

# **ENHANCING OPERATIONAL PROCESSES AT ESNAD COMPANY**

By

<b>Abdullah A. Alothman</b>	<b>1635304</b>
<b>Abdullah W. Hawarnah</b>	<b>1635455</b>
<b>Bader O. Balamash</b>	<b>1635669</b>
<b>Suliman S. Alhumied</b>	<b>1636491</b>
<b>Mautaz A. Aljayzani</b>	<b>1640593</b>

**Advisor**

**Dr. Ammar Y. Alqahtani**

**DEPARTMENT OF INDUSTRIAL ENGINEERING  
FACULTY OF ENGINEERING  
KING ABDULAZIZ UNIVERSITY, JEDDAH  
RABI II 1441 – DECEMBER 2019**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

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**A senior project report submitted in order to complete the  
requirements for the bachelor degree of science in Industrial  
Engineering approval by**

## **Examination Committee**

**Dr. Ammar Y. Alqhatani \_\_\_\_\_(Advisor)**  
**Dr. Majed A. Baghdadi \_\_\_\_\_(Examiner1)**  
**Dr. Mohannad R. Kabli \_\_\_\_\_(Examiner2)**

**DEPARTMENT OF INDUSTRIAL ENGINEERING  
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## **DEDICATION**

First of all, we would like to thank almighty Allah for giving us the patience and strength to complete and apply our knowledge to benefit the people around us. In addition, we are very grateful to our families, friends, and everyone who helped us achieve our goals and needs through the journey of the senior project. In the end, a special thank and appreciation go to our advisor Dr. Ammar Y. Alqahtani, for his efforts and time to accomplish this work!

## **ACKNOWLEDGMENT**

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## **ABSTRACT**

Esnad factory faced many problems in their inventory process due to poor forecasting. The objective of this project is trying to solve the main problem, which is the demand forecasting results by using different types of forecasting methods. The developing team used more than five methods of forecasting to overcome the problem. The data collected from the management were analyzed, and then the forecasting methods were applied and interpreted. The findings show that the best forecasting method is seasonality without trend and this method gives the most accurate results in comparison with the other methods. Game theory is also one of the tools used in this project. The documentation of the procedures will make a big difference in the factory running.

## المستخلص

مصنع شركة إسناد يواجه بعض المشكلات المتعلقة بعملية تخزين منتجاتهم، وذلك بسبب ضعف عمليات التنبؤ بالطلب التي يقوم بها قسم المبيعات في الشركة. الهدف من هذا المشروع هو حل واحدة من أهم المشكلات التي تواجهها الشركة في الوقت الراهن، ألا وهي عمليات التنبؤ بالطلب. فريق التطوير لديه توجّه في حل هذه المشكلة باستخدام عدة طرق للتنبؤ. الفريق استخدم أكثر من خمس طرق للتنبؤ من أجل حل المشكلة. المعلومات التي حصل عليها الفريق من قبل إدارة الشركة قد خللت من قبل الفريق من أجل محاولة إيجاد الطريقة المثلث لحل المشكلة. بعد التحليلات والتجربة، أتضح أن طريقة *Seasonality without trend* هي الطريقة الأفضل التي تُعطي أدق النتائج الممكنة. *Game Theory* هي طريقة أخرى استخدمت لحل بعض مشاكل الشركة وإعطائهم نصائح للتحسين. توثيق عمليات التصنيع والعمليات الإدارية هي أيضاً من أهم المشكلات التي يواجهها مصنع إسناد وقام الفريق بحلها.

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## **CHAPTER - 1**

### **INTRODUCTION & PROBLEM STATEMENT**

#### **1.1 INTRODUCTION**

##### **1.1.1 GENERAL INFORMATION**

The Kingdom of Saudi Arabia is blessed with many rich assets; our geographic, cultural, social, demographic, and economic advantages have enabled us to take a leading position in the world. One of the most important sectors, which represents the country's economy, is industry. There are different types of industries in Saudi Arabia such as the food industry. Vision 2030 supports industrial sectors in Saudi Arabia and trying to ease the process of launching new factories with various types of industries. Saudi Arabia aims to be ranked as one of the top ten countries on the global competitiveness index. The industrial city in Jeddah is very organized and contains all the facilities needed for any factory to start producing. Saudi Arabia is planning to change from a consumer to producer country in the next upcoming years. According to K Nirmal Babu, director of Kozhikode-based Indian Institute of Spices Research (IISR), spices will emerge as an \$18 billion industry by 2020. The annual growth rate of spices demand in the world is around 3.19%, according to the Department of Applied Botany of Mangalore University. Esnad company is one of the leading companies specialized in the spices industry.

Since its inception in August 1989, Esnad has been providing its customers with excellent and up-to-the-standards food products that keep them satisfied, under the corporate philosophy of 'Quality and Taste', while giving safety and security the highest priority. This was driven by the management's inexhaustible aspiration for spices and other related food products; they put all the efforts for spreading the finest quality of spices throughout the Middle

East and North Africa. This was made possible through introducing a wide variety of spices in the market. Esnad has earned a remarkable reputation in the market throughout the past 30 years and, therefore, has managed to build trust among the customers.

For three decades, Esnad has been following the strategic management ideology of ‘Excellence and Ethics’. Efficiency, customer satisfaction, and a maintained market position are the three top playmakers for the Esnad brand.

### **1.1.2 VISION**

Esnad’s management has envisioned seeing Esnad at the top of the list when it comes to food production and solutions. With a solid customer base and 30 years of experience in the production of spices, Esnad aims at incorporating food products as well, like canned foods, ready meals, and other similar food solutions. Esnad’s main purpose is to give each and every family a dynamic food experience that makes them happy.

### **1.1.3 MISSION**

Esnad assures its customers that we will provide them with the best possible taste, without compromising on quality or standards. We promise our customers to exceed their expectations through an incomparable experience in predicting consumer needs and constructing solutions accordingly. We promise to redefine the word ‘TASTE’ for you.

## **1.2 PROBLEM STATEMENT**

### **1.2.1 PROCEDURE DOCUMENTATION**

Esnad Company deals almost daily with different governmental procedures such as residence card renewal procedures, sponsorship transfer procedures, continuity of the work in the factory procedures, and social insurance procedures. There is no documentation of the governmental procedures available in the current time. The undocumented governmental procedures have been a serious issue for Esnad Company. Esnad Company needs to document the governmental procedures to provide a detailed

description of how to carry out a business process to keep a record of processes known only to a few people specialized in doing them. That way even when they leave, the newcomers can resume the work easily. In the methodology chapter, tools used and steps carried out in documenting the procedures will be discussed in detail.

### **1.2.2 FORECASTING**

In Esnad Company, a couple of serious problems took place in the last couple of years. By some estimations provided by the company's management, the most critical issues Esnad faces were the demand forecasting errors in addition to the documentation of the procedures, whether the governmental process or the machines working criteria. Regarding the forecasting error problem, based on the data given from the management, several scientific methods and techniques were followed in order to combat this problem. Esnad Company was following a primitive technique for the demand forecasting of its products, which exceeds 800. With the industrial engineering mindset, the forecasting issues are our specialty! In the methodology chapter, the methods and techniques used will be discussed in detail.

### **1.2.3 GAME THEORY**

This study will address five problems that are related to social interactions. Starting with Marketing Campaign, we have two competitive companies thinking of making a marketing campaign. But they need to consider if all the expenses that come with making a marketing campaign and compare it with the outcomes expected from the campaign. Not only that, but each party needs to think about the other party choose because it affects the results of the campaign. So, each party needs to make a conscientious decision.

The second problem is the Price War. The two companies are in an oligopoly market structure. Normally in oligopoly markets, companies tend to compete with prices, which is known as Price War. Now in a price war, usually powerful companies reduce their prices (which reduces their marginal profit) intentionally for a period of time to gain a bigger market share. In an attempt

to steal customers from their competitor by attracting them with lower prices. But if both companies did that for a long period of time, they will start to have serious financial issues. We will try to find an answer to what should Esnad do when facing a price war scenario.

The third problem is Investing in R&D. Esnad and Maggi are deciding whether to invest in developing their products to appeal more to customers' needs. Like coming up with a new package or a unique flavor. But R&D takes time and requires a lot of funding to come up with new ideas and to test them to see if they fit the market. Esnad and Maggi are facing the same question, should they invest their money directly on the daily operations, or should they invest some money into their R&D department.

The fourth problem is Releasing a new product. Esnad and Maggi are looking into the option of introducing a new product to the market. In an attempt to increase their market share and customer satisfaction by entering a new customer segment. But this expansion might backfire on the company and start losing customers and money spent on the new product. Esnad needs to consider all of the options concerning what Maggie would do.

The fifth and last problem is New Policy. Esnad wants to adopt a new policy for employee promotions and yearly bounces system. That would make the bounces get distributed through the employees on a curve. As an attempt to reduce cost by reducing the number of people who get bounces at the end of the year. On the other hand, this new policy might not get a warm welcome from the company employees. Because they fear that their end year bounces might get affected. As a result, they might revolt on Esnad in an attempt to overthrow this policy.

## **CHAPTER - 2**

## **BACKGROUND STUDIES**

### **2.1 PROCEDURE DOCUMENTATION**

When companies grow, organizational complexity also increases. Technological advancements have increased reliance on big data such that companies are involved in processing volumes of unstructured information for different activities. There is a need for such processes to be organized efficiently. The procedure documentation is a detailed illustration of how the company will carry out its operations. The origins of the term procedure documentation or Standard Operating Procedures (SOP) are unclear. The Britannica Encyclopedia suggests that the abbreviation was used around the mid-1900s. Procedure documentation used during the Second World War. Therefore, nowadays, the use of Standard Operating Procedures is used in several areas such as business routines or manufacturing processes to medical activities (Encyclopedia Britannica, 2019).

Creating a new procedure document may be extremely complicated or simple, depending on the scale of the system. If it is small-scale, an individual may be able to create the entire report. On the other hand, if it involves working between several different departments, then a small team of different experts would have to be created. There are a variety of benefits of procedure documentation such as maintain safety and efficiency. Moreover, it will always take a longer time to complete tasks if the same task is completed in many different ways. Having a documented standard procedure in place streamlines the process so that more can be achieved in less time by employees, as well as providing consistency, which means that business processes are conducted in the right way, regardless of who is employed (Tallyfy,2009).

For instance, in March 2014, the World Health Organization used Standard

Operating Procedures for coordinating public health event preparedness and response in the WHO African Region. Try to inform and assist staff at the forefront of public health action at the WHO. The main purpose of the SOPs is to identify the measures that workers will normally take in terms of prevention, diagnosis, and response to acute public health incidents in support of countries in the region. Considering their significance in the African Region, the SOPs have been published with an emphasis on outbreaks of infectious diseases. The goal of these SOPs is that an early warning system leading to a fast and effective response to acute Public Health Event (PHEs) in the African region would deter the continuing spread of disease and reduce the negative impact of disease outbreaks on public health and social and economic implications (Who.int, 2019).

## **2.2 FORECASTING**

Any ongoing business in this world that is related to manufacturing products need to do demand forecasting for the quantity to be produced. When business forecasting was introduced first as an academic interest, the most popular method that people and organizations were mainly using it was the exponential smoothing forecasting method. A practitioner called Robert G Brown, has introduced methods in the late '50s. At that time, the exponential smoothing method was popularly used. After that, in the '60s and '70s, other demand forecasting methods were introduced which takes the trend and seasonality into consideration. These methods were found and introduced by scholars such as "Holt" who introduced the trend method, and "Winter" who invented the trend and seasonality method.

Ryu et al., (2003), a data analyst, has evaluated the forecasting method for institutional food service facility. The management was identifying the most appropriate forecasting method of forecasting meal count for an institutional food service facility. The forecasting method analyzed included: naïve model 1,2 and 3; moving average method, double moving method, exponential smoothing method, double exponential method, Holt's method (the trend method), Winter method (seasonal and trend), linear regression and multiple regression method. The accuracy of forecasting methods was measured

using different types of errors such as; mean absolute deviation, mean squared error, mean percentage error, mean absolute percentage error method. The result of this study showed that multiple regressions were the most accurate forecasting method. This experiment proves that in order to determine the best demand forecasting method, the developing team in any organization must first try plenty of demand forecasting method, then calculate the errors using their formulas. Based on the result of the errors, then the best forecasting method can be used to give the highest accuracy.

Nestlé is the biggest food and beverage company in the world. In the past couple of years, Nestlé's main focus was on finding the best demand forecasting method in order to increase the effectiveness of their production line and reduce their inventories. Charles Chase, Innovator, and expert in sales forecasting, work at Nestlé, have helped the company improve its forecast accuracy and make multi of millions reduction in their inventories. The technology that Chase used senses demands signals rather than trend and seasonality, telling a business automatically what demand signals influence the purchase of products by consumers up and down. The effect of advertising and price will be measured automatically, allowing' demand shaping' up and down.

## **2.3 GAME THEORY**

### **2.3.1 GAME THEORY & WATER RESOURCES**

Kaveh Madani has conducted a study to examine the applicability of game theory to water resource management and conflict resolution using a series of non-cooperative water resource games (Madani, 2010). Kaveh Madani suggests that the outcomes predicted by game theory often vary from the results proposed by optimization techniques, which suppose that all parties are willing to act towards the best system-wide outcomes. This research examines the applicability of game theory to water resource management and conflict resolution through a sequence of non-cooperative water resource games. He used a famous game structure in game theory, like the Prisoner Dilemma, Stack Hint, and Chicken game. In an attempt to solve problems related to water resources management.

		<i>Farmer 2</i>	
		<i>PR 1</i>	<i>PR 2</i>
<i>Farmer 1</i>	<i>Pumping Rate 1</i> ( <i>PR 1</i> )	3,3	1,4
	<i>Pumping Rate 2</i> ( <i>PR 2</i> )	4,1	2,2

**Figure 2.1:** Groundwater exploitation game with ordinal payoffs

Figure 2.1 is an example of one of the issues he discussed in the paper. It shows the ordinal payoff matrix for a groundwater game with a Prisoner's Dilemma structure in which two farmers tap a shared aquifer. The payoff for each farmer represents his revenues from crop sales minus pumping costs. Each player must choose between the cooperative (PR1) and non-cooperative (PR2) pumping rates. If both farmers choose the "pumping rate 1" the groundwater level will not drop, and the farmers can enjoy long-term low pumping costs. However, if both farmers are pumping at a higher rate "pumping rate 2" it will reduce groundwater levels, increasing pumping cost, and reduces the profit, eventually making pumping economically a wrong decision. "pumping rate 1" increases profits for both farmers. Getting "free ride" (going for "pumping rate 2" while others are going for "pumping rate 1") would be the best result for each farmer. In that scenario, one farmer pumps at a higher rate (PR2) while the other one has committed to pumping at a lower rate (PR1). The free rider is going to have the highest payoff in this situation due to pumping costs lower than the scenario in which both farmers pump at the "pumping rate 2" and higher crop revenue than the scenarios in which he decides to cooperate. Thus, choosing a cooperative strategy action plan while the other farmer is willing to cooperate, end up in the lowest payoff due to high pumping costs and low crop sale revenues (Madani, 2010).

This is just one example taken from the paper. The paper has more games with in-depth analysis for each game. This paper proves the diversity of game theory and its ability to analyze different social interactions and come

up with solutions with regards to human behavior.

### **2.3.2 Facilitating International Agreements Through an Interconnected Game Approach: The Case of River Basins**

Shannon E. Ragland from Hagler Bailly and two doctors from Yale University Dr. Lynne L. Bennett and Dr. Peter Yolles made a research paper discussing the problem of international conflicts on water resources like river basins. International rivers are a significant source of water throughout the whole world. Interdependence between countries leads to resource conflicts as upstream nations have leverage on water quantity and quality of downstream countries. We can analyze these conflicts using game theory. The study covers two main topics, first is a study of tensions and stress over a shared basin in Central Asia. The second is a study of shared water in the Euphrates and Orontes River Basins in the Middle East (Bennett, Ragland, Yolles, 1998).

We are going to showcase an interconnected game that was used in the study. The interconnected game links water and non-water issues to expand the range and benefits provided by negotiations across multiple issues. Syria has been supplying refuge to the irredentist Kurdish rebels fighting a secessionist battle in Turkey under the Marxist Kurdistan Workers Party (PKK) flag (Gruen 1993). Turkey has insinuated that Syria supports this rebel group as a bargaining chip for water.

		Turkey	
		Share	Not Share
		2	-2
Syria	Not Support	1	3
	Support	1	0
		-1	0

**Figure 2.2:** Interconnected game with ordinal payoffs

We represent the implicit linkage using the stage game in Figure 2.2. As in the Central Asia case, we assume that Syria is better off when Turkey shares

water in the Euphrates, and Turkey is better off when Syria ceases to support the Kurdish rebels. However, Turkey has a dominant strategy: to not share the water. Syria's best response to this strategy is to support the rebels. Consequently, the stage game iterated dominance equilibrium is Support and Not Share.

This is just one example taken from the paper. The paper has more games with in-depth analysis for each game. This paper shows the applicability of game theory in the international river basins conflicts (Bennett, Ragland, Yolles, 1998).

### 2.3.3 A Survey on Applications of Game Theory in Blockchain

A bunch of scientists and engineers from the IEEE society has made a survey on applications of Game Theory in Blockchain. In the past decades, blockchain technology has attracted tremendous attention from both academia and industry. The popularity of blockchain networks was originated from a crypto-currency to serve as a decentralized and tamperproof transaction data ledger. Nowadays, blockchain, as the key framework in the decentralized public data-ledger, has been applied to a wide range of scenarios far beyond crypto-currencies, such as the Internet of Things (IoT), healthcare, and insurance.

This survey aims to fill the gap between a large number of studies on the blockchain network, where game theory emerges as an analytical tool, and the lack of a comprehensive survey on the game-theoretical approaches applied in blockchain-related issues.

**Table 2.1:** Summary of Game Theoretical Applications For Security

	Game Model	Player	Action	Strategy	Payoff	Solution
Selfish Mining Attack	Non-cooperative game	Mining pools	Infiltrate other pools to launch BWH attack	Determination of the infiltration rate	Mining rewards minus cost	Nash equilibrium
	Splitting game	One miner and pools	Distribute mining power for selfish mining	Determination of the power distribution	Mining rewards minus cost	Mixed strategy Nash equilibrium
	Mean-payoff game	Mining pools	Migrate to other pools to launch PBWH attack	Determination of the migration rate	Mean-payoff	Mean-payoff objective

	<b>Game Model</b>	<b>Player</b>	<b>Action</b>	<b>Strategy</b>	<b>Payoff</b>	<b>Solution</b>
majority Attack	Stochastic game	Miners	Block withholding (BWH) attack	Selection between honest mining and selfish mining	Social welfare	Zero-Determinant strategy
	Non-cooperative game	Miners	Selfish propagation attack	Selection of identity duplication and transactions relaying	Mining rewards	Nash equilibrium
	Non-cooperative game	Miners	Fork chain	Selection of fork to mine	Transaction fees	Nash equilibrium
	Non-cooperative game	Miners	Delay submitting shares	Decision of the proper time to submit shares	Mining rewards	Nash equilibrium
	Non-cooperative game	Miners	Select or create a chain to mine	Selection of the chain to mine	Mining rewards	Nash equilibrium
	Stochastic game	Miners	BWH attack	Decision of the proper time to release the block	Mining rewards	Nash equilibrium
DoS Attack	Non-cooperative game	Miners	Post smart contract transaction of mining on private chain	Selection between working on smart contract transaction and honestly mining	Transaction fees and mining rewards	Nash equilibrium
	Stochastic game	Miners	Compete to fork chain	Selection of adding the block to the chain	Mining rewards minus cost	Nash equilibrium
	Non-cooperative game	Attacking and defending miners	Issue whale transaction to attract miners mine on the private chain	Determination of the threshold of attack cost and block selection	Mining reward minus cost	Nash equilibrium
	Sequential game	Attacking and defending miners	Buy stake to launch majority attack	Determine the cost of attack and selling selection	Function of profit and interest	Nash equilibrium
	Non-cooperative game	Attacking and defending miners	Goldfinger attack	Decision of forming cartel and determination of the tax paid to the attacker	Profits minus cost	Nash equilibrium
	Stackelberg game	Blockchain users and miners	Form cartel to launch majority attack	Setting transaction fee and selection of recruiting miners	Profits minus cost	Stackelberg equilibrium
DoS Attack	Non-cooperative game	Mining pools	DDoS attack	Selection of launching attack or not	Profits minus cost	Nash equilibrium
	Sequential game	Mining pools	DDoS attack	Chosen of the attack level	Profits minus cost	Nash equilibrium
	Repeated game	Mining pools	DDoS attack under a reputation-based scheme	Selection of launching attack or not	Profits associate with the loss of reputation	Nash equilibrium
	Non-cooperative game	One server and devices	DDoS attack in edge network	Selection between executing or sending request and launching attack	Profits minus cost	Nash equilibrium

	<b>Game Model</b>	<b>Player</b>	<b>Action</b>	<b>Strategy</b>	<b>Payoff</b>	<b>Solution</b>
Other security issues	Non-cooperative game	Groups of information sharing network	Form group and infiltrate other groups to withhold data	Determination of infiltration rate	Profits minus cost	Nash equilibrium
	Extensive-form game	Clouds of cloud computing network	Collude to output the same wrong data	Selection of collusion or not	Function of payment and deposit	Sequential equilibrium
	Extensive-form game	Buyer and seller of the blockchain trading system	Cheats of buyer or seller	Selection of cheating or not	Profits associated with deposits	Subgame perfect Nash equilibrium
	Non-cooperative game	Buyer and seller of the blockchain trading system	Cheats of buyer or seller	Selection of cheating or not	Profits associated with deposits	Nash equilibrium
	Coordination game	Voter and verifiers	Manipulate data of data verification system	Statement of the correctness of data	Profits associated with deposits	Nash equilibrium
	Stackelberg game	Blockchain users, one provider, and one insurer	Purchase insurance to compensate for the attack	Determination of the service price, service demand, and insurance price	Profits minus cost	Stackelberg equilibrium

In Table 2.1, is a summary of game theoretical applications for security, one of the results of the survey. In the paper, more Tables like this discuss and reviews game models proposed to address common issues in the blockchain network. Issues regarding mining management, like computational power allocation, reward allocation, and pool selection, as well as issues regarding blockchain economic and currencies (Liu, Z., 2019).

