so the mathematics model was built to determine the popularity of product. From the model, the most popular product is DSLR Camera, Body Only, Black. Not only product popularity that cause the product damage, but also the probability of damage which are surface area, high per base area, and weight. These factors have been weighted and the model was created to determine the level of damage. Then the product was arranged in store follow the diagram. Lastly, the new layout of store was designed in the form of Archimedes spiral.

Letter

April 4, 2020

[address]

Dear store manager,

We are writing to make a proposal of our strategies including of floor plan layout that was designed delicately for overcoming flash sale problems.

According to a limited selection of sale products, a short time period of flash sale, and a numerous number of customers who are coming for this big sale, they sometimes caused both people hurting and damage of products. Aside from the damage that might be occurred, some customers cannot get their desired items due to it has been sold before they arrived at the store.

Thus, since we have an opportunity to rearrange the floor plan layout of the flash sale store, we have designed our new effective floor plan layout that has higher chance to be successful. Deducting the probability of product damage was considered as a main goal. Consequently, we have developed many models to quantitatively predict the behaviors of flash sale customers, the popularity of any products, and the level of product damage which uses. After that, these values were used for organizing the best placement of different department of products. Furthermore, by considering these values, a superior floor plan layout was designed by using Machine Learning and another program. The file of our new floor plan layout was attached.

The placement of products' locations was designed to be the Archimedean spiral with some cut-off areas, which could be visualized in the file. Firstly, this layout provided one-way walkway which is the core of spiral for customer who prefers to walk around. Although people can still walk by several routes, people might tend to walk through this one-way walkway which causing people not to walk in opposite direction. That leads lower chance of product damage. Secondly, by its shape, the items with high Product Popularity can be placed at the external layers of the spiral which occupy more area than the internal layers. Therefore, most people will be attracted by those items. They then quickly purchase and get out from the store promptly. People will not be massively grouped by this strategy. Thirdly, this shape of arrangement leaves only low empty area, therefore, the walkway with large area for customers was left. The total area of the store was utilized efficiently.

In summary, this type of floor plan layout might be not the best layout. However, it was designed and planned logically to solve flash sale's problems by reducing product's damage as well as provide convenience for customers.

Thank you for having taken the time to review our plans and strategies. We hope that we have given you some valuable plans for a successful flash sale. We look forward to hearing from you.

Sincerely,

Puri, Theppawan, Krittaboon, and Virginia

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APPENDIC

Table A: The information that manager has provided about the product in flash sale.

Product No.	Department	Major Product Category	Product Type	Make (Brand)	Product (Item)	A	B	C	D
1	Cameras	DSLR Cameras	Body Only	Brand E	DSLR Camera, Body Only, Black	2499.99	2199.99	20.00	4.90
2	Appliances	Major Kitchen Appliances	Range/Stove/Oven	Brand W	30" Combination Double Electric Convection Wall Oven with Built-In Microwave	3329.99	2199.99	5.00	4.30
3	Appliances	Major Kitchen Appliances	Refrigerator	Brand W	27.8cu ft 4 Door French Door Refrigerator, PrintProof, InstaView Door-in-Door, Stainless	3149.99	2299.99	8.00	4.70
4	Cameras	Mirrorless Cameras	Camera Package	Brand DD	Mirrorless Camera with FE 28-70mm F3.5-5.6 OSS Lens	2199.99	1999.99	20.00	4.90
5	TV&Home Theater	TVS 70" - 75"	4K QLED	Brand BB	75" 4K UHD HDR Smart QLED TV, Q70 Series	2199.99	1999.99	12.00	4.70
6	TV&Home Theater	TVS 65"	4K OLED	Brand DD	65" 4K UHD HDR Smart OLED TV, A8G Series	2499.99	1999.99	12.00	4.80
7	TV&Home Theater	TVS 70" - 75"	4K QLED	Brand BB	75" 4K UHD HDR Smart QLED TV, Q60 Series	1299.99	1199.99	15.00	4.80
8	Appliances	Major Kitchen Appliances	Refrigerator	Brand FF	26.8cu ft French Door Refrigerator, Stainless Steel	2474.99	1799.99	8.00	4.50
9	TV&Home Theater	TVS 65"	4K QLED	Brand BB	65" 4K UHD HDR Smart QLED TV, Q70 Series	1399.99	1199.99	12.00	4.70
10	TV&Home Theater	TVS 65"	4K LED	Brand DD	65" 4K UHD HDR Smart LED TV, X900F Series	1299.99	1099.99	12.00	4.80
11	Appliances	Major Kitchen Appliances	Refrigerator	Brand W	26.2cu ft French Door Smart Wi-Fi Enabled Refrigerator, PrintProof, Black Stainless	2204.99	1749.99	10.00	4.70
12	TV&Home Theater	TVS 70" - 75"	4K LED	Brand DD	75" 4K UHD HDR LED Smart TV, X800G Series	1399.99	1099.99	8.00	4.80
13	TV&Home Theater	TVS 65"	4K QLED	Brand BB	65" 4K UHD HDR Smart QLED TV, Q80 Series	1799.99	1699.99	15.00	4.70
14	Cameras	DSLR Cameras	Camera Package	Brand AA	DSLR Two Lens Kit with 18-55mm and 70-300mm Lenses, Black	1199.99	999.99	20.00	4.90
15	TV&Home Theater	TVS 65"	4K QLED	Brand BB	65" 4K UHD HDR Smart QLED TV, Q60 Series	1099.99	999.99	15.00	4.70
16	Video Gaming	PC Gaming	Gaming Desktop	Brand F	Gamer Supreme Liquid Cool Gaming Desktop, AMD Ryzen 7 3700X	1499.99	1049.99	10.00	5.00
17	Computers &Tablets	Laptops	2-in-1 Laptop	Brand P	2-in-1 15.6" 4K Ultra HD Touch-Screen Laptop, Intel Core i7, 16GB	1599.99	1099.99	10.00	4.60
18	Appliances	Major Kitchen Appliances	Refrigerator	Brand M	25.1cu ft Side-by-Side Refrigerator, Fingerprint Resistant, Stainless Steel	1619.99	1099.99	5.00	4.60
19	Computers &Tablets	Desktops and All-In-Ones	All-In-One	Brand P	27" Touch-Screen All-in-One, Intel Core i7, 12GB RAM, 256GB SSD	1379.99	999.99	15.00	4.80
20	Video Gaming	PC Gaming	Gaming Laptop	Brand Z	15.6" Gaming Laptop, Intel Core i7, 32GB RAM, NVIDIA GeForce RTX 2060, 5	1799.99	1399.99	15.00	4.60
21	Video Gaming	PC Gaming	Gaming Desktop	Brand Q	Gaming Desktop, Intel Core i7-9700K, 16GB RAM, NVIDIA GeForce	1699.99	1499.99	15.00	4.70
22	Cameras	DSLR Cameras	Body Only	Brand AA	DSLR Camera, Body Only, Black	1499.99	999.99	10.00	4.90
23	TV&Home Theater	TVS 50" - 55"	4K OLED	Brand DD	55" 4K UHD HDR Smart OLED TV, A8G Series	1799.99	1499.99	12.00	4.80
24	Cameras	Mirrorless Cameras	Camera Package	Brand DD	Full-Frame Mirrorless Camera with 28-70mm Lens, Black	1599.99	999.99	10.00	4.80
25	Computers &Tablets	Laptops	PC Laptop	Brand Y	13.5" 8GB RAM 256GB Solid State Drive	1299.99	999.00	12.00	4.60
26	Appliances	Major Kitchen Appliances	Range/Stove/Oven	Brand W	6.3cu ft Slide-In Electric Range with ProBake Convection, Stainless Steel	1439.99	999.99	5.00	4.70

Remarks: A: Regular/ Suggested Retail Price (USD), B: Price During Flash Sale (USD), C: Quantity Available During Flash Sale, and D: Customer Rating (1 - 5)

Table A: The information that manager has provided about the product in flash sale.

