Project Dissertation Report on

ANALYSIS OF

INVENTORY MANAGEMENT MODELS

FOR

PERISHABLE AND NON-PERISHABLE ITEMS

Submitted By

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CERTIFICATE

This is to certify that the Project Dissertation Report titled "Analysis of inventory management models for perishable and non- perishable items", is a bona fide work carried out by Mr. Madhur Pratap Singh, and submitted for MBA program 2018-2020 in Delhi School Of Management, Delhi Technological University, Bawana Road, Shahbad Daulatpur, Delhi in partial fulfillment of the requirement for the award of the Degree Of Masters Of Business Administration.

Signature of Guide

Place: Delhi

DECLARATION

I hereby declare that the Project Dissertation Report titled "Analysis of inventory management models for perishable and non- perishable items" is the outcome of my own efforts under guidance of Mr. Dhiraj Kumar Pal. The project is submitted to the Delhi School Of Management, Delhi Technological University as a part of Masters Of Business Administration Program for the academic session 2019-2020.

I also declare that this project dissertation report has not been previously submitted to any other university.

Madhur Pratap Singh(2K18/MBA/101)

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I would also like to thank Mr. Dhiraj Kumar Pal, Assistant Professor, DSM for his invaluable guidance throughout.

I can confidently say that this experience has not only enriched me with management knowledge but also has unparsed the maturity of thought and vision, the attributes required being a successful professional.

Madhur Pratap Singh(2K18/MBA/101)

EXECUTIVE SUMMARY

Supply chain management is one of the key functions for each of the companies. An effective and efficient supply chain management is very important for the overall success of a company.

Inventory management is a key part of supply chain of any business. There are various kinds of inventories like raw material inventory, store inventory, warehouse inventory and retail inventory etc. Inventory consists of two categories of items which are perishable items and non- perishable items. For non- perishable items many inventory models like LIFO, FIFO, ABC analysis, EOQ model, FSN model etc are used but all these models focus on the quantity aspect only while for perishable items focus is on quality as well as quantity and concept of shelf life is used in inventory models of perishable items.

Shelf life is commonly associated with perishable items like food and drugs since their usable period tends to be shorter, and methods like FEFO are employed for their inventory management. Such approach however, is not applied non-perishable items due to relatively longer shelf lives. But, if similar criteria is applied even for non -perishable maintenance items like bearings, fasteners, gears, welding rods, couplings, it can be an effective approach of their inventory management., leading to higher operational efficiencies for the whole system.

The purpose of this study is to analyze inventory models of perishable and non- perishable items and identify the requirement of introducing quality concepts such as shelf life in non- perishable items inventory models also and develop a new inventory model based on shelf life for such items.

In order to identify the requirement of introducing shelf life based model the efforts in this research were focused primarily on two regions which were store inventory and consumer buying behaviour differences in case of perishable and non-perishable items and based on this analysis a new inventory model was developed.

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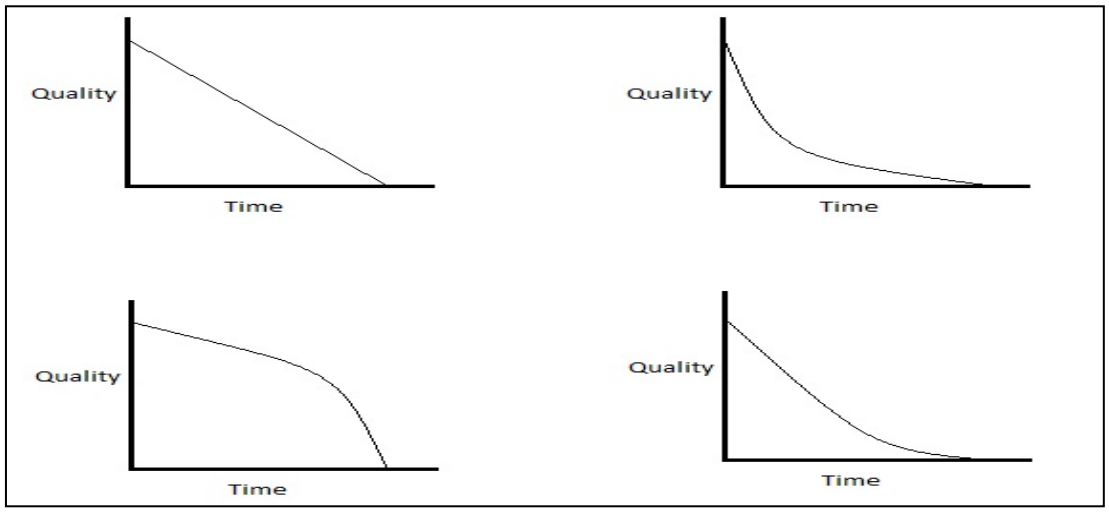
CHAPTER 1: INTRODUCTION

1. INTRODUCTION

1.1 Background

Every component has a defined shelf life which depends upon the properties of the constituent material. The material starts to decay as soon as it is manufactured or in other words its designed quality begins to diminish as soon as it is transformed. The rate of decay however differs for different material. The decay function of quality with respect to time for a material may be expressed as a linear, exponential, parabolic, hyperbolic or any other relation as shown below in figure 1.1

Figure 1.1 Decay Functions



Source: Own Analysis

The quality decay function can be determined experimentally with great accuracy, but in most cases the management assumes almost linear curve for simplistic approach. Now while deciding shelf life a certain percentage of decay is accepted which is usually 10% of the original value and the time period for that amount of decay usually denoted by t_{90} is termed as shelf life of that material. Now, based on shelf life, the items are broadly classified into two categories

1.Perishable Items- Items such as food, drugs and chemicals for which t90 is very short usually ranging from few days to few weeks.

2.Non-Perishable Items- Items for which t_{90} or shelf life is very long but is finite.

As shelf life of perishable items like food products is relatively short, so shelf-life has been a major criteria for their inventory management. One of the associated methods used is First Expire First Out (FEFO) etc. But in case of non-perishable items no such criteria has been used for inventory management.

Inventory management is a key part of supply chain of any business. There are various kinds of inventories like raw material inventory, store inventory, warehouse inventory and retail inventory etc.

For non- perishable items many inventory models like LIFO, FIFO, ABC analysis, EOQ model, FSN model etc are used but all these models focus on the quantity aspect only while for perishable items focus is on quality as well as quantity and concept of shelf life is used in inventory models of perishable items.

Shelf life is commonly associated with perishable items like food and drugs since their usable period tends to be shorter, and methods like FEFO are employed for their inventory management. Such approach however, is not applied non-perishable items due to relatively longer shelf lives. But, if similar criteria is applied even for non-perishable maintenance items like bearings, fasteners, gears, welding rods, couplings, it can be an effective approach of their inventory management., leading to higher operational efficiencies for the whole system

1.2 Problem Statement

- To identify the requirement of introducing shelf life based inventory model for non- perishable items.
- To understand the consumer buying behaviour differences in case of perishable and non- perishable items
- Based on analysis develop a new inventory model for non- perishable items

1.3 Objectives of the study

The overall objective of this research is to analyze inventory models of perishable and non- perishable items and identify the requirement of introducing quality concepts such as shelf life in non- perishable items inventory models also and develop a new inventory model based on shelf life for such items.

The specific objectives are

- Study of various inventory models for non- perishable items.
- Study of various inventory models for perishable items.
- Understanding the consumer buying behaviour differences in case of perishable and non- perishable items.
- Preparation of questionnaire for above mentioned point.
- Analyzing the collected Data
- Develop a new inventory model based on shelf life.

1.4 Scope of Study

The inventory model developed through this research would help in eliminating the need of other types of inventory management techniques such as FSN method, Minimum Safety Stock method as it also incorporates concept of quality along with quantity unlike other methods giving it distinct advantage over other inventory methods. Additionally, this method have many other benefits like identifying issues in MRP, designing better inventory norms etc.

This study will also help to understand consumer buying behaviour and help retailers keep their inventories according to consumer requirements thus eliminating waste and improving profits.

CHAPTER 2: LITERATURE REVIEW

2. LITERATURE REVIEW

Deeper analysis revealed the following inventory management methods that are adopted by most of the firms as shown in figure 2.1

But none of these techniques uses shelf life as basis due to non-perishable nature of most of the items in a firm. On the other hand shelf life is used extensively as basis of inventory management for perishable items such as fruits, milk products etc.

Figure 2.1 Types of inventory management

Source: https://efinancemanagement.com

Types of inventory management models

JUST IN TIME (JIT) METHOD

In Just in Time method of inventory control, the company keeps bare minimum amount of inventory just to meet the production requirements. By doing so company reduces the cost of inventory significantly but this method is a little risky method of inventory management because a little delay order fulfillment could lead to stock out situation. Therefore this method requires very good planning.

ABC ANALYSIS

ABC analysis stands for Always Better Control Analysis. In ABC inventory management technique inventory items are classified into A, B, and C categories. The items in category A are high-priced, low quantity inventory and are closely controlled. The items in category B are relatively less expensive and level of control is moderate. The category C consists of lesser investment, large volume inventory so the control level is minimum.

MATERIAL REQUIREMENTS PLANNING (MRP) METHOD

In Material Requirements Planning inventory control method the manufacturer orders the inventory after taking sales forecast into consideration. MRP system integrates inventory data from various areas of the business and based on this data and demand forecast new orders are placed with the suppliers.

MINIMUM SAFETY STOCKS

The minimum safety stock is the level of inventory which a company maintains to avoid the stock-out situation. It is the level when order is placed before the existing inventory is over. For example, if the total inventory in an organization is 20,00 units, order is placed when the inventory reaches 1400 units. Therefore, the 600 units of inventory shall be the minimum safety stock level.

ECONOMIC ORDER QUANTITY (EOQ) MODEL

In this model, the store manager calculates the economic order quantity and reorder the inventory only when inventory reaches that level. EOQ model helps to save the carrying costs and ordering cost incurred while placing the order.

VED ANALYSIS

VED stands for Vital Essential and Desirable. Companies mainly use this technique for controlling inventory of spare parts. For vital parts that are very costly and essential for production higher level of inventory are maintained. For essential spare parts, absence of those may lead to slow down of the production process, medium level of inventory is

maintained. Similarly, low level of inventory management is done for desirable parts, which are rarely required for production.