## **CHAPTER - 3**

### **METHODOLOGY**

The methodology section describes the systematic approach used in the research, theoretical analysis of the methods applied, and an explanation of software application used in the research. The methodology section contains a brief description of the tool, advantages, and disadvantages of the tool, steps carried out in each tool, and a software application used.

#### **3.1 PROCEDURE DOCUMENTATION**

##### **3.1.1 PROCEDURE DOCUMENTATION METHODOLOGY**

Procedures documentation is providing a detailed description of how to carry out a business process. The procedures documentation makes it easy for the organization to monitor and do the required maintenance for the workload environment. It can also help minimize the errors done by employees and workers in the workplace environment.

##### **3.1.2 ADVANTAGES OF PROCEDURES DOCUMENTATION**

The advantages of procedures documentation can be illustrated as follow:

- 1- It helps improve the process, by documenting the exact procedures and removing unnecessary steps, which will save time and prevent errors.
- 2- It Helps train employees, one of the advantages of procedures documentation, that the organization can easily help new employees understand their job and familiarize themselves with the procedures.
- 3- It helps mitigate risk and maintain operational consistency. If the procedures are documented, the organization will not be affected by any experienced employee leaving them, which will maintain the operational consistency, and it will reduce risks taken by the organization.

### **3.1.3 DIFFICULTIES OF PROCEDURES DOCUMENTATION**

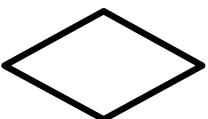
The difficulties of procedures documentation can be illustrated as follow:

- 1- The concept of procedures documentation is new in Saudi Arabia. Therefore, the importance of procedures documentation is unknown. For this reason, sometimes there will be a resistance to apply this new concept from the management.
- 2- The misunderstanding of procedures documentation from employees, they think that procedures documentation is applied in order to replace them. Therefore, employees may not collaborate.

### **3.1.4 FLOWCHART DIAGRAM**

A flowchart is a diagram describing a process or activity. It involves various steps that "flow" the process from beginning to end. Common flowcharts use include the development of business plans, the definition of troubleshooting steps and the development of mathematical algorithms. The development team used a flowchart diagram in order to visualize multiple steps and their sequence into a single document. The flowchart symbols and their explanation are in Table 3.1 as follow:

**Table 3.1:** Flowchart diagram symbols and their explanations.

<b>Symbol</b>	<b>Name</b>	<b>Function</b>
	Start / End	An oval represents a start or endpoint.
	Arrows	A connector that shows relationship between the representative shapes.
	Input / Output	A parallelogram represents input or output.
	Process	A rectangle represents a process.
	Decision	A diamond indicates a decision.

### **3.1.5 STEP-BY-STEP METHOD TO DOCUMENT THE PROCEDURES**

1. Select the procedure that will be documented.
2. Give a name to the procedure.
3. Provide a brief description of the procedure function.
4. Identify the procedure's inputs: list down resources needed to carry out each step in the process.
5. Identify the procedure's outputs: establish what the process will produce.
6. Gather all information on process steps from starting point to ending point.
7. Organize the steps sequentially.
8. Brainstorm the process steps in order to eliminate the unnecessary steps to keep the number of steps to a minimum.
9. Assign responsibility: define each individual who will be responsible for each process step, defining them using their job titles.
10. Finally, visualize the steps and sequence of the procedure using a flowchart diagram to improve clarity and readability

## **3.2 FORECASTING**

The main purpose of this research is to conduct the most accurate demand forecasting as much as possible. The main and most complex problem Esnad faces in their sales department, and the manufactured products being produced are the demand forecasting. Some products are being produced upon request and others and being overproduced, which is due to the inefficient forecasting methods and techniques are done by Esnad.

Across different areas of concern, forecasting plays an important role. As in the case of production planning, management has to decide what to produce and with what assets. Thus, forecasting is considered to be the essential element of business because it allows management to make the right decisions. Forecasting is making predictions on the future based on past and present data.

### **3.2.1 CATEGORIES OF DEMAND FORECASTING**

The qualitative forecasting method is one of the two main categories of forecasting. In the qualitative methods. It is a statistical technique that predicts the future using expert judgment instead of numerical analysis. To predict future outcomes, this method of forecasting depends on the opinions and knowledge of the highly skilled and experienced staff. There are several types of qualitative methods and techniques. The first technique is called executive opinions, which basically can be defined as taking the opinions of expert people into consideration for forecasting the future demand of a certain product. As discussed before, the qualitative technique has to deal with opinions, not numbers! The second type is called the Delphi technique. In this method, expert panels are selected, and the upcoming events are questioned individually. This approach is versatile and very effective for long-range forecasting. This method's main disadvantage is that there is a lack of returns and low reliability. The third and last type which will be discussed in this report is the consumer surveys. In this method, simply the surveys will be conducted on customers who purchase the products using different types of medium, and then the results will be analyzed by a team that consists of expert people, and based on the results, demand forecasting will be implemented.

The other category of demand forecasting methods is quantitative techniques. This type is used in this project in order to do the demand forecasting needed for Esnad to improve the accuracy of producing products and to reduce the waste as much as possible. The developing team is trying to find out the best quantitative forecasting method to be used based on the data taken from Esnad management. Six quantitative methods will be used in this report; four of them will be discussed in detail.

The first type is the exponential smoothing method. Exponential smoothing is a time series forecasting method for univariate data that can be extended to support data with a systematic trend or seasonal component. To calculate demand forecasting using an exponential smoothing method, this equation is suitable:  $F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$ .

Some of the advantages of the exponential smoothing forecasting method:

- It is easy to learn and apply.**

Only three pieces of data are required for exponential smoothing methods. One, it needs the forecast for the most recent time period. Two, it needs the actual value for that time period. And three, it needs the value of the smoothing constant, a weighting factor that reflects the weight given to the most recent data values.

- It produces accurate forecasts.**

An exponential smoothing method produces a forecast for one period ahead. Using the trend projection technique, forecasts for more periods ahead can then be generated. The forecast is considered accurate as it accounts for the difference between actual projections and what occurred.

On the other hand, exponential smoothing also has some disadvantages:

- It cannot handle trends well.**

Exponential smoothing is best used for forecasts that are short-term and in the absence of seasonal or cyclical variations. As a result, forecasts aren't accurate when data with cyclical or seasonal variations are present. As such, this averaging won't work well if there is a trend in the series.

- It produces forecasts that lag behind the actual trend.**

The lag is a side effect of the smoothing process. There's a reason this method has "smoothing" in its name because it neglects the ups and downs associated with random variation.

The other quantitative method which will be used is the project is the linear regression. Linear regression is a statistical tool used to help predict future values from past values. It is commonly used as a quantitative way to determine the underlying trend and when prices are overextended. The advantage of regression analysis is that it can allow you to essentially crunch the numbers to help make better decisions for the current and or future business.

On the other hand, the disadvantage of the linear regression method is by its

definition. Linear regression only models relationships between dependent and independent variables that are linear. It assumes there is a straight-line relationship between them, which is incorrect sometimes. The linear regression forecasting method is calculated using the following equation:  
$$Y = a + bX.$$

The next method is the simple moving average. The moving average is calculated by adding a stock's prices over a certain period and dividing the sum by the total number of periods.

The main advantage of the (SMA) is that it offers a smoothed line, less prone to whipsawing up and down in response to slight, temporary price swings back and forth. Therefore, it provides a more stable level indicating support or resistance.

Moving averages draw trends from past information. They don't take into account changes that may affect a security's future performance, such as new competitors, higher or lower demand for products in the industry, and changes in the managerial structure of the company.

Some of the disadvantages of using a simple moving average method (SMA). Ideally, a moving average will show a consistent change in the price of a security over time. Unfortunately, moving averages don't work for all companies, especially for those in very volatile industries or those that are heavily influenced by current events. This is especially true for the oil industry and highly speculative industries in general.

Another quantitative demand forecasting method is the trend adjusted forecasting (TAF). It is simply a variation of simple exponential smoothing that can be used when the time series data exhibits a trend. It is also known as a double adjusted trend.



**Figure 3.1:** TAF Method

Figure 3.1 shows an example of the trend adjusted forecasting method. The x-axis represents the months (periods), and the y-axis represents the housing starts from 1800 up to 2200.

$$AF_{t+1} = F_{t+1} + T_{t+1}$$

Where...

$$T_{t+1} = \beta (F_{t+1} - F_t) + (1 - \beta) T_t$$

= trend factor for the next period

$T_t$  = trend factor for the current period

B = smoothing constant for the adjustment factor

(just add a trend adjustment factor)

**Figure 3.2:** Formula of TAF

Figure 3.2 shows the steps of how to use the trend adjusted forecasting formula when there are data that needs forecasting. One of the pros of trend adjusted forecasting (TAF) is that the applications for trend analysis seem almost limitless. Since a trend analysis is based on verifiable data. The use of numbers makes the analysis more exacting. Trend analysis can be

replicated, checked, updated and refined when necessary. On the other hand, one of the cons of using trend adjusted forecasting (TAF) is that the historical data may not give a true picture of an underlying trend.

Another type of quantitative forecasting method is the weighted moving average. A Weighted Moving Average puts more weight on recent data and less on past data. This is done by multiplying each bar's price by a weighting factor.

Week	Sales	2WMA	Weights: 3 and 2
1	39		
2	44		
3	40	42.0	
4	45	41.6	
5	38	43.0	
6	43	40.8	
7	39	41.0	$F_7 = \frac{3(43) + 2(38)}{5}$
8			

**Figure 3.3:** Weighted Moving Average Formula

Figure 3.3 shows the way used to find the weighted moving average of any given data that needs forecasting. The weighted moving average model, like the moving average model, has an advantage over other forecasting models in that it does smooth out the peak in a set of observations. However, like the moving average model, it also has several disadvantages. In particular, this model does not produce an actual equation. Therefore, it is not all that useful as a medium-long range forecasting tool. It can only reliably be used to forecast a few periods into the future.

The fifth and sixth methods respectively are Trend Projected Adjusted and seasonality without a trend. Trend component: is a long-term increase or decrease in the data, which might not be linear. Sometimes the trend might change direction as time increases. The seasonal component exists when a series exhibits regular fluctuations based on the season (e.g., every month/quarter/year). Seasonality is always of a fixed and known period.

Trend Projected Adjusted is the presence of both seasonal and trend in the data at the same time, while seasonality without trend from its name, the data includes seasonal without the presence of a trend.

### **3.3 GAME THEORY**

Game Theory is used in this study to address social problems and interactions in an attempt to find an optimal solution for every encounter. Game theory is the study of mathematical models of strategic interaction between rational decision-makers (Myerson, Roger B. 1991). It has applications in all fields of social science, as well as in logic and computer science. Originally, it addressed zero-sum games. Today, game theory applies to a wide range of behavioral relations and is now an umbrella term for the science of logical decision making in humans, animals, and computers.

Before addressing the games that we are going to apply in this study, we need to define a couple of terminologies so it will be easier in the upcoming chapters to address them — starting with key elements that must be defined before each game which are: Players, Strategies, and Payoffs. Players in game theory are the decision-makers; they can be companies, governments, or employees (Ben Polak, 2007). Next, Strategies are simple actions. But in game theory, a strategy is any of the options which he or she chooses in a setting where the outcome depends not only on their actions but on the actions of others (Ben Polak, 2007). Next, Payoffs represent players' preferences according to the assumptions expressed in utilities, which are the currency of payoffs (Spaniel, 2015). There are two types of payoffs, Cardinal and Ordinal payoffs. Cardinal payoffs are numbers representing the outcomes of a game where the numbers represent some continuum of values, such as money, quantity, or market share. Cardinal payoffs allow the theorist to vary the degree or intensity of payoffs, unlike ordinal payoffs, in which only the order of values is important. For mixed strategy calculations, payoffs must be cardinal (Shor, 2019). Ordinal payoffs are numbers representing the outcomes of a game where the value of the numbers is not important, but only the ordering of numbers. For example, when solving for a Nash equilibrium in pure strategies, one is only concerned with whether one

payoff is larger than another, the degree of the difference is not important. Thus, we can assign values like "1" for the worst outcome, "2" for the next best, and so on. Thus, ordinal payoffs rank all of the outcomes. For mixed strategy calculations, cardinal payoffs must be employed (Shor, 2019).

In the definition of payoffs, we mentioned assumptions that determine how to think and act in the game. Assumptions are our insights into how the players see the world (Gayu, 2019). One thing we usually assume in games is complete information, which is knowledge about other market participants or players is available to all participants. Payoffs, strategies, and "types" of players are common knowledge (Thomas, 2003). Another thing we usually assume is self-interested, which means that each player is looking to maximize its benefits. Not that they want to harm each other, it's just that the agent has its description of states of the world that it likes, and acts based on this description (Spaniel, 2015).

Types of games, in-game theory, we categorize games by their types. One of the types is Cooperative / non-cooperative. A game is cooperative if the players are able to form binding commitments externally enforced. A game is non-cooperative if players cannot form alliances or if all agreements need to be self-enforcing (Shor, 2019). Another game type is Simultaneous / Sequential move games. Simultaneous move games are games where both players move (make actions) simultaneously without knowledge of the other player's actions. Sequential move games are games where later players have some knowledge about earlier actions. Usually, sequential move games tend to have perfect information property, which means that every player is aware of what the other party chosen strategy (action).

In-game theory, we represent games in three different ways, which are Normal form (or Strategic form), Extensive form, and Characteristic function form. In this study, we will work on games that are represented in the Normal and Extensive Form.

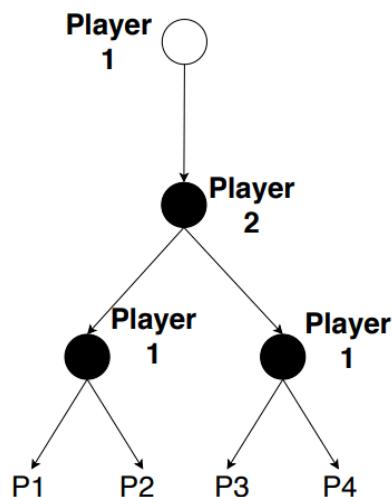
The Normal form games are usually represented by a matrix that shows the players, strategies, and payoffs (see Figure 3.4). More generally, it can be represented by any function that associates a payoff for each player with every possible combination of actions (Leyton & Shoham, 2008). The

Extensive form can be used to formalize games with a time sequencing of moves.

		Player 2	
		Strategy A	Strategy B
		Strategy A	$p_{1A}, p_{2B}$
Player 2	Strategy A	$p_{1A}, p_{2B}$	
	Strategy B	$p_{1B}, p_{2A}$	$p_{1B}, p_{2B}$

**Figure 3.4:** Normal form matrix of 2 players, two strategy game

In Figure 3.5, the game is represented as a tree. Here each vertex (or node) represents a point of choice for a player. A number listed by the vertex specifies the player. The lines out of the vertex represent a possible action for that player. The payoffs are specified at the bottom of the tree. The extensive form can be viewed as a multi-player generalization of a decision tree (Fudenberg & Tirole, 1991). To solve any extensive form game, Backward Induction must be used. It involves working backward up the game tree to determine what a rational player would do at the last vertex of the tree, what the player with the previous move would do given that the player with the last move is rational, and so on until the first vertex of the tree is reached (Williams, 2013).



**Figure 3.5:** Extensive form game of 2 player

In this study, we are going to apply famous games in game theory, such as the Prisoner's Dilemma and DeadLock. We are going to use them in an attempt to help Esnad better deal with its social interactions with its environment.

Starting with the Prisoner's Dilemma, the prisoner's dilemma is probably the most widely used game in game theory. It depicts a scenario in which two prisoners are taken into custody, accused of robbery. Police officers, however, do not have sufficient evidence to convict them of the felony, only to convict them on the charge of ownership of stolen goods. If none of them confess (they cooperate), the lesser sentence, one year each, will be prosecuted to both of them. Police will interrogate them in separate interrogation chambers, which means the two inmates are unable to interact (hence imperfect information). The police will attempt to persuade each inmate by providing them a "get out of prison free card" to confess the crime, while the other inmate will be sentenced to ten years. If both inmates confess (and therefore they defect), each inmate will be sentenced to eight years. Both inmates are given the same deal and understand the consequences of each action (complete information) and are completely aware that precisely the same deal was provided to the other inmate (common knowledge) (Gallego, 2019).

Now, we are going to showcase a general form of the Prisoner's Dilemma. Prisoner's Dilemma is not always presented, as we previously mentioned in the story. Payoffs for each set of strategies will vary depending on each person. However, there are a few rules that can be used to build a "proper" prisoner's dilemma game (Gallego, 2019).

		PRISONER 2	
		Confess	Lie
		B , B	D , A
PRISONER 1	Confess		
	Lie	A , D	C , C

**Figure 3.6:** General form of the Prisoner Dilemma

In Figure 3.6, we've renamed each player's payoffs, in order to determine the conditions needed to design a prisoner's dilemma game. In a traditional prisoner's dilemma, we have:  $A > B > C > D$  (in absolute terms). In every case,  $A > B$  and  $C > D$  imply that confess-confess is a Nash equilibrium. The interesting thing about this game is the fact that the Nash equilibrium is not socially optimum (Gallego, 2019).

Next is DeadLock. In-game theory, Deadlock is a game where the action that is mutually most beneficial (Nash equilibrium) is also dominant (see Figure 3.7). This provides a contrast to the Prisoner's Dilemma, where the mutually most beneficial action is dominated. This makes Deadlock slightly less attractive since there is no conflict between self-interest and mutual benefit.

		Player 2	
		Strategy A	Strategy B
		Strategy A	
Player 2	Strategy A	$a, b$	$c, d$
	Strategy B	$e, f$	$g, h$

**Figure 3.7** General form of DeadLock

The general form of DeadLock is any game that satisfies the following two conditions:

$$e > g > a > c$$

$$d > h > b > f$$

These conditions require that strategy B and B be dominant. Like the Prisoner's Dilemma, this game has one unique Nash equilibrium: (B, B) (Shor, 2019).

## **CHAPTER - 4**

# **PROCEDURE DOCUMENTATION**

### **4.1 DATA COLLECTION**

Data collection is the procedure of gathering raw data, measuring, and analyzing accurate insights for research using standard validate techniques. Regardless of types of data, "qualitative or quantitative" data collection is one of the most important steps in any research because it is like the base of the research. Everything built depends on the accuracy of the data collected. In documenting the governmental procedures, in-person interviews were done to assure a high degree of confidence in the data. There are some difficulties encountered by the team such as the misunderstanding of process documentation from employees. They thought that process documentation created to replace them. By explaining the importance of process documentation, employees started to collaborate.

### **4.2 GOVERNMENTAL PROCEDURES DOCUMENTATION RESULTS AND ANALYSIS**

Esnad Company deals daily with different governmental procedures. Documenting these procedures is a priority to Esnad Company. The ten steps explained in the methodology chapter for procedures documentation were carried out one by one for every governmental procedure. The team focused on the most used procedures in the organization, and four governmental procedures were selected and documented.

#### **4.2.1 SPONSORSHIP TRANSFER PROCEDURES**

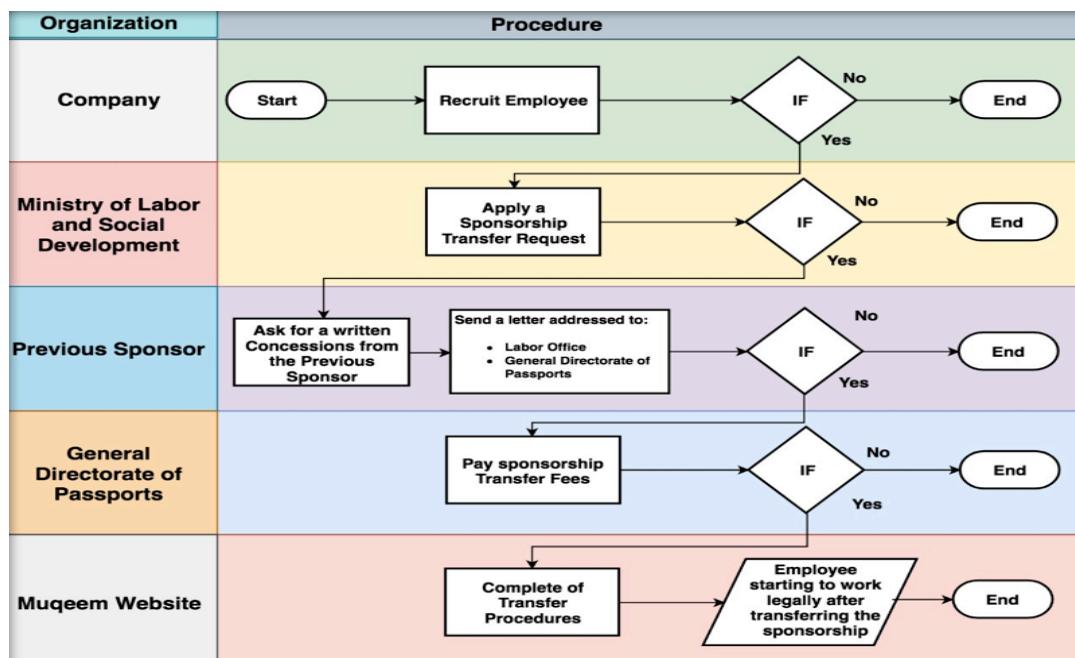
The first governmental procedure is transferring an employee to Esnad Company from another company inside Saudi Arabia. After selecting the procedure, a name should be given to the procedure; "Sponsorship Transfer

"Procedure" is the name for this procedure. The output of this procedure is an employee starting to work legally in Esnad Company after transferring the sponsorship from another company. Using in-person interviews with Human Resource department employees, the information needed in this procedure were gathered and summarized into these steps:

Recruit employees and take approval from him/her to start the procedure of sponsorship transfer.