Product No.	Department	Major Product Category	Product Type	Make (Brand)	Product (Item)	A	B	C	D
27	TV&Home Theater	TVS 85"	4K LED	Brand DD	85" 4K UHD HDR Smart LED TV, X900F Series	2999.99	2599.99	8.00	4.80
28	Computers &Tablets	Laptops	PC Laptop	Brand BB	15" 16GB RAM 256GB Solid State Drive	1249.99	949.99	12.00	4.60
29	Cameras	DSLR Cameras	Camera Package	Brand E	DSLR Camera with 18-55mm IS STM Lens, Black	1149.99	899.99	15.00	4.80
30	Appliances	Major Kitchen Appliances	Refrigerator	Brand FF	24.7cu ft French Door Refrigerator, Black Stainless Steel	2564.99	1499.99	5.00	4.50
31	Computers &Tablets	Desktops and All-In-Ones	Desktop	Brand P	Intel Core i7 9700, 16GB RAM, NVIDIA GeForce GTX 1660 Ti,	1249.99	899.99	12.00	4.70
32	Computers &Tablets	Laptops	PC Laptop	Brand P	2-in-1 15.6" Touch-Screen Laptop, Intel Core i7, 12GB RAM, 512GB S	1099.99	899.99	12.00	4.70
33	Video Gaming	PC Gaming	Gaming Laptop	Brand C	17.3" Gaming Laptop, Intel Core i7, 16GB RAM, NVIDIA GeForce GTX 1660 T	1399.99	899.99	12.00	4.40
34	TV&Home Theater	TVS 70" - 75"	4K LED	Brand BB	75" 4K UHD HDR Smart LED TV, NU6900 Series	899.99	749.99	8.00	4.60
35	Appliances	Major Kitchen Appliances	Range/Stove/Oven	Brand FF	30" Built-In Single Electric Wall Oven, Stainless Steel	1169.99	799.99	5.00	4.60
36	Appliances	Major Kitchen Appliances	Range/Stove/Oven	Brand M	5.3cu ft Slide-In Electric Range, Stainless Steel	1359.99	799.99	5.00	4.60
37	Cameras	Mirrorless Cameras	Camera Package	Brand E	Mirrorless Camera with Lens	629.99	599.99	20.00	4.80
38	Computers &Tablets	Desktops and All-In-Ones	All-In-One	Brand P	23.8" Touch-Screen All-in-One, Intel Core i5, 12GB RAM, 256GB SSD	949.99	699.99	15.00	4.70
39	TV&Home Theater	TVS 65"	4K LED	Brand DD	65" 4K UHD HDR Smart LED TV, X800G Series	899.99	699.99	12.00	4.70
40	Computers &Tablets	Laptops	2-in-1 Laptop	Brand BB	2-in-1 13.3" 8GB RAM 256GB Flash Memory	1099.99	749.99	10.00	4.70
41	TV&Home Theater	TVS 70" - 75"	4K LED	Brand BB	70" 4K UHD HDR Smart LED TV, 6 Series	599.99	549.99	15.00	4.10
42	TV&Home Theater	TVS 65"	4K LED	Brand EE	65" 4K UHD HDR Smart LED Roku TV, 4 Series	449.99	399.99	12.00	4.50
43	Video Gaming	Console Game Systems	Consoles	Brand GG	32GB Console - Gray Joy-Con + 2 more items	424.99	384.99	15.00	4.60
44	Cameras	DSLR Cameras	Camera Package	Brand E	DSLR Two Lens Kit with EF-S 18-55mm IS II and EF 75-300m	399.99	359.99	20.00	4.80
45	Video Gaming	PC Gaming	Gaming Desktop	Brand Q	Gaming Desktop, Intel Core i5-9400F, 8GB RAM, NVIDIA GeForce G	849.99	649.99	15.00	4.70
46	TV&Home Theater	TVS 65"	4K LED	Brand BB	65" 4K UHD HDR Smart LED TV, 7 Series	699.99	599.99	12.00	4.70
47	TV&Home Theater	TVS 65"	4K LED	Brand BB	65" 4K UHD HDR Smart LED TV, NU6900 Series	479.99	429.99	12.00	4.60
48	Cameras	DSLR Cameras	Camera Package	Brand AA	DSLR Two Lens Kit with AF-P DX NIKKOR 18-55mmf/3.5-5.6G VR &	449.99	399.99	20.00	4.80
49	Appliances	Laundry Appliances	Washer	Brand FF	3.8cu ft 12-Cycle Top-Loading Washer, White	499.99	449.99	8.00	4.50
50	TV&Home Theater	TVS 50" - 55"	4K LED	Brand BB	50" 4K UHD HDR Smart LED TV, 7 Series	399.99	349.99	12.00	4.70
51	Computers &Tablets	Desktops and All-In-Ones	All-In-One	Brand V	23.8" Touch-Screen All-in-One, AMD Ryzen 3-Series, 8GB Memory, 256GB	679.99	529.99	15.00	4.60
52	TV&Home Theater	TVS 50" - 55"	4K LED	Brand BB	55" 4K UHD HDR Smart LED TV, NU6900 Series	379.99	329.99	12.00	4.60

Remarks: A: Regular/ Suggested Retail Price (USD), B: Price During Flash Sale (USD), C: Quantity Available During Flash Sale, and D: Customer Rating (1 - 5)

Table A: The information that manager has provided about the product in flash sale.

Product No.	Department	Major Product Category	Product Type	Make (Brand)	Product (Item)	A	B	C	D
53	Video Gaming	PC Gaming	Gaming Desktop	Brand F	Gamer Master Gaming Desktop, AMD Ryzen 3 2300X, 8GB Memory	599.99	479.99	15.00	4.70
54	Appliances	Laundry Appliances	Dryer	Brand W	7.3cu ft 8-Cycle Electric Dryer, White	719.99	579.99	8.00	4.70
55	Cameras	Mirrorless Cameras	Camera Package	Brand DD	Mirrorless Camera Two Lens Kit with 16-50mm and 55-210mm Le	849.99	599.99	10.00	4.70
56	Video Gaming	PC Gaming	Gaming Desktop	Brand F	Gamer Master Gaming Desktop, AMD Ryzen 5 3600, 8GB Memory	819.99	599.99	12.00	5.00
57	Appliances	Laundry Appliances	Dryer	Brand W	7.4cu ft 10-Cycle Smart Wi-Fi Enabled Electric Dryer, White	809.99	599.99	8.00	4.60
58	Appliances	Laundry Appliances	Washer	Brand R	4.1cu ft 11-Cycle HE Top-Loading Washer, White	499.99	399.99	8.00	4.40
59	TV&Home Theater	TVS 50" - 55"	4K LED	Brand EE	55" 4K UHD HDR Smart LED Roku TV, 4 Series	319.99	279.99	12.00	4.60
60	TV&Home Theater	TVS 50" - 55"	4K LED	Brand BB	50" 4K UHD HDR Smart LED TV, NU6900 Series	329.99	279.99	12.00	4.60
61	Video Gaming	PC Gaming	Gaming Laptop	Brand C	15.6" Gaming Laptop, Intel Core i5, 8GB RAM, NVIDIA GeForce GTX 1650, 51	879.99	579.99	12.00	4.30
62	TV&Home Theater	TVS 50" - 55"	4K LED	Brand DD	55" 4K UHD HDR Smart LED TV, X800G Series	699.99	499.99	8.00	4.70
63	Cell Phones	Cell Phones and Accessories	Headsets	Brand HH	Wireless Wearable Speaker - Black	299.99	249.99	15.00	4.70
64	Computers &Tablets	Laptops	2-in-1 Chromebook	Brand G	2-in-1 14" Touch-Screen Chromebook, Intel Core i3, 4GB RAM, 128GB	549.00	449.00	10.00	4.60
65	TV&Home Theater	TVS 50" - 55"	4K LED	Brand EE	50" 4K UHD HDR Smart LED Roku TV	279.99	249.99	12.00	4.60
66	Appliances	Laundry Appliances	Dryer	Brand FF	7.0cu ft 13-Cycle Electric Dryer, White	679.99	499.99	5.00	4.60
67	Appliances	Laundry Appliances	Washer	Brand FF	4.3cu ft 12-Cycle Top-Loading Washer, White	679.99	499.99	5.00	4.30
68	Computers &Tablets	Desktops and All-In-Ones	Desktop	Brand P	Desktop, Intel Core i7, 8GB RAM, 256GB SSD	799.99	499.99	10.00	4.70
69	Appliances	Vacuum Cleaners & Floor Care	Upright Vacuum	Brand I	Ball Animal + Allergy Bagless Upright Vacuum	699.99	449.99	10.00	4.70
70	TV&Home Theater	TVS 50" - 55"	4K LED	Brand W	55" 4K UHD HDR Smart LED TV, UK6090PUA Series	399.99	299.99	8.00	4.70
71	Appliances	Laundry Appliances	Dryer	Brand M	7.2cu ft 3-Cycle Electric Dryer, White	629.99	429.99	5.00	4.50
72	Appliances	Major Kitchen Appliances	Range/Stove/Oven	Brand FF	5.1cu ft Freestanding Gas Range, Stainless Steel	629.99	449.99	8.00	4.40
73	Appliances	Vacuum Cleaners & Floor Care	Robot Vacuum	Brand CC	App-Controlled Robot Vacuum	449.99	299.99	15.00	4.30
74	Computers &Tablets	Tablets	Tablet	Brand N	12.3" Tablet, 64GB	799.99	449.00	10.00	4.10
75	Video Gaming	Console Game Systems	Consoles	Brand Y	1TB NBA 2K20 Bundle - Black	499.99	299.99	20.00	4.80
76	Appliances	Major Kitchen Appliances	Dishwasher	Brand L	24" Front Control Tall Tub Built-In Dishwasher, Stainless Steel	384.99	299.99	8.00	4.30
77	Appliances	Laundry Appliances	Washer	Brand M	4.2cu ft 11-Cycle Top-Loading Washer, White on White	656.99	429.99	5.00	4.40
78	Appliances	Major Kitchen Appliances	Range/Stove/Oven	Brand M	5.0cu ft Freestanding Gas Range, Stainless Steel	719.99	499.99	8.00	4.60
79	Computers &Tablets	Monitors	LED	Brand G	27" LED QHD G-Sync Monitor, Black	599.99	349.99	12.00	4.60

Remarks: A: Regular/ Suggested Retail Price (USD), B: Price During Flash Sale (USD), C: Quantity Available During Flash Sale, and D: Customer Rating (1 - 5)

Table A: The information that manager has provided about the product in flash sale.