FAST, SLOW & NON-MOVING (FSN) METHOD

This method of inventory control is very helpful in identifying obsolete inventory. All the items in the inventory are not used at same rate; some are required frequently, while some of the items are not required at all. This method divides inventory into three types.

- Fast-moving
- Slow-moving
- Non-moving

The items in non-moving category for long period of time are considered as obsolete materials.

Although shelf life is mostly associated with perishable items because shelf life of other materials is very long but it can be easily be associated with non-perishable items also whose shelf lives vary from few months to many years. For example shelf life of bearings as given by SKF bearings is 3 years while shelf life of chemicals are only few months.

Lack of study material such as research papers on shelf life of non-perishable items led to identifying shelf life of such items from various online sources and manufacturer catalogs. This revealed that shelf of maintenance materials such as bearings etc. depends upon the chemicals such as lubricants associated with such materials and their own material composition which is usually found out experimentally.

According to research paper **Experimental analysis of shelf life based inventory management policies for RIFD enabled supply chains** presented in FAIM Conference, 2010, various techniques based on shelf life like LSFO(Least Shelf Life First Out) , FEFO(First Expiry First Out) are used for analysis of perishable items. In the work done by **Aiello G. et al.(2010)** an experimental shelf life model for perishable items was formed and replacement of FIFO model with LSFO model was proposed. But no relevant literature could be identified where inventory management of non-perishable items

utilized the shelf life principle. The gap thus observed in the area led to the development of this proposed method to fill the gap.

CHAPTER 3: RESEARCH METHODOLOGY

3. RESEARCH METHODOLOGY

This research is focused on inventory of perishable and non- perishable items in company stores and retail stores. So research is also divided into two sub categories and different methodology is used in both cases.

For Store Inventory

The data was collected using SAP system of the companies and the information required to develop new method of inventory managements was collected from various online websites such as

"https://efinancemanagement.com/costing-terms/inventory-management-techniques"

"https://www.skf.com/in/products/bearings-units-housings/super-precision-bearings/principles/bearing-storage/index.html"

"https://www.inorganicventures.com/guides-and-papers/shelf-life-vs.-expiration-date-of-a-chemical-standard"

"https://www.slideshare.net"

Lack of study material such as research papers on shelf life of non-perishable items led to identifying shelf life of such items from various online sources and manufacturer catalogs. This revealed that shelf of maintenance materials such as bearings etc. depends upon the chemicals such as lubricants associated with such materials and their own material composition which is usually found out experimentally.

For Retail Inventory Preferences

For Retail Inventory Preferences, consumer buying behaviour data for perishable and non-perishable items was analyzed and data was collected using a questionnaire.

The data collected by questionnaire was analyzed and new formulas were developed based on that data.

A total of 38 responses were utilized for this analysis.

CHAPTER 4: ANALYSIS, DISCUSSION AND RECOMMENDATIONS

4. ANALYSIS, DISCUSSION AND RECOMMENDATIONS

The analysis of this research is done in two parts

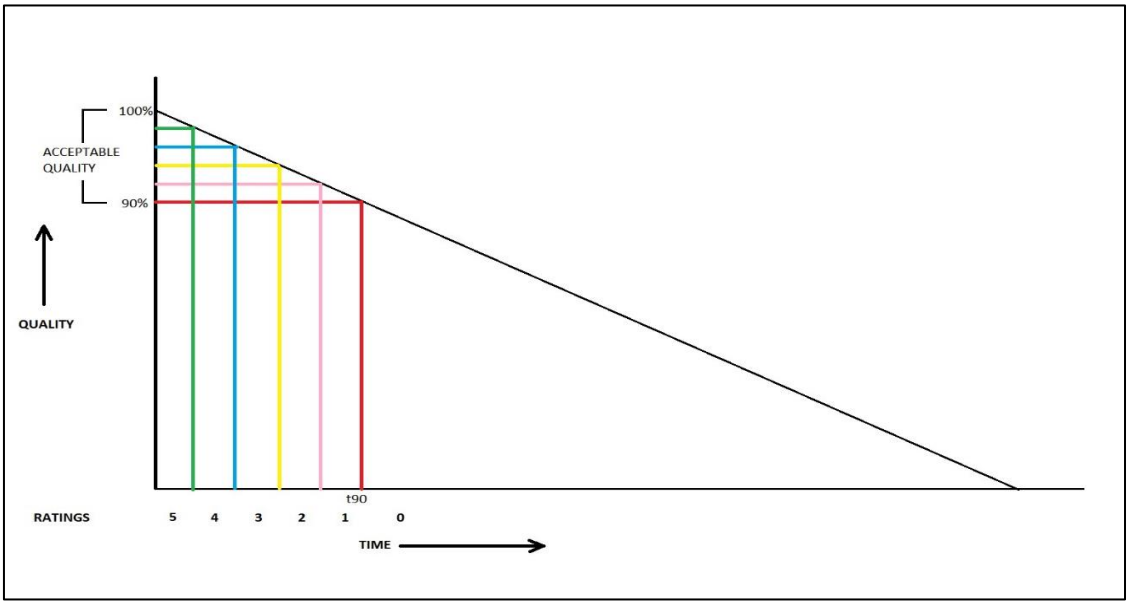
1. Inventory model for non- perishable items used in stores
2. Analysis of consumers retail buying preferences to identify need of shelf life based inventory model in retail stores and warehouses

4.1 Shelf Life Based Inventory model for non- perishable items used in stores

In the proposed method Shelf Life of non-perishable material is subdivided into five parts and rated through 5 to 1. Although the quality is acceptable all through 5 to 1 but the material rated as 5 is regarded as qualitatively superior, because it is in its first stage of decay, as compared to a rated 4 material and so on.

The method is designed to ensure utilization of material in the qualitatively superior stages (Ratings: 5 > 4 > 3 > 2 >1) and thus reduce wastage of items thereby leading to inventory minimization. As in this method aspect of quality level of items automatically enters into inventory management it commands advantage over other methods focusing only on the total number of items in inventory. This division of shelf life can be depicted in figure 4.1

FIGURE 4.1 Shelf life division



Source: Own Analysis

There can be many methods of division of shelf life to arrive at qualitative ratings but following three systems of division offer ease of implementation.

i. Arithmetic System- In this system shelf life is divided into five equal parts. Suppose shelf life is n years, each rating would be for n/5 years. For example for an item with shelf life of 5 years rating would be as given below in table 4.1

Table 4.1 Arithmetic System Of Shelf Life Division

Rating	Interval in years	Time in years
5	1	0-1
4	1	1-2
3	1	2-3
2	1	3-4
1	1	4-5
0		Greater than 5

Source: Own Analysis

ii. Geometric System- In this system time interval for each rating is half that of previous rating, for example if shelf life of any item is n years then rating would be as given below in table 4.2

Table 4.2 Geometric System Of Shelf Life Division

Rating	Interval in years	Time in years
5	n/2	0-n/2
4	n/4	n/2-3n/4
3	n/8	3n/4-7n/8
2	n/16	7n/8-15n/16
1	n/32	15n/16-n
0		Greater than n

Source: Own Analysis

iii. Custom System- In this system the shelf life is divided according to specific need as per requirements of the organizations .

Each method gives a different level of control over inventory. In arithmetic system the control level is uniform throughout but in geometric system control is more strict toward end of shelf life since rating change rate is more rapid towards end in geometric system. Custom divisions are decided according to control level required by the firm.

Illustration:

For SKF brand bearings with shelf life of three years, division of shelf life can be as follows

Arithmetic System

Table 4.3 Arithmetic System Of Shelf Life Division for SKF bearing (3 years shelf life)

Rating	Interval in years	Time in years
5	3/5	0-3/5
4	3/5	3/5-6/5
3	3/5	6/5-9/5
2	3/5	9/5-12/5
1	3/5	12/5-3
0		Greater than 3

Source: Own Analysis

Geometric System

Table 4.4 Geometric System Of Shelf Life Division for SKF bearing (3 years shelf life)

Rating	Interval in years	Time in years
5	3/2	0-3/2
4	3/4	3/2-9/4
3	3/8	9/4-21/8
2	3/16	21/8-45/16
1	3/32	45/16-3
0		Greater than 3

Source: Own Analysis

Similarly, shelf life for more such components can be found through experimentation or through manufacturer data and then ratings can be obtained by placing that value in place of n in above given tables.

Procedure Of Rating

I. As soon as material is received rating is assigned on the basis of above discussed charts and referencing manufacturing date as t_{100}

II. At regular intervals which may be week or month or as defined by the organization policy, ratings are re-calculated according to shelf life chart.

For release of items from stores, these ratings are used in accordance with the other existing methods. For example for LSFO, items with lowest rating ($1 < 2 < 3 < 4 < 5$) are released first.

ADVANTAGES OF SHELF LIFE BASED INVENTORY MANAGEMENT METHOD

This system has several indirect advantages besides inventory management.

1. Vendor evaluation- By observing the rating history of items supplied by particular vendor, vendor evaluation can be done, vendor is rated high on scale if material supplied by him is of higher rating, which implies that he is providing fresh material.
2. MRP correction- If some item is achieving lower ratings again and again, it implies that it is spending more time on shelf and thus indicating some error in Material Requirement planning.
3. Breakdown instance reduction- In plant some process are highly critical while some are less critical, same material is sometime used in both process. For example same type of bearing is used in several places, so by matching higher rating item with critical process and lower rating item with less critical process chances of plant breakdown can be reduced while at the same time utilizing low rating items thus reducing wastage.
4. Planning maintenance schedules - Since during installation rating of item is known which helps in identifying approximate time of failure of that material, material with higher rating would last longer as compared to material with lower rating. By knowing the approximate time of failure primary maintenance schedule can be made.
5. Better purchase scheduling- Since purchase department has knowledge about primary maintenance schedule, they would have an idea when Purchase requisition would be raised and purchase department can make schedule before hand, this would help in streamlining purchase process.
6. Redesigning inventory norms- By observing the pattern of rating change purchase department can reset maxima and minima. For example if any item is going to lower ratings again and again, it implies maxima is set at higher value and it should be reduced.
7. Identification of obsolete items- Items that reach rating zero repeatedly are obsolete items.