1. Apply a sponsorship transfer request to the ministry of labor and social development.
2. Ask for a written concession from the previous sponsor.
3. Send the letter to the Labor's Office and General Directorate of Passports.
4. Pay sponsorship transfer fees to the General Directorate of Passports.
5. Complete transfer procedures on Muqeem website.

The last step is visualizing the steps into a flowchart diagram, as shown in Figure 4.1, in order to make it easy for employees to follow up on these steps.



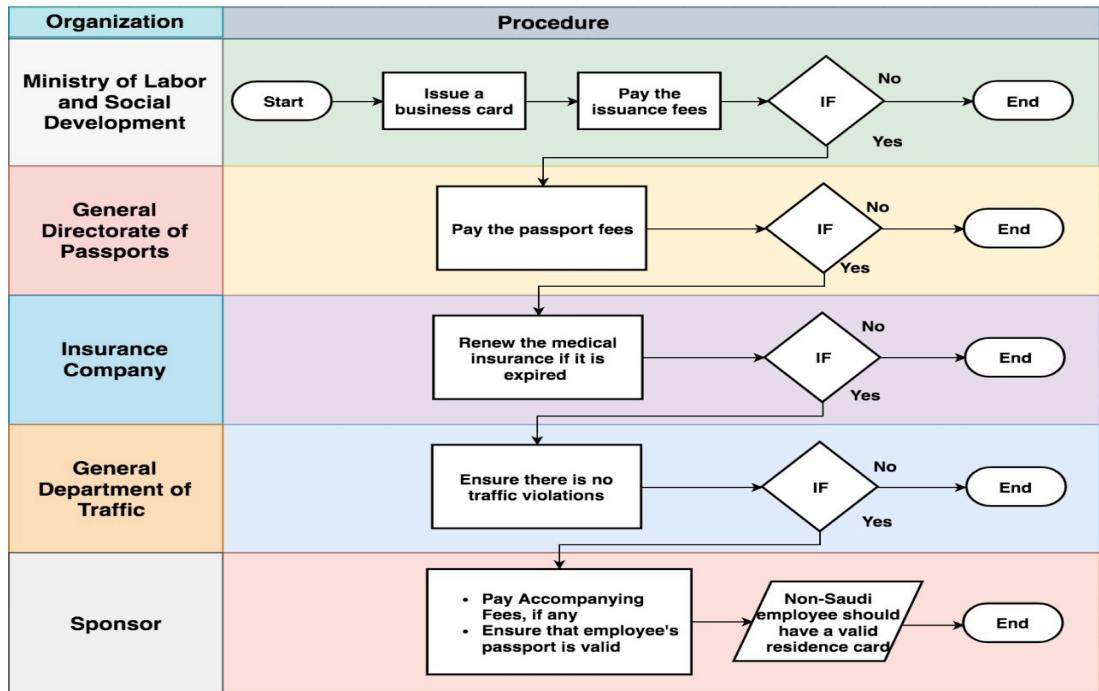
**Figure 4.1:** Sponsorship Transfer Flowchart Diagram

#### 4.2.2 RESIDENCE CARD RENEWAL PROCEDURES

The second governmental procedure is renewing the residence card for non-Saudi employees in Esnad Company. "Residence Card Renewal" is the chosen name for this procedure. At the end of this procedure, the non-Saudi employees should have a valid residence card that authorizes him/her to work inside Saudi Arabia in a legal form. Using in-person interviews with Human Resource department employees, the information needed in this procedure were gathered and summarized into these steps:

- 1- Issue a business card from the Ministry of Labor and Social Development.
- 2- Pay the issuance fees to the Ministry of Labor and Social Development.
- 3- Pay the passport fees to the General Directorate of Passports
- 4- Renew the medical insurance if it is expired from the Insurance Company.
- 5- Ensure there are no traffic violations to the employee in the General Department of Traffic.
- 6- Pay the dependents' fees, if any, using the bank's website.
- 7- Ensure that the employee's passport is valid for at least six months.

Finally, visualizing the steps mentioned above in the form of a flowchart diagram, as shown in Figure 4.2, to ease the mission of completing the residence card renewal procedure.



**Figure 4.2:** Residence Card Renewal Flowchart Diagram

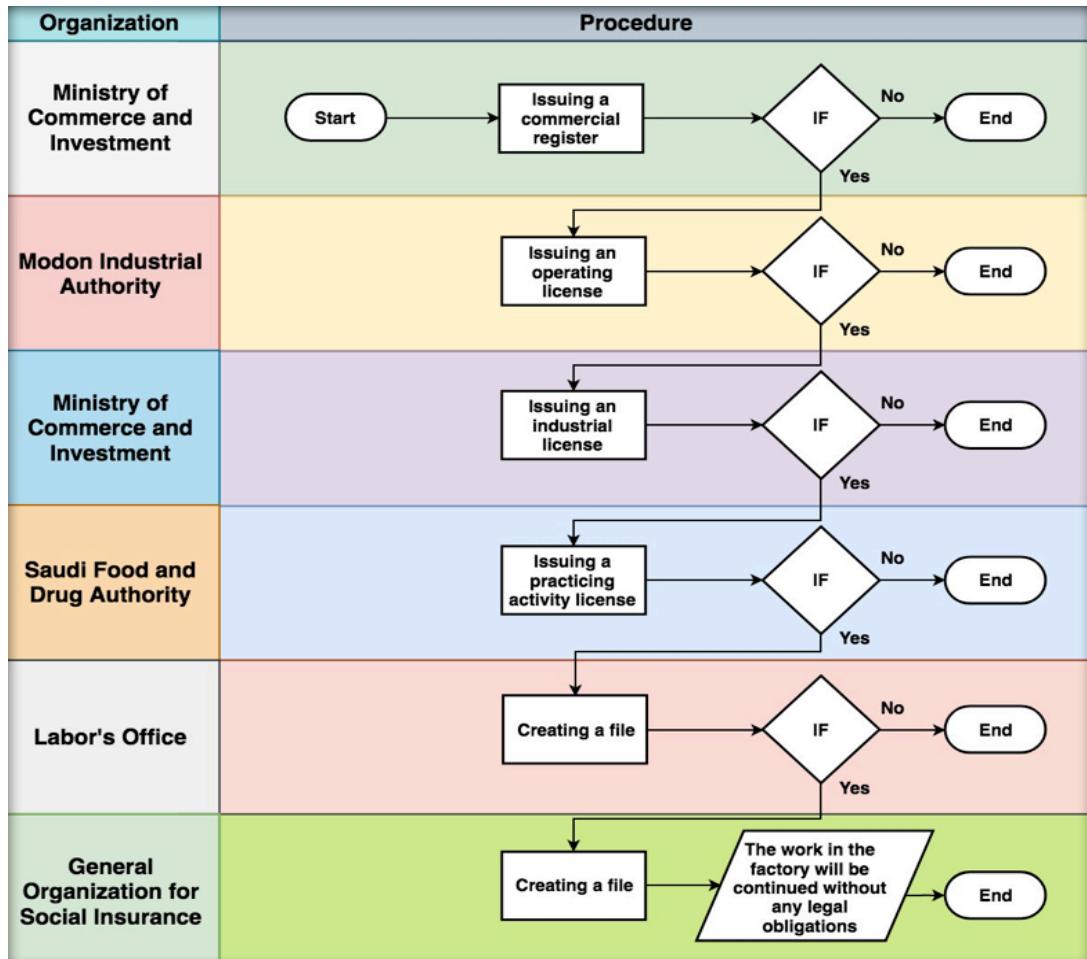
#### 4.2.3 CONTINUITY OF THE WORK IN THE FACTORY PROCEDURES:

The third governmental procedure is maintaining the validity of the work in the factory in terms of legal requirements. The name selected for this procedure is "Continuity of the Work in the Factory Procedures". When this procedure is accomplished, the work in the factory will be continued without any legal obligations. Using in-person interviews with Human Resource department employees, the information needed in this procedure were gathered and summarized into these steps:

- 1- Issue/renew the commercial register from the Ministry of Commerce and Investment.
- 2- Issue/renew an operating license from Modon Industrial Authority.
- 3- Issue/renew the industrial license from the Ministry of Commerce and Investment.
- 4- Issue/renew the practicing activity license from the Saudi Food and Drug Authority.
- 5- Create a file in the Ministry of Labor and Social Development.
- 6- Create a file in the General Organization for Social Insurance.

The last step is translating the steps above into a flowchart diagram, as

shown in Figure 4.3, to make it easy for the employee responsible for doing this procedure.



**Figure 4.3:** Continuity of the Work in the Factory Flowchart Diagram

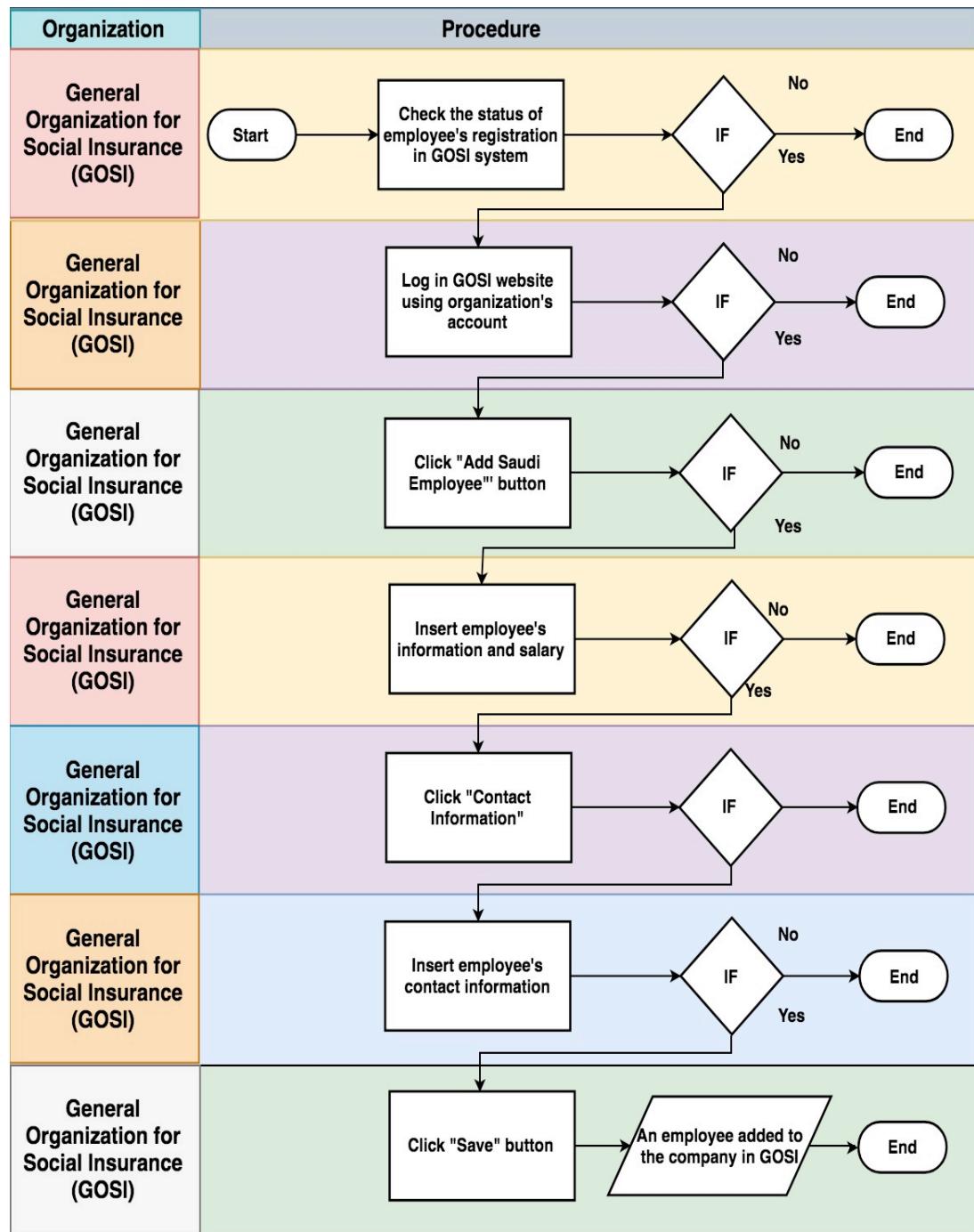
#### 4.2.4 SOCIAL INSURANCE PROCEDURES:

The last governmental procedure is adding a Saudi employee to the General Organization for Social Insurance. After selecting the procedure, a name should be given to the procedure; "Social Insurance Procedures" is the name for this procedure. The output of this procedure is an employee added to Esnad Company in the General Organization for Social Insurance. Using in-person interviews with Human Resource department employees, the information needed in this procedure were gathered and summarized into these steps:

- 1- Check the status of employee's registration in GOSI system by clicking "Check Employment Status".

- 2- Log in to the GOSI website using the organization's account.
- 3- Click the "Add Saudi Employee" button.
- 4- Insert employee's information and salary.
- 5- Click "Contact Information".
- 6- Insert employee's contact information.
- 7- Click the "Save" button.

The last step is visualizing the steps into a flowchart diagram, as shown in Figure 4.4, in order to make it easy for employees to follow up on these steps.



**Figure 4.4:** Social Insurance Flowchart Diagram

## **CHAPTER - 5**

# **FORECASTING**

### **5.1 DATA COLLECTION**

Data collection is an essential step in any research which is getting the actual raw data. The goal of the process is getting the information that helps to solve the problem by using specific tools and techniques. The success of the project depends significantly on what method used for collecting the data and how to analyze it. After collecting data, the first step is data cleaning, which means the process of correcting the erroneous data to contribute to the improvement of data quality and obtaining the best results. In this section, will explain the data source and structure, and the data difficulties and preparation.

#### **5.1.1 DATA SOURCE AND STRUCTURE**

The data were taken for the entire year of 2017 and 2018 from the CFO of Esnad that was requested during an in-person interview with him. The data received from the factory was large and more complex, and it was difficult to process by using simple tools. The key to handling vast data is cleaning the data from incorrect or incomplete data because the quality of the data affected on the results of the project when it was not suitable so, caution is required in this phase. Data was exported from a database of the factory, and it was delivered as Excel files.

**Table 5.1: The raw data**

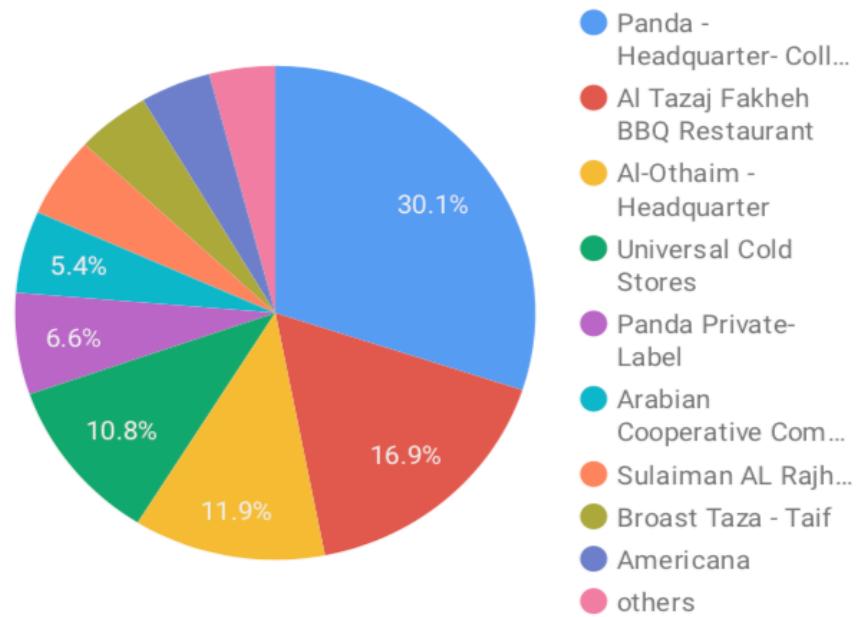
Qty.CTN	Gross	Discount	et Amount	Date	Year	Month	Voucher	Item Code	Item Name	Unit	Segment	Customers Code	Customers Name	nomerAC	CustomerAC Name	Salesman Name	Branches Name	Sales Channels	Dl_Name	Voucher name	Division Name
71,30	855,60	0,00	855,60	01-04-2017	2017	4	SAL-SK73	AM01	Chicken Kubas	Meat	AM0	KIT001	Noodle (pine Hill)	KIT002	Noodle (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
26,45	317,40	0,00	317,40	01-04-2017	2017	4	SAL-SK73	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT003	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
11,50	138,00	0,00	138,00	01-04-2017	2017	4	SAL-SK73	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT004	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
41,40	496,80	0,00	496,80	01-04-2017	2017	4	SAL-SK73	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
1,15	13,80	0,00	13,80	01-04-2017	2017	4	SAL-SK74	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
20,70	248,40	0,00	248,40	01-04-2017	2017	4	SAL-SK74	AM01	Chicken Kubas	Meat	AM0	KIT006	MENA (pine Hill)	KIT006	MENA (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
34,50	414,00	0,00	414,00	01-04-2017	2017	4	SAL-SK74	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
70,15	841,80	0,00	841,80	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT001	Noodle (pine Hill)	KIT001	Noodle (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
26,45	317,40	0,00	317,40	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT002	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
11,50	138,00	0,00	138,00	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT003	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
41,40	496,80	0,00	496,80	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
1,15	13,80	0,00	13,80	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
5,75	69,00	0,00	69,00	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT006	MENA (pine Hill)	KIT006	MENA (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
34,50	414,00	0,00	414,00	15-04-2017	2017	4	SAL-SK85	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
72,45	869,40	0,00	869,40	29-04-2017	2017	4	SAL-SK96	AM01	Chicken Kubas	Meat	AM0	KIT001	Noodle (pine Hill)	KIT001	Noodle (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
25,30	303,60	0,00	303,60	29-04-2017	2017	4	SAL-SK96	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT002	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
11,50	138,00	0,00	138,00	29-04-2017	2017	4	SAL-SK96	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT003	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
55,20	662,40	0,00	662,40	29-04-2017	2017	4	SAL-SK96	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
1,15	13,80	0,00	13,80	29-04-2017	2017	4	SAL-SK96	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
5,75	69,00	0,00	69,00	15-05-2017	2017	5	AL-SK08	AM01	Chicken Kubas	Meat	AM0	KIT006	MENA (pine Hill)	KIT006	MENA (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
34,50	414,00	0,00	414,00	15-05-2017	2017	5	AL-SK08	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
59,80	717,60	0,00	717,60	15-05-2017	2017	5	AL-SK08	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
20,70	248,40	0,00	248,40	01-07-2017	2017	7	AL-SK126	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT002	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
13,80	165,60	0,00	165,60	01-07-2017	2017	7	AL-SK126	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT003	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
46,00	552,00	0,00	552,00	01-07-2017	2017	7	AL-SK126	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
2,30	27,60	0,00	27,60	01-07-2017	2017	7	AL-SK126	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
5,75	69,00	0,00	69,00	01-07-2017	2017	7	AL-SK127	AM01	Chicken Kubas	Meat	AM0	KIT006	MENA (pine Hill)	KIT006	MENA (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
34,50	414,00	0,00	414,00	01-07-2017	2017	7	AL-SK127	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
63,25	759,00	0,00	759,00	29-07-2017	2017	7	AL-SK146	AM01	Chicken Kubas	Meat	AM0	KIT001	Noode (pine Hill)	KIT001	Noode (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
26,45	317,40	0,00	317,40	29-07-2017	2017	7	AL-SK146	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT002	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
12,65	151,80	0,00	151,80	29-07-2017	2017	7	AL-SK146	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT003	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
46,00	552,00	0,00	552,00	29-07-2017	2017	7	AL-SK146	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
3,45	41,40	0,00	41,40	29-07-2017	2017	7	AL-SK147	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
5,75	69,00	0,00	69,00	29-07-2017	2017	8	AL-SK147	AM01	Chicken Kubas	Meat	AM0	KIT006	MENA (pine Hill)	KIT006	MENA (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
34,50	414,00	0,00	414,00	29-07-2017	2017	8	AL-SK147	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
62,10	745,20	0,00	745,20	29-07-2017	2017	8	AL-SK149	AM01	Chicken Kubas	Meat	AM0	KIT001	Noode (pine Hill)	KIT001	Noode (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
23,00	276,00	0,00	276,00	29-07-2017	2017	8	AL-SK149	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT002	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
13,80	165,60	0,00	165,60	29-07-2017	2017	8	AL-SK149	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT003	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
46,00	552,00	0,00	552,00	01-08-2017	2017	7	AL-SK149	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
3,45	41,40	0,00	41,40	01-08-2017	2017	7	AL-SK149	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
5,75	69,00	0,00	69,00	01-08-2017	2017	8	AL-SK155	AM01	Chicken Kubas	Meat	AM0	KIT006	MENA (pine Hill)	KIT006	MENA (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
34,50	414,00	0,00	414,00	01-08-2017	2017	8	AL-SK155	AM01	Chicken Kubas	Meat	AM0	KIT004	SBTC	KIT004	SBTC	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
61,85	842,30	0,00	842,30	01-08-2017	2017	8	AL-SK155	AM01	Chicken Kubas	Meat	AM0	KIT001	Noode (pine Hill)	KIT001	Noode (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
27,60	331,20	0,00	331,20	01-08-2017	2017	8	AL-SK155	AM01	Chicken Kubas	Meat	AM0	KIT002	Seasoning (pine Hill)	KIT002	Seasoning (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
13,80	165,60	0,00	165,60	01-08-2017	2017	8	AL-SK155	AM01	Chicken Kubas	Meat	AM0	KIT003	Chili (pine Hill)	KIT003	Chili (pine Hill)	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
46,00	552,00	0,00	552,00	01-08-2017	2017	8	AL-SK155	AM01	Chicken Kubas	Meat	AM0	KIT005	ESNAD	KIT005	ESNAD	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	
2,30	27,60	0,00	27,60	19-08-2017	2017	8	AL-SK157	AM01	Chicken Kubas	Meat	AM0	KIT007	Wazara	KIT007	Wazara	CATRNG - Office	Br. Catering	CATERNG	Sales Invoices	Catering Div	

As shown in Table 5.1, the data has 22 columns and 436474 rows. Each row shows items bought from customers. The first column indicates the number of cartons that were purchased from the customer. The second column shows the gross, which means the total amount of transactions without any discount. The third column shows a special discount for the customer. The fourth column shows the total amount of transactions after the discount is made. From the sixth to eighth column shows the date of the purchase. The ninth and tenth column show item code and name. The eleventh and twelfth column shows unit and the segment of items; this means dividing the items into groups, and each group has common attributes. The fourth and fifth column shows customer code and name. The sixth and seventh column shows salesman and branch names. The Twentieth column shows sales channels. The last two columns show voucher and division name, and the voucher means a document gives for the customer as proof of transaction.