Product No.	Department	Major Product Category	Product Type	Make (Brand)	Product (Item)	A	B	C	D
80	Video Gaming	Console Game Systems	Consoles	Brand Y	1TB Star Wars Jedi: Fallen Order Deluxe Edition Console Bundle	499.99	299.99	15.00	4.80
81	Computers &Tablets	Printers	All-In-One	Brand P	Color Wireless All-in-One Printer	428.99	279.99	15.00	4.60
82	TV&Home Theater	TVS 30" to 45"	4K LED	Brand BB	43" 4K UHD HDR Smart LED TV, 6 Series	279.99	229.99	10.00	4.70
83	Video Gaming	PC Gaming	Gaming Laptop	Brand P	15.6" Gaming Laptop, AMD Ryzen 5, 8GB Ram, NVIDIA GeForce GTX 1050, 25	799.99	449.99	10.00	5.00
84	Computers &Tablets	Laptops	PC Laptop	Brand P	17.3" Laptop, Intel Core i5, 8GB Memory, 256GB SSD, Jet Black, Maglia Pattern	599.99	399.99	10.00	4.60
85	Video Gaming	Console Game Systems	Consoles	Brand DD	1TB Fortnite Neo Versa Console Bundle - Jet Black	299.90	229.99	15.00	4.80
86	Appliances	Laundry Appliances	Washer	Brand X	24" Tall Tub Built-In Dishwasher, Monochromatic Stainless Steel24" Tall Tub Built-In Dishwasher, Monochromatic Stainless Steel24" Tall Tub Built-In Dishwasher, Monochromatic Stainless Steel24" Tall Tub Built-In Dishwasher, Monochromatic Stainless Steel	809.99	469.99	5.00	4.50
87	TV&Home Theater	TVS 65"	4K LED	Brand O	65" 4K UHD HDR Smart LED TV, H6500F Series	499.99	299.99	8.00	4.10
88	Computers &Tablets	Monitors	LED	Brand BB	28" LED 4K UHD Monitor, UE590 Series	299.99	229.99	15.00	4.50
89	Computers &Tablets	Laptops	2-in-1 Laptop	Brand P	2-in-1 14" Touch-Screen Laptop, Intel Core i5, 8GB RAM, 256GB S	799.99	499.99	8.00	4.60
90	Appliances	Vacuum Cleaners & Floor Care	Upright Vacuum	Brand I	Ball Animal 2 Bagless Upright Vacuum	499.99	299.99	10.00	4.70
91	Computers &Tablets	Laptops	2-in-1 Laptop	Brand P	2-in-1 11.6" Touch-Screen Laptop, Intel Pentium, 4GB RAM, 128GB	399.99	279.99	10.00	4.60
92	Appliances	Major Kitchen Appliances	Dishwasher	Brand FF	24" Tall Tub Built-In Dishwasher, Monochromatic Stainless Steel	584.99	329.99	10.00	4.40
93	Computers &Tablets	Laptops	2-in-1 Chromebook	Brand BB	2-in-1 12.2" Touch-Screen Chromebook, Intel Celeron, 4GB RAM, 32G	449.00	299.00	8.00	4.50
94	Appliances	Vacuum Cleaners & Floor Care	Robot Vacuum	Brand S	App-Controlled Self-Charging Robot Vacuum	499.99	279.99	10.00	4.30
95	Computers &Tablets	Laptops	PC Laptop	Brand G	15.6" Touch-Screen Laptop, Intel Core i5, 8GB Ram, 256GB SSD	599.99	349.99	8.00	4.50
96	Computers &Tablets	Laptops	2-in-1 Chromebook	Brand P	2-in-1 14" Touch-Screen Chromebook, Intel Core i3, 8GB RAM, 64GB eMMC Fla	599.00	349.00	8.00	4.60
97	Computers &Tablets	Laptops	PC Laptop	Brand G	15.6" Touch-Screen Laptop, Intel Core i3, 8GB Ram, 128GB SSD	449.99	279.99	10.00	4.50
98	Computers &Tablets	Laptops	2-in-1 Chromebook	Brand A	2-in-1 11.6" Touch-Screen Chromebook, Intel Celeron, 4GB RAM, 32GB	279.99	219.00	10.00	4.50
99	Appliances	Vacuum Cleaners & Floor Care	Robot Vacuum	Brand S	App-Controlled Robot Vacuum	299.99	199.99	15.00	4.50
100	TV&Home Theater	Video	Blu-Ray Players	Brand DD	Streaming 4K Ultra HD Hi-Res Audio Wi-Fi Built-In Blu-Ray Player	299.99	199.99	10.00	4.60
101	Appliances	Major Kitchen Appliances	Microwave	Brand M	1.6cu ft Over-the-Range Microwave, Stainless Steel	289.99	199.99	15.00	4.00
102	Cell Phones	Cell Phones and Accessories	Headsets	Brand W	Wireless Bluetooth Headset - Black	199.99	159.99	20.00	4.10
103	Computers &Tablets	Monitors	LED	Brand P	32" LED QHD Monitor	379.99	209.99	12.00	4.70

Remarks: A: Regular/ Suggested Retail Price (USD), B: Price During Flash Sale (USD), C: Quantity Available During Flash Sale, and D: Customer Rating (1 - 5)

Table A: The information that manager has provided about the product in flash sale.

Product No.	Department	Major Product Category	Product Type	Make (Brand)	Product (Item)	A	B	C	D
104	TV&Home Theater	TVS 30" to 45"	1080p LED Smart	Brand BB	40" 1080p Smart LED HDTV, 5 Series	259.99	179.99	8.00	4.70
105	Computers &Tablets	Laptops	PC Laptop	Brand P	14" Laptop, AMD A9 Series, 4GB Ram, AMD Radeon R5, 128GB SSD, WIndows	299.99	199.99	10.00	4.50
106	Computers &Tablets	Monitors	LED	Brand C	24" LED FHD Monitor, Black	249.99	169.99	15.00	4.80
107	Appliances	Vacuum Cleaners & Floor Care	Stick Vacuum	Brand CC	Bagless Cordless Pet Handheld/Stick Vacuum	249.99	169.99	15.00	4.40
108	TV&Home Theater	TVS 30" to 45"	720p LED Smart	Brand EE	32" 720p Smart LED HDTV Roku TV, 3 Series	129.99	119.99	10.00	4.70
109	Computers &Tablets	Laptops	2-in-1 Chromebook	Brand V	2-in-1 11.6" Touch-Screen Chromebook, 4GB RAM, 32GB eMMC Flash Mem	299.00	179.00	8.00	4.50
110	Computers &Tablets	Laptops	2-in-1 Laptop	Brand G	2-in-1 11.6" 4GB RAM 32GB Flash Memory	259.99	169.00	8.00	4.70
111	Computers &Tablets	Printers	All-In-One	Brand E	Wireless Color All-in-One Printer	349.99	169.99	12.00	4.20
112	Computers &Tablets	Printers	All-In-One	Brand K	Wireless All-in-One Printer	249.99	149.99	12.00	4.60
113	Appliances	Major Kitchen Appliances	Microwave	Brand B	1.6cu ft Over-the-Range Microwave, Black on Stainless	189.99	139.99	10.00	4.60
114	Audio	Headphones	Wireless Earphones	Brand T	Sport Wireless Earbud Headphones	219.99	131.99	25.00	4.10
115	Appliances	Vacuum Cleaners & Floor Care	Robot Vacuum	Brand J	App-Controlled Self-Charging Robot Vacuum	279.99	149.99	10.00	4.50
116	Computers &Tablets	Monitors	LED	Brand P	31.5" IPS LED FHD Monitor	299.99	149.99	12.00	4.60
117	TV&Home Theater	Video	Blu-Ray Players	Brand BB	Streaming 4K Ultra HD Audio Wi-Fi Built-In Blu-Ray Player	299.99	149.99	8.00	4.70
118	TV&Home Theater	Video	Blu-Ray Players	Brand DD	Streaming 4K Ultra HD Hi-Res Audio Wi-Fi Built-In Blu-Ray Player	249.99	129.99	8.00	4.80
119	Audio	Headphones	Wireless Earphones	Brand D	Wireless Earbud Headphones	249.99	119.99	25.00	4.50
120	Computers &Tablets	Laptops	PC Laptop	Brand V	11.4" Laptop, AMD A6 Series, 4GB Ram, AMD Radeon R4, 65GB e	229.99	129.99	10.00	4.10
121	Computers &Tablets	Laptops	Chromebook	Brand BB	11.6" Chromebook, Intel Atom x5, 4GB Memory, 32GB eMMC Flash Memo	219.00	119.00	12.00	4.60
122	TV&Home Theater	TVS 30" to 45"	720p LED HDTV	Brand W	32" 720p LED HDTV	169.99	99.99	8.00	4.70
123	Cell Phones	Cell Phones and Accessories	Headsets	Brand II	Wireless Noise Cancelling Earbud Headphones - Graphite	129.99	84.99	20.00	4.00
124	Computers &Tablets	Monitors	LED	Brand P	27" IPS LED FHD FreeSync Monitor, 27f	249.99	109.99	12.00	4.80
125	TV&Home Theater	Video	Blu-Ray Players	Brand W	4K Ultra HD Blu-Ray Player	199.99	99.99	8.00	4.60
126	TV&Home Theater	TVS 30" to 45"	720p LED Smart	Brand O	32" LED 720p Smart TV, H5500 Series	149.99	79.99	12.00	4.50
127	Computers &Tablets	Laptops	Chromebook	Brand BB	11.6" Chromebook, Intel Atom x5, 2GB Ram, 16GB eMMC Flash Memory	189.00	89.00	10.00	4.60
128	Computers &Tablets	Printers	All-In-One	Brand P	Wireless All-in-One Instant Ink Ready Printer	179.99	79.99	12.00	4.50

Remarks: A: Regular/ Suggested Retail Price (USD), B: Price During Flash Sale (USD), C: Quantity Available During Flash Sale, and D: Customer Rating (1 - 5)

Table A: The information that manager has provided about the product in flash sale.