8. Eliminate the need of FSN inventory management method- Items released with only rating five every time is fastest moving while the items reaching rating one is slowest moving and with rating zero is non-moving.

EXTENSION OF METHOD

This method can be further extended to match inventory of spare and maintenance parts with critical process as stated in advantages before.

Purpose of this is to match quality of spares with criticality of process to reduce instances of breakdowns. The method is termed as ISLPCM, a short abbreviation for *Inventory Shelf Life and Process Criticality Matching method*.

Inventory Shelf Life and Process Criticality Matching method (ISLPCM)

This method is ~~a~~ links operations process and store inventory management for a firm. In this method it is proposed that a five point ratings is given to the operation processes just like five point ratings of inventory with most critical processes given a rating of five and least critical processes given a rating of one. The subsequent –release of inventory is done by matching ratings i.e. five rating process is allotted rating five inventory and so on till rating one. Since ratings are directly proportional to quality, this would ensure most critical processes are allocated highest quality items thereby ensuring reduction in breakdowns. Also by matching lower rating items to non-critical processes it is ensured that no items are wasted on shelf.

Illustration : If there are five processes A,B,C,D and E each requiring one bearing 6202 out of the five 6202 bearings in store with ratings 1 to 5 and ratings of process are as given in table 4.5

Table 4.5 Criticality Rating

Process	Criticality Rating
A	5
B	3
C	1
D	2
E	4

Source: Own Analysis

Then matching would be as shown in table 4.6

Table 4.6 Process Matching

Bearing Rating	Process
5	A
4	E
3	B
2	D
1	C

Source: Own Analysis

Exceptions to ISLPCM- In case number of process are less than five. In this one suggestion could be that the inventory ratings can be clubbed together to match the number of process. For example if there are 3 process A,B,C with rating 3,2,1 respectively requiring bearings 6205 and there are bearings of ratings 5, 3, 1 in stock the matching can be done as shown in table 4.7

Table 4.7 Adjusted Process Matching

Bearing ratings	Bearings in stock	New rating	Process
5	1	3	A
4	0		
3	1	2	B
2	0		
1	1	1	C

Source: Own Analysis

4.2 Analysis of consumers retail buying preferences

Introduction

The purpose of this part of research was to understand the views of consumers towards purchase of perishable and non- perishable items with respect to quality and quantity so that suggestions for the methods of inventory management in retail stores can be proposed and provide a basis for future researches in the field of syncing retail inventory management and shelf life based inventory management model derived in previous part of research. For this purpose the purchasing behaviour data of consumers were collected and analyzed.

Data collection

Data was collected through a questionnaire and analysis was done on the basis of 38 responses received. For data collection random sampling was used.

The questions asked from respondents are given below.

In perishable items two major categories groceries and medicines were chosen and in non-perishable items again two major categories electronic and general household items were chosen for analysis.

Figure 4.2 Questionnaire

Buying behaviour in case of perishable and non perishable goods

My name is Madhur Pratap Singh and i am currently working on a research related to development of new inventory model. This research would be used in writing my dissertation for MBA course. I hope you can take couple of minutes to complete my questionnaire.

* Required

1. Email address *

2. Gender *

Mark only one oval.

- Male
- Female
- Prefer not to say

3. Age Group *

Mark only one oval.

- 15-20
- 21-25
- 26-30
- 31-35
- 36-40
- 40-45
- 45+

4. Profession *

Mark only one oval.

- ◯ Student
- ◯ Business
- ◯ Unemployed
- ◯ Corporate
- ◯ Educator
- ◯ other

5. Have you ever purchased perishable goods like groceries, medicines etc. *

Mark only one oval.

- ◯ Yes
- ◯ No

6. Have you ever purchased non perishable goods like electronics and household products *

Mark only one oval.

- ◯ Yes
- ◯ No

7. Do you check the manufacturing or packaging date of perishables like groceries and medicines before purchasing *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Sometimes

8. Do you check the expiration or best before date of perishables like groceries and medicines before purchasing *

Mark only one oval.

- ◯ yes
- ◯ No
- ◯ Sometimes

9. Do you check the check the manufacturing or packaging date of non perishables like electronics and household items before purchasing *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Sometimes

10. During shopping of items like groceries and medicines, how many times you check the manufacturing date *

Mark only one oval.

- ◯ Never
- ◯ less than 25% times
- ◯ 25% to 50 % times
- ◯ 50% to 75% times
- ◯ Always

11. During shopping of items like groceries and medicines, how many times you check the expiration date *

Mark only one oval.

- ◯ Never
- ◯ less than 25% times
- ◯ 25% to 50 % times
- ◯ 50% to 75% times
- ◯ Always

12. During shopping of non perishable items like electronics and household items, how many times you check the manufacturing date *

Mark only one oval.

- ◯ Never
- ◯ less than 25% times
- ◯ 25% to 50 % times
- ◯ 50% to 75% times
- ◯ Always

13. Have you ever checked the shelf life of products before purchasing *

Mark only one oval.

- ◯ Yes
- ◯ No

14. Do you think non perishable items like electronics and household items with older manufacturing dates are of lower quality than items with latest manufacturing dates as older items spend more time in warehouses and shelves *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

15. Rate your preferences in terms of manufacturing dates for products *

Mark only one oval per row.

	less than 1 month old	1 to 3 month old	3 to 6 month old	6 to 12 month old	older than 1 year	older than 2 years
Groceries	◯	◯	◯	◯	◯	◯
Medicine	◯	◯	◯	◯	◯	◯
Electronics	◯	◯	◯	◯	◯	◯
Household items	◯	◯	◯	◯	◯	◯

16. Rate your preferences in terms of expiration days remaining for products *

Mark only one oval per row.

	less than 1 month	1 to 3 month	3 to 6 month	6 to 12 month	more than 1 year	more than 2 years
Groceries	◯	◯	◯	◯	◯	◯
Medicine	◯	◯	◯	◯	◯	◯
Electronics	◯	◯	◯	◯	◯	◯
Household items	◯	◯	◯	◯	◯	◯

17. How many times you purchase these items in one month *

Mark only one oval per row.

	0-5	6-10	11-15	16-20	more than 20 times
Groceries	◯	◯	◯	◯	◯
Medicine	◯	◯	◯	◯	◯
Electronics	◯	◯	◯	◯	◯
Household items	◯	◯	◯	◯	◯

Source: Own Creation

The following responses were received

Figure 4.3 Responses of Questionnaire

	Gender	Age Group	Profession	Have you ever purchased	Have you ever purchased	Do you check the manufa	Do you check the expirati
2	Male	21-25	Student	Yes	Yes	Yes	yes
3	Female	21-25	Student	Yes	Yes	Yes	yes
4	Male	31-35	Educator	Yes	Yes	Yes	yes
5	Male	36-40	Educator	Yes	Yes	Yes	yes
6	Female	21-25	Student	Yes	Yes	Yes	yes
7	Male	21-25	Student	Yes	Yes	Yes	yes
8	Female	21-25	Student	Yes	Yes	Yes	yes
9	Male	21-25	Student	Yes	Yes	Yes	yes
10	Male	26-30	Student	Yes	Yes	Yes	yes
11	Female	21-25	Student	Yes	Yes	Yes	yes
12	Male	21-25	Student	Yes	Yes	Yes	yes
13	Male	26-30	Student	Yes	Yes	Yes	yes
14	Male	26-30	Student	Yes	Yes	No	No
15	Female	21-25	Student	Yes	Yes	Sometimes	Sometimes
16	Male	21-25	Student	Yes	Yes	Yes	yes
17	Male	26-30	Student	Yes	Yes	Yes	yes
18	Male	21-25	Student	No	Yes	Yes	yes
19	Female	21-25	Student	Yes	Yes	Yes	yes
20	Male	21-25	Student	Yes	Yes	Yes	yes

	Do you check the check t	During shopping of items	During shopping of items	During shopping of non p	Have you ever checked th	Do you think non perishat	Rate your preferences in t
2	Sometimes	Always	Always	25% to 50 % times	Yes	Yes	1 to 3 month old
3	No	50% to 75% times	50% to 75% times	Never	No	No	less than 1 month old
4	Sometimes	Always	Always	25% to 50 % times	Yes	Yes	3 to 6 month old
5	No	25% to 50 % times	25% to 50 % times	less than 25% times	Yes	Yes	less than 1 month old
6	No	Always	Always	less than 25% times	No	Maybe	less than 1 month old
7	Sometimes	less than 25% times	Always	less than 25% times	No	Maybe	3 to 6 month old
8	Yes	50% to 75% times	Always	50% to 75% times	Yes	Maybe	less than 1 month old
9	No	Always	Always	less than 25% times	No	No	less than 1 month old
10	Yes	Always	Always	Always	Yes	Yes	less than 1 month old
11	Yes	Always	Always	Always	Yes	No	less than 1 month old
12	Sometimes	Always	Always	less than 25% times	No	No	less than 1 month old
13	Sometimes	Always	Always	50% to 75% times	Yes	No	less than 1 month old
14	No	less than 25% times	less than 25% times	less than 25% times	No	No	less than 1 month old
15	No	25% to 50 % times	25% to 50 % times	Never	Yes	No	less than 1 month old
16	Yes	50% to 75% times	50% to 75% times	50% to 75% times	Yes	Yes	1 to 3 month old
17	Yes	50% to 75% times	50% to 75% times	50% to 75% times	Yes	Yes	1 to 3 month old
18	Yes	Always	Always	Always	Yes	Yes	less than 1 month old
19	Yes	Always	Always	Always	Yes	Maybe	less than 1 month old
20	No	25% to 50 % times	50% to 75% times	less than 25% times	No	Maybe	less than 1 month old