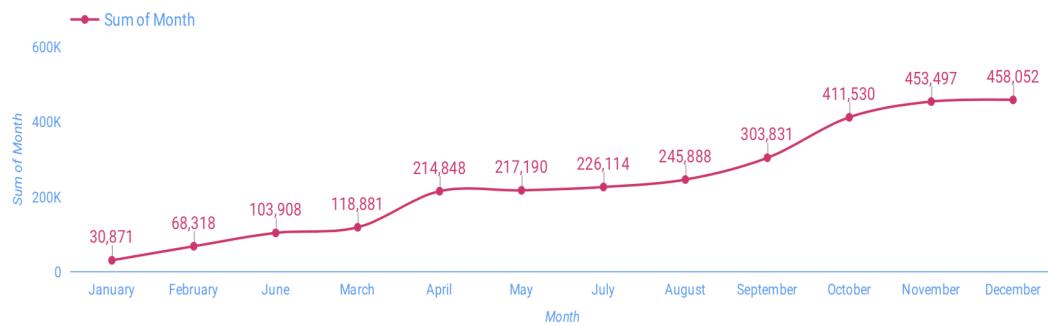
Summarizing data are useful to give a general idea about the data and help to understand data easily and extract information before analyzing the data. There are some tools used to represent data such as a pie chart, bar chart, line graph, and histogram and make data easy to read. A data analysis platform called Google Data Studio was used for this analysis.

**Table 5.2:** The most valuable customers of Esnad

	Customers Name	Sum of Net Amount ▾
1.	Panda - Headquarter- Collecti...	13,282,764.26
2.	Al Tazaj Fakheh BBQ Restaura...	7,461,186.14
3.	Al-Othaim - Headquarter	5,267,147.2
4.	Universal Cold Stores	4,772,302.52
5.	Panda Private-Label	2,933,080.47
6.	Arabian Cooperative Company	2,380,283.8
7.	Sulaiman AL Rajhi Est.	2,318,496.82
8.	Broast Taza - Taif	2,023,885
9.	Americana	1,938,638.41
10.	Badr Al-Din Markets	1,810,383.95
11.	Matajer Saudia	1,786,145.67
12.	Mohammed Saeed Balubaid ...	1,653,985.65
13.	National Marketing & Distribu...	1,605,285
14.	Saudi Hypermarkets Compan...	1,549,461.21
15.	Ganeem Center	1,469,157.33
16.	Broast Max Food	1,458,581.32



**Figure 5.1:** The most valuable customers of Esnad



**Figure 5.2:** The factory's sales for each month

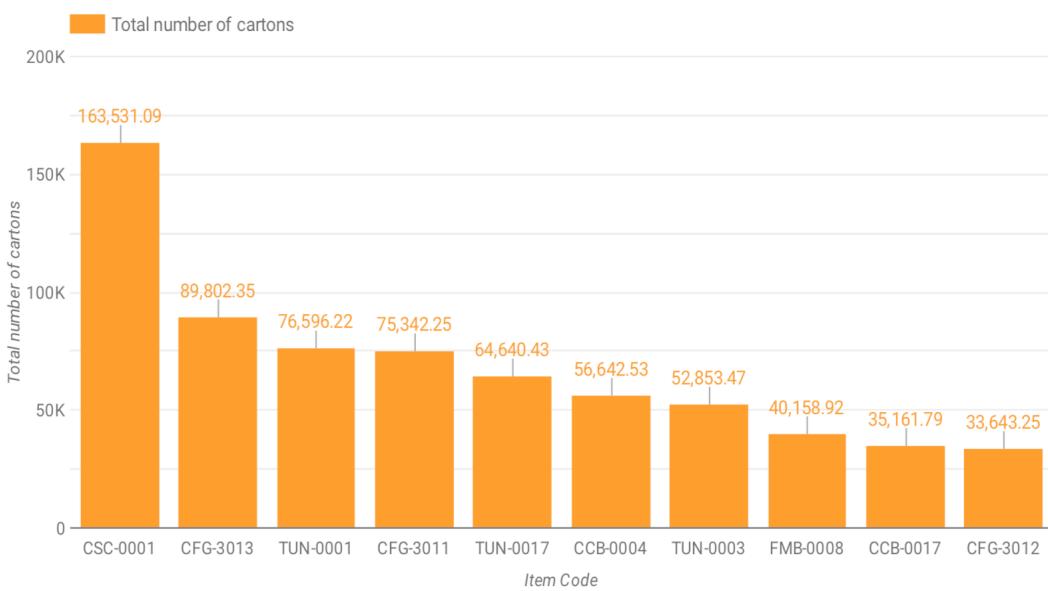
Table 5.2 illustrates the most valuable customers of Esnad in the years 2017 and 2018. Referring to Table 5.2 & Figure 5.1, it can be seen that approximately 70% of the factory's revenues coming from just four companies, which means they should focus on those customers who give them huge profits to the business. It is noticed that more than 30% of the factory's revenues from the Panda supermarket, that is equal to SAR 13282764.26 of the factory's revenues. While approximately 17 % of the factory's revenues from AlTazaj Fakheh restaurant, that is equal to SAR 7461186.143, whereas about 12% of products purchased from AlOthaim supermarket. 10.8% of the factory's revenues coming from Universal cold

stores. The other revenues coming from the remaining companies were accounting for 31.1%.

The line chart, as shown in Figure 5.2, shows the factory's sales for each month during the years 2017 and 2018. There was a gradual rise in the sales from the first month of the year until the end of the year and December was the highest throughout the two years.



**Figure 5.3:** The sales for each product in the years 2017 and 2018.



**Figure 5.4:** The number of cartons sold in the years 2017 and 2018.

The bar charts, as shown in Figure 5.3 and 5.4, show the number of cartons sold and the sales for each product in the years 2017 and 2018 respectively.

Esnad factory sold over 163531.09 cartons from CSC-0001 product that is equal to SAR 11420794.9 of the factory's sales. TUN-0001 was the highest sales product in The Esnad factory during the two years, which contributed to SAR 16871657.1 in the total sales which are equal to 76596.22 cartons.

### **5.1.2 DATA DIFFICULTIES AND PREPARATION**

Before starting forecasting the demand for Esnad company, the data should be clear from incorrect or incomplete data because of the poor quality of data will impact on the results of the forecasting. Researchers spend more than 80% of their work time on the data preparation process so that this step is important and difficult. There were some challenges faced by the developing team during the data preparation process. One of these challenges was that the data given were huge. To deal with this problem, the developing team used a tool called the Pareto principle. It was contributed to decrease the data and focus on the important. In this section, will explain the challenges faced by the team and solving them and preparing the data for analysis

**Table 5.3: The Pareto Analysis**

NO.	Item Code	Total Sales	Qty CTN	% of sales
1	TUN-0001	19338259	86235.6825	7.952
2	FMB-0008	15895405.5	40905.73	6.536
3	FMB-0002	15153737.5	27276.9535	6.231
4	CSC-0001	12248205.3	173842.591	5.036
5	TUN-0017	9515474.54	69542.3745	3.913
6	TUN-0003	9165468.72	56392.826	3.769
7	FMB-0011	7691430.53	30896.038	3.163
8	CCB-0004	6717944.13	58844.2005	2.762
9	FMB-0012	6647136.8	20917.35	2.733
10	CCB-0017	4406041.08	37358.4055	1.812
11	TUN-0011	3370064.02	19374.9815	1.386
12	CCB-0015	3307487.46	26189.962	1.360
13	CPB-0008	3199799.05	11444.6735	1.316
14	CPB-0009	3006666.26	12002.412	1.236
15	CCB-0006	2998743.11	25432.0775	1.233
16	CPB-0026	2749511.66	13087.5175	1.131
17	CCB-0003	2695951.56	26145.71	1.109
18	CCB-0010	2686508.74	22683.589	1.105
19	CCB-0009	2676265.51	23108.491	1.100
20	CPB-0016	2420123.84	17785.4975	0.995
21	CCB-0016	2382517.97	19590.503	0.980
22	FLO-0022	2365873.13	351.6125	0.973
23	FMB-0057	2352670	5616.025	0.967
24	CPB-0015	2231530.1	12344.3415	0.918
25	CCB-0021	2092840.24	17731.321	0.861
26	CPB-0014	2078681.19	10898.895	0.855
27	FMB-0058	2021763.05	16597.5245	0.831
28	CPB-0001	1771851.43	10238.4155	0.729
29	CPB-0022	1606156.69	15473.503	0.660
30	CCB-0002	1583919.7	14571.2015	0.651

The first challenge is the data given from the factory was huge, and analysis of this data needs more effort and time. The developing team decided to use tools and techniques to minimize this data without affecting the accuracy of data and focus on the important data. One of these tools is the Pareto principle, which means 20 percent of the Esnad factory's products will generate 80 percent of its revenue, but in fact, that 20 percent of the products produced approximately 95 percent of sales in the years 2017 and 2018. By using Excel, 187 products were selected for the forecasting based on the sales volume (see Table 5.3).

**Table 5.4:** The zero value in the sales.

Year	Month	Period	Qty CTN
2017	1	1	81.65
2017	2	2	80.5
2017	3	3	26.45
2017	4	4	16.1
2017	5	5	20.7
2017	6	6	44.85
2017	7	7	144.9
2017	8	8	27.14
2017	9	9	1.15
2017	10	10	83.95
2017	11	11	78.2
2017	12	12	142.6
2018	1	13	63.25
2018	2	14	3.45
2018	3	15	78.2
2018	4	16	63.25
2018	5	17	5.75
2018	6	18	0
2018	7	19	77.05
2018	8	20	70.15
2018	9	21	40.25
2018	10	22	1.15
2018	11	23	189.75
2018	12	24	17.25

The second challenge is having zero in a given month, which affects the accuracy of forecasting. As shown in Table 6.4, there is zero in period 18, which means the product has not been sold to consumers within this period, so that the developing team decided to use interpolation by using Excel to fill this gap to have accurate data.

**Table 5.5:** The sold products in a few months only.

Year	Month	Period	Qty CTN
2017	1	1	0
2017	2	2	0
2017	3	3	0
2017	4	4	0
2017	5	5	0
2017	6	6	0
2017	7	7	0
2017	8	8	0
2017	9	9	0
2017	10	10	0
2017	11	11	46
2017	12	12	0
2018	1	13	0
2018	2	14	0
2018	3	15	0
2018	4	16	0
2018	5	17	138
2018	6	18	0
2018	7	19	0
2018	8	20	0
2018	9	21	253
2018	10	22	0
2018	11	23	0
2018	12	24	0

The third challenge is that the product has been sold in a few months throughout the two years, as shown in Table 5.5, which makes forecasting difficult. The developing team decided to delete this product from the data.

**Table 5.6:** The Discontinued products

Year	Month	Period	Qty CTN
2017	1	1	1488.997
2017	2	2	3811.905
2017	3	3	1323.5465
2017	4	4	381.501
2017	5	5	3791.78
2017	6	6	338.6865
2017	7	7	3430.335
2017	8	8	2449.063
2017	9	9	3861.2515
2017	10	10	2356.028
2017	11	11	294.998
2017	12	12	5563.424
2018	1	13	0
2018	2	14	0
2018	3	15	0
2018	4	16	0
2018	5	17	0
2018	6	18	0
2018	7	19	0
2018	8	20	0
2018	9	21	0
2018	10	22	0
2018	11	23	0
2018	12	24	0

The fourth challenge is that some products have been discontinued at the end of 2017, as shown in Table 5.6. The developing team decided to delete this product from the data because the factory does not produce the product in the current time.

**Table 5.7:** The negative values in the number of cartons.

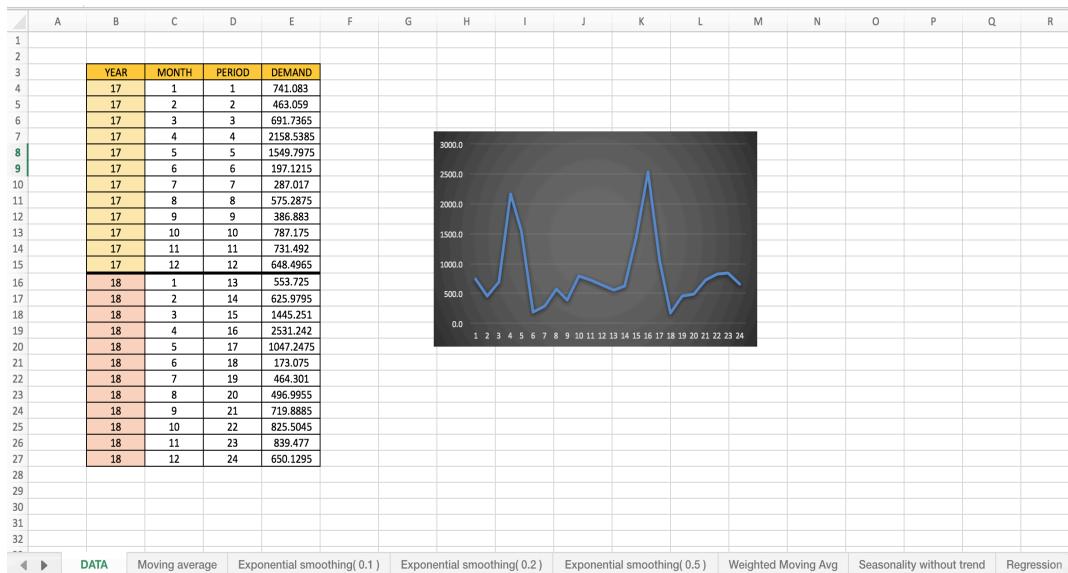
Qty CTN	Net Amount	Year	Month	Item Code
-575.00	-76,477.88	2018	1	TUN-0017
-575.00	-99,072.50	2017	9	TUN-0013
-345.00	-51,750.00	2018	3	TUN-0017
-320.85	-43,358.06	2017	3	TUN-0017
-293.25	-50,526.98	2017	11	TUN-0013
-279.45	-65,670.75	2017	7	TUN-0001
-273.94	-87,618.16	2017	8	TUN-0001
-241.50	-14,490.00	2018	5	CSC-0001
-234.60	-30,544.92	2017	4	TUN-0017
-233.31	-58,326.56	2017	5	TUN-0001
-230.00	-43,700.00	2017	12	TUN-0001
-230.00	-31,082.20	2018	3	TUN-0017

The fifth challenge is having some negative values in the number of cartons and the net amount, as shown in Table 5.7, and this means that the customer returned the product which was purchased before to the factory. The developing team decided to delete these values from the data.

**Table 5.8:** A summary of the number of cartons

Year	Month	Period	Qty CTN
2017	1	1	456.527
2017	2	2	410.9295
2017	3	3	607.7635
2017	4	4	1565.058
2017	5	5	808.8065
2017	6	6	177.192
2017	7	7	198.2945
2017	8	8	350.5545
2017	9	9	326.117
2017	10	10	579.8875
2017	11	11	385.4455
2017	12	12	624.7375
2018	1	13	503.125
2018	2	14	478.1125
2018	3	15	1085.7725
2018	4	16	1557.284
2018	5	17	755.067
2018	6	18	111.3545
2018	7	19	389.4475
2018	8	20	350.175
2018	9	21	570.8715
2018	10	22	835.636
2018	11	23	863.4545
2018	12	24	579.5885

By using Excel, the pivot Table was used for summarizing the number of cartons for each month, as shown in Table 5.8, and each product is in separate sheets before making the forecast.



**Figure 5.5:** The forecasting process in excel (Interface page)

In the forecast process, firstly, the data is put in the first sheet. And this means the demand for each period is put in the Table, as shown in Figure 5.5. After that, the forecast process occurs automatically in six methods depend on the data in the first sheet. The six methods are a simple moving average, exponential smoothing, linear regression, a trend projected adjusted, weighted moving average, and seasonality without a trend.

MFE	MAD	MSE	MAPE				
88.89	552.08	558402.83	0.01195	SMA (3)	SMA	Simple Moving Avg	
83.85	564.68	586097.45	0.00966	SMA (4)	ES	Exponential Smoothing	
157.64	611.62	672492.51	0.01107	SMA (5)	LR	Linear Regression	
1.67	391.70	346066.96	0.00750	ES (0.1)	TPA	Trend Projected Adjusted	
-5.65	401.62	368788.07	0.00820	ES (0.2)	SWT	Seasonal Without Trend	
-5.93	417.54	404613.50	0.00922	ES (0.5)	WA	Weighted Moving Avg	
0.00	394.22	316152.86	0.00704	LR			
0.00	103.57	21742.34	0.00144	SWT			
-1.79	123.11	27986.39	0.00159	TPA			
85.69	512.11	511564.64	0.01116	WA			
				ES (0.5)	MFE		
				SWT	MAD		
				SWT	MSE		
				SWT	MAPE		
				SWT	BEST		

**Figure 5.6:** The forecasting process in excel (The comparison page)

As shown in Figure 5.6, the best forecast is chosen by comparing the six methods to evaluate forecast performance based on four measures of accuracy and then selecting the right method with the lowest value in each measure. Finally, the method with the most frequency in the four measures is the best forecast for the product.

## 5.2 FORECASTING RESULTS

In this part of the project, the developing team will discuss three types of products using four methods which are, exponential smoothing, linear regression, a trend projected adjusted, and seasonality without a trend. The forecasting period will be one. After that, the developing team will elaborate more and discuss the results of each method used in addition to the product type. In conclusion, there will include recommendations on the best method to be used for each product so that Esnad can apply it easily and get the most accurate results possible!

### 5.2.1 EXPONENTIAL SMOOTHING

#### 5.2.1.1 EXPONENTIAL SMOOTHING [TUN-0001]:

**Table 5.9:** TUN-0001 Exponential Smoothing Calculations

Periods	Item Quantity (cartons)	Forecast Value (cartons)
1	142.9	1145
2	170.5	644
3	228.7	407
4	196.5	318
5	247.5	257
6	161.5	252
7	102.6	207
8	185.2	155
9	173.4	170
10	254.8	172
11	506.6	213

Periods	Item Quantity (cartons)	Forecast Value (cartons)
12	289.4	360
13	4812.8	325
14	4082.8	2569
15	5617.8	3326
16	7520.9	4472
17	8211.3	5996
18	1864.2	7104
19	4739.5	4484
20	1672.0	4612
21	7943.1	3142
22	6970.5	5543
23	16016.3	6257
24	14124.9	11136
25		4471.7506

**Table 5.10:** TUN-0001 Statistics

<b>Alpha (<math>\alpha</math>)</b>	<b>0.05</b>
<b>Initial forecast</b>	1145 cartons
<b>MFA</b>	9.571E+02
<b>MAD</b>	1809.6
<b>MSE</b>	8696735.4
<b>MAPE</b>	0.009489489

As shown in Table 5.9 & 5.10, the first method to be used is the exponential smoothing. For this product, based on the Table above, the forecasting result for the next period (25) is 4471.75 cartons. The alpha value used is 0.05. The values of error were as follows: MFA=957.1, MAD= 1809.6, MSE= 8,696,735.4, and MAPE= 0.009489489, and then the developing team will calculate the same types of errors for the rest of the forecasting methods and then select the best one!

### 5.2.1.2 EXPONENTIAL SMOOTHING [FMB-0008]:

**Table 5.11:** FMB-0008 Exponential Smoothing Calculations

Periods	Item Quantity (cartons)	Forecast Value (cartons)
1	1251.3	1622
2	1297.8	1585
3	1343.2	1556
4	1419.9	1535
5	1811.7	1523
6	1001.4	1552
7	1972.7	1497
8	1414.6	1545
9	1830.3	1532
10	1458.2	1562
11	1865.5	1551
12	2567.5	1583
13	1035.8	1681
14	1714.5	1617
15	2344.3	1626
16	1641.9	1698
17	1159.8	1693
18	1439.3	1639
19	1451.3	1619
20	1540.1	1602
21	1452.2	1596
22	2158.8	1582
23	2115.7	1640
24	3617.9	1687
25		1698.1742

**Table 5.12: FMB-0008 Statistics**

<b>Alpha (<math>\alpha</math>)</b>	<b>0.01</b>
<b>Initial forecast</b>	1622 cartons
<b>MFA</b>	1.076E+02
<b>MAD</b>	405.8
<b>MSE</b>	320215.2
<b>MAPE</b>	0.002285636

As shown in Table 5.11 & 5.12, the first method to be used is the exponential smoothing. For this product, based on the Table above, the forecasting result for the next period (25) is 1698.17 cartons. The alpha value used is 0.01. The values of error were as follow: MFA=107.6, MAD=405.8, MSE=320,215.2, and MAPE= 0.002285636. Then the developing team will calculate the same types of errors for the rest of the forecasting methods and then select the best one!