Product No.	Department	Major Product Category	Product Type	Make (Brand)	Product (Item)	A	B	C	D
129	Computers &Tablets	Printers	All-In-One	Brand E	Wireless All-in-One Printer	129.99	69.99	12.00	4.10
130	Computers &Tablets	Tablets	Tablet	Brand H	10.1" Tablet, 32GB	99.99	59.99	10.00	3.70
131	TV&Home Theater	Video	Blu-Ray Players	Brand W	Streaming Audio Blu-Ray Player	69.99	49.99	15.00	4.50
132	Computers &Tablets	Monitors	LED	Brand P	20.7" LED FHD Monitor	99.90	59.99	8.00	4.60
133	TV&Home Theater	Video	Blu-Ray Players	Brand W	Streaming Audio Wi-Fi Built-In Blu-Ray Player	79.99	49.99	10.00	4.10
134	Computers &Tablets	Printers	All-In-One	Brand P	Wireless All-in-One Printer	69.99	19.99	12.00	4.10

Remarks: A: Regular/ Suggested Retail Price (USD), B: Price During Flash Sale (USD), C: Quantity Available During Flash Sale, and D: Customer Rating (1 - 5)

Table B: The information that was used in the model including with the data that was provided, normalized data, data coming from internet with reference, and data coming from the model

Product No.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	2499.99	2199.99	20.00	4.90	12.00	6.00	4.82	100.0	2199.99	0.84	7.62	13.97	10.41	106.45	0.10	0.06	0.01	0.60	0.60	0.01	6.60	10.71
2	3329.99	2199.99	5.00	4.30	33.93	15.00	4.81	97.81	2199.99	0.84	128.00	76.20	24.00	9753.60	0.00	0.00	0.38	58.06	0.00	0.00	78.11	1500.90
3	3149.99	2299.99	8.00	4.70	26.98	15.00	4.80	94.85	2299.99	0.88	176.00	78.00	80.00	13728.00	0.01	0.00	0.83	147.69	0.00	0.00	176.46	7341.25
4	2199.99	1999.99	20.00	4.90	9.09	4.00	4.80	94.83	1999.99	0.77	30.48	25.40	22.86	774.19	0.03	0.02	0.04	5.90	5.90	0.11	19.05	98.52
5	2199.99	1999.99	12.00	4.70	9.09	5.00	4.80	94.41	1999.99	0.77	168.40	35.56	105.66	5988.38	0.02	0.01	0.71	37.51	37.51	0.72	219.50	13084.1
6	2499.99	1999.99	12.00	4.80	20.00	10.00	4.79	93.34	1999.99	0.77	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	159.12	6881.52
7	1299.99	1199.99	15.00	4.80	7.69	5.00	4.73	77.21	1199.99	0.46	168.40	35.56	105.66	5988.38	0.02	0.01	0.71	37.51	37.51	0.72	129.07	7693.84
8	2474.99	1799.99	8.00	4.50	27.27	15.00	4.73	76.86	1799.99	0.69	176.00	78.00	80.00	13728.00	0.01	0.00	0.83	136.35	0.00	0.00	135.85	5651.59
9	1399.99	1199.99	12.00	4.70	14.29	10.00	4.73	75.30	1199.99	0.46	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	93.50	4043.79
10	1299.99	1099.99	12.00	4.80	15.38	10.00	4.72	74.56	1099.99	0.42	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	85.53	3698.95
11	2204.99	1749.99	10.00	4.70	20.64	15.00	4.72	74.05	1749.99	0.67	90.81	88.58	177.17	8043.78	0.02	0.00	0.73	126.28	0.00	0.00	114.92	4170.38
12	1399.99	1099.99	8.00	4.80	21.43	5.00	4.72	73.92	1099.99	0.42	168.40	35.56	105.66	5988.38	0.02	0.01	0.71	37.51	37.51	0.72	117.83	7023.64
13	1799.99	1699.99	15.00	4.70	5.56	10.00	4.72	73.25	1699.99	0.65	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	132.91	5748.01
14	1199.99	999.99	20.00	4.90	16.67	6.00	4.72	72.21	999.99	0.38	12.40	7.01	9.70	86.90	0.11	0.07	0.01	0.39	0.39	0.01	3.10	5.37
15	1099.99	999.99	15.00	4.70	9.09	10.00	4.71	72.02	999.99	0.38	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	77.45	3349.76
16	1499.99	1049.99	10.00	5.00	30.00	9.00	4.71	70.72	1049.99	0.40	50.04	20.57	52.07	1029.48	0.05	0.03	0.11	15.60	15.60	0.30	24.15	310.23
17	1599.99	1099.99	10.00	4.60	31.25	20.00	4.71	70.48	1099.99	0.42	54.10	3.56	43.94	192.39	0.23	0.15	0.08	2.26	2.26	0.04	16.45	137.32
18	1619.99	1099.99	5.00	4.60	32.10	15.00	4.71	70.48	1099.99	0.42	172.50	90.00	76.50	15525.00	0.00	0.00	0.86	145.15	0.00	0.00	84.72	3640.63
19	1379.99	999.99	15.00	4.80	27.54	5.00	4.71	70.02	999.99	0.38	20.83	46.99	47.50	978.71	0.05	0.03	0.06	9.48	9.48	0.18	13.59	103.29
20	1799.99	1399.99	15.00	4.60	22.22	9.00	4.71	69.62	1399.99	0.53	36.07	26.16	2.79	943.61	0.00	0.00	0.03	2.69	2.69	0.05	7.48	22.25
21	1699.99	1499.99	15.00	4.70	11.76	9.00	4.70	68.76	1499.99	0.57	20.83	38.10	45.72	793.55	0.06	0.04	0.05	12.25	12.25	0.23	21.91	177.92
22	1499.99	999.99	10.00	4.90	33.33	6.00	4.70	68.27	999.99	0.38	7.62	13.97	10.41	106.45	0.10	0.06	0.01	0.60	0.60	0.01	2.90	4.69
23	1799.99	1499.99	12.00	4.80	16.67	8.00	4.70	68.06	1499.99	0.57	139.70	16.00	83.31	2235.48	0.04	0.02	0.42	17.01	17.01	0.33	90.39	3030.11
24	1599.99	999.99	10.00	4.80	37.50	4.00	4.70	67.95	999.99	0.38	12.70	4.80	9.40	60.97	0.15	0.10	0.01	0.47	0.47	0.01	3.86	8.33
25	1299.99	999.00	12.00	4.60	23.15	20.00	4.70	67.79	999.00	0.38	20.83	46.99	47.50	978.71	0.05	0.03	0.06	1.54	1.54	0.03	9.03	45.71
26	1439.99	999.99	5.00	4.70	30.56	15.00	4.69	66.55	999.99	0.38	91.44	76.20	63.50	6967.73	0.01	0.01	0.38	83.92	0.00	0.00	34.23	657.22
27	2999.99	2599.99	8.00	4.80	13.33	1.00	4.69	65.49	2599.99	1.00	205.74	37.47	125.10	7708.05	0.02	0.01	1.00	48.17	48.17	0.92	385.67	31709.7
28	1249.99	949.99	12.00	4.60	24.00	20.00	4.69	64.57	949.99	0.36	20.83	46.99	47.50	978.71	0.05	0.03	0.06	1.72	1.72	0.03	8.65	44.30
29	1149.99	899.99	15.00	4.80	21.74	6.00	4.69	64.14	899.99	0.34	7.62	13.97	10.41	106.45	0.10	0.06	0.01	1.37	1.37	0.03	2.98	5.57

Remarks: A: regular/suggested retail price(USD), B: Price during flash sale, C: Quantity available during flash sale, D: Customer rating, E: Percent discount, F: Amount of brand, G: Product popularity, H: Product popularity normalized, I: price, J: normalize price, K: Width, L: Length, M: Height, N: Base area, O: High per base area, P: Normalize high per base area, Q: Normalized surface area, R: Weight, S: Edit weight, T: Normalize edit weight, U: Damage score, and V: Damage score squae.

Table B: The information that was used in the model including with the data that was provided, normalized data, data coming from internet with reference, and data coming from the model

Product No.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
30	2564.99	1499.99	5.00	4.50	41.52	15.00	4.68	63.94	1499.99	0.57	176.00	78.00	80.00	13728.00	0.01	0.00	0.83	138.00	0.00	0.00	111.81	4651.43
31	1249.99	899.99	12.00	4.70	28.00	5.00	4.68	62.87	899.99	0.34	20.83	46.99	47.50	978.71	0.05	0.03	0.06	14.52	14.52	0.28	14.70	135.41
32	1099.99	899.99	12.00	4.70	18.18	20.00	4.68	61.84	899.99	0.34	15.24	12.70	10.16	193.55	0.05	0.03	0.01	2.26	2.26	0.04	3.16	6.25
33	1399.99	899.99	12.00	4.40	35.71	9.00	4.67	60.94	899.99	0.34	57.00	44.50	21.60	2536.50	0.01	0.00	0.11	2.20	2.20	0.04	13.32	111.28
34	899.99	749.99	8.00	4.60	16.67	5.00	4.64	52.80	749.99	0.28	168.40	35.56	105.66	5988.38	0.02	0.01	0.71	37.51	37.51	0.72	78.32	4668.63
35	1169.99	799.99	5.00	4.60	31.62	15.00	4.64	51.63	799.99	0.30	76.20	74.00	24.00	5638.80	0.00	0.00	0.22	128.82	0.00	0.00	15.76	177.10
36	1359.99	799.99	5.00	4.60	41.18	15.00	4.63	50.05	799.99	0.30	91.44	76.20	63.50	6967.73	0.01	0.01	0.38	81.19	0.00	0.00	26.89	516.27
37	629.99	599.99	20.00	4.80	4.76	4.00	4.63	49.86	599.99	0.22	24.30	20.70	14.10	503.01	0.03	0.02	0.03	1.60	1.60	0.03	2.62	6.58
38	949.99	699.99	15.00	4.70	26.32	5.00	4.63	49.22	699.99	0.26	54.10	3.56	43.94	192.39	0.23	0.15	0.08	5.90	5.90	0.11	11.61	110.36
39	899.99	699.99	12.00	4.70	22.22	10.00	4.63	48.50	699.99	0.26	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	52.75	2281.28
40	1099.99	749.99	10.00	4.70	31.82	20.00	4.63	47.81	749.99	0.28	20.83	46.99	47.50	978.71	0.05	0.03	0.06	1.70	1.70	0.03	6.69	34.23
41	599.99	549.99	15.00	4.10	8.33	5.00	4.62	47.36	549.99	0.21	112.78	6.35	65.53	716.13	0.09	0.06	0.24	13.20	13.20	0.25	20.32	434.69
42	449.99	399.99	12.00	4.50	11.11	10.00	4.62	47.04	399.99	0.15	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	29.44	1273.34
43	424.99	384.99	15.00	4.60	9.41	4.00	4.62	46.95	384.99	0.14	34.80	19.81	9.40	689.42	0.01	0.01	0.03	1.20	1.20	0.02	1.67	4.28
44	399.99	359.99	20.00	4.80	10.00	6.00	4.62	46.93	359.99	0.13	12.95	7.87	10.16	102.00	0.10	0.06	0.01	2.72	2.72	0.05	1.46	3.51
45	849.99	649.99	15.00	4.70	23.53	9.00	4.62	46.54	649.99	0.24	27.69	17.02	33.78	471.16	0.07	0.05	0.04	5.15	5.15	0.10	5.94	31.29
46	699.99	599.99	12.00	4.70	14.29	10.00	4.62	45.82	599.99	0.22	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	44.89	1941.61
47	479.99	429.99	12.00	4.60	10.42	10.00	4.62	45.35	429.99	0.16	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	31.72	1372.00
48	449.99	399.99	20.00	4.80	11.11	6.00	4.62	45.22	399.99	0.15	12.45	9.65	6.86	120.13	0.06	0.04	0.01	3.81	3.81	0.07	1.51	3.38
49	499.99	449.99	8.00	4.50	10.00	9.00	4.61	44.99	449.99	0.17	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	52.16	52.16	1.00	36.29	1712.32
50	399.99	349.99	12.00	4.70	12.50	8.00	4.61	44.96	349.99	0.13	112.52	24.13	69.34	2715.16	0.03	0.02	0.32	7.39	7.39	0.14	13.96	330.13
51	679.99	529.99	15.00	4.60	22.06	5.00	4.61	44.77	529.99	0.20	54.10	3.56	43.94	192.39	0.23	0.15	0.08	5.90	5.90	0.11	8.67	82.47
52	379.99	329.99	12.00	4.60	13.16	8.00	4.61	44.49	329.99	0.12	139.70	16.00	83.31	2235.48	0.04	0.02	0.42	17.01	17.01	0.33	18.58	622.87
53	599.99	479.99	15.00	4.70	20.00	9.00	4.61	44.21	479.99	0.18	46.99	20.83	47.50	978.71	0.05	0.03	0.10	14.52	14.52	0.28	9.56	111.09
54	719.99	579.99	8.00	4.70	19.44	9.00	4.61	44.04	579.99	0.22	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	55.66	0.00	0.00	22.83	520.70
55	849.99	599.99	10.00	4.70	29.41	4.00	4.61	44.01	599.99	0.22	11.99	4.52	6.68	54.20	0.12	0.08	0.00	1.45	1.45	0.03	2.12	4.32
56	819.99	599.99	12.00	5.00	26.83	9.00	4.61	43.83	599.99	0.22	46.99	20.83	47.50	978.71	0.05	0.03	0.10	14.52	14.52	0.28	12.05	140.03
57	809.99	599.99	8.00	4.60	25.93	9.00	4.61	43.36	599.99	0.22	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	55.34	0.00	0.00	23.63	539.00
58	499.99	399.99	8.00	4.40	20.00	9.00	4.61	43.26	399.99	0.15	68.58	71.44	110.01	4899.36	0.02	0.00	0.38	115.00	0.00	0.00	12.74	239.09