	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	How many times you pu	How many times you pu	How many times you pu	How many times you p
2	1 to 3 month old	6 to 12 month old	3 to 6 month old	1 to 3 month	1 to 3 month	6 to 12 month	3 to 6 month	0-5	0-5	0-5	0-5
3	less than 1 month old	1 to 3 month old	less than 1 month old	less than 1 month	more than 1 year	more than 2 years	more than 1 year	0-5	0-5	0-5	0-5
4	6 to 12 month old	older than 1 year	older than 2 years	6 to 12 month	more than 1 year	more than 2 years	more than 2 years	6-10	0-5	0-5	0-5
5	1 to 3 month old	3 to 6 month old	1 to 3 month old	less than 1 month	1 to 3 month	3 to 6 month	less than 1 month	0-5	0-5	0-5	0-5
6	less than 1 month old	6 to 12 month old	6 to 12 month old	more than 2 years	more than 2 years	more than 2 years	more than 2 years	more than 20 times	0-5	0-5	16-20
7	3 to 6 month old	6 to 12 month old	6 to 12 month old	more than 1 year	more than 1 year	more than 2 years	more than 1 year	0-5	0-5	0-5	0-5
8	1 to 3 month old	6 to 12 month old	3 to 6 month old	less than 1 month	6 to 12 month	more than 1 year	more than 1 year	11-15	0-5	0-5	6-10
9	3 to 6 month old	6 to 12 month old	1 to 3 month old	1 to 3 month	3 to 6 month	3 to 6 month	3 to 6 month	11-15	6-10	0-5	0-5
10	1 to 3 month old	1 to 3 month old	1 to 3 month old	3 to 6 month	6 to 12 month	more than 1 year	more than 1 year	6-10	0-5	0-5	0-5
11	1 to 3 month old	6 to 12 month old	3 to 6 month old	less than 1 month	6 to 12 month	more than 2 years	more than 1 year	0-5	0-5	0-5	0-5
12	less than 1 month old	6 to 12 month old	3 to 6 month old	6 to 12 month	more than 2 years	more than 2 years	6 to 12 month	6-10	0-5	0-5	6-10
13	less than 1 month old	3 to 6 month old	1 to 3 month old	more than 1 year	more than 1 year	more than 2 years	6 to 12 month	16-20	6-10	0-5	6-10
14	1 to 3 month old	3 to 6 month old	less than 1 month old	less than 1 month	1 to 3 month	3 to 6 month	less than 1 month	6-10	0-5	0-5	6-10
15	1 to 3 month old	3 to 6 month old	3 to 6 month old	1 to 3 month	more than 1 year	more than 2 years	more than 1 year	6-10	6-10	0-5	0-5
16	3 to 6 month old	6 to 12 month old	3 to 6 month old	1 to 3 month	6 to 12 month	6 to 12 month	3 to 6 month	0-5	0-5	0-5	0-5
17	1 to 3 month old	3 to 6 month old	3 to 6 month old	6 to 12 month	6 to 12 month	6 to 12 month	6 to 12 month	6-10	0-5	0-5	0-5
18	less than 1 month old	6 to 12 month old	6 to 12 month old	less than 1 month	less than 1 month	3 to 6 month	more than 2 years	0-5	0-5	0-5	0-5
19	less than 1 month old	less than 1 month old	less than 1 month old	more than 2 years	more than 2 years	more than 2 years	more than 2 years	0-5	0-5	0-5	6-10
20	1 to 3 month old	3 to 6 month old	1 to 3 month old	1 to 3 month	6 to 12 month	6 to 12 month	1 to 3 month	0-5	0-5	0-5	0-5

1	Gender	Age Group	Profession	Have you ever purchased	Have you ever purchased	Do you check the manufa	Do you check the expirat
21	Female	21-25	Student	Yes	Yes	Yes	yes
22	Male	26-30	Student	Yes	Yes	Yes	yes
23	Female	21-25	Student	Yes	Yes	Yes	yes
24	Female	21-25	Student	Yes	Yes	Yes	yes
25	Female	21-25	Student	Yes	Yes	Yes	yes
26	Female	26-30	Student	Yes	Yes	Yes	yes
27	Male	21-25	Student	Yes	Yes	Yes	yes
28	Male	45+	Educator	Yes	Yes	Yes	yes
29	Female	31-35	Educator	Yes	Yes	Yes	yes
30	Male	21-25	Business	Yes	Yes	Yes	yes
31	Female	21-25	Student	Yes	Yes	Yes	yes
32	Female	21-25	Student	Yes	Yes	Sometimes	Sometimes
33	Female	21-25	Student	Yes	Yes	Yes	yes
34	Female	31-35	Educator	Yes	Yes	Yes	yes
35	Male	45+	other	Yes	Yes	Yes	yes
36	Female	31-35	other	Yes	Yes	Yes	yes
37	Male	21-25	Student	Yes	Yes	Sometimes	Sometimes
38	Male	26-30	other	No	Yes	Sometimes	yes
39	Male	26-30	Student	Yes	Yes	Sometimes	Sometimes

1	Do you check the check t	During shopping of items	During shopping of items	During shopping of non p	Have you ever checked th	Do you think non perishat	Rate your preferences in t
21	Yes	50% to 75% times	50% to 75% times	50% to 75% times	Yes	Yes	less than 1 month old
22	Yes	Always	Always	Always	Yes	Maybe	3 to 6 month old
23	No	50% to 75% times	50% to 75% times	Never	Yes	Yes	less than 1 month old
24	No	50% to 75% times	50% to 75% times	Never	Yes	Maybe	less than 1 month old
25	Yes	Always	Always	Always	Yes	Yes	1 to 3 month old
26	No	Always	50% to 75% times	25% to 50 % times	No	Maybe	less than 1 month old
27	Yes	Always	Always	Always	Yes	Yes	3 to 6 month old
28	Yes	Always	Always	Always	Yes	Yes	1 to 3 month old
29	Yes	50% to 75% times	Always	Always	Yes	Maybe	1 to 3 month old
30	No	50% to 75% times	50% to 75% times	less than 25% times	Yes	No	less than 1 month old
31	Yes	50% to 75% times	Always	25% to 50 % times	Yes	Maybe	less than 1 month old
32	No	25% to 50 % times	25% to 50 % times	less than 25% times	Yes	No	less than 1 month old
33	No	Always	Always	Never	Yes	No	less than 1 month old
34	Yes	50% to 75% times	25% to 50 % times	25% to 50 % times	Yes	Maybe	3 to 6 month old
35	Yes	50% to 75% times	Always	25% to 50 % times	No	Yes	less than 1 month old
36	Sometimes	50% to 75% times	Always	25% to 50 % times	Yes	Maybe	less than 1 month old
37	No	less than 25% times	less than 25% times	less than 25% times	Yes	Yes	less than 1 month old
38	Yes	50% to 75% times	Always	50% to 75% times	Yes	Yes	less than 1 month old
39	Sometimes	less than 25% times	50% to 75% times	50% to 75% times	Yes	Yes	less than 1 month old

1	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	Rate your preferences ir	How many times you put	How many times you put	How many times you put	How many times you
21	3 to 6 month old	3 to 6 month old	3 to 6 month old	1 to 3 month	3 to 6 month	6 to 12 month	6 to 12 month	6-10	6-10	0-5	0-5
22	1 to 3 month old	3 to 6 month old	1 to 3 month old	3 to 6 month	1 to 3 month	3 to 6 month	1 to 3 month	0-5	0-5	6-10	0-5
23	1 to 3 month old	3 to 6 month old	6 to 12 month old	less than 1 month	1 to 3 month	3 to 6 month	6 to 12 month	0-5	0-5	0-5	0-5
24	less than 1 month old	3 to 6 month old	less than 1 month old	less than 1 month	less than 1 month	3 to 6 month	less than 1 month	6-10	0-5	0-5	11-15
25	1 to 3 month old	6 to 12 month old	6 to 12 month old	1 to 3 month	6 to 12 month	more than 2 years	more than 2 years	6-10	0-5	0-5	0-5
26	1 to 3 month old	6 to 12 month old	6 to 12 month old	3 to 6 month	6 to 12 month	6 to 12 month	6 to 12 month	6-10	0-5	0-5	0-5
27	1 to 3 month old	3 to 6 month old	6 to 12 month old	3 to 6 month	more than 1 year	6 to 12 month	more than 2 years	6-10	11-15	0-5	0-5
28	1 to 3 month old	3 to 6 month old	3 to 6 month old	more than 1 year	more than 1 year	more than 1 year	more than 1 year	0-5	0-5	0-5	0-5
29	less than 1 month old	6 to 12 month old	3 to 6 month old	6 to 12 month	3 to 6 month	more than 2 years	more than 1 year	16-20	6-10	0-5	11-15
30	3 to 6 month old	3 to 6 month old	3 to 6 month old	less than 1 month	3 to 6 month	6 to 12 month	3 to 6 month	11-15	11-15	11-15	11-15
31	1 to 3 month old	3 to 6 month old	3 to 6 month old	less than 1 month	6 to 12 month	3 to 6 month	3 to 6 month	6-10	0-5	0-5	0-5
32	1 to 3 month old	6 to 12 month old	6 to 12 month old	more than 1 year	more than 1 year	more than 1 year	more than 1 year	6-10	0-5	0-5	0-5
33	1 to 3 month old	3 to 6 month old	1 to 3 month old	1 to 3 month	1 to 3 month	1 to 3 month	less than 1 month	0-5	0-5	0-5	0-5
34	6 to 12 month old	older than 1 year	3 to 6 month old	1 to 3 month	more than 1 year	more than 2 years	more than 2 years	0-5	0-5	0-5	0-5
35	1 to 3 month old	3 to 6 month old	6 to 12 month old	1 to 3 month	more than 1 year	more than 2 years	more than 2 years	16-20	11-15	0-5	6-10
36	3 to 6 month old	6 to 12 month old	3 to 6 month old	3 to 6 month	6 to 12 month	more than 2 years	more than 2 years	6-10	0-5	0-5	0-5
37	1 to 3 month old	1 to 3 month old	less than 1 month old	less than 1 month	1 to 3 month	1 to 3 month	less than 1 month	16-20	0-5	0-5	6-10
38	less than 1 month old	1 to 3 month old	3 to 6 month old	less than 1 month	less than 1 month	3 to 6 month	6 to 12 month	6-10	0-5	11-15	16-20
39	1 to 3 month old	6 to 12 month old	older than 1 year	less than 1 month	less than 1 month	6 to 12 month	more than 1 year	11-15	0-5	16-20	16-20