#### **5.2.1.3 EXPONENTIAL SMOOTHING [FMB-0002]:**

**Table 5.13: FMB-0002 Exponential Smoothing Calculations**

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
1	413.1	1069
2	1004.7	1003
3	1193.3	1003
4	870.4	1022
5	1154.2	1007
6	361.1	1022
7	1487.5	956
8	1308.7	1009
9	989.8	1039
10	884.8	1034
11	1116.3	1019

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
<b>12</b>	2685.7	1029
<b>13</b>	669.7	1194
<b>14</b>	793.1	1142
<b>15</b>	1096.9	1107
<b>16</b>	1100.6	1106
<b>17</b>	480.3	1106
<b>18</b>	888.6	1043
<b>19</b>	1730.4	1028
<b>20</b>	772.4	1098
<b>21</b>	1282.8	1065
<b>22</b>	935.5	1087
<b>23</b>	1986.8	1072
<b>24</b>	2070.2	1163
<b>25</b>		1106.0746

**Table 5.14:** FMB-0002 Statistics

<b>Alpha (<math>\alpha</math>)</b>	<b>0.01</b>
<b>Initial forecast</b>	1069 cartons
<b>MFA</b>	7.727E+01
<b>MAD</b>	395.0
<b>MSE</b>	301696.9
<b>MAPE</b>	0.004233024

As shown in Table 5.13 & 5.14, the first method to be used is the exponential smoothing. For this product, based on the Table above, the forecasting result for the next period (25) is 1069 cartons. The alpha value used is 0.05. The values of error were as follows: MFA=77.27, MAD= 395.0, MSE= 301696.9, and MAPE= 0.004233024. Then the developing team will calculate the same types of errors for the rest of the forecasting methods and then select the best one!

## 5.2.2 LINEAR REGRESSION

### 5.2.2.1 LINEAR REGRESSION [TUN-0001]

**Table 5.15:** TUN-0001 Linear Regression Calculations

Periods	Item Quantity (cartons)	Forecast Value (cartons)
1	142.9	-2307.5
2	170.5	-1794.4
3	228.7	-1281.3
4	196.5	-768.2
5	247.5	-255.1
6	161.5	258.0
7	102.6	771.1
8	185.2	1284.2
9	173.4	1797.3
10	254.8	2310.4
11	506.6	2823.5
12	289.4	3336.6
13	4812.8	3849.7
14	4082.8	4362.8
15	5617.8	4875.9
16	7520.9	5389.0
17	8211.3	5902.1
18	1864.2	6415.2
19	4739.5	6928.3
20	1672.0	7441.4
21	7943.1	7954.5
22	6970.5	8467.6
23	16016.3	8980.7
24	14124.9	9493.8
25		10006.9

**Table 5.16:** TUN-0001 Statistics

<b>Initial forecast</b>	-2307.5 cartons
<b>MFA</b>	-6.063E-13
<b>MAD</b>	2100.4
<b>MSE</b>	7496615.8
<b>MAPE</b>	0.04003809

The second forecasting method is linear regression. For this product, as shown in Table 5.15 & 5.16, the forecasting result for the next period (25) is 4471.75 cartons. the values of error were as follows: MFA=-6.063E-13, MAD= 2100.4, MSE= 7496615.8, and MAPE= 0.04003809. Then the developing team will calculate the same types of errors for the rest of the methods, and then the best one will be selected and recommended.

### 5.2.2.2 LINEAR REGRESSION [FMB-0008]

**Table 5.17:** FMB-0008 Linear Regression Calculations

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
1	1251.3	1292.4
2	1297.8	1328.3
3	1343.2	1364.1
4	1419.9	1399.9
5	1811.7	1435.7
6	1001.4	1471.6
7	1972.7	1507.4
8	1414.6	1543.2
9	1830.3	1579.0
10	1458.2	1614.8
11	1865.5	1650.7
12	2567.5	1686.5
13	1035.8	1722.3
14	1714.5	1758.1
15	2344.3	1794.0
16	1641.9	1829.8
17	1159.8	1865.6

Periods	Item Quantity (cartons)	Forecast Value (cartons)
18	1439.3	1901.4
19	1451.3	1937.3
20	1540.1	1973.1
21	1452.2	2008.9
22	2158.8	2044.7
23	2115.7	2080.5
24	3617.9	2116.4
25		2152.2

**Table 5.18:** FMB-0008 Statistics

<b>Initial forecast</b>	1292.4 cartons
<b>MFA</b>	-3.505E-13
<b>MAD</b>	367.5
<b>MSE</b>	251432.8
<b>MAPE</b>	0.002184857

The second forecasting method is linear regression. For this product, as shown in Table 5.17 & 5.18, the forecasting result for the next period (25) is 2152.2 cartons. the values of error were as follows: MFA=-3.505E-13, MAD= 367.5, MSE= 251432.8, and MAPE= 0.002184857. Then the developing team will calculate the same types of errors for the rest of the methods, and then the best one will be selected and recommended.

### 5.2.2.3 LINEAR REGRESSION [FMB-0002]

**Table 5.19:** FMB-0002 Linear Regression Calculations

Periods	Item Quantity (cartons)	Forecast Value (cartons)
1	413.1	847.9
2	1004.7	873.0
3	1193.3	898.1
4	870.4	923.2
5	1154.2	948.3

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
6	361.1	973.4
7	1487.5	998.5
8	1308.7	1023.6
9	989.8	1048.7
10	884.8	1073.8
11	1116.3	1098.9
12	2685.7	1124.0
13	669.7	1149.1
14	793.1	1174.2
15	1096.9	1199.3
16	1100.6	1224.4
17	480.3	1249.5
18	888.6	1274.6
19	1730.4	1299.7
20	772.4	1324.8
21	1282.8	1349.9
22	935.5	1375.0
23	1986.8	1400.1
24	2070.2	1425.2
25		1450.3

**Table 5.20:** FMB-0002 Statistics

<b>Initial forecast</b>	847.9 cartons
<b>MFA</b>	-2.747E-13
<b>MAD</b>	387.4
<b>MSE</b>	254269.4
<b>MAPE</b>	0.004297375

The second forecasting method is linear regression. For this product, as shown in Table 5.19 & 5.20, the forecasting result for the next period (25) is 1450.3 cartons. the values of error were as follows: MFA=-2.747E-13, MAD= 387.4, MSE= 254269.4, and MAPE= 0.004297375. Then the developing team will calculate the same types of errors for the rest of the methods, and then the best one will be selected and recommended.

### 5.2.3 TREND PROJECTED ADJUSTED

#### 5.2.3.1 TREND PROJECTED ADJUSTED [TUN-0001]

**Table 5.21:** TUN-0001 Trend Projected Adjusted Calculations

Periods	Item Quantity (cartons)	Forecast Value (cartons)
1	142.9	-1591.2
2	170.5	-1062.0
3	228.7	-1042.4
4	196.5	-825.0
5	247.5	-300.3
6	161.5	72.7
7	102.6	519.6
8	185.2	331.9
9	173.4	2030.0
10	254.8	2322.9
11	506.6	6491.9
12	289.4	6692.6
13	4812.8	2654.8
14	4082.8	2582.2
15	5617.8	3966.8
16	7520.9	5787.3
17	8211.3	6947.2
18	1864.2	1808.3
19	4739.5	4668.3
20	1672.0	1923.1
21	7943.1	8984.2
22	6970.5	8513.5
23	16016.3	20648.6
24	14124.9	19042.7
25		6900.8

**Table 5.22:** TUN-0001 Statistics

<b>Initial forecast</b>	-1591.2 cartons
<b>MFA</b>	-6.222E+02
<b>MAD</b>	1816.3
<b>MSE</b>	6485530.0
<b>MAPE</b>	0.038822361

The third forecasting method is the trend projected adjusted. As shown in Table 5.21 & 5.22, the forecasting result for the next period (25) is 6900.8 cartons, and the values of error was as follow: MFA=-6.222E+02, MAD= 1816.3, MSE= 6485530.0, and MAPE= 0.038822361, then the developing team will calculate the same types of errors for the last product and the best one will be selected

#### 5.2.3.2 TREND PROJECTED ADJUSTED [FMB-0008]

**Table 5.23:** FMB-0008 Trend Projected Adjusted Calculations

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
1	1251.3	867.2
2	1297.8	1173.8
3	1343.2	1475.6
4	1419.9	1257.4
5	1811.7	1251.5
6	1001.4	1053.7
7	1972.7	1514.1
8	1414.6	1337.6
9	1830.3	1520.5
10	1458.2	1713.5
11	1865.5	1927.8
12	2567.5	3060.2

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
13	1035.8	1155.6
14	1714.5	1553.6
15	2344.3	1940.6
16	1641.9	1643.5
17	1159.8	1626.3
18	1439.3	1361.5
19	1451.3	1945.9
20	1540.1	1710.2
21	1452.2	1934.5
22	2158.8	2169.6
23	2115.7	2429.9
24	3617.9	3840.2
25		1444.0

**Table 5.24:** FMB-0008 Statistics

<b>Initial forecast</b>	867.2 cartons
<b>MFA</b>	-2.327E+01
<b>MAD</b>	249.8
<b>MSE</b>	92863.7
<b>MAPE</b>	0.001529499

The third forecasting method is the trend projected adjusted. As shown in Table 5.23 & 5.24, the forecasting result for the next period (25) is 1444.0 cartons, and the values of error was as follow: MFA=-2.327E+01, MAD= 249.8, MSE= 92863.7, and MAPE= 0.001529499, then the developing team will calculate the same types of errors for the last product and the best one will be selected

### 5.2.3.3 TREND PROJECTED ADJUSTED [FMB-0002]

**Table 5.25:** FMB-0002 Trend Projected Adjusted Calculations

Periods	Item Quantity (cartons)	Forecast Value (cartons)
1	413.1	403.9
2	1004.7	690.5
3	1193.3	904.9
4	870.4	800.5
5	1154.2	681.9
6	361.1	535.1
7	1487.5	1413.5
8	1308.7	937.2
9	989.8	1048.5
10	884.8	859.9
11	1116.3	1500.2
12	2685.7	2351.7
13	669.7	547.4
14	793.1	928.7
15	1096.9	1208.3
16	1100.6	1061.6
17	480.3	898.5
18	888.6	700.7
19	1730.4	1839.9
20	772.4	1212.9
21	1282.8	1349.6
22	935.5	1101.1
23	1986.8	1911.4
24	2070.2	2981.9
25		690.8

**Table 5.26:** FMB-0002 Statistics

<b>Initial forecast</b>	403.9 cartons
<b>MFA</b>	-2.470E+01
<b>MAD</b>	223.3
<b>MSE</b>	90793.7
<b>MAPE</b>	0.002229649

The third forecasting method is the trend projected adjusted. As shown in Table 5.25 & 5.26, the forecasting result for the next period (25) is 690.8

cartons, and the values of error was as follow: MFA=-2.470E+01, MAD= 223.3, MSE= 90793.7, and MAPE= 0.002229649, then the developing team will calculate the same types of errors for the last product and the best one will be selected

#### **5.2.4 SEASONALITY WITHOUT TREND**

##### **5.2.4.1 SEASONALITY WITHOUT TREND [TUN-0001]**

**Table 5.27: TUN-0001 Seasonality Without Trend Calculations**

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
1	3641.2	3562.7
2	9105.0	8468.1
3	4665.9	7643.9
4	6984.3	11915.3
5	9292.3	9902.9
6	2401.7	1763.2
7	7345.0	5548.0
8	21963.2	13587.3
9	3705.5	4234.4
10	5548.9	6585.1
11	5601.2	8192.9
12	8681.8	7532.2
13	3326.4	3401.3
14	7476.4	8084.5
15	10140.6	7297.6
16	16083.1	11375.5
17	10037.2	9454.2
18	1073.6	1683.3
19	3581.0	5296.6
20	4975.3	12971.7
21	4547.5	4042.5
22	7276.0	6286.8
23	10295.9	7821.7
24	6093.6	7191.0
25		3247.2

**Table 5.28:** TUN-0001 Statistics

<b>Initial forecast</b>	3562.7 cartons
<b>MFA</b>	-3.411E-13
<b>MAD</b>	2064.9
<b>MSE</b>	9330397.1
<b>MAPE</b>	0.003072715

The fourth forecasting method is seasonality without a trend. As shown in Table 5.27 & 5.28, the forecasting result for the next period (25) is 3247.2 cartons and the values of error was as follow: MFA=-3.411E-13, MAD= 2064.9, MSE= 9330397.1, and MAPE= 0.003072715.

#### 5.2.4.2 SEASONALITY WITHOUT TREND [FMB-0008]

**Table 5.29:** FMB-0008 Seasonality Without Trend Calculations

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
1	1251.3	1085.3
2	1297.8	1409.7
3	1343.2	1711.9
4	1419.9	1438.6
5	1811.7	1420.5
6	1001.4	1139.4
7	1972.7	1630.4
8	1414.6	1390.7
9	1830.3	1559.6
10	1458.2	1687.1
11	1865.5	1871.6
12	2567.5	2889.2
13	1035.8	1222.8
14	1714.5	1588.4
15	2344.3	1928.8
16	1641.9	1620.8
17	1159.8	1600.5
18	1439.3	1283.8
19	1451.3	1837.0
20	1540.1	1567.0
21	1452.2	1757.2
22	2158.8	1900.9
23	2115.7	2108.8
24	3617.9	3255.4
25		1377.8

**Table 5. 30:** FMB-0008 Statistics

<b>Initial forecast</b>	1085.3 cartons
<b>MFA</b>	4.737E-14
<b>MAD</b>	211.6
<b>MSE</b>	65764.7
<b>MAPE</b>	0.001305252

The fourth forecasting method is seasonality without a trend. As shown in Table 5.29 & 5.30, the forecasting result for the next period (25) is 1377.8 cartons and the values of error was as follow: MFA=4.737E-14, MAD= 211.6, MSE= 65764.7, and MAPE= 0.001305252.

#### 5.2.4.3 SEASONALITY WITHOUT TREND [FMB-0002]

**Table 5.31:** FMB-0002 Seasonality Without Trend Calculations

<b>Periods</b>	<b>Item Quantity (cartons)</b>	<b>Forecast Value (cartons)</b>
1	413.1	533.2
2	1004.7	889.2
3	1193.3	1131.7
4	870.4	972.0
5	1154.2	811.4
6	361.1	614.0
7	1487.5	1587.8
8	1308.7	1031.1
9	989.8	1120.6
10	884.8	898.7
11	1116.3	1527.2
12	2685.7	2352.6
13	669.7	546.6
14	793.1	911.5
15	1096.9	1160.1
16	1100.6	996.4
17	480.3	831.8
18	888.6	629.4
19	1730.4	1627.6
20	772.4	1057.0
21	1282.8	1148.7
22	935.5	921.2
23	1986.8	1565.6
24	2070.2	2411.6
25		560.3

**Table 5.32: FMB-0002 Statistics**

<b>Initial forecast</b>	533.2 cartons
<b>MFA</b>	0
<b>MAD</b>	190.8
<b>MSE</b>	51920.2
<b>MAPE</b>	0.002051843

The fourth forecasting method is seasonality without a trend. As shown in Table 5.31 & 5.32, the forecasting result for the next period (25) is 560.3 cartons and the values of error was as follow: MFA=0, MAD= 190.8, MSE= 51920.2, and MAPE= 0.002051843.

### 5.2.5 FORECAST METHODS COMPARISON

As a conclusion based on the results discussed above, the best forecasting method is seasonality without trend as shown in Table 5.33 & 5.34 & 5.35, which gives an indicator, based on the values of errors calculated for each method, that it is the best method and gives the most accurate results, and as a recommendation, Esnad should use the seasonality without trend method for all three products in order to get accurate results and not producing excess of products which will be considered as waste!

**Table 5.33: TUN-0001 Forecast Methods Comparison**

TUN-0001	MFE	MAD	MSE	MAPE
Exponential Smoothing	957.148	1809.649	8696735.407	0.009
Linear Regression	0.000	2100.438	7496615.807	0.040
Seasonality Without Trend	0.000	483.033	715068.279	0.002
Trend Projected Adjusted	-622.161	1816.337	6485529.954	0.039
The Best	Seasonality Without Trend			

**Table 5.34:** FMB-0008 Forecast Methods Comparison

FMB-0008	MFE	MAD	MSE	MAPE
Exponential Smoothing	107.62	405.83	320215.21	0.00229
Linear Regression	0.00	367.46	251432.77	0.00218
Seasonality Without Trend	0.00	211.63	65764.70	0.00131
Trend Projected Adjusted	-23.27	249.83	92863.68	0.00153
The Best	Seasonality Without Trend			

**Table 5.35:** FMB-0002 Forecast Methods Comparison

FMB-0008	MFE	MAD	MSE	MAPE
Exponential Smoothing	77.27	394.96	301696.86	0.00423
Linear Regression	0.00	387.39	254269.43	0.00430
Seasonality Without Trend	0.00	190.80	51920.24	0.00205
Trend Projected Adjusted	-24.70	223.29	90793.67	0.00223
The Best	Seasonality Without Trend			

## **CHAPTER - 6**

### **GAME THEORY**

Esnad Food company encounters a lot of social interactions while working in its environment. Whether it's outside or inside the environment. For an outside environment, interaction examples could be competitors, consumers, and government extra. On the other hand, inside environment interactions, examples are own workers, managers, and lawyers extra.

In this section, we will try to analyze these interactions using Game Theory. We will use applications of famous games in Game Theory like the Prisoner Dilemma, Deadlock, and Extensive Form games. We will be looking at several social interactions like Marketing Campaign, Price War, Releasing a New Product, Investing in Research and Development (R&D), and Adapting a New Policy. All of the previous interactions can be viewed as games.

We will analyze each game through a series of steps which are: Game, Players, Strategies (Actions), Assumptions, Payoffs, Representations, and Analysis & Results.

#### **6.1 PRISONER DILEMMA GAME IN ESNAD FOOD COMPANY:**

##### **6.1.1 MARKETING CAMPAIGN**

###### **Game:**

We have two rival firms, Esnad and Maggi, two competitive companies which are deciding whether to make a marketing campaign or not. The options are as follows, we have four scenarios. In the first scenario, Esnad creates a marketing campaign, and Maggie does not. The second scenario, the opposite of the first scenario. In the third scenario, both companies create a marketing campaign. In the fourth scenario, both will not create a marketing campaign. This game is categorized as a Non-Cooperation game.

**Players:**

We have two players (decision-makers), Esnad and Maggi. Both are working in the food spices sector.

**Strategies (Actions):**

Each company must decide whether to engage in a marketing campaign or not.

**Assumptions:**

Each company is looking to maximize its benefits. It means that each company (agent) is self-interested. Not that they want to harm each other, it means that the agent has its description of states of the world that it likes, and acts based on this description (Kenton, 2019). In our situation, the states are their own profit and revenue.

Each company would want to advertise alone rather than with a competitor. Making the first scenario the most preferred outcome for Esnad, and the second scenario the most preferred outcome for Maggi. On the other hand, the third scenario is ok for both if they both advertise and create a marketing campaign. But looking at the fourth scenario, they rather if both did not advertise to avoid buying for marketing campaign expenses.

We are going to assume that the Marketing Campaign is an imperfect information game due to its nature as a simultaneous move game where you don't know the decisions made by the other party when making your decision.

The reason that we see the Marketing Campaign game as a simultaneous move game and not as a sequential move game is that when the results of the campaign are obtained, it is already too late to react to it. For example, if Maggi decides to make a back to school campaign theme. It will take them at least a whole month to prepare it. When it is time to start advertising the campaign, it will be too late for Esnad to come back and make a back to school campaign. Because Maggi, we have one month lead over Esnad.

We are going to assume that the Marketing Campaign game is a complete information game in which knowledge about other market players like Maggi

is available to all participants. The utility, payoffs, strategies, and "types" of players are thus common knowledge (Harsanyi, 1967).

In summary, a marketing campaign game is a non-cooperative static simultaneous move game of complete, imperfect information represented in a Normal form (Matrix).

### **Payoffs:**

The payoffs for this game are represented in Ordinal payoffs. There are four potential outcomes for this game. Let us see the utilities for each outcome for every player. First outcome Esnad gets four utility points while Maggi gets zero. Second outcome Esnad gets zero utility points while Maggi gets four utility points. Third outcome Esnad gets one utility points while Maggi gets one utility point. Fourth outcome Esnad gets three utility points while Maggi gets three utility points.

### **Representations:**

	Maggi	
	Pass	Engage
Esnad	Pass	3,3      0,4
	Engage	4,0      1,1

**Figure 6.1:** Marketing Campaign Game in a Normal Form (Matrix)

In Figure 6.1, the marketing Campaign game is represented in a normal form (Matrix). Which is a great way for condensing a lot of information in a neat, simple way.

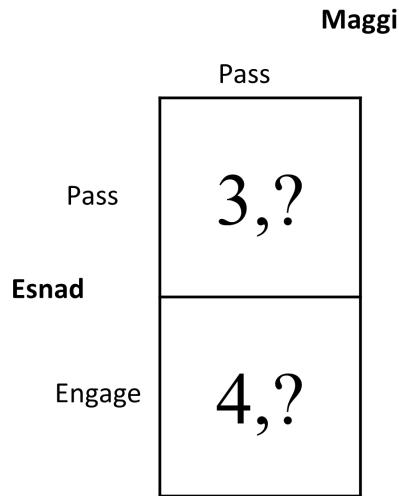
### **Results and Analysis:**

The story contains a lot of information. But we can condense everything we need to know into a simple matrix (see Figure 6.1).

We will use normal form representation, so it is important to understand how

to interpret it. There are two players in this game. The first player Esnad strategies (“Engage” and “Pass”) are in the rows, and the second player Maggi strategies are in the columns. Esnad payoffs are listed first for each outcome, and Maggi are listed second. For example, if the Esnad engages and the Maggi pass, then the game ends in the top right set of payoffs; Esnad gets a payoff of zero, and Maggi gets a payoff of four.

To know which strategy each player should choose, we need to look at each move in isolation. This solution approach is called case analysis. Consider the game from Esnad's perspective. Suppose she knew Maggi would engage. How should Esnad respond to Maggi?