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Table B: The information that was used in the model including with the data that was provided, normalized data, data coming from internet with reference, and data coming from the model

Prod uct No.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
59	319.99	279.99	12.00	4.60	12.50	8.00	4.61	43.01	279.99	0.10	139.70	16.00	83.31	2235.48	0.04	0.02	0.42	17.01	17.01	0.33	15.56	521.78
60	329.99	279.99	12.00	4.60	15.15	8.00	4.61	42.53	279.99	0.10	112.52	24.13	69.34	2715.16	0.03	0.02	0.32	7.39	7.39	0.14	10.98	259.59
61	879.99	579.99	12.00	4.30	34.09	9.00	4.60	42.11	579.99	0.22	36.07	26.16	2.79	943.61	0.00	0.00	0.03	2.69	2.69	0.05	2.97	8.83
62	699.99	499.99	8.00	4.70	28.57	8.00	4.60	41.84	499.99	0.19	139.70	16.00	83.31	2235.48	0.04	0.02	0.42	17.01	17.01	0.33	28.71	962.39
63	299.99	249.99	15.00	4.70	16.67	3.00	4.60	41.81	249.99	0.09	29.72	28.45	8.89	845.42	0.01	0.01	0.03	0.31	0.31	0.01	1.00	2.45
64	549.00	449.00	10.00	4.60	18.21	20.00	4.60	41.79	449.00	0.17	32.51	22.61	1.52	734.97	0.00	0.00	0.02	0.95	0.95	0.02	1.44	2.71
65	279.99	249.99	12.00	4.60	10.71	8.00	4.60	41.75	249.99	0.09	112.52	24.13	69.34	2715.16	0.03	0.02	0.32	7.39	7.39	0.14	9.70	229.49
66	679.99	499.99	5.00	4.60	26.47	9.00	4.60	41.58	499.99	0.19	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	52.16	0.00	0.00	19.53	445.43
67	679.99	499.99	5.00	4.30	26.47	9.00	4.60	41.58	499.99	0.19	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	61.24	0.00	0.00	19.53	445.43
68	799.99	499.99	10.00	4.70	37.50	5.00	4.60	41.12	499.99	0.19	20.83	46.99	47.50	978.71	0.05	0.03	0.06	14.52	14.52	0.28	7.88	72.59
69	699.99	449.99	10.00	4.70	35.71	7.00	4.60	41.06	449.99	0.17	57.00	44.50	21.60	2536.50	0.01	0.00	0.11	9.52	9.52	0.18	8.20	87.68
70	399.99	299.99	8.00	4.70	25.00	8.00	4.60	41.05	299.99	0.11	139.70	16.00	83.31	2235.48	0.04	0.02	0.42	17.01	17.01	0.33	16.74	561.03
71	629.99	429.99	5.00	4.50	31.75	9.00	4.60	40.72	429.99	0.16	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	47.63	0.00	0.00	16.67	380.21
72	629.99	449.99	8.00	4.40	28.57	15.00	4.60	40.58	449.99	0.17	91.44	76.20	63.50	6967.73	0.01	0.01	0.38	61.62	0.00	0.00	14.71	282.45
73	449.99	299.99	15.00	4.30	33.33	7.00	4.60	40.55	299.99	0.11	34.00	34.00	90.00	1156.00	0.08	0.05	0.13	3.60	3.60	0.07	5.27	55.64
74	799.99	449.00	10.00	4.10	43.87	2.00	4.60	40.52	449.00	0.17	28.96	20.32	0.76	588.39	0.00	0.00	0.02	0.72	0.72	0.01	1.11	1.60
75	499.99	299.99	20.00	4.80	40.00	4.00	4.60	40.44	299.99	0.11	13.72	31.75	47.75	435.48	0.11	0.07	0.03	5.66	5.66	0.11	2.63	13.86
76	384.99	299.99	8.00	4.30	22.08	15.00	4.60	40.41	299.99	0.11	89.00	61.00	61.00	5429.00	0.01	0.01	0.33	26.76	26.76	0.51	15.18	461.62
77	656.99	429.99	5.00	4.40	34.55	9.00	4.60	40.22	429.99	0.16	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	66.68	0.00	0.00	16.66	380.05
78	719.99	499.99	8.00	4.60	30.56	15.00	4.60	40.18	499.99	0.19	91.44	76.20	63.50	6967.73	0.01	0.01	0.38	61.62	0.00	0.00	16.42	315.19
79	599.99	349.99	12.00	4.60	41.67	7.00	4.60	39.86	349.99	0.13	73.91	17.78	52.32	1314.19	0.04	0.03	0.16	9.80	9.80	0.19	8.19	114.17
80	499.99	299.99	15.00	4.80	40.00	4.00	4.60	39.84	299.99	0.11	13.72	31.75	47.75	435.48	0.11	0.07	0.03	5.66	5.66	0.11	2.63	13.85
81	428.99	279.99	15.00	4.60	34.73	6.00	4.59	39.67	279.99	0.10	44.53	56.44	12.80	2513.01	0.01	0.00	0.09	6.45	6.45	0.12	3.85	32.09
82	279.99	229.99	10.00	4.70	17.86	5.00	4.59	39.38	229.99	0.08	96.77	20.57	60.45	1991.03	0.03	0.02	0.24	7.39	7.39	0.14	6.87	126.12
83	799.99	449.99	10.00	5.00	43.75	9.00	4.59	39.25	449.99	0.17	36.07	26.16	2.79	943.61	0.00	0.00	0.03	2.69	2.69	0.05	2.28	6.77
84	599.99	399.99	10.00	4.60	33.33	20.00	4.59	39.15	399.99	0.15	20.83	46.99	47.50	978.71	0.05	0.03	0.06	2.95	2.95	0.06	3.73	20.56
85	299.90	229.99	15.00	4.80	23.31	4.00	4.59	39.09	229.99	0.08	42.93	34.29	9.65	1471.93	0.01	0.00	0.06	3.48	3.48	0.07	1.86	9.21
86	809.99	469.99	5.00	4.50	41.98	9.00	4.59	38.82	469.99	0.17	103.00	69.00	78.50	7107.00	0.01	0.01	0.46	29.40	0.00	0.00	18.27	416.66
87	499.99	299.99	8.00	4.10	40.00	10.00	4.59	38.74	299.99	0.11	156.97	18.80	95.76	2950.45	0.03	0.02	0.54	22.00	22.00	0.42	21.55	932.00