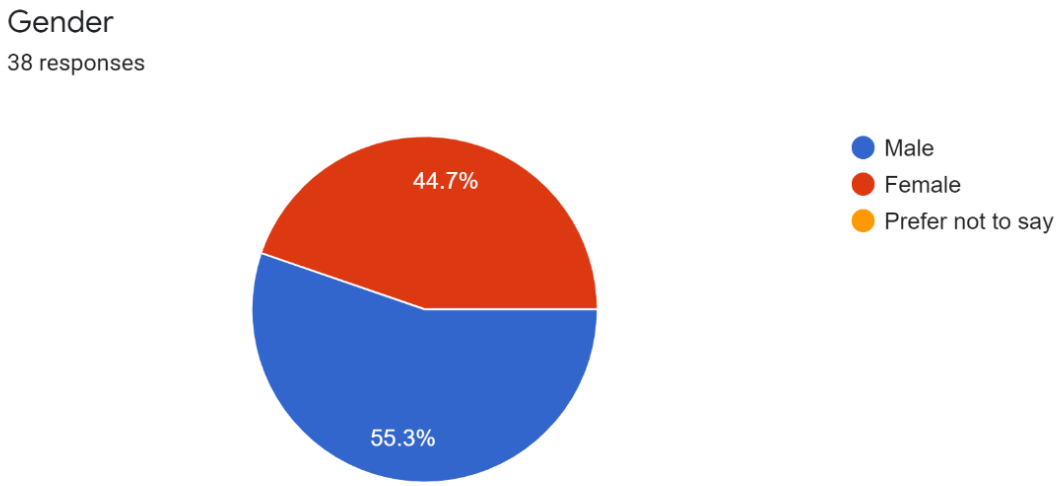
Source: Own Creation

Data analysis

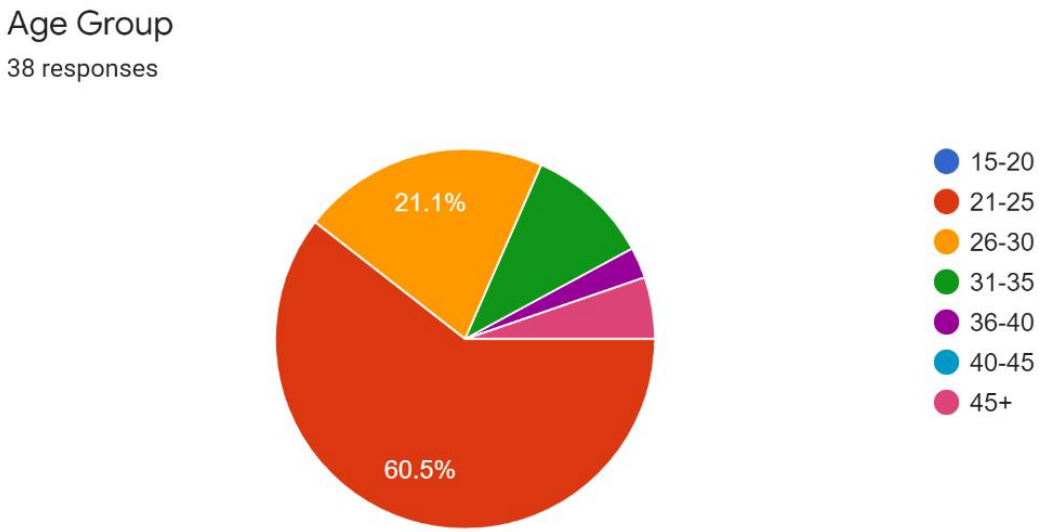
Based on above data following graphs and count tables can be formed

Figure 4.4 Graphical Representation of Responses

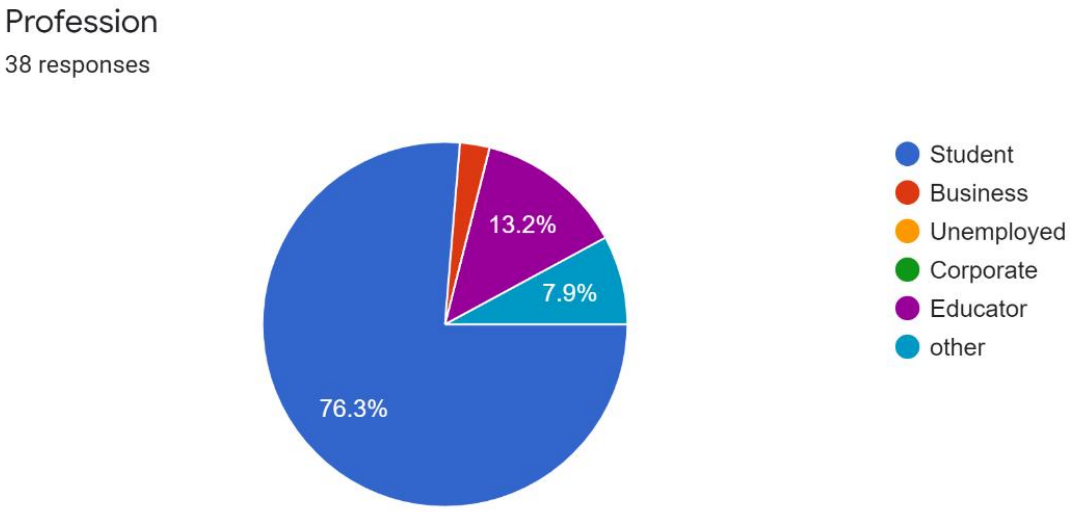
Gender	Count
Male	21
Female	17



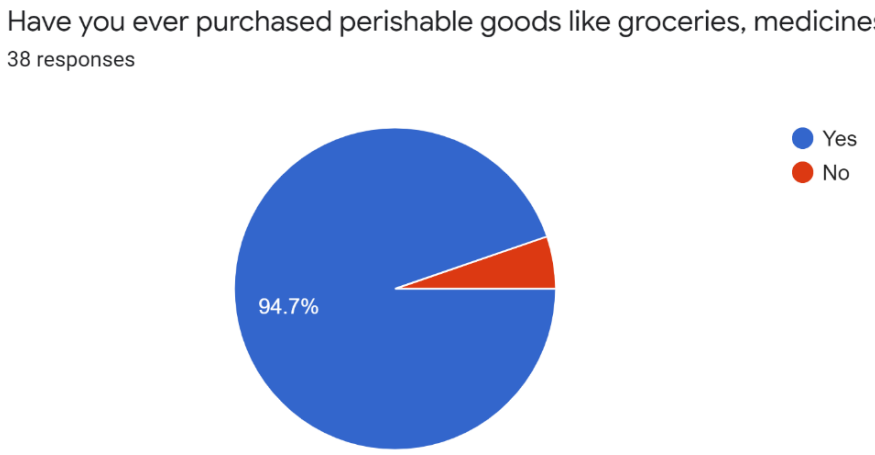
Age(years)	Count
15-20	0
21-25	23
26-30	8
31-35	4
36-40	1
40-45	0
45+	2



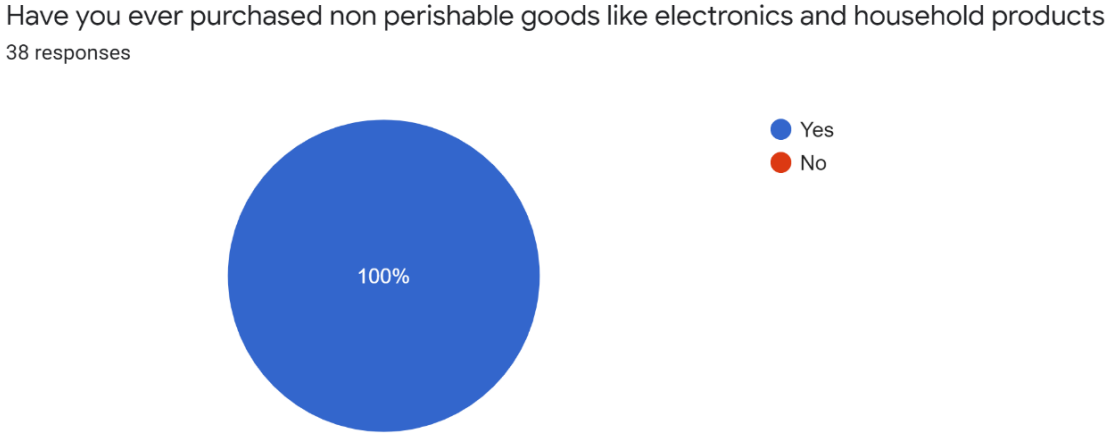
Profession	Count
Student	29
Business	1
Unemployed	0
Corporate	0
Educator	5
Other	3



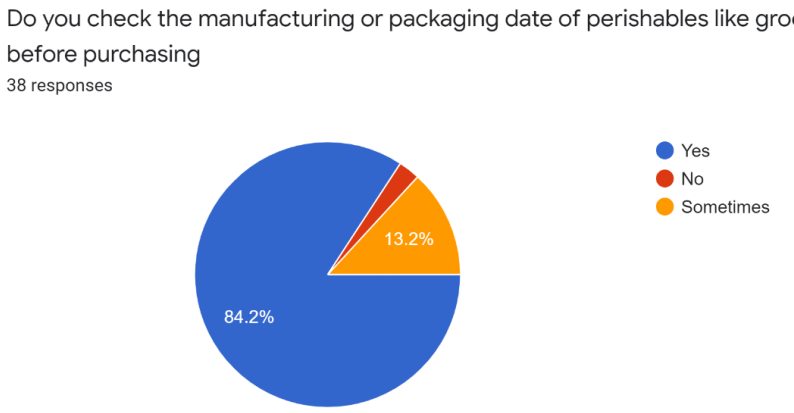
Purchased Perishables	Count
Yes	36
No	2



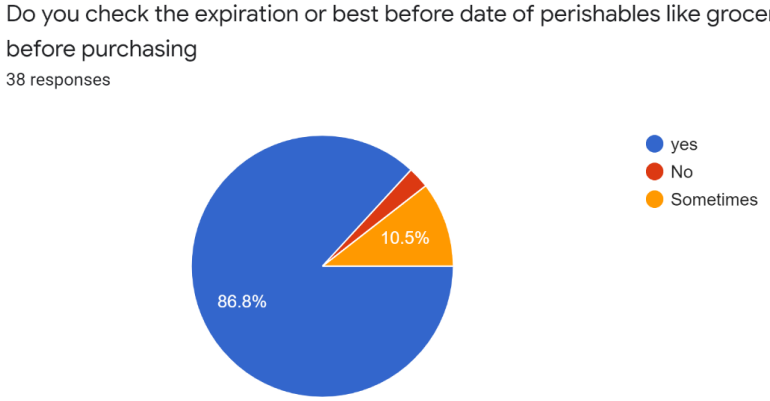
Purchased Non- Perishables	Count
Yes	38
No	0