**Figure 6.2:** Esnad move with isolation to Maggi's payoffs

In Figure 6.2, Esnad should engage. If Esnad passes, it will get a payoff of three. But if she engages, she gets a payoff of four. Since she prefers more payoff points, engaging produces the best outcome.

Note that Maggi's payoffs are completely irrelevant to Esnad decision in this context, if Esnad knows that Maggi will pass, then she only needs to look at her payoffs to decide which strategy to pick. Thus, the question marks hiding Maggi's payoffs could be any number at all, and Esnad optimal decision given Maggi move will remain the same.

On the other hand, suppose Esnad knew that Maggi would engage. What should Esnad do? Again, to reach the answer, we only look at the relevant information:

		Maggi
	Engage	
Pass		0,?
Esnad		
Engage		1,?

**Figure 6.3:** Esnad's move with isolation to Maggi's payoffs

As shown in Figure 6.3, Engage wins a second time: engage leads to one utility point, whereas passing zero utilities. So, Esnad would want to engage if Maggi engages.

Combining these two pieces of information, we reach an important conclusion—Esnad is better off engaging regardless of Maggi's strategy. Thus, Esnad can effectively ignore whatever he thinks Maggi will do since engaging gives him more utilities in either scenario.

Let's switch over to Maggi's perspective. Suppose Maggi knew that Esnad would pass, even though we realize he should not. Here is Maggi's situation:

		Maggi
	Pass	Engage
Pass	? , 3	? , 4
Esnad		

**Figure 6.4:** Maggi's move with isolation to Esnad's payoffs

In Figure 6.4, as before, Maggi should engage, as she will get a payoff of four rather than three. Finally, suppose Maggi knew that Esnad would engage. How should Maggi respond?

	<b>Maggi</b>	
	Pass	Engage
Engage	? , 0	? , 1
<b>Esnad</b>		

**Figure 6.5:** Maggi's move with isolation to Esnad's payoffs

In Figure 6.5, unsurprisingly, Maggi should engage. Once more, Maggi prefers engaging regardless of what Esnad does. Thus, we have found a solution: both players engage, and both players get a payoff of one.

This outcome confuses a lot of people who are new to the field of game theory. Compare the `<pass, pass>` outcome to the `<engage, engage>` outcome:

	<b>Maggi</b>	
	Pass	Engage
Pass	3 , 3	? , ?
<b>Esnad</b>		
Engage	? , ?	1 , 1

**Figure 6.6:** Comparing `<pass, pass>` outcome to `<engage, engage>`

Looking at Figure 6.6, the game matrix, people see that the `<pass, pass>` outcome leaves both players better off than the `<engage, engage>` outcome. They then think about why the players cannot coordinate on

passing the marketing campaign. But as we just saw, promises not to make a marketing campaign are unsustainable. Esnad wants Maggi not to make a campaign, so when she engages, she walks away with four utility points. The same goes for Maggi. As a result, the  $\langle \text{pass}, \text{pass} \rangle$  outcome is inherently unsTable. Ultimately, the players finish in the second class (but sustainable)  $\langle \text{engage}, \text{engage} \rangle$  outcome.

In conclusion, each player has a strictly dominant strategy, which is to engage. If a strictly dominant strategy exists for one player in a game, that player will play that strategy in each of the game's Nash equilibria. If both players have a strictly dominant strategy, the game has only one unique pure strategy Nash equilibrium  $\langle \text{engage}, \text{engage} \rangle$ . However, that Nash equilibrium is not necessarily "efficient", meaning that there may be non-equilibrium outcomes of the game that would be better for both players  $\langle \text{pass}, \text{pass} \rangle$  (Nash, 1950,1951).

We should also mention that this game does not have a mixed strategy, Nash equilibrium, or a weakly dominated strategy. The best response for each player is  $\langle \text{engage}, \text{engage} \rangle$ .

### 6.1.2 PRICE WAR

#### Game:

We have two rival firms, Esnad and Maggi, two competitive companies in an oligopoly market structure. Normally in oligopoly companies that you find price competition, which is known as a price war. Now we are looking at what will happen if these two companies decided to enter in a price war. The options are as follows, with four possible scenarios. In the first scenario, Esnad keeps the prices as it is, and Maggie lowers them. The second scenario, the opposite of the first scenario. In the third scenario, both companies lower their prices. The fourth scenario, both companies, keep the prices as it is. This game is categorized as a Non-Cooperation game.

#### Players:

We have two players (decision-makers), Esnad and Maggi. Both are working in the food spices sector.

### **Strategies (Actions):**

Each company must decide whether to keep the prices as it is or lower them.

### **Assumptions:**

Each company is looking to maximize its benefits. It means that each company (agent) is self-interested. Not that they want to harm each other, it means that the agent has its description of states of the world that it likes, and acts based on this description (Kenton, 2019). In our situation, the states are their own profit, revenue, and market share.

Each company would want to lower the prices and take a bigger market share, and that will only happen if only one of them did it. Making the first scenario the most preferred outcome for Esnad, and the second scenario the most preferred outcome for Maggi. On the other hand, the third scenario is ok for both if they both lower their prices. But looking at the fourth scenario, they rather if both did not lower the prices. Because that will not increase their sales if both companies did it, causing their marginal profit to go down.

We are going to assume that the Marketing Campaign is an imperfect information game due to its nature as a simultaneous move game where you don't know the decisions made by the other party when making your decision.

The reason that we see Price War game as a simultaneous move game and not as a sequential move game is when the market share is getting bigger because of lowering the prices, it is already too late to react to it. For example, if Maggi decides to lower the prices. They are going to gain more market share, potentially Esnad consumers. By that time, it will be too late for Esnad to make the same move because the consumers have switched brands, and it will take a lot more than lowering the price to match Maggi to win them back.

We are going to assume that the Price War game is a complete information game in which knowledge about other market players like Maggi is available to all participants. The utility, payoffs, strategies, and "types" of players are thus common knowledge (Harsanyi, 1967).

In summary, the Price War game is a non-cooperative static simultaneous move game of complete, imperfect information represented in a Normal form (Matrix).

### **Payoffs:**

The payoffs for this game are represented in Ordinal payoffs. There are four potential outcomes for this game. Let us see the utilities for each outcome for every player. First outcome Esnad gets four utility points while Maggi gets 0. Second outcome Esnad gets 0 utility points while Maggi gets four utility points. Third outcome Esnad gets one utility points while Maggi gets one utility point. Fourth outcome Esnad gets three utility points while Maggi gets three utility points.

	Maggi	
	Same	Lowering
Esnad	3,3	4,0
Foods	4,0	1,1
Lowering		

**Figure 6.7:** Price War Game in a Normal Form (Matrix)

### **Representations:**

In Figure 6.7, the price War game is represented in a normal form (Matrix). Which is a great way for condensing a lot of information in a neat, simple way.

### **Results and Analysis:**

We will not solve this game because we already did. All applications of Prisoner Dilemma have the same answer. So, we will not throw the solution process again.

In conclusion, each player has a strictly dominant strategy, which is to lower the price. If a strictly dominant strategy exists for one player in a game, that

player will play that strategy in each of the game's Nash equilibria. If both players have a strictly dominant strategy, the game has only one unique pure strategy Nash equilibrium <lowering, lowering>. However, that Nash equilibrium is not necessarily "efficient", meaning that there may be non-equilibrium outcomes of the game that would be better for both players <same, same> (Nash, 1950,1951).

We should also mention that this game does not have a mixed strategy, Nash equilibrium, or a weakly dominated strategy. The best response for each player is <lowering, lowering>.

## **6.2 APPLICATION OF DEADLOCK GAMES IN ESNAD FOOD COMPANY:**

### **6.2.1 INVESTING IN R&D:**

#### **Game:**

We have two rival firms, Esnad and Maggi, two competitive companies which are deciding whether to invest in developing their products to appeal more to customers' needs. The options are as follows: we have four scenarios. In the first scenario, Esnad invests in R&D, and Maggie does not. The second scenario, the opposite of the first scenario. In the third scenario, both companies invest in R&D. In the fourth scenario, both will not invest in R&D. This game is categorized as a Non-Cooperation game.

#### **Players:**

We have two players (decision-makers), Esnad and Maggi. Both are working in the food spices sector.

#### **Strategies (Actions):**

Each company must decide whether to invest in R&D or not.

#### **Assumptions:**

Each company is looking to maximize its benefits. It means that each company (agent) is self-interested. Not that they want to harm each other, it means that the agent has its description of states of the world that it likes, and acts based on this description (Kenton, 2019). In our situation, the states are its profit, revenue, market share, and overall financial situation.

Each company would rather invest in R&D without a race with its competitor. Making the first scenario the most preferred outcome for Esnad, and the second scenario the most preferred outcome for Maggi. On the other hand, the third scenario where they both don't invest in R&D, which is ok for both parties. Thus, looking at the fourth scenario, they rather if both did invest to avoid being left behind in the market. Both parties prefer the fourth scenario because if both companies decided not to move forward and innovate, other companies might see this as an opportunity to enter the market and take a market share from both of them.

We are going to assume that the Marketing Campaign is an imperfect information game due to its nature as a simultaneous move game where you don't know the decisions made by the other party when making your decision.

The reason that we see Investing in R&D game as a simultaneous move game and not as a sequential game is that when you see the results of the researches done by the R&D department, it is already too late to react to it. For example, if Maggi decides to make a new kind of packaging for its products that would extend the expiry date of the product with less cost and materials. It will take a long time. They need to do researches and run tests to make sure that the new packaging is at high quality and safe for use. When it is time to start introducing the new packaging to the market, it will be too late for Esnad to come back and make a smellier thing. Because Maggi, we have a huge lead over Esnad.

We are going to assume that the Investing in R&D game is a complete information game in which knowledge about other market players like Maggi is available to all participants. The utility, payoffs, strategies, and "types" of players are thus common knowledge (Harsanyi, 1967).

In summary, Investing in the R&D game is a non-cooperative static simultaneous move game of complete, imperfect information represented in a Normal form (Matrix).

### **Payoffs:**

The payoffs for this game are represented in Ordinal payoffs. There are four

potential outcomes for this game. Let us see the utilities for each outcome for every player. First outcome Esnad gets three utility points while Maggi gets zero. Second outcome Esnad gets zero utility points while Maggi gets three utility points. In the third outcome, both companies receive one utility point. In the fourth outcome, both companies receive two utility points.

	Maggi	
	Invest	Don't
Esnad	Invest	2,2 3,0
	Don't	0,3 1,1

**Figure 6.8:** Investing in R&D Game in a Normal Form (Matrix)

#### Representations:

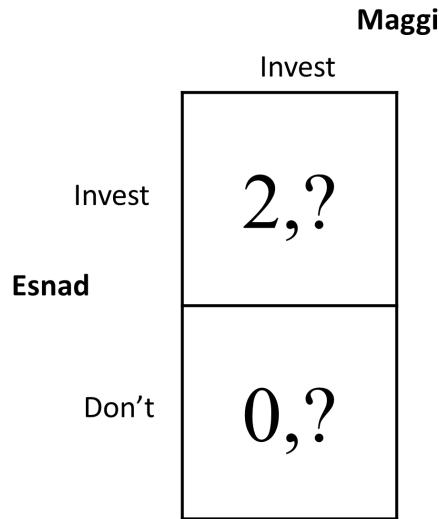
In Figure 6.8, investing in the R&D game is represented in a normal form (Matrix). Which is a great way for condensing a lot of information in a neat, simple way.

#### Results and Analysis:

There are two players in this game. The first player Esnad strategies (“Invest” and “Don’t”) are in the rows, and the second player Maggi strategies are in the columns. Esnad payoffs are listed first for each outcome, and Maggi are listed second. For example, if the Esnad invests and the Maggi don’t, then the game ends in the top right set of payoffs; Esnad gets a payoff of three, and Maggi gets a payoff of zero.

To find dominated strategies, we must focus on one player payoffs at a time. When searching for strictly dominated strategies, block out the irrelevant payoffs and strategies in a similar manner.

Which strategy should each company choose? To find the answer, we must look at each move in isolation. This solution approach is called case analysis. Consider the game from Esnad's perspective. Suppose he knew Maggi would invest. How should Esnad react?



**Figure 6.9:** Esnad move with isolation to Maggi's payoffs

In Figure 6.9, Esnad should invest. If Esnad did not invest, it would get a payoff of zero. But if she invests, she gets a payoff of two. Since she prefers high utility points, investing produces the best outcome.

Note that Maggi's payoffs are completely irrelevant to Esnad decision in this context, if Esnad knows that Maggi will pass, then he only needs to look at his own set of payoffs to choose which strategy to pick. Keeping in mind that the question marks could be any number at all, and Esnad's optimal decision given Maggi's move will remain the same.

On the other hand, suppose Esnad knew that Maggi would not invest. What should Esnad do? We can find the answer easily by only looking at the relevant information:

		Maggi
	Don't	
Esnad	Invest	3,?
	Don't	1,?

**Figure 6.10:** Esnad's move with isolation to Maggi's payoffs

In Figure 6.10, Investing wins a second time: “invest” leads to three utility points, whereas “don’t” one utility points. So, Esnad would want to “invest” if Maggi chooses “don’t”.

Putting these two pieces of information together, we reach an important conclusion. Esnad is better off investing regardless of Maggi’s strategy. Thus, Esnad can effectively ignore whatever he thinks Maggi will do since investing gives him more utilities in either scenario.

Let’s switch over to Maggi’s perspective. Suppose Maggi knew that Esnad would invest. Here is Maggi’s situation:

		Maggi
	Invest	Don't
Esnad	Invest	? , 2
	Don't	? , 0

**Figure 6.11:** Maggi’s move with isolation to Esnad’s payoffs

In Figure 6.11, as before, Maggi should invest, as she will get a payoff of three rather than zero. Finally, suppose Maggi knew that Esnad would not invest. How should Maggi respond?

	Maggi	
	Invest	Don't
Esnad	?	, 3
		, 1

**Figure 6.12:** Maggi's move with isolation to Esnad's payoffs

In Figure 6.12, unsurprisingly, Maggi should invest. Once more, Maggi prefers investing regardless of what Esnad does. Thus, we have found a solution: both players invest, and both players get a payoff of two, which is the strict dominance strategy for both players.

In conclusion, each player has a strictly dominant strategy, which is to invest. In-game theory, Deadlock is a game where the action that is mutually most beneficial is also dominant (Shor, 2019). As you can see, the most beneficial outcome for both players is <invest, invest>, making it a pure strategy Nash equilibrium.

Thus, this provides a contrast to the Prisoner's Dilemma, where the mutually most beneficial action is dominated. This makes Deadlock of rather less interest since there is no conflict between self-interest and mutual benefit (Shor, 2019).

We should also mention that this game does not have a mixed strategy, Nash equilibrium, or a weakly dominated strategy. The best response for each player is <invest, invest>.

### 6.2.2 RELEASING NEW PRODUCT

#### Game:

We have two rival firms, Esnad and Maggi, two competitive companies looking into the option of introducing a new product to the market. In an attempt to increase their market share and customer satisfaction. The options are as follows: we have four scenarios. In the first scenario, Esnad releases, and Maggie does not. The second scenario, the opposite of the first

scenario. In the third scenario, both companies release a new product. In the fourth scenario, both companies do not release a new product. This game is categorized as a Non-Cooperation game.

**Players:**

We have two players (decision-makers), Esnad and Maggi. Both are working in the food spices sector.

**Strategies (Actions):**

Each company must decide whether to release a new product or not.

**Assumptions:**

Each company is looking to maximize its benefits. It means that each company (agent) is self-interested. Not that they want to harm each other, it means that the agent has its description of states of the world that it likes, and acts based on this description (Kenton, 2019). In our situation, the states are its profit, revenue, market share, and overall financial situation.

Each company would rather release a new product faster than its competitor to gain a bigger market share. Making the first scenario the most preferred outcome for Esnad, and the second scenario the most preferred outcome for Maggi. On the other hand, the third scenario where they both don't release any new product is ok for both parties. Thus, looking at the fourth scenario, they rather if both did release a new product to avoid being left behind in the market and gain new customers. Both parties prefer the fourth scenario because if both companies decided not to move forward and innovate, other companies might see this as an opportunity to enter the market and take a market share from both of them.

We are going to assume that the Marketing Campaign is an imperfect information game due to its nature as a simultaneous move game where you don't know the decisions made by the other party when making your decision.

The reason that we see Releasing a New Product game as a simultaneous move game and not as a sequential game is that when you see the sales of the new product, it is already too late to react to it. For example, if Maggi

decides to make a new kind of spice. It will take a long time. They need to do researches and run tests to make sure that the spices taste good and at high quality and safe for use. When it is time to start introducing the new product to the market, it will be too late for Esnad to come back and make a smellier thing. Because Maggi, we have a huge lead over Esnad.

We are going to assume that Releasing a New Product game is a complete information game in which knowledge about other market players like Maggi is available to all participants. The utility, payoffs, strategies, and "types" of players are thus common knowledge (Harsanyi, 1967).

In summary, Releasing a New Product game is a non-cooperative static simultaneous move game of complete, imperfect information represented in a normal form (Matrix).

### **Payoffs:**

The payoffs for this game are represented in Ordinal payoffs. Let us see the utilities for each outcome for every player. First outcome Esnad gets three utility points while Maggi gets zero. Second outcome Esnad gets zero utility points while Maggi gets three utility points. The third outcome both companies receive one utility point. In the fourth outcome, both companies receive two utility points.

		Maggi
	Adding	Same
Esnad Foods	Adding	2,2      3,0
	Same	0,3      1,1

**Figure 6.13:** Releasing a New Product Game in a Normal Form (Matrix)

### **Representations:**

In Figure 6.13, releasing a New Product game is represented in a normal

form (Matrix). Which is a great way for condensing a lot of information in a neat, simple way.

### **Results and Analysis:**

We will not solve this game because we already did. All applications of Dead Lock have the same answer. So, we will not throw the solution process again.

In conclusion, each player has a strictly dominant strategy, which is to add a new product. In-game theory, Deadlock is a game where the action that is mutually most beneficial is also dominant (Shor, 2019). As you can see, the most beneficial outcome for both players is <adding, adding >, making it a pure strategy Nash equilibrium.

Thus, this provides a contrast to the Prisoner's Dilemma, where the mutually most beneficial action is dominated. This makes Deadlock of rather less interest since there is no conflict between self-interest and mutual benefit (Shor, 2019).

We should also mention that this game does not have a mixed strategy, Nash equilibrium, or a weakly dominated strategy. The best response for each player is <adding, adding >.

## **6.3 APPLICATION OF EXTENSIVE FORM GAMES IN ESNAD FOOD COMPANY**

### **6.3.1 NEW POLICY**

#### **Game:**

Esnad wants to adopt a new policy for employee promotions and yearly bonuses system. That would make the bounces get distributed through the employees on a curve. In an attempt to reduce cost by reducing the number of people who get bounces at the end of the year.

Now, on the other hand, this new policy might not get a warm welcome from the company employees. Because they fear that their end year bonuses might get affected. As a result, they might revolt on Esnad in an attempt to overthrow this policy.

The game will be played as a sequential move game, and it will be played as follow: the game starts with Esnad. The company has a choice from the beginning to issue the new policy. Or forget about it and start searching for another method to cut costs and that will be the end of this game. But if Esnad decided to issue the policy, the game moves, and now the employees have to make a decision, whether accepting or revolting the new policy. If they accept, the game ends there. But if they decided to revolt, the game continues, and now Esnad has to make a choice. They can enforce the policy or back off. Enforcing the policy means that some people might get fired for revolting against the company. Also, backing off leaves a bad image of the company management in the minds of its employees. This game is categorized as a Non-Cooperation game.

### **Players:**

We have two players (decision-makers), Esnad and the employees.

### **Strategies (Actions):**

Each party has a set of strategies that depends on the other party's decision (strategy).

### **Assumptions:**

Each party is looking to maximize its benefits. It means that each party (agent) is self-interested. Not that they want to harm each other, it means that the agent has its description of states of the world that it likes, and acts based on this description (Kenton, 2019). In our situation, the states are their own income, wellbeing, job status, and overall financial situation.

Let's start from the beginning, Esnad would rather issue the new policy so it can cut some expenses. The employees, on the other hand, would like not to have this new policy. They are going to fight it, but not at the expense of their career. So, if they knew that the Esnad is going to enforce the policy, they will not revolt fearing of losing their jobs. Because of the dependency of the decisions that are made in this game by the players and decisions are made sequentially, we are going to represent this game in an extensive form game rather than a normal form game.

We are going to assume the new policy game is a complete information game in which knowledge about other players is available to all participants. The utility, payoffs, strategies, and "types" of players are thus common knowledge (Harsanyi, 1967).