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Product No.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
88	299.99	229.99	15.00	4.50	23.33	7.00	4.59	38.62	229.99	0.08	61.20	20.30	45.00	1242.36	0.04	0.02	0.12	3.68	3.68	0.07	3.58	34.30
89	799.99	499.99	8.00	4.60	37.50	20.00	4.59	38.01	499.99	0.19	20.83	46.99	47.50	978.71	0.05	0.03	0.06	0.95	0.95	0.02	4.16	20.29
90	499.99	299.99	10.00	4.70	40.00	7.00	4.59	38.00	299.99	0.11	57.00	44.50	21.60	2536.50	0.01	0.00	0.11	9.52	9.52	0.18	5.33	56.95
91	399.99	279.99	10.00	4.60	30.00	20.00	4.59	37.64	279.99	0.10	54.10	3.56	43.94	192.39	0.23	0.15	0.08	1.66	1.66	0.03	3.77	30.74
92	584.99	329.99	10.00	4.40	43.59	15.00	4.59	37.53	329.99	0.12	89.00	61.00	61.00	5429.00	0.01	0.01	0.33	40.00	40.00	0.77	19.10	661.58
93	449.00	299.00	8.00	4.50	33.41	20.00	4.59	37.49	299.00	0.11	20.83	46.99	47.50	978.71	0.05	0.03	0.06	1.32	1.32	0.03	2.48	12.36
94	499.99	279.99	10.00	4.30	44.00	7.00	4.59	37.24	279.99	0.10	34.00	34.00	90.00	1156.00	0.08	0.05	0.13	3.60	3.60	0.07	4.88	51.53
95	599.99	349.99	8.00	4.50	41.67	20.00	4.59	37.08	349.99	0.13	15.24	12.70	10.16	193.55	0.05	0.03	0.01	2.26	2.26	0.04	1.16	2.30
96	599.00	349.00	8.00	4.60	41.74	20.00	4.59	37.06	349.00	0.13	32.51	22.61	1.52	734.97	0.00	0.00	0.02	0.95	0.95	0.02	1.10	2.07
97	449.99	279.99	10.00	4.50	37.78	20.00	4.58	36.23	279.99	0.10	15.24	12.70	10.16	193.55	0.05	0.03	0.01	2.26	2.26	0.04	0.91	1.81
98	279.99	219.00	10.00	4.50	21.78	20.00	4.58	35.52	219.00	0.08	28.96	20.57	1.78	595.74	0.00	0.00	0.02	1.18	1.18	0.02	0.60	1.01
99	299.99	199.99	15.00	4.50	33.33	7.00	4.57	34.30	199.99	0.07	34.00	34.00	90.00	1156.00	0.08	0.05	0.13	3.60	3.60	0.07	3.37	35.59
100	299.99	199.99	10.00	4.60	33.33	6.00	4.57	33.96	199.99	0.07	38.10	30.48	10.16	1161.29	0.01	0.00	0.05	1.91	1.91	0.04	1.22	4.63
101	289.99	199.99	15.00	4.00	31.04	15.00	4.57	33.51	199.99	0.07	75.00	43.50	39.50	3262.50	0.01	0.01	0.19	15.70	15.70	0.30	5.62	99.01
102	199.99	159.99	20.00	4.10	20.00	3.00	4.57	33.40	159.99	0.05	22.12	6.91	26.11	152.85	0.17	0.11	0.02	0.24	0.24	0.00	0.84	2.86
103	379.99	209.99	12.00	4.70	44.74	7.00	4.57	32.85	209.99	0.07	54.10	3.56	43.94	192.39	0.23	0.15	0.08	7.12	7.12	0.14	3.33	32.98
104	259.99	179.99	8.00	4.70	30.77	5.00	4.57	32.38	179.99	0.06	90.42	18.29	57.66	1653.67	0.03	0.02	0.21	8.48	8.48	0.16	4.76	80.14
105	299.99	199.99	10.00	4.50	33.33	20.00	4.57	31.85	199.99	0.07	54.10	3.56	43.94	192.39	0.23	0.15	0.08	2.14	2.14	0.04	2.65	21.99
106	249.99	169.99	15.00	4.80	32.00	7.00	4.56	31.42	169.99	0.06	72.90	21.84	21.60	1592.38	0.03	0.02	0.16	4.72	4.72	0.09	3.26	40.16
107	249.99	169.99	15.00	4.40	32.00	7.00	4.56	31.42	169.99	0.06	57.00	44.50	49.78	2536.50	0.01	0.00	0.11	9.52	9.52	0.18	2.84	30.35
108	129.99	119.99	10.00	4.70	7.69	5.00	4.56	28.95	119.99	0.04	73.15	17.27	48.26	1263.48	0.04	0.02	0.14	3.90	3.90	0.07	1.99	22.37
109	299.00	179.00	8.00	4.50	40.13	20.00	4.55	28.40	179.00	0.06	28.96	20.57	1.78	595.74	0.00	0.00	0.02	1.18	1.18	0.02	0.47	0.80
110	259.99	169.00	8.00	4.70	35.00	20.00	4.55	28.24	169.00	0.06	20.83	46.99	47.50	978.71	0.05	0.03	0.06	1.18	1.18	0.02	1.30	6.44
111	349.99	169.99	12.00	4.20	51.43	6.00	4.55	27.83	169.99	0.06	44.53	56.44	12.80	2513.01	0.01	0.00	0.09	6.45	6.45	0.12	2.20	18.34
112	249.99	149.99	12.00	4.60	40.00	6.00	4.55	27.45	149.99	0.05	44.53	56.44	12.80	2513.01	0.01	0.00	0.09	6.45	6.45	0.12	1.91	15.89
113	189.99	139.99	10.00	4.60	26.32	15.00	4.55	27.13	139.99	0.05	75.00	43.50	39.50	3262.50	0.01	0.01	0.19	15.70	15.70	0.30	3.73	65.67
114	219.99	131.99	25.00	4.10	40.00	2.00	4.55	26.69	131.99	0.04	3.05	2.54	3.05	7.74	0.39	0.26	0.00	0.01	0.01	0.00	0.84	3.60
115	279.99	149.99	10.00	4.50	46.43	7.00	4.54	25.99	149.99	0.05	34.00	34.00	90.00	1156.00	0.08	0.05	0.13	3.60	3.60	0.07	2.42	25.53
116	299.99	149.99	12.00	4.60	50.00	7.00	4.54	25.54	149.99	0.05	54.61	11.43	39.37	624.19	0.06	0.04	0.08	1.43	1.43	0.03	1.53	10.27

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Product No.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
117	299.99	149.99	8.00	4.70	50.00	6.00	4.54	25.32	149.99	0.05	38.10	30.48	10.16	1161.29	0.01	0.00	0.05	1.91	1.91	0.04	0.87	3.32
118	249.99	129.99	8.00	4.80	48.00	6.00	4.53	23.01	129.99	0.04	38.10	30.48	10.16	1161.29	0.01	0.00	0.05	1.91	1.91	0.04	0.74	2.80
119	249.99	119.99	25.00	4.50	52.00	2.00	4.53	22.81	119.99	0.04	1.78	1.78	4.06	3.16	1.29	0.84	0.00	0.04	0.04	0.00	2.45	34.18
120	229.99	129.99	10.00	4.10	43.48	20.00	4.53	22.06	129.99	0.04	46.99	32.77	8.13	1539.67	0.01	0.00	0.06	2.12	2.12	0.04	0.88	4.05
121	219.00	119.00	12.00	4.60	45.66	20.00	4.52	20.28	119.00	0.04	28.96	20.57	1.78	595.74	0.00	0.00	0.02	1.18	1.18	0.02	0.29	0.50
122	169.99	99.99	8.00	4.70	41.18	5.00	4.52	19.80	99.99	0.03	73.15	17.27	48.26	1263.48	0.04	0.02	0.14	3.90	3.90	0.07	1.58	17.76
123	129.99	84.99	20.00	4.00	34.62	3.00	4.52	19.59	84.99	0.03	9.91	1.02	15.47	10.06	1.54	1.00	0.00	0.03	0.03	0.00	1.94	32.91
124	249.99	109.99	12.00	4.80	56.00	7.00	4.52	18.86	109.99	0.03	61.21	20.07	41.66	1228.32	0.03	0.02	0.11	6.80	6.80	0.13	1.59	16.12
125	199.99	99.99	8.00	4.60	50.00	6.00	4.51	18.14	99.99	0.03	38.10	30.48	10.16	1161.29	0.01	0.00	0.05	1.91	1.91	0.04	0.53	2.03
126	149.99	79.99	12.00	4.50	46.67	5.00	4.51	15.78	79.99	0.02	73.15	17.27	48.26	1263.48	0.04	0.02	0.14	3.90	3.90	0.07	1.18	13.28
127	189.00	89.00	10.00	4.60	52.91	20.00	4.50	14.19	89.00	0.03	28.96	20.57	1.78	595.74	0.00	0.00	0.02	1.18	1.18	0.02	0.20	0.34
128	179.99	79.99	12.00	4.50	55.56	6.00	4.50	14.13	79.99	0.02	44.53	56.44	12.80	2513.01	0.01	0.00	0.09	6.45	6.45	0.12	0.87	7.25
129	129.99	69.99	12.00	4.10	46.16	6.00	4.50	13.96	69.99	0.02	44.53	56.44	12.80	2513.01	0.01	0.00	0.09	6.45	6.45	0.12	0.73	6.04
130	99.99	59.99	10.00	3.70	40.00	2.00	4.50	13.52	59.99	0.02	28.96	20.32	0.76	588.39	0.00	0.00	0.02	0.72	0.72	0.01	0.10	0.15
131	69.99	49.99	15.00	4.50	28.58	6.00	4.50	13.40	49.99	0.01	38.10	30.48	10.16	1161.29	0.01	0.00	0.05	1.91	1.91	0.04	0.20	0.76
132	99.90	59.99	8.00	4.60	39.95	7.00	4.50	12.77	59.99	0.02	54.10	3.56	43.94	192.39	0.23	0.15	0.08	3.00	3.00	0.06	0.60	5.13
133	79.99	49.99	10.00	4.10	37.50	6.00	4.49	11.54	49.99	0.01	38.10	30.48	10.16	1161.29	0.01	0.00	0.05	1.91	1.91	0.04	0.20	0.76
134	69.99	19.99	12.00	4.10	71.44	6.00	4.45	0.00	19.99	0.00	44.53	56.44	12.80	2513.01	0.01	0.00	0.09	6.45	6.45	0.12	0.00	0.00

Remarks: A: regular/suggested retail price(USD), B: Price during flash sale, C: Quantity available during flash sale, D: Customer rating, E: Percent discount, F: Amount of brand, G: Product popularity, H: Product popularity normalized, I: price, J: normalize price, K: Width, L: Length, M: Height, N: Base area, O: High per base area, P: Normalize high per base area, Q: Normalized surface area, R: Weight, S: Edit weight, T: Normalize edit weight, U: Damage score, and V: Damage score squae.