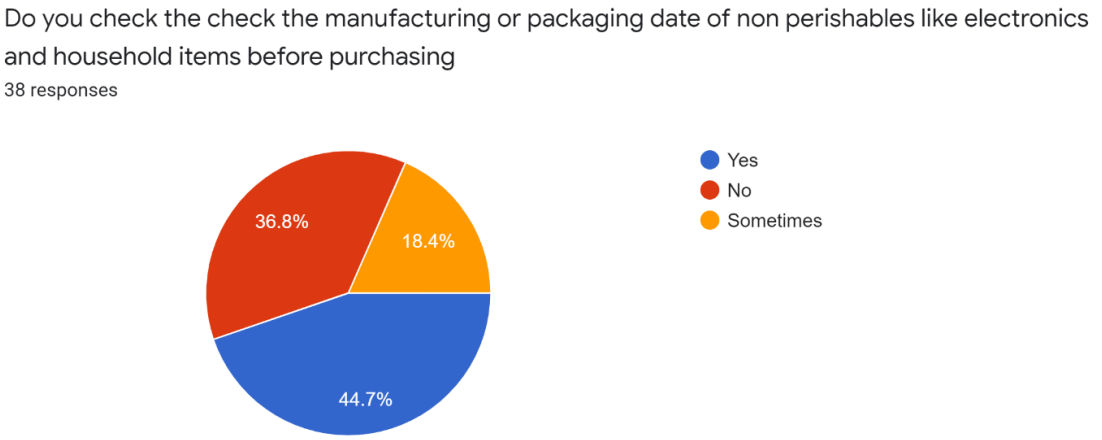
Check manufacturing date of perishables	Count
Yes	32
No	1
Sometimes	5



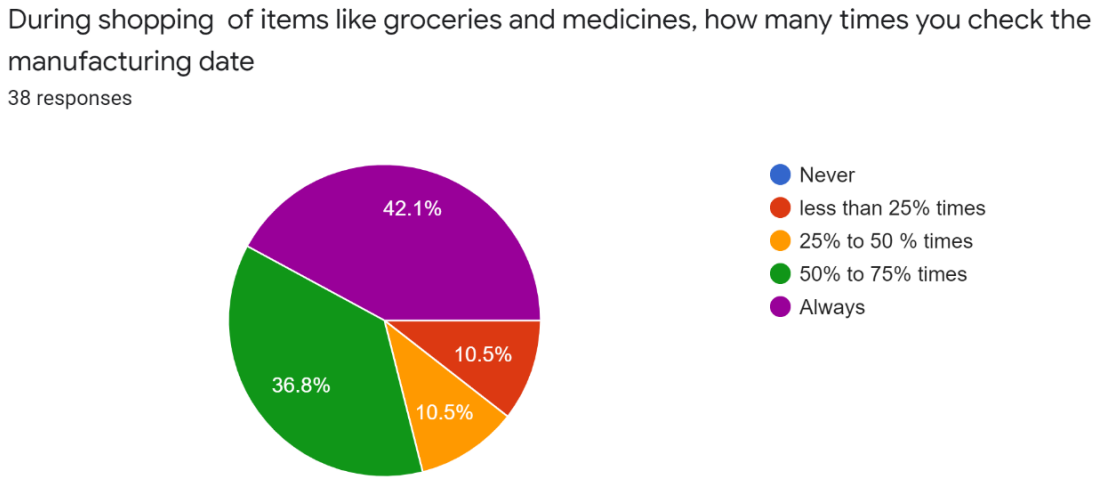
Check Expiry Date of Perishables	Count
Yes	33
No	1
Sometimes	4



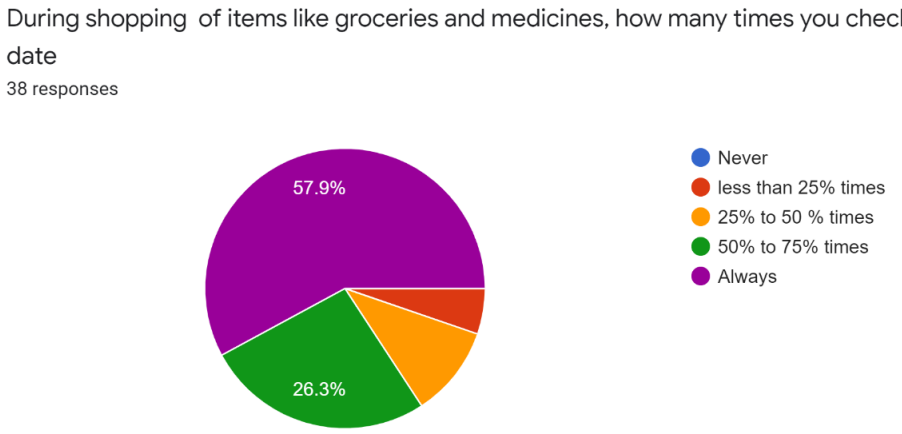
Checked manufacturing dates of Non-Perishables	Count
Yes	17
No	14
Sometimes	7



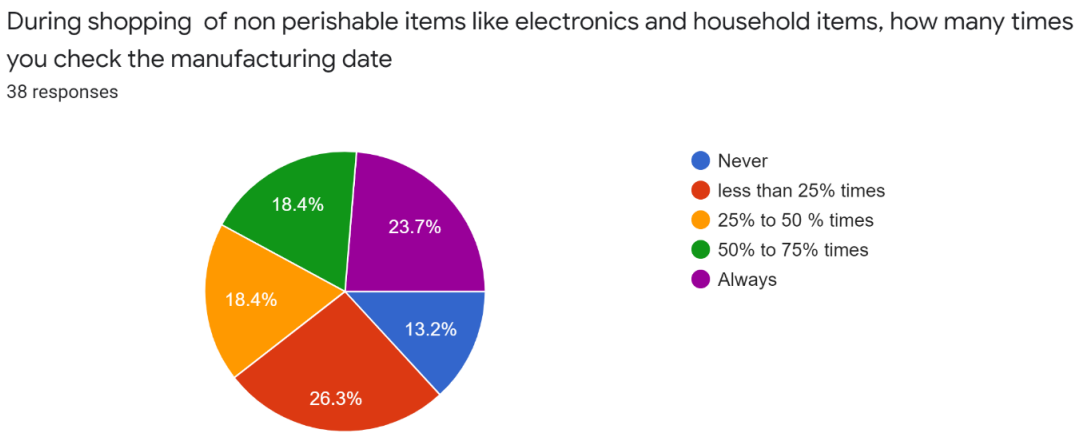
Number of times checked manufacturing dates for perishables	Count
Never	0
<25%	4
25%-50%	4
50%-75%	14
Always	16



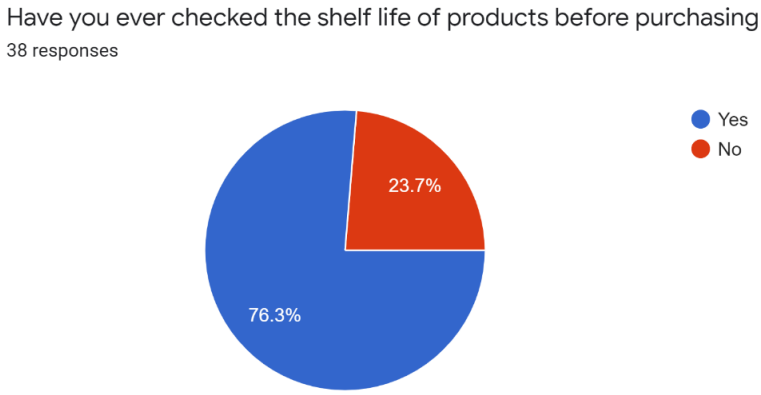
Number of times checked expiration dates for perishables	Count
Never	0
<25%	2
25%-50%	4
50%-75%	10
Always	22



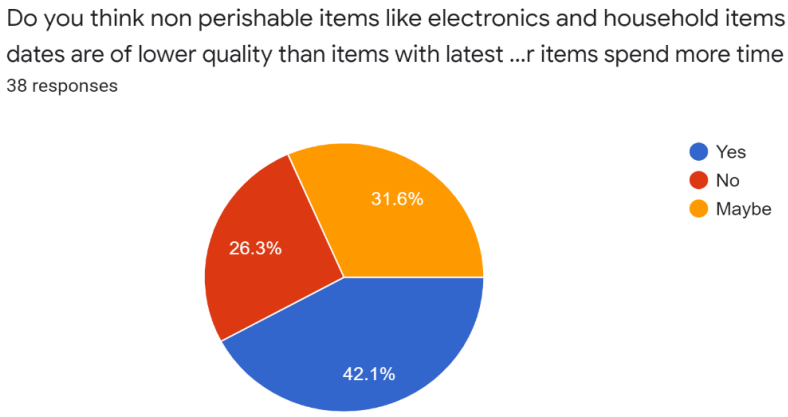
Number of times checked manufacturing dates for non- perishables	Count
Never	5
<25%	10
25%-50%	7
50%-75%	7
Always	9