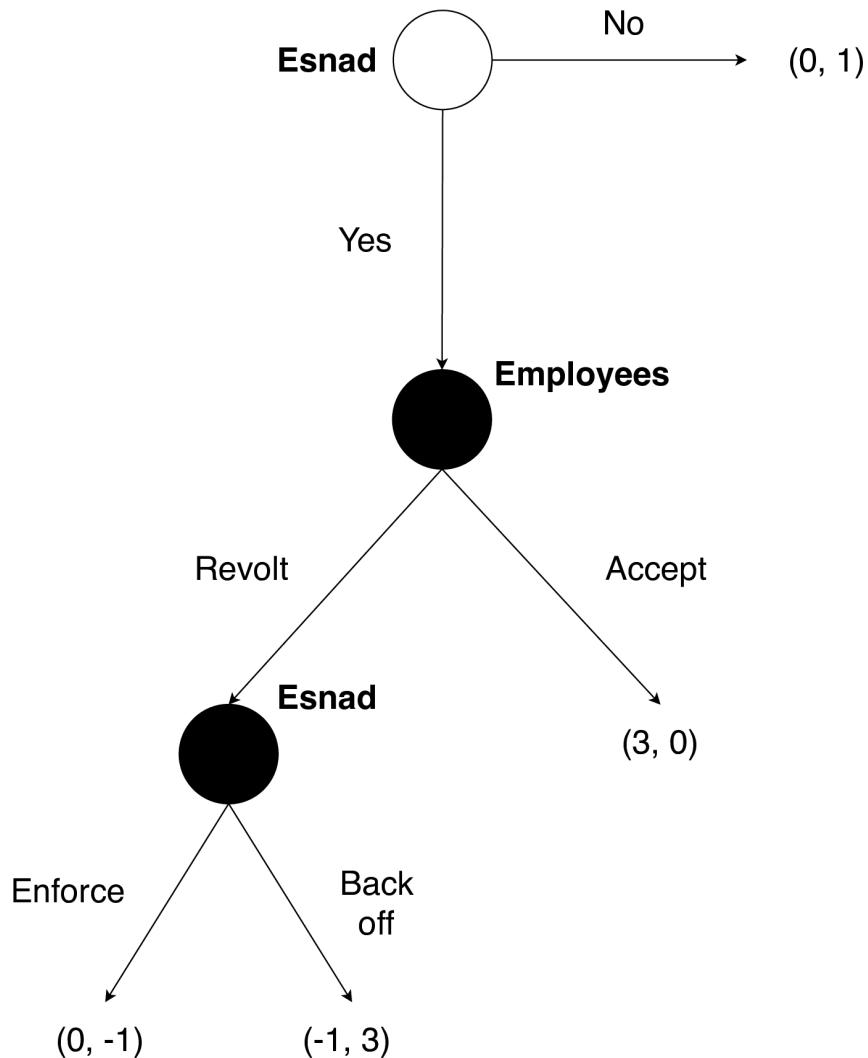
We are going to assume the new policy game is a perfect information game in which every player knows the strategies chosen by the players who preceded them (Osborne & Rubinstein, 1994).

In summary, the New Policy game is a non-cooperative sequential move game of complete, perfect information represented in an Extensive form (Game Tree).

### **Payoffs:**

The payoffs for this game are represented in Ordinal payoffs. There are four potential outcomes for this game. Before setting the payoffs, a quick reminder of the definition. Payoffs represent player preference according to the assumptions. In-Game Theory payoffs are represented through utilities, which in this case represent players' preferences. Let us see the utilities for each outcome for every player. The first outcome was Esnad decide not to issue the new policy, Esnad gets a payoff of zero, and the employees get a payoff of one. The second outcome, Esnad issue the new policy, and the employees accept it. Payoffs are Esnad three utilities and employees' zero utilities. In the third outcome, employees revolt on the company and the company enforces the policy. Payoffs are Esnad zero utilities and employees negative one utility. Fourth and last outcome, Esnad backs off and does not enforce the new policy. Payoffs are Esnad negative one utility and employees three utilities.

### Representations:



**Figure 6.14:** New Policy Game in an Extensive Form (Game Tree)

In Figure 6.14, the new Policy game is represented in an extensive form (Game Tree). Which is a great way for condensing a lot of information in a neat, simple way, and for representing sequential moves games. The interaction begins at the open circle, called a decision node. Where Esnad chooses whether to issue the policy or not. Employees choice whether to accept or revolt at her decision node only if Esnad issues the policy.

### Results and Analysis:

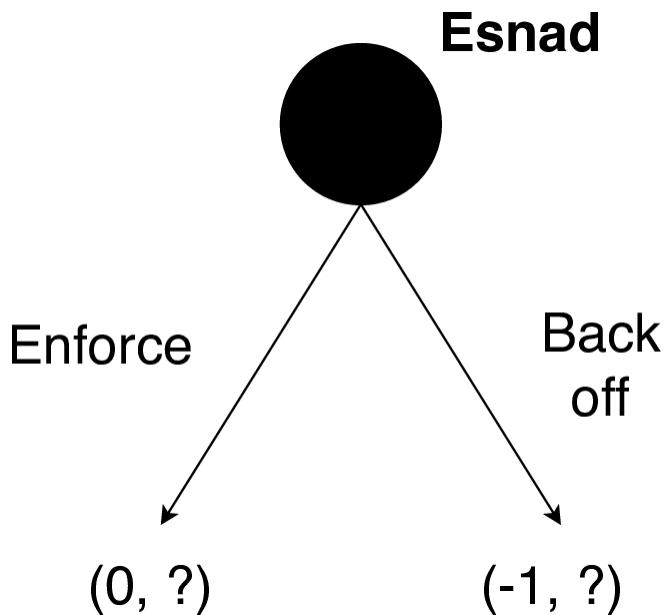
Since this is an extensive form game, there are methods to find Nash

equilibrium. The first one is the subgame perfect equilibrium; the second one is Backward Induction. Using the subgame perfect equilibrium, we could convert the extensive form game into a matrix, find the game's Nash equilibria, and then work through the logic of the game tree to see if any of those Nash equilibria rely on incredible threats.

Alternatively, we could apply Backward Induction, which is the easiest way to solve extensive form games when there are no simultaneous moves. Since the new policy game has no simultaneous moves, we will choose Backward Induction.

To apply Backward Induction, we start at the end of the game and work our way to the beginning. Specifically, we see what the players would want to do at the end of the game and take that information to the previous step to see how players should rationally respond to those future moves. After all, the smartest move today depends on what will happen tomorrow. We repeat this process until we arrive at the beginning of the game.

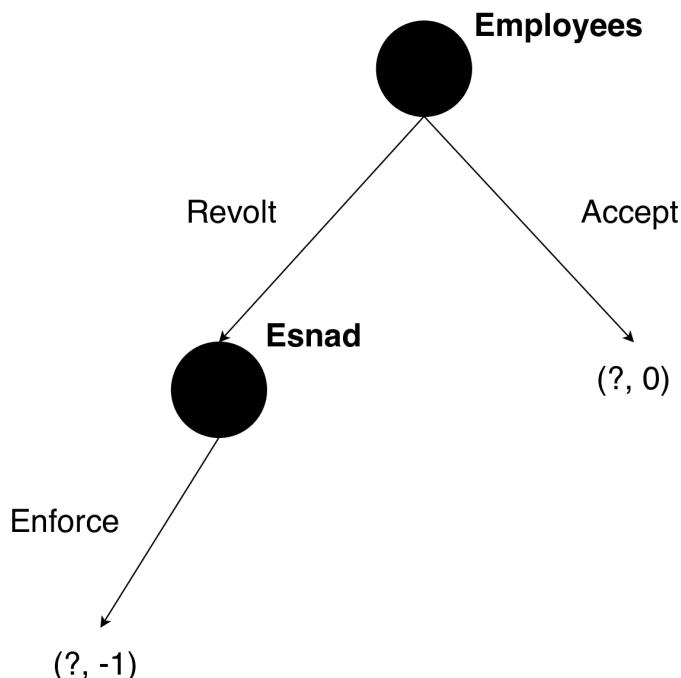
Although that may sound complicated, Backward Induction is straightforward in practice. We begin at the end of the game when Esnad decides between enforcing the new policy or backing off:



**Figure 6.15:** Esnad move with isolation to the employee's payoffs

In Figure 6.15, if Esnad decided to enforce, she earns zero. If she backs off, she earns a negative one. Since zero is greater than a negative one, we know that Esnad will enforce if he has the opportunity.

Now let's look at the employee's decisions between revolt and accept. They know that Esnad will enforce the new policy if they revolt. As such, they can functionally ignore the outcome where Esnad backs off, as they know that she will never play that strategy. Consequently, they can focus their decision between the following two outcomes:

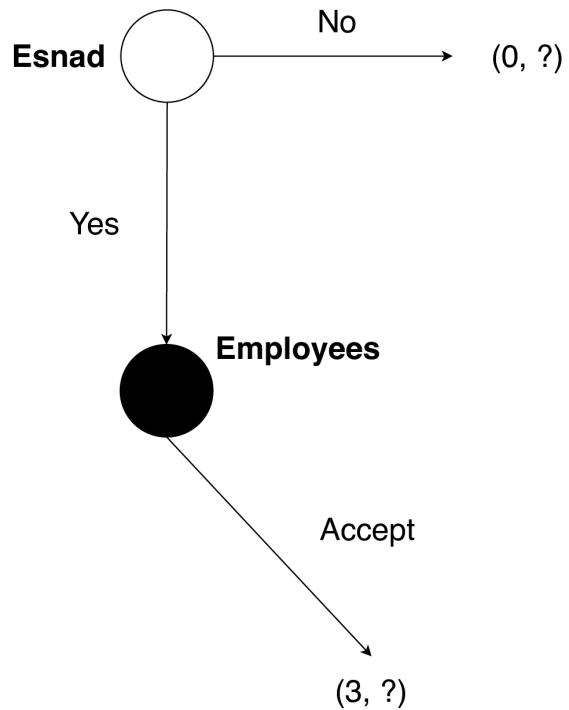


**Figure 6.16:** Employees move with isolation to Esnad's payoffs

In Figure 6.16, essentially, we erased the back off outcome from the game. This allows us to concentrate on the employees' decision between revolting and accepting, knowing that Esnad will follow with enforcing. If they accept, they earn zero. If they revolt, Esnad will enforce, and they earn a negative one. Since zero beats a negative one, the employees will accept.

Knowing that we can move to the beginning of the game where Esnad chooses whether to accept the status quo or issue a new policy. We know that if Esnad issues the policy, employees will accept, which is the preferred outcome for Esnad based on the assumptions. But there is still one more

option to go:



**Figure 6.17:** Esnad move with isolation to the employee's payoffs

In Figure 6.17, if Esnad issues the policy, she earns three. If she doesn't, she earns zero. Since three is greater than zero, Esnad issues the policy, and the game will end by the employees accepting the new policy. This makes the outcome where Esnad issues the policy and the employees accepting it a pure strategy Nash equilibrium.

We should also mention that this game does not have a mixed strategy, Nash equilibrium, or a weakly dominated strategy. The best response for each player is, Esnad issuing the policy and employees accepting it.

#### 6.4 SUMMARY TABLE

In this section, we are going to put all the previous games into one Table. Summarizing some key factors and features (see Table 7.1).

**Table 6.1:** Summary of key factors for the previous games

Game	Players	Strategies per player	Number of pure strategy Nash equilibrium	Number of mixed strategy Nash equilibrium	Sequential	Perfect Info.	Complete Info.
<b>Application of Prisoner Dilemma</b>							
Marketing campaign	2	2	1	0	No	No	Yes
Price war	2	2	1	0	No	No	Yes
<b>Application of Dead-Lock</b>							
Investing in R&D	2	2	1	0	No	No	Yes
Releasing a New Product	2	2	1	0	No	No	Yes
<b>Application of Extensive form</b>							
New Policy	2	2	1	0	Yes	Yes	Yes

## **CHAPTER - 7**

# **CONCLUSIONS AND RECOMMENDATIONS**

### **7.1 CONCLUSIONS**

In conclusion, procedures documentation provides substance to the operations of a workplace not only for legal issues, audits, or conflicts but also for laws and regulations as well. It maintains a systematic and ethical running of an office. It would be hard for staff to remember everything in a training program if it were only submitted orally. The developing team documented four governmental procedures using steps explained in the methodology chapter. Now the four documented procedures are clear for employees, and they are able to do it in a fast and efficient way.

In conclusion, forecasting is an essential element of any business because it helps management in making the right decisions and predicting future sales for the products. The purpose of this chapter was to conduct the most accurate demand forecasting for Esnad company depend on the historical data for 2017 and 2018. In the beginning, the data collection was discussed. The data were collected by using one of the data-gathering techniques, which was an interview with the CFO of Esnad. Then, the data were summarized by using a data analysis platform called Google Data Studio to give a general idea about the data and help to understand data easily and extract information. Before starting forecasting the demand for the Esnad company, the developing team faced some challenges during the data preparation process. It was explained how the team faced these challenges and solved them, and Excel was used for the data analysis.

In data analysis, the three types of products were selected for the forecasting process in this research based on the most valuable products which give huge profits to the business. Then the four methods were selected, which are exponential smoothing, linear regression, a trend projected adjusted, and

seasonality without a trend in order to choose the best method. The comparison was done between the four methods depending on the forecast performance based on four measures of accuracy, which are a mean squared error (MSE), mean absolute deviation (MAD), mean absolute percent error (MAPE), and mean forecast error (MFE). Then the lowest value was selected in each measure, and the method with the most frequency in the four measures is the best forecast for the product. Based on the results of the data analysis, the best forecasting method is seasonality without trend for all three products that give the most accurate results. The recommendation for future research is the researchers should not only depend on the traditional forecasting methods because there are a lot of methods that can give the most accurate results. So, they should read papers and books to discover the latest developments in the forecasting process. Finally, the company should be taken into account that many internal and external factors impact the forecast accuracy, such as the quality of the product, the prices, the high competition in the market, the occurrence of an economic crisis, and the volatility of oil prices. So, the sales forecasting will never be 100 percent accurate.

In conclusion, for the Marketing Campaign game which follows a Prisoner Dilemma game strategy, each player has a strictly dominant strategy, which is to engage. The game has a unique pure strategy Nash equilibrium which is <engage, engage>. For Price War game which also follows a Prisoner Dilemma game strategy, each player has a strictly dominant strategy, which is to lower the price. The game has only one unique pure strategy Nash equilibrium which is <lowering, lowering>. For Investing in R&D game which follows a Dead Lock game strategy, each player has a strictly dominant strategy, which is to <invest, invest>, making it a pure strategy Nash equilibrium. For Releasing New Product game which also follows a Dead Lock game strategy, each player has a strictly dominant strategy, which is to add a new product <adding, adding >, making it a pure strategy Nash equilibrium. For the final game New Policy which does not follow a particular game strategy and it is represented as a game tree strategy. The pure strategy Nash equilibrium for this game is Esnad issues the policy and the

employees Accepting it.

## **7.2 RECOMMENDATIONS**

The developing team recommends generalizing the concept of documentation to all departments of the firm, especially the operational department. Documenting the operational procedures will reduce the processing time and errors, which will lead to increased profitability and this is the main goal for the organization. In documenting operational procedures, safety precautions could be applied in each step using "Job Safety Analysis," and this will reduce accidents within the firm, which will lead to reducing the cost associated with accidents and increasing people's tranquility.

The last step of the research is giving recommendations for the company based on the results of the research, and this step will help them in knowing the appropriate solutions to the problem and what should they do in the future based on the result of the research. The first recommendation is that the company should follow the same forecasting process that was explained for all their products in the current or future, and our results show that the best forecasting method for the three products mentioned in the research is seasonality without trend. The second recommendation is that the company should not only depend on the historical data of the product to get the most accurate results but also they should get information from the marketing and knowledge of customers to develop their sales plan and achieve the targets.

Lastly, we recommend Esnad to think about its strategic position and strategic decisions using game theory. As an attempt to know how its competitor will think and finding the best response to their actions, by utilizing the concept of Nash equilibrium which means that both parties do not have a profitable deviation from the Nash equilibrium.

### **7.2.1 POTENTIAL STUDY AREAS FOR FUTURE RESEARCHES**

For the future studies, the developing team recommend future teams to work in improving the safety performance in the factory because multiple accidents happened and caused serious injuries to more than one employee. Inventory control is one of the areas that should be improved to fully utilize the storage

capacity. Finally, future teams should focus in reducing the operational cost by using multiple techniques such as cost of quality.

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## APPENDIX – A

### DETAILED VIEW OF DATA

**Table A-1:** The Total Sales of All Products

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
TUN-0001	19338258.96	86235.6825	7.951703631
FMB-0008	15895405.48	40905.73	6.536035828
FMB-0002	15153737.46	27276.9535	6.231069168
CSC-0001	12248205.3	173842.5905	5.036342656
TUN-0017	9515474.544	69542.3745	3.912670402
TUN-0003	9165468.72	56392.826	3.768751418
FMB-0011	7691430.529	30896.038	3.162641279
CCB-0004	6717944.132	58844.2005	2.762353159
FMB-0012	6647136.804	20917.35	2.733237876
CCB-0017	4406041.08	37358.4055	1.811721154
TUN-0011	3370064.018	19374.9815	1.385737482
CCB-0015	3307487.457	26189.962	1.36000661
CPB-0008	3199799.054	11444.6735	1.315726188
CPB-0009	3006666.26	12002.412	1.236311866
CCB-0006	2998743.105	25432.0775	1.233053941
CPB-0026	2749511.655	13087.5175	1.130572398
CCB-0003	2695951.555	26145.71	1.108549007
CCB-0010	2686508.744	22683.589	1.104666215
CCB-0009	2676265.51	23108.491	1.100454297
CPB-0016	2420123.837	17785.4975	0.995131337
CCB-0016	2382517.974	19590.503	0.979668173
FLO-0022	2365873.127	351.6125	0.972823974
FMB-0057	2352670	5616.025	0.967394977
CPB-0015	2231530.104	12344.3415	0.917583432
CCB-0021	2092840.242	17731.321	0.860555512
CPB-0014	2078681.189	10898.895	0.854733448
FMB-0058	2021763.055	16597.5245	0.831329266
CPB-0001	1771851.425	10238.4155	0.728568039
CPB-0022	1606156.688	15473.503	0.660435978
CCB-0002	1583919.702	14571.2015	0.651292346
CPB-0002	1582034.277	9915.9325	0.650517077
CCB-0007	1557107.153	13071.6475	0.640267287
FSS-0016	1528810	2262.05	0.628631773
CCB-0013	1507014.291	13039.9995	0.61966959
CAT-0034	1464950.109	6604.45	0.602373209
CPB-0024	1385234.696	4645.517	0.569595008

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FMB-0007	1337151	3220	0.54982346
FSP-0005	1333739.284	8342.606	0.548420596
CPB-0017	1321851.055	8181.491	0.543532272
CCB-0005	1295723.124	10581.9205	0.532788721
TUN-0016	1293950.641	11902.9485	0.532059894
FSG-0001	1260363.43	6887.0855	0.51824916
CPB-0021	1249753.829	9012.182	0.513886595
FMB-0050	1179631.234	7699.25	0.485052867
CCB-0014	1170745.023	9834.432	0.481398944
CPB-0027	1166098.804	6146.7615	0.479488464
CCB-0022	1149694.641	11765.6845	0.472743232
CFG-3013	1107728.576	89802.35	0.455487195
CPB-0018	1097840.013	7884.2275	0.451421115
FMB-0003	1093632.773	7349.65	0.449691139
PT6-0008	1043437.366	6377.8885	0.429051276
CPB-0003	1043289.499	7275.774	0.428990475
CSC-0007	1025794.25	15781.45	0.421796599
PT6-1002	1017827.338	3877.708	0.418520682
FSP-0007	982813	2584.05	0.404123128
FMB-0010	958355.49	1999.275	0.394066438
CCB-0008	957014.7395	8090.6065	0.393515135
CFG-3011	949954.05	75342.25	0.390611848
CSC-0005	948814.4	11996.8	0.390143235
CSC-0004	946174	10359.2	0.389057528
FLO-0011	896706.75	1221.3	0.368717077
PT6-0001	836171.739	5985.9915	0.34382567
FMB-0060	801442.337	2023.1375	0.329545279
FSP-0006	795646.8775	11863.4	0.327162242
PT6-0009	784863.0515	6071.724	0.322728038
CCB-0011	776478.988	7677.837	0.319280593
TUN-0013	735308.4245	5003.029	0.302351658
TUN-0012	735079.517	2674.4745	0.302257534
PT6-0007	720929.779	5265.298	0.2964393
CPB-0011	691123.596	4679.189	0.284183288
PT6-0005	682301.647	4969.8515	0.280555788
FFP-0073	668109.75	578.45	0.274720218
CCB-0001	662425.2195	6317.9275	0.272382795
CPB-0005	643105.277	7289.1715	0.264438623
FLV-151-073	640596	2024	0.263406832
FLV-151-111	636525	2323	0.261732877
PT6-0011	636234.1995	4751.501	0.261613303
PT6-1003	630051.098	2385.3185	0.259070872
FLV-131-262	616837	1179.9	0.253637363

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FMB-0056	601461.5	1624.95	0.247315107
PT6-0013	584166.443	4665.78	0.240203549
CPB-0006	577815.5565	6748.1885	0.237592126
FMB-0059	568728.291	7060.011	0.233855531
CCB-0020	562727.384	5064.9335	0.231388016
FLO-0029	561773.16	268.525	0.230995649
CAT-0102	554524.135	2597.85	0.22801492
PT6-1004	546942.7485	2058.1895	0.224897528
PT6-0012	538645.533	3734.6595	0.221485794
FSS-0017	495307.4955	6201.168	0.203665615
PT6-0003	488887.3675	1668.926	0.201025721
FMB-0001	467186.465	1131.025	0.192102522
CAT-0019	459267.5765	964.85	0.188846352
PRO-0132	448408	4125.2455	0.184381
PT6-1058	443615.122	5399.848	0.182410215
BCR-0001	437285.545	7716.3275	0.179807555
PT6-1005	437014.26	1555.4555	0.179696005
FLO-0033	429271.126	221.6625	0.176512104
CFG-3012	418869.1	33643.25	0.172234892
FMB-0015	409814	1599.65	0.168511523
PT6-1064	400930.066	3838.8495	0.164858536
CAT-0042	388301.985	2726.65	0.159665992
CAT-0289	382691.25	892.4	0.157358913
PT6-1006	375832.8685	3432.2095	0.154538813
PT6-1001	361786.021	1282.7905	0.148762886
CPB-0012	334931.175	2784.38	0.137720435
PT6-2008	325880.1	2898	0.133998721
CFG-3014	315845.6945	26072.8	0.129872672
PT6-1057	314383.09	2126.005	0.129271263
FLO-0007	301781.2405	43.9875	0.124089505
CAT-0259	297217.5	1651.4	0.12221294
CAT-0154	291410.92	1006.25	0.11982533
CAT-0032	286591.96	1886.69	0.117843821
FLV-165-090	282947.4375	830.3	0.116345229
BCR-0003	274641.9765	4251.9065	0.112930104
CAT-0050	271879.7455	2406.95	0.111794302
BCR-0002	265398.3455	4244.8225	0.109129213
FLV-151-843	261211	972.9	0.107407418
FMB-0078	233871.9235	5708.462	0.096165856
PT6-0010	228428.8585	2083.8345	0.093927721
PT6-0022	227948.4575	1979.5065	0.093730184
FLO-0002	225110.2	101.4875	0.09256312
PT6-1060	218168.547	1697.1585	0.08970878