Code#1: Machine Learning for finding - Product Demand (Python)

Part 1: Importing module or library to use in the program

```python
## Import Module
import numpy as np
from numpy import asarray
from numpy import savetxt
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.tree import DecisionTreeClassifier
from sklearn.tree import DecisionTreeRegressor
from sklearn.neighbors import KNeighborsClassifier
from sklearn.neighbors import KNeighborsRegressor
from sklearn.naive_bayes import GaussianNB
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import RandomForestRegressor
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import GridSearchCV
from sklearn.svm import SVC
from matplotlib import cm as cm
from sklearn.preprocessing import LabelEncoder
from sklearn import preprocessing
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import StratifiedShuffleSplit
from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import r2_score
from sklearn.ensemble import RandomForestRegressor
from collections import defaultdict
from sklearn import datasets, linear_model
from sklearn.model_selection import cross_val_predict
from sklearn.svm import SVR
from sklearn.model_selection import GridSearchCV
import matplotlib.pyplot as plt
from matplotlib.ticker import MultipleLocator
import pylab as py
import statsmodels.api as sm
from statsmodels.stats.outliers_influence import summary_table
## Import Module
```

Code#1: Machine Learning for finding - Product Demand (Python)

Part 2 : Importing product data into the program.

```python
## Import Data
dataset = pd.read_csv('dataset.csv', index_col='ID')
dataset.name = 'dataset'
## Import Data
```

Part 3 : Machine Learning model with using

```python
## Model SVM with Hyperparameter Tuning technique
dataset = dataset.apply(lambda x: pd.to_numeric(x, errors='ignore'))
dataset = dataset.fillna(method='ffill')
Y = dataset["rating"].to_numpy().astype(np.float)
data = dataset.iloc[:, 1:]
h = data.columns.tolist()
hx = np.array(h)
data = data.to_numpy().astype(np.float)
X = np.array(data)

X_internal, X_external, Y_internal, Y_external = train_test_split(X, Y,
test_size=0.2, random_state=13)

param_grid = {
    'C': [1.0, 2.0, 3.0, 4.0, 5.0],
    'epsilon': [0.1, 0.2, 0.3, 0.4, 0.5],
    'degree': [2, 3, 4, 5],
    'verbose': [False, True],
    'shrinking': [False, True],
    'kernel': ['rbf', 'linear', 'sigmoid']
}

grid_search = GridSearchCV(estimator=SVR(), param_grid=param_grid, scoring='r2',
cv=13, n_jobs=-1, verbose=2)
grid_search.fit(X_internal, Y_internal)
print(grid_search.best_params_)

def evaluate(model, test_features, test_labels):
    predictions = model.predict(test_features)
    errors = abs(predictions - test_labels)
    mape = 100 * np.mean(errors / test_labels)
    accuracy = 100 - mape
    print('Model Performance')
    print('Average Error: {:0.4f} degrees.'.format(np.mean(errors)))
    print('Accuracy = {:0.2f}%.'.format(accuracy))
    return accuracy

base_model = SVR()

base_model.fit(X_internal, Y_internal)
prediction_external_base_model = base_model.predict(X_external)
Q2_External_base_model = r2_score(Y_external, prediction_external_base_model)
base_accuracy = evaluate(base_model, X_external, Y_external)
print('Q2: %0.4f' % (Q2_External_base_model))

best_grid = grid_search.best_estimator_
prediction_external_best_grid = best_grid.predict(X_external)
Q2_External_best_grid = r2_score(Y_external, prediction_external_best_grid)
grid_accuracy = evaluate(best_grid, X_external, Y_external)
print('Q2: %0.4f' % (Q2_External_best_grid))
```

Code#1: Machine Learning for finding - Product Demand (Python)

```python
print('Improvement of {:0.2f}%.'.format(100 * (grid_accuracy - base_accuracy) /
base_accuracy))
## Model SVM with Hyperparameter Tuning technique
```

Part 4 : Virtualizing data between Customer Rating and Product Demand

```python
## Plot graph between Customer Rating and Customer Demand
cm = plt.cm.RdBu

fig_size = plt.rcParams["figure.figsize"]
fig_size[0] = 5
fig_size[1] = 5

x_graph = np.array(Y)
y_graph = m.predict(X.flatten())
py.scatter(x_graph, y_graph, s=50, marker='.', alpha=0.4, c='g', cmap=cm,
edgecolors='b')
plt.plot(X, predict_ci_low, '--b', linewidth=0.5, alpha=0.5)
plt.plot(X, predict_ci_upp, '--b', linewidth=0.5, alpha=0.5)

plt.legend(loc=2, prop={'size': 6})
plt.xlabel("Customer Rating", fontsize=10)
plt.ylabel("Customer Demand", fontsize=10)

min_axis = np.min(np.concatenate([Y_internal, prediction], axis=0))
max_axis = np.max(np.concatenate([Y_internal, prediction], axis=0))
plt.xlim([(min_axis * 0.9), (max_axis * 1.05)])
plt.ylim([(min_axis * 0.9), (max_axis * 1.05)])
plt.tick_params(axis='both', which='major', labelsize=14)

plt.savefig('graph.pdf', dpi=300)
plt.show()
## Plot graph between Customer Rating and Customer Demand
```