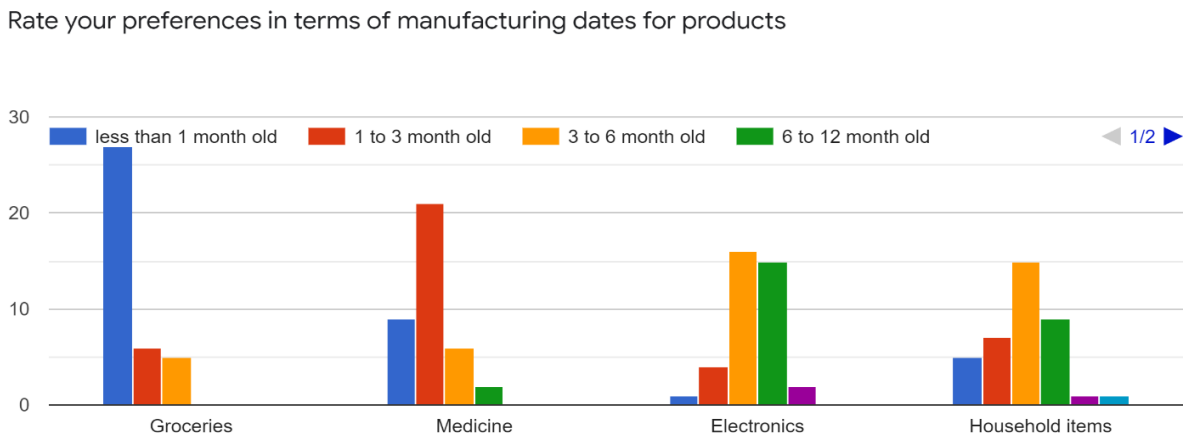
Checked shelf life	Count
Yes	29
No	9



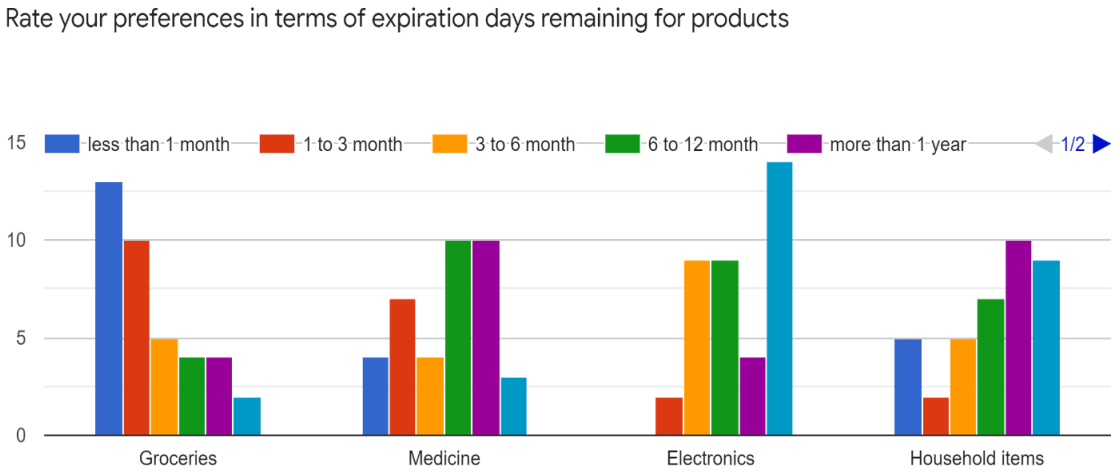
Does quality of non- perishables decreases with time	Count
Yes	16
No	10
Maybe	12



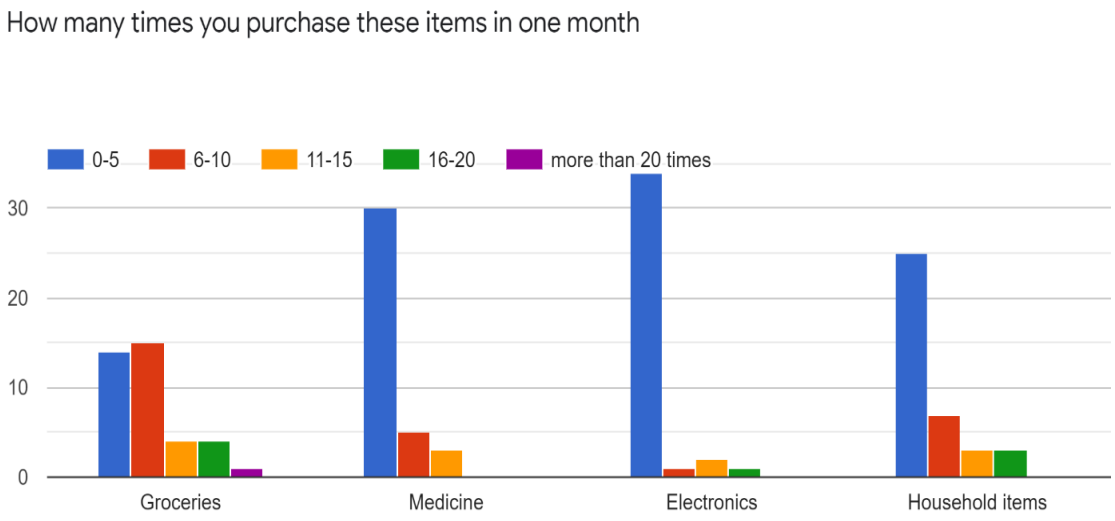
Manufacturing date preferences	<1 month	1-3 months	3-6 months	6-12 months	12-24 months	>24 months
Groceries	27	6	5	0	0	0
Medicines	9	21	6	2	0	0
Electronics	1	4	16	15	2	0
Household Items	5	7	15	9	1	1



Expiry date preferences	<1 month	1-3 months	3-6 months	6-12 months	12-24 months	>24 months
Groceries	13	10	5	4	4	2
Medicines	4	7	4	10	10	3
Electronics	0	2	9	9	4	14
Household Items	5	2	5	7	10	9



Number of purchases in 1 month	0-5	6-10	11-15	16-20	>20
Groceries	14	15	4	4	1
Medicines	30	5	3	0	0
Electronics	34	1	2	1	0
Household Items	25	7	3	3	0



Source: Own Creation

Since analysis was required for perishable and non-perishable items, there was a requirement of combining groceries and medicine groups into a single group of perishable items and also combining electronics and household items groups into a single group of non-perishable items. This was done using the weightage method as given in next section.

Calculation for combining groups

Count of manufacturing dates preferences of consumers in case of perishable items for a time period t can be calculated using formula

$$CPM_t=(Wg*CMg_t)+(Wm*CMm_t)$$

Where,

M symbolize manufacturing

t = Time period preference

Wg= Weight of groceries

Wm= Weight of medicines

CMg=Manufacturing dates preference count of groceries for period t

CMm= Manufacturing dates preference count of medicines for period t

Similarly

Count of manufacturing dates preferences of consumers in case of non-perishable items for a time period t can be calculated using formula

$$CNPM_t=(We*CMe_t)+(Wh*CMh_t)$$

Where,

M symbolize manufacturing

t = Time period preference

We= Weight of electronics

Wh= Weight of household items

CMe=Manufacturing dates preference count of electronics for period t

CMh= Manufacturing dates preference count of household items for period t

Count of expiration dates preferences of consumers in case of perishable items for a time period t can be calculated using formula

$$CPE_t=(Wg*CEg_t) + (Wm*CEm_t)$$

Where,

E symbolize expiration

t = Time period preference

Wg= Weight of groceries

Wm= Weight of medicines

CEg=Expiration dates preference count of groceries for period t

CEm= Expiration dates preference count of medicines for period t

Count of expiration dates preferences of consumers in case of non-perishable items for a time period t can be calculated using formula

$$CNPE_t=(We*CEe_t) + (Wh*CEh_t)$$

Where,

E symbolize expiration

t = Time period preference

We= Weight of electronics

Wh= Weight of household items

CEe=Expiration dates preference count of electronics for period t

CEh= Expiration dates preference count of household items for period t

Now weights were calculated as follows

Total perishable items purchased in a month (TP)=Total groceries purchased in a month (Tg) + Total medicines purchased in a month (Tm).

TP=Tg + Tm

Total non-perishable items purchased in a month (TNP)=Total electronics purchased in a month (Te)+ Total household items purchased in a month (Th).

TNP=Te + Th

Weight of groceries (Wg)=Total groceries purchased in a month/ Total perishable items purchased in a month.

Wg=Tg/TP

Similarly

Weight of medicines (Wm)= Total medicines purchased in a month/ Total perishable items purchased in a month.

Wm=Tm/TP

Weight of electronics (We)= Total electronics purchased in a month/ Total non- perishable items purchased in a month.

We=Te/TNP

Weight of household items (Wh)= Total household items purchased in a month/ Total non- perishable items purchased in a month.

Wh=Th/TNP

Total of products were calculated using formulas

$$Tg = \sum Ng * fg$$

Where Ng=class marks of groceries

fg=count of groceries

$$Tm = \sum Nm * fm$$

Where Nm=class marks of medicines

fm=count of medicines

$$Te = \sum Ne * fe$$

Where Ne=class marks of electronics

fe=count of electronics

$$Th = \sum Nh * fh$$

Where Nh=class marks of household items

fh=count of household items

For collected data class marks are 2.5,7.5,12.5,17.5 and 22.5

Now using above formulas values of manufacturing and expiry date preferences of consumers for perishable and non- perishable items can be found out as given below and tabulated in table 4.8 and table 4.9.