Part 5 : Export Data

```python
## Export Data
out_predict = best_grid.predict(X)
out_real = Y
savetxt('predict.csv', out_predict, delimiter=',')
savetxt('rating.csv', out_real, delimiter=',')
## Export Data
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
#include <bits/stdc++.h>
using namespace std;

#define M_PI 3.14159265358979323846

// Define Struct
typedef struct ellipses{
    float a; // Major Axis
    float b; // Minor Axis
    float h; // Coordinate X
    float k; // Coordinate Y
}ellipses;

//Define Permanent Valuable
int number_of_case = 0;
float min_of_intersect_area = FLT_MAX;
pair<int,int> coordinate_of_area[18];
int using_which_area[18];
float damage_of_category[8];
float popularity_of_category[8];
float base_area_of_category[8];
float base_area_of_area_zone[18];
int time_visit_each_category[8];
float b_to_a_of_each_area[18];
float the_least_area_of_intersect = FLT_MAX;
int the_best_using_which_area[18];

//Define each case valuable
float total_area_each_category[8];
float damage_of_each_area[18];
float popularity_of_each_area[18];
ellipses damage_property_of_ellipse[18];
ellipses popularity_property_of_ellipse[18];

//Find Area of intersect sub function
float find_area_intersect_function(int E0, int E1, int mode){

    // Initialize data
    float h1,h2,k1,k2,a1,a2,b1,b2;

    if(mode==1){
        h1 = damage_property_of_ellipse[E0].h;
        k1 = damage_property_of_ellipse[E0].k;
        a1 = damage_property_of_ellipse[E0].a;
        b1 = damage_property_of_ellipse[E0].b;
        h2 = damage_property_of_ellipse[E1].h;
        k2 = damage_property_of_ellipse[E1].k;
        a2 = damage_property_of_ellipse[E1].a;
        b2 = damage_property_of_ellipse[E1].b;
    }else{
        h1 = popularity_property_of_ellipse[E0].h;
        k1 = popularity_property_of_ellipse[E0].k;
        a1 = popularity_property_of_ellipse[E0].a;
        b1 = popularity_property_of_ellipse[E0].b;
        h2 = popularity_property_of_ellipse[E1].h;
        k2 = popularity_property_of_ellipse[E1].k;
        a2 = popularity_property_of_ellipse[E1].a;
        b2 = popularity_property_of_ellipse[E1].b;
    }
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
    // Initialize Inclination
    float PHI_1,PHI_2;

    if(b1>a1){
        if(b2>a2){
            float swap1;
            swap1 = b1;
            b1 = a1;
            a1 = swap1;
            int swap2;
            swap2 = b2;
            b2 = a2;
            a2 = swap2;
            PHI_1 = M_PI/2.00;
            PHI_2 = M_PI/2.00;
        }else{
            float swap1;
            swap1 = b1;
            b1 = a1;
            a1 = swap1;
            PHI_1 = M_PI/2.00;
            PHI_2 = 0.00;
        }
    }else{
        if(b2>a2){
            float swap2;
            swap2 = b2;
            b2 = a2;
            a2 = swap2;
            PHI_1 = 0.00;
            PHI_2 = M_PI/2.00;
        }else{
            PHI_1 = 0.00;
            PHI_2 = 0.00;
        }
    }
    // Open File
    int counter = 1;

    FILE *fp;
    fp = fopen("raw_data.txt","w");
    fprintf(fp,"%d %f %f %f %f %f %f %f %f %f %f", counter,a1,b1,h1,k1,PHI_1,a2,b2
,h2,k2,PHI_2);
    fclose(fp);

    // Code For Execute overlap
    system("./overlap raw_data.txt 1>/dev/null");

    //Read File
    fp = fopen("results.txt","r");
    char drop_first_row[100];
    fgets(drop_first_row,100,fp);
    for(int i=1;i<=4;i++){
        float a;
        fscanf(fp,"%f",&a);
    }Towe

    float results_each;
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
    fscanf(fp,"%f",&results_each);

    fclose(fp);

    return results_each;


}

// Find Area of Intersect Main function
void find_area_intersect(){
    float summation_area_of_intersect = 0.0;

    // Initialize
    for(int i=1;i<=17;i++)damage_of_each_area[i] = 0;
    for(int i=1;i<=17;i++)popularity_of_each_area[i] = 0;
    for(int i=1;i<=17;i++){
        damage_property_of_ellipse[i].a = 0.0;
        damage_property_of_ellipse[i].b = 0.0;
        damage_property_of_ellipse[i].h = 0.0;
        damage_property_of_ellipse[i].k = 0.0;
        popularity_property_of_ellipse[i].a = 0.0;
        popularity_property_of_ellipse[i].b = 0.0;
        popularity_property_of_ellipse[i].h = 0.0;
        popularity_property_of_ellipse[i].k = 0.0;
    }

    // Find total area of each category
    for(int i=1;i<=17;i++){
        total_area_each_category[using_which_area[i]] += base_area_of_area_zone[i]
;
    }

    // Find Each Damage and Popularity of each area
    for(int i=1;i<=17;i++){
        damage_of_each_area[i] = damage_of_category[using_which_area[i]]*(base_are
a_of_area_zone[i]/total_area_each_category[using_which_area[i]]);
        popularity_of_each_area[i] = popularity_of_category[using_which_area[i]]*(
base_area_of_area_zone[i]/total_area_each_category[using_which_area[i]]);
    }

    // Finding a & b
    for(int i=1;i<=17;i++){
        damage_property_of_ellipse[i].a = sqrt((damage_of_each_area[i]/b_to_a_of_e
ach_area[i])/M_PI);
        damage_property_of_ellipse[i].b = (damage_property_of_ellipse[i].a)*b_to_a
_of_each_area[i];
        popularity_property_of_ellipse[i].a = sqrt((popularity_of_each_area[i]/b_t
o_a_of_each_area[i])/M_PI);
        popularity_property_of_ellipse[i].b = (popularity_property_of_ellipse[i].a
)*b_to_a_of_each_area[i];
        damage_property_of_ellipse[i].h = coordinate_of_area[i].first;
        damage_property_of_ellipse[i].k = coordinate_of_area[i].second;
        popularity_property_of_ellipse[i].h = coordinate_of_area[i].first;
        popularity_property_of_ellipse[i].k = coordinate_of_area[i].second;
    }

    // Finding Summation of area
    for(int i=1;i<=16;i++){
        for(int j=i+1;j<=17;j++){
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
            summation_area_of_intersect += find_area_intersect_function(i,j,1);
            summation_area_of_intersect += find_area_intersect_function(i,j,2);
        }
    }

    if(summation_area_of_intersect <= the_least_area_of_intersect){
        the_least_area_of_intersect = summation_area_of_intersect;
        for(int i=1;i<=17;i++)the_best_using_which_area[i] = using_which_area[i];
    }

    return;
}

void initialize_valuable(){
    //using_which_area
    for(int i=0;i<18;i++)using_which_area[i]=0;

    //coordinate_of_area
    coordinate_of_area[1].first  = 110; coordinate_of_area[1].second  = 448;
    coordinate_of_area[2].first  = 343; coordinate_of_area[2].second  = 493;
    coordinate_of_area[3].first  = 284; coordinate_of_area[3].second  = 576;
    coordinate_of_area[4].first  = 352; coordinate_of_area[4].second  = 406;
    coordinate_of_area[5].first  = 352; coordinate_of_area[5].second  = 277;
    coordinate_of_area[6].first  = 258; coordinate_of_area[6].second  = 279;
    coordinate_of_area[7].first  = 449; coordinate_of_area[7].second  = 277;
    coordinate_of_area[8].first  = 111; coordinate_of_area[8].second  = 264;
    coordinate_of_area[9].first  = 111; coordinate_of_area[9].second  = 193;
    coordinate_of_area[10].first = 257; coordinate_of_area[10].second = 202;
    coordinate_of_area[11].first = 319; coordinate_of_area[11].second = 202;
    coordinate_of_area[12].first = 413; coordinate_of_area[12].second = 202;
    coordinate_of_area[13].first = 7;   coordinate_of_area[13].second = 347;
    coordinate_of_area[14].first = 537; coordinate_of_area[14].second = 520;
    coordinate_of_area[15].first = 537; coordinate_of_area[15].second = 394;
    coordinate_of_area[16].first = 537; coordinate_of_area[16].second = 166;
    coordinate_of_area[17].first = 582; coordinate_of_area[17].second = 300;

    // Popularity of each Category
    popularity_of_category[1] = 43186.576;
    popularity_of_category[2] = 2734.166;
    popularity_of_category[3] = 15507.661;
    popularity_of_category[4] = 4122.328;
    popularity_of_category[5] = 41632.799;
    popularity_of_category[6] = 48724.166;
    popularity_of_category[7] = 18139.446;

    // Damage of each Category
    damage_of_category[1] = 5297.693;
    damage_of_category[2] = 140.511;
    damage_of_category[3] = 419.238;
    damage_of_category[4] = 111.881;
    damage_of_category[5] = 2255.824;
    damage_of_category[6] = 164021.900;
    damage_of_category[7] = 1802.453;

    // Base Area of each Category
    base_area_of_category[1] = 184.311;
    base_area_of_category[2] = 0.035;
    base_area_of_category[3] = 4.897;
    base_area_of_category[4] = 9.378;
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
        base_area_of_category[5] = 59.435;
        base_area_of_category[6] = 135.644;
        base_area_of_category[7] = 1.645;

        // Base area of each area zone
        base_area_of_area_zone[1] = 110.25;
        base_area_of_area_zone[2] = 42.40;
        base_area_of_area_zone[3] = 36.00;
        base_area_of_area_zone[4] = 79.20;
        base_area_of_area_zone[5] = 50.40;
        base_area_of_area_zone[6] = 12.00;
        base_area_of_area_zone[7] = 12.00;
        base_area_of_area_zone[8] = 76.00;
        base_area_of_area_zone[9] = 9.60;
        base_area_of_area_zone[10] = 5.29;
        base_area_of_area_zone[11] = 9.66;
        base_area_of_area_zone[12] = 16.10;
        base_area_of_area_zone[13] = 32.76;
        base_area_of_area_zone[14] = 13.95;
        base_area_of_area_zone[15] = 41.85;
        base_area_of_area_zone[16] = 62.00;
        base_area_of_area_zone[17] = 45.00;

        // Time visit each category
        for(int i=1;i<=7;i++)time_visit_each_category[i]=1;

        // Using Which Arae
        using_which_area[9] = 3;
        using_which_area[10] = 2;
        using_which_area[11] = 7;
        using_which_area[16] = 5;

        // B divideed by A of each area
        b_to_a_of_each_area[1] = 1.0000;
        b_to_a_of_each_area[2] = 0.3333;
        b_to_a_of_each_area[3] = 0.0300;
        b_to_a_of_each_area[4] = 0.3158;
        b_to_a_of_each_area[5] = 0.8000;
        b_to_a_of_each_area[6] = 3.2000;
        b_to_a_of_each_area[7] = 3.2000;
        b_to_a_of_each_area[8] = 0.7143;
        b_to_a_of_each_area[9] = 0.0857;
        b_to_a_of_each_area[10] = 1.0000;
        b_to_a_of_each_area[11] = 0.5476;
        b_to_a_of_each_area[12] = 0.2706;
        b_to_a_of_each_area[13] = 40.4444;
        b_to_a_of_each_area[14] = 1.4516;
        b_to_a_of_each_area[15] = 4.3548;
        b_to_a_of_each_area[16] = 3.2258;
        b_to_a_of_each_area[17] = 45.0000;

}

void recursive_function(int present_category){

    if(present_category==2){
        recursive_function(3);
    }else if(present_category==3){
        recursive_function(4);
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
    }else if(present_category==5){
        recursive_function(6);
    }else if(present_category==7){
        recursive_function(8);
    }else{
    //cout << "Present CAT : " << present_category << " ." << endl;

    //Check whether use every area
    int count_dont_use = 0;
    for(int i=1;i<=17;i++)if(using_which_area[i]==0) count_dont_use +=1 ;
    if(count_dont_use==0)return;

    if(present_category==8){
        //for(int j=1;j<=17;j++)cout << present_category << " : using " << j << "
on " << using_which_area[j] << endl;
        find_area_intersect();
        number_of_case += 1;
        //cout << "Finish at Time : " << number_of_case << "." << endl;
        return;
    }

    int max_location = 0;
    if(time_visit_each_category[present_category]==1)max_location = 1;
    else{
        for(int j=1;j<=17;j++){
            if(using_which_area[j]==present_category) max_location = max(max_locat
ion,j);
        }
    }

    for(;max_location<=17;max_location++){
        if(using_which_area[max_location]==0){

            using_which_area[max_location] = present_category;

            float count_total_area = 0.00;

            for(int j=1;j<=17;j++)if(using_which_area[j]==present_category){
                count_total_area += base_area_of_area_zone[j];
            }

            if(count_total_area>=base_area_of_category[present_category]){
                time_visit_each_category[present_category]+=1;
                recursive_function(present_category+1);
                time_visit_each_category[present_category]-=1;
            }else{
                time_visit_each_category[present_category]+=1;
                recursive_function(present_category);
                time_visit_each_category[present_category]-=1;
            }

            using_which_area[max_location] = 0;
        }
    }

    }
    return;
}
```

Code 2 : Recursive Relation (C++) – Finding the best solution for placing the category in the area

```cpp
int main(){

    ios_base::sync_with_stdio(0); cin.tie(0);

    //Initializing Value
    initialize_valuable();

    recursive_function(1);

    cout << "Number of total case : " << number_of_case << "." << endl;

    cout << "The least area of intersect : " << the_least_area_of_intersect << "."
 << endl;

    for(int i=1;i<=17;i++){
        if(i==6){
            cout << "Area F1";
        }else if(i==7){
            cout << "Area F2";
        }else{
            cout << "Area  " << char(i-1+'A');
        }
        cout << " is for category " << the_best_using_which_area[i] << "." << endl
;
    }

    return 0;
}
```