Tg=290

Tm=150

Te=135

Th=205

Wg=0.659

Wm=0.341

We=0.397

Wh=0.603

Table 4.8 Manufacturing dates preferences of consumers

Manufacturing date preferences	<1 month	1-3 months	3-6 months	6-12 months	12-24 months	>24 months
Perishables	21	11	5	1	0	0
Non-Perishables	3	6	16	11	1	1

Source: Own Analysis

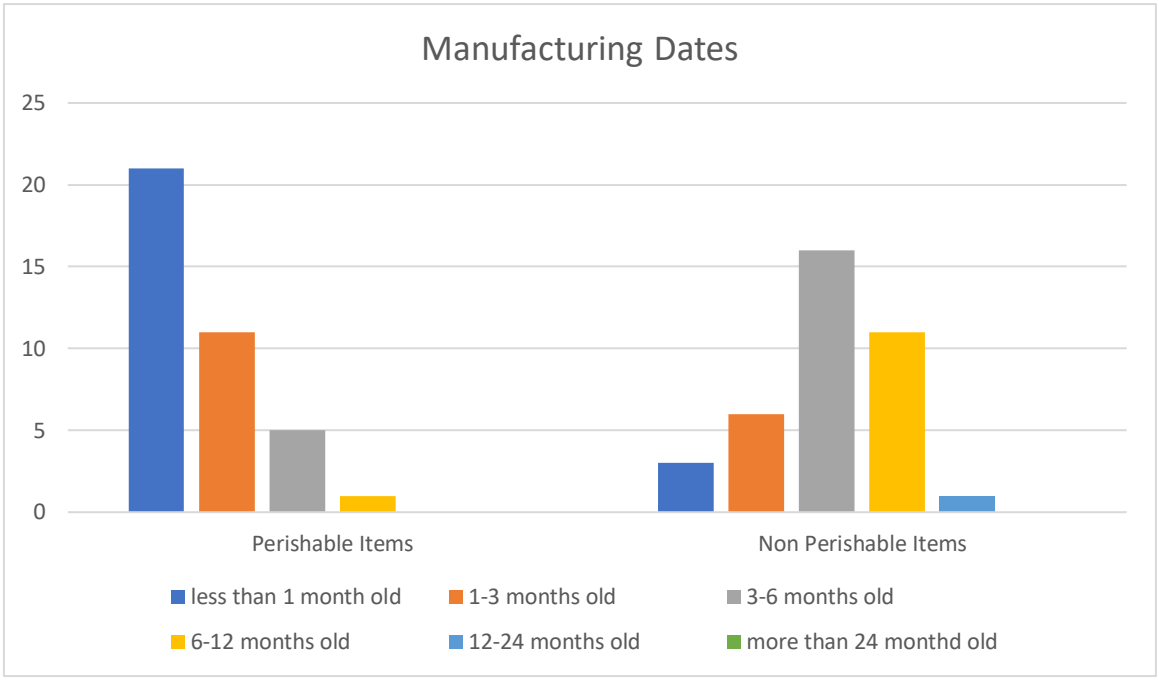
Table 4.9 Expiry dates preferences of consumers

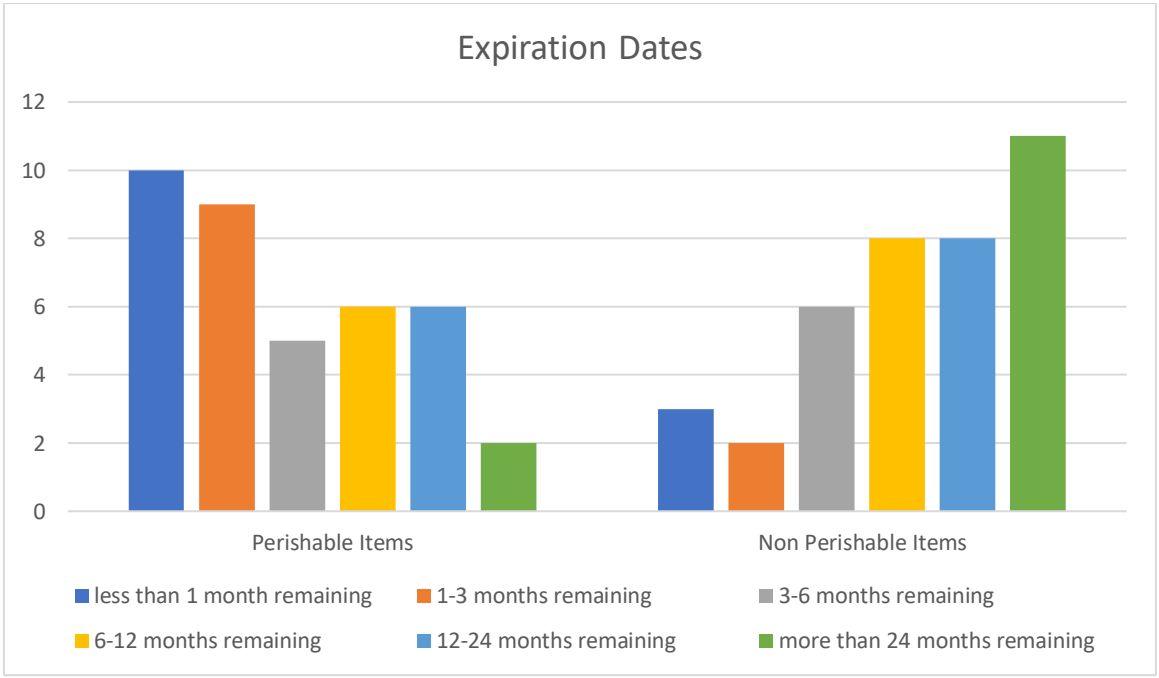
Manufacturing date preferences	<1 month	1-3 months	3-6 months	6-12 months	12-24 months	>24 months
Perishables	10	9	5	6	6	2
Non-Perishables	3	2	6	8	8	11

Source: Own Analysis

The above values can be used to form bar charts as shown in Figure 4.5

Figure 4.5 Bar charts showing manufacturing and expiration dates preferences for perishable and non- perishable items





Source: Own Creation

Findings and Recommendations

Key findings of the analysis were

- All of the respondents of the survey had bought non- perishable items in the past while a majority which was 95% of the respondents had bought perishable items in the past so the data collected from survey was reliable for this study.
- Majority of the people check manufacturing and expiration dates of the perishable items most of the times before purchase and prefer perishable items with latest manufacturing dates and high time period remaining before expiry thus preferring items that have spent less time on shelf. This was in accordance with most of the research work done on perishable items in the past.
- It was also revealed that in case of perishable items people check expiration dates more often than manufacturing dates.
- Majority of the people nearly 77% check shelf life of the items too before purchasing.
- More than 60% of the people also check manufacturing and expiration dates of non- perishable items too and more than 50% of the people believe that the quality of non- perishable items deteriorates if they spend more time on the shelves of retail stores thus contradicting previous belief that shelf life is only important in case of perishable items. This further proved the need for development of shelf life based inventory model for non- perishable items stored in retail and distribution warehouses just like shelf life based inventory model previously developed for stores in the research.
- Calculation of manufacturing and expiration dates preferences of customers for both perishable and non- perishable items revealed that for perishable items highest number of customers preferred manufacturing dates to be less than 1 month old and expiration time remaining to be less than a year.
- It was also revealed that for non-perishable items highest number of people preferred manufacturing dates to be 3 to 6 months old and a large majority preferred expiration time remaining to be more than 2 years thus pointing to the fact that for non-perishable items also customers prefer items which have spent

less time on shelves thus having early manufacturing dates and more time remaining before expiration.

Recommendations

Based on above analysis it is recommended that a shelf life based inventory model should be followed at every level of supply chain to increase customer satisfaction and improve efficiency by reducing waste. The graphs developed in the analysis could be used as a guiding framework for designing shelf life based inventory model for retail stores and warehouses.

Limitations of the study

Due to Covid-19 outbreak during conduction of this research, data related to warehouses of the companies could not be collected and thus detailed analysis of warehouse inventory could not be done. The number of participants involved in the survey were also less than expected due to covid-19 outbreak which might have affected the analysis to some extent but still the dataset was found reliable and this research could provide a good basis for further researches in this field.

Also in case of shelf life based inventory model for stores, analysis of subcategories was not done in detail and left for further studies.

CHAPTER 5: CONCLUSION

CONCLUSION

In order to increase the efficiency of inventory management in supply chain there is a need to focus on quality also along with quantity and for that a shelf life based inventory model could be very useful. It can improve the efficiency of inventory management along with improved customer satisfaction. It can also make the operations in the company more efficient and increase profitability.

It is a common belief that shelf life plays an important role only in case of perishable items and inventory management methods based on shelf life should be adopted for such items but this research have proved that in case of non-perishable items also the shelf life plays an equally significant role and shelf life based inventory management model should be adopted for such items also.

It was also revealed by this research that by adopting shelf life based inventory model the need for adopting other inventory management models like FSN, LIFO, FIFO, Minimum order quantity method is eliminated since this model automatically perform all those functions.

Shelf life based inventory model for non-perishable items is not applicable for raw material stores only but rather for every part of supply chain inventory weather its warehouses or retail stores as evident from analysis of consumer purchasing preference data collected through survey.

The retailers can also adjust their inventory levels according to preferences of consumers depicted in this research to reduce their inventory waste and use their available shelves in the best possible manner while providing high level of customer satisfaction.

By adjusting the inventory level according to manufacturing dates, expiration dates and shelf life a retailer can provide the best possible quality levels to the consumers with most efficient utilization of store space. By adjusting raw material supply according to shelf life the store manager of a firm can help improve efficiency and quality level of production and improve on the profitability of the firm. Similar approach can be adopted at warehouse and all other inventory levels of supply chain.

To conclude if in case of non-perishable items, quality is also used as a criteria for inventory management by using methods like shelf life based inventory model along with quantity criteria at every level of supply chain then inventory waste could be minimized to a great extent and consumers would obtain best possible quality products resulting in highest level of customer satisfaction which would ultimately result in customer loyalty and increased profitability for the firms.

REFERENCES

1. Sinha, D.K. (2014, May). Inventory Control: Forms and Models of Inventory Management – Explained! *Your Article Library*. Retrieved from https://efinancemanagement.com/costing-terms/inventory-management-techniques
2. Chand, S. (2014, February). 6 Most Important Techniques of Inventory Control System. *Your Article Library*. Retrieved from https://efinancemanagement.com/costing-terms/inventory-management-techniques
3. Hayes, A. (2019, August). How Average Inventory Works. *Investopedia*. Retrieved from https://efinancemanagement.com/costing-terms/inventory-management-techniques
4. SKF. (2019). *Bearing Storage*. Retrieved from https://www.skf.com/in/products/bearings-units-housings/super-precision-bearings/principles/bearing-storage/index.html
5. Dhonde, V. (2014, December 13). *shelf life determination*. Retrieved from https://www.slideshare.net/vidyadhonde5/shelf-life-determination-ppt
6. Harland, C.M. (1996). *Supply Chain Management, Purchasing and Supply Management, Logistics, Vertical Integration, Materials Management and Supply Chain Dynamics.*
7. Kamath, N. and Saurav, S. (2016). *Handbook of Research on Strategic Supply Chain Management in the Retail Industry.*
8. Hertog, M. L., Uysal, I., McCarthy, U., Verlinden, B. M., & Nicolaï, B. M. (2014). Shelf life modelling for first-expired-first-out warehouse management. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences*, *372*(2017), 20130306. Retrieved from https://doi.org/10.1098/rsta.2013.0306

9. Muriana, C. (2010). *Experimental analysis of shelf life based inventory management policies for RIFD enabled supply chains*.