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
CAT-0091	212864.7355	875.15	0.087527905
FMB-0037	198934.6015	1654.85	0.081799969
CAT-0020	198741.7465	608.35	0.081720669
CAT-0024	195288.4805	2051.6	0.08030072
CAT-0186	193890	757.85	0.079725679
PT6-1047	192619.6525	1604.0545	0.079203324
FLV-133-1144	191957.0685	402.5	0.078930876
CAT-0028	189526.8195	1357.69	0.077931581
CAT-0230	180666.541	416.645	0.074288321
FLO-0044	172500	37.95	0.070930319
PT6-1030	167353.75	1581.25	0.068814231
PT6-1059	165288.35	979.317	0.067964959
FLO-0003	160985.901	68.7125	0.066195834
PT6-2022	159873.966	2028.6	0.065738617
CAT-0168	159819.18	934.95	0.065716089
CAT-0021	156400.7705	1046.799	0.064310473
PRO-0065	155046.0015	1139.121	0.063753405
PT6-2007	154666.26	1738.8	0.063597259
FLV-163-155	147617.45	485.3	0.060698857
FFP-0046	147602.5	526.7	0.06069271
FMB-0054	145605.249	1424.367	0.059871459
PT6-1050	143702.9535	742.1525	0.059089254
CAT-0072	141944.27	1071.8	0.058366101
CAT-0300	141061.3	302.45	0.058003032
FLV-163-073	140954.58	414	0.05795915
PT6-0004	140088.3885	1059.9665	0.05760298
PT6-0024	138865.5015	1127.483	0.057100141
PT6-2001	138669.3	1593.9	0.057019465
PRO-0067	136118.6115	1335.978	0.055970647
FSP-0012	135252.9605	2026.3	0.055614699
PT6-2006	132800.85	1883.7	0.054606415
PT6-2003	131493.852	579.6	0.054068991
IM01	130361.7	10896.25	0.053603461
SM01	129223.2	10768.6	0.053135321
FLV-123-0662	129030	391	0.053055879
PRO-0068	126638.759	891.9745	0.052072624
SM07	126504.6	10542.05	0.052017459
CAT-0136	124043.6115	223.1	0.051005524
FLV-203-014	122636	368	0.050426728
PT6-2023	121252.32	1449	0.049857772
FLV-100-111	120750	473.8	0.049651223
PT6-2013	120194.55	1449	0.049422828
CAT-0096	119481.3775	460	0.049129578

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
PT6-0006	118823.6925	1145.952	0.048859144
PT6-2005	117916.722	1304.1	0.048486207
FLV-123-111	116955	437	0.048090756
FMB-0077	116725	1667.5	0.047996182
FFP-0089	114597.5	1138.5	0.047121375
FMB-0021	114374.4	219.65	0.047029639
PT6-0023	112927.5275	927.383	0.046434699
FMB-0062	111744.695	446.3955	0.04594833
CAT-0266	111036.295	630.43	0.045657042
PT6-2012	109764.648	1159.2	0.045134154
FMB-0027	105997.225	688.85	0.043585026
FLV-123-0155	105656.25	345	0.04344482
FLV-131-1144	104500.5	221.95	0.042969587
PT6-2009	103806.36	1304.1	0.042684164
IM08	103593.15	8673.3	0.042596494
PT6-2011	102531.24	1159.2	0.042159847
FMB-0053	101701.492	960.1465	0.041818662
FLV-160-120	101660	299	0.041801601
P32-0012	100222.5	477.25	0.041210515
CAT-0173	99069.0385	947.6	0.040736223
CAT-0169	98036.7985	496.685	0.040311776
CAT-0068	97510.501	517.5	0.040095368
PT6-0002	96950.9685	856.1175	0.039865293
SM09	96048	8076.45	0.039494002
PT6-0017	94162.2875	799.848	0.038718615
PT6-2004	93437.316	1014.3	0.038420514
SM02	93301.8	7775.15	0.038364791
FLV-111-111	93150	289.8	0.038302372
PT6-2002	92156.4	1159.2	0.037893814
IM03	91792.425	7665.9	0.037744151
KAR007	90955.8	8236.3	0.037400139
SM05	90831.6	7569.3	0.037349069
CAT-0252	90775.9285	591.1	0.037326177
FLV-159-662	88550	253	0.036410897
CAT-0238	88441.647	290.72	0.036366343
CAT-0115	87515.5865	625.6	0.035985556
FLV-195-161	87158.5	253	0.035838726
FLV-169-073	86336.25	253	0.035500625
FSS-0001	86167.2	512.9	0.035431113
FLO-0009	85394.4	16.1	0.035113345
FLV-194-155	84415.75	243.8	0.034710934
IM05	84138.6	7049.5	0.034596972
CAT-0382	83375	667	0.034282987

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
PT6-2016	82462.59	1014.3	0.033907813
PT6-0021	82419.1775	614.7095	0.033889963
PT6-0014	82280.269	617.688	0.033832845
FLV-100-073	80613.5625	231.15	0.033147511
IM12	78813.525	6595.25	0.032407353
FLV-151-1367	78200	276	0.032155078
SM03	77749.2	6479.1	0.031969713
PT6-1049	77111.5595	1059.3455	0.031707522
BRC-0005	77050	466.9	0.031682209
CAT-0236	76830.258	557.29	0.031591853
FFP-0075	76705	26.45	0.031540348
RAM01	76493.4	4289.5	0.031453341
FMB-0016	76431.3	195.5	0.031427806
CAT-0365	76245	117.3	0.031351201
CAT-0297	76166.8575	450.225	0.03131907
CAT-0264	76058.47	339.02	0.031274502
PT6-0016	74824.313	622.472	0.030767028
FLV-174-111	74175	230	0.030500037
IM06	73602.3	6152.5	0.030264548
AM03	73409.1	6122.6	0.030185107
PT6-0015	72741.847	560.326	0.029910739
FMB-0005	72737.5	139.15	0.029908951
PRO-0066	72485.167	546.986	0.029805194
FLV-176-148	71875	230	0.0295543
FSP-0008	70346.3625	157.55	0.028925739
CAT-0026	70198.4725	414.115	0.028864928
FMB-0019	69989.92	134.55	0.028779173
PT6-0025	68935.7495	593.4805	0.028345708
FFP-0032	68741.25	100.05	0.028265732
FHB-0010	66719.0325	405.95	0.027434216
KAS007	66107.175	6001.85	0.027182626
FLV-131-394	65607.5	125.35	0.026977165
FMB-0083	64400	115	0.026480652
SM06	64314.9	5364.75	0.02644566
IM02	62859	5260.1	0.025847008
KAR010	61309.95	5607.4	0.025210054
CSC-0009	60874.1	305.9	0.025030837
CAT-0004	60361.384	177.1	0.024820013
PT6-1032	60197.325	1868.75	0.024752553
SM10	58898.4	4928.9	0.024218448
CAT-0017	57821.31	325.45	0.023775559
PT6-1048	57675.6165	826.1715	0.023715651
CAT-0355	55250.37	199.985	0.022718414

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLV-186-073	54944.7	179.4	0.022592725
CAT-0166	54557.2075	338.1	0.022433392
IM07	53661.3	4476.95	0.022065004
KF003	52871.825	4836.9	0.021740379
FLV-115-662	51520	161	0.021184522
FLV-123-073	51422.825	167.9	0.021144565
AM01	51315.3	4281.45	0.021100351
AM09	51161.2	4347	0.021036987
AM06	51129	4260.75	0.021023747
CAT-0025	51128.7585	554.3	0.021023647
FLO-0030	50728.8	23	0.020859188
CAT-0128	50567.34	88.55	0.020792797
FM03	50370	4229.7	0.020711653
FLV-133-511	50361.375	104.65	0.020708107
FMB-0073	50255	529	0.020664366
FLV-193-619	49956	138	0.02054142
CAT-0003	49161.4075	112.7	0.020214692
IM13	48943.425	4138.85	0.020125059
FLV-131-111	48875	184	0.020096924
FLV-154-262	48616.25	92	0.019990528
FHB-0003	48531.8285	436.9885	0.019955815
FLV-152-780	48444.67	146.05	0.019919976
FM05	47844.6	4007.75	0.019673233
FLV-163-111	46575	142.6	0.019151186
KAR006	46166.175	4226.25	0.018983081
FLV-162-091	45942.017	128.8	0.01889091
CAT-0251	45648.9395	203.32	0.018770399
IM11	45638.325	3830.65	0.018766034
AM10	45595.2	3799.6	0.018748302
FLV-168-090	45361.75	132.25	0.01865231
FFP-0045	44413	434.7	0.018262193
CAT-0231	43670.376	411.585	0.017956833
CAT-0027	43567.9455	304.75	0.017914715
PT6-0020	43344.0405	318.619	0.017822647
AM02	42876.6	3573.05	0.01763044
KF002	42343.575	3875.5	0.017411265
CAT-0232	42337.25	86.825	0.017408665
FLV-123-619	41860	138	0.017212424
CAT-0243	41204.5	185.15	0.016942889
FFP-0030	41042.0625	187.68	0.016876096
FFP-0087	40365	31.05	0.016597695
FLO-0013	40335.56	14.95	0.016585589
FLV-100-050	40250	115	0.016550408

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FM07	40213.2	3351.1	0.016535276
FMB-0079	39847.5	20.7	0.016384904
FMB-0013	39468	560.05	0.016228857
KI009	39167.85	3555.8	0.016105438
IM09	38865.4	3320.05	0.015981074
FFP-0068	38631.95	515.2	0.015885081
PT6-0018	37940.7655	335.5355	0.015600873
FLV-165-073	37317.5	115	0.015344592
FLV-165-619	37231.25	108.1	0.015309127
FM06	37135.8	3094.65	0.015269879
KF001	36984	3413.2	0.01520746
CAT-0071	36882.455	240.35	0.015165706
AM08	36848.3	3076.25	0.015151662
CAT-0235	36546.448	216.2	0.015027543
KAS001	35255.55	3195.85	0.014496739
KI007	34870.875	3162.5	0.014338564
KI001	34601.775	3157.9	0.014227913
CAT-0031	34523	192.05	0.014195521
CAT-0250	34197.021	144.325	0.014061482
CAT-0248	33870.95	50.945	0.013927405
CAT-0090	33588.6135	389.85	0.013811311
FLV-159-619	32223	92	0.013249784
FLV-159-090	32200	92	0.013240326
FMB-0082	32200	57.5	0.013240326
FLV-100-843	32085	119.6	0.013193039
FLV-123-843	32056.25	104.65	0.013181218
TUN-0018	30863.7805	241.6955	0.012690886
KI005	30529.05	2807.15	0.012553248
KI003	30403.125	2783	0.012501469
AM05	30028.8	2502.4	0.01234755
P32-0005	28462.5	86.25	0.011703503
FLV-154-394	28290.046	52.9	0.011632591
FLQ-0011	28031.25	28.75	0.011526177
AM07	27765.6	2313.8	0.011416944
CAT-0269	27060.6385	153.87	0.011127071
FFP-0083	26795	27.6	0.011017843
FLV-183-486	26013	55.2	0.010696292
CAT-0141	25961.25	346.15	0.010675013
PT6-0019	25455.296	243.662	0.01046697
AM04	25336.8	2111.4	0.010418245
FSG-0003	25300	184	0.010403113
IM10	24834.825	2148.2	0.010211838
FLV-131-511	24694.8125	47.15	0.010154266

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
KF007	24529.5	2355.2	0.010086291
FMB-0074	23891.25	198.95	0.009823849
FM08	23432.4	1952.7	0.009635175
FMB-0061	22969.8125	33.35	0.009444963
FLV-100-091	22780.0625	60.95	0.00936694
FHB-0004	22550.557	184.5175	0.009272569
CAT-0233	22545.75	155.25	0.009270593
FLV-116-014	22425	69	0.009220941
FLV-174-090	22239.5625	65.55	0.009144691
FLV-133-1440	21850	26.45	0.008984507
KF006	21188.75	2043.55	0.008712608
KAS008	21000.15	1918.2	0.008635057
FLV-142-111	20930	80.5	0.008606212
CAT-0370	20892.625	129.605	0.008590844
FMB-0065	20786.2615	156.4	0.008547108
FM04	20562	1713.5	0.008454894
CAT-0360	20182.5	44.85	0.008298847
PT6-1035	20076.7	402.5	0.008255343
FLO-0046	20038.75	11.7875	0.008239739
FFP-0090	19550	23	0.008038769
CAT-0371	19435	119.6	0.007991483
CAT-0005	19321.15	128.8	0.007944669
KAS006	19200.975	1760.65	0.007895254
FMB-0067	19025.6	50.6	0.007823141
CAT-0270	18975	115	0.007802335
FLV-131-780	18921.2375	43.7	0.007780228
CAT-0209	18569.625	79.35	0.007635649
KAS002	18498.9	1670.95	0.007606567
FMB-0075	18342.5	156.4	0.007542257
FLV-168-1051	18317.2	50.6	0.007531854
FFP-0014	18216	41.4	0.007490242
CAT-0011	18116.755	32.2	0.007449433
FLV-165-780	18045.984	55.2	0.007420333
FHB-0022	17812.925	74.75	0.007324501
CAT-0039	17579.8775	104.65	0.007228674
FM01	17457	1454.75	0.007178148
FLV-115-067	17438.6	52.9	0.007170582
FLV-159-655	17365	48.3	0.007140319
PT6-1034	17167.2	517.5	0.007058985
PT6-1041	17167.2	517.5	0.007058985
PT6-1042	17167.2	517.5	0.007058985
CAT-0084	17097.05	32.2	0.00703014
PT6-1044	16807.25	494.5	0.006910977

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FMB-0080	16790	166.75	0.006903884
FLO-0010	16758.95	34.7875	0.006891117
FLV-126-1220	16495.6	50.6	0.00678283
FLV-151-1445	16475.475	46	0.006774555
FLV-162-448	16387.5	46	0.00673838
FLV-100-090	16223.625	43.7	0.006670996
CAT-0041	16142.665	85.1	0.006637707
CAT-0261	16123.92	94.53	0.006629999
FFP-0003	16100	11.5	0.006620163
KAR009	15887.25	1423.7	0.006532682
FLV-168-111	15870	55.2	0.006525589
KAS005	15809.625	1449	0.006500764
FLO-0014	15778	8.05	0.00648776
FLO-0047	15750.4	296.7	0.006476411
FLV-115-098	15295	46	0.006289155
FLV-133-1232	15214.5	31.05	0.006256054
FLV-100-063	15134.299	39.1	0.006223076
FLO-0048	15065	115	0.006194581
PT6-1029	14939.65	437	0.006143038
FLV-165-1218	14904	46	0.00612838
FLV-163-386	14863.75	29.9	0.006111829
CAT-0150	14739.8375	105.8	0.006060878
FSS-0005	14683.2	35.65	0.006037589
FLV-131-1556	14547.5	26.45	0.00598179
CAT-0256	14464.125	87.4	0.005947507
FLV-165-104	14444	46	0.005939232
FHB-0017	14441.079	50.6	0.005938031
FLV-133-865	14378.726	28.75	0.005912392
FLV-115-050	14154.2	39.1	0.005820069
FLV-165-1144	13800	36.8	0.005674426
FSP-0010	13800	86.25	0.005674426
FMB-0063	13800	34.5	0.005674426
P32-0016	13656.25	109.25	0.005615317
PT6-1025	13555.625	310.5	0.005573941
PT6-1033	13521.125	345	0.005559755
PT6-1063	13440.625	310.5	0.005526654
FLV-166-090	13235.0625	35.65	0.005442129
FLV-123-1445	13202	41.4	0.005428534
FLV-198-780	13123.2825	41.4	0.005396166
PT6-1009	13106.55	345	0.005389286
CAT-0229	13001.693	63.25	0.005346169
CAT-0362	12885.75	26.45	0.005298495
CAT-0081	12823.65	86.25	0.00527296

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
KAS004	12815.025	1171.85	0.005269413
RMP-0347	12765	5.75	0.005248844
PT6-1045	12688.525	575	0.005217398
FLV-131-1105	12447.6	27.6	0.005118332
PT6-1052	12401.025	552	0.005099181
FLO-0045	12397	5.75	0.005097526
FLV-124-091	12326.16	36.8	0.005068397
PT6-1012	12290.625	287.5	0.005053785
CAT-0009	12196.67	72.45	0.005015152
CAT-0045	12190.46	60.95	0.005012598
KAR005	11878.35	1036.15	0.004884262
FLV-126-486	11773.125	24.15	0.004840994
DBS-0008	11750.7	8.7285	0.004831773
FLV-131-098	11500	23	0.004728688
FLV-115-1218	11240.1	32.2	0.00462182
FLV-154-511	11212.5	23	0.004610471
FLV-171-090	11212.5	29.9	0.004610471
CAT-0044	10929.37	24.15	0.00449405
PT6-1019	10922.125	287.5	0.004491071
FLV-126-780	10741.92	33.35	0.004416973
CAT-0094	10660.5	20.7	0.004383494
CAT-0374	10637.5	85.1	0.004374036
FLV-174-1105	10598.4	27.6	0.004357959
CAT-0040	10521.5455	63.25	0.004326357
FLO-0018	10408.65	8.05	0.004279935
CAT-0242	10350	23	0.004255819
FLV-192-450	10235	23	0.004208532
FLV-204-1051	10212	27.6	0.004199075
FMB-0055	10212	27.6	0.004199075
FLV-165-1051	10151.05	29.9	0.004174013
CAT-0057	10140.7	60.95	0.004169757
CAT-0372	10120.046	48.3	0.004161264
PT6-1013	10028.575	437	0.004123652
FLV-131-297	9832.5	23	0.004043028
CAT-0113	9778.91	48.3	0.004020992
CAT-0391	9775	42.55	0.004019385
IM04	9708.3	819.95	0.003991958
FLV-165-1375	9660	27.6	0.003972098
FFP-0009	9645.625	36.8	0.003966187
FLV-123-1051	9588.125	26.45	0.003942544
PT6-1039	9562.25	287.5	0.003931904
FLV-133-1103	9510.5	18.4	0.003910625
FLV-165-1105	9487.5	27.6	0.003901168

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLV-174-098	9466.8	24.15	0.003892656
P32-0004	9458.75	40.25	0.003889346
FLQ-0003	9457.14	28.658	0.003888684
FFP-0077	9384	17.25	0.003858609
CAT-0029	9315	66.7	0.003830237
CAT-0352	9306.95	99.245	0.003826927
FLV-123-120	9200	28.75	0.00378295
FLV-133-386	9085	17.25	0.003735663
DBS-0015	9065.634	10.58	0.0037277
KF008	9063.15	853.3	0.003726679
FLV-115-780	9039	24.15	0.003716749
FLV-186-1445	8970	27.6	0.003688377
CAT-0234	8962.0535	62.445	0.003685109
CAT-0363	8912.5	28.75	0.003664733
CAT-0167	8772.2	69	0.003607043
CAT-0185	8671.897	96.6	0.0035658
FLV-115-448	8596.25	23	0.003534694
FLV-126-1105	8551.4	25.3	0.003516252
CAT-0306	8331.75	80.5	0.003425934
FLV-168-662	8326	23	0.00342357
FLV-168-780	8303.1725	25.3	0.003414184
FLV-154-1144	8191.45	16.1	0.003368244
FLV-142-1220	8162.7	24.15	0.003356423
FLV-115-1445	8067.25	23	0.003317175
KI010	7983.3	724.5	0.003282655
FSG-0020	7935	69	0.003262795
CAT-0260	7909.125	95.45	0.003252155
FLV-168-843	7889	24.15	0.00324388
SM08	7852.2	654.35	0.003228748
DBS-0006	7784.948	15.157	0.003201095
CAT-0387	7762.5	62.1	0.003191864
PT6-1061	7649.8	230	0.003145523
FLV-162-098	7618.75	23	0.003132756
CAT-0316	7618.175	52.9	0.003132519
FLV-151-063	7602.144	21.85	0.003125928
FLV-111-1144	7452	20.7	0.00306419
CAT-0079	7423.48	21.85	0.003052463
FLV-163-1105	7341.6	18.4	0.003018794
FLV-133-094	7201.875	13.8	0.002961341
CAT-0219	7085.633	44.85	0.002913543
FLV-157-780	7082.3325	20.7	0.002912186
FSG-0024	7072.5	69	0.002908143
FMB-0064	7066.75	17.25	0.002905779

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
CAT-0257	6918.4	54.05	0.002844779
DBS-0007	6904.025	12.282	0.002838868
FFP-0076	6900	13.8	0.002837213
CAT-0321	6864.925	21.85	0.00282279
FLV-174-1220	6762	17.25	0.002780469
FMB-0081	6727.5	58.65	0.002766282
DBS-0009	6706.248	5.9455	0.002757544
FLV-151-072	6555	18.4	0.002695352
PT6-1056	6553.275	172.5	0.002694643
FLV-151-090	6540.625	19.55	0.002689441
FLV-123-511	6534.3	13.8	0.00268684
PT6-1021	6325	57.5	0.002600778
KAS009	6301.425	580.75	0.002591085
FLV-174-486	6245.9375	12.65	0.002568269
CAT-0305	6235.875	65.55	0.002564131
FLV-123-090	6158.25	19.55	0.002532212
FLO-0049	6114.55	128.8	0.002514243
FLV-198-1105	6095	18.4	0.002506205
FLV-111-1220	6037.5	16.1	0.002482561
FLV-114-090	6037.5	17.25	0.002482561
FLV-165-486	6008.75	12.65	0.002470739
FMB-0045	5980	37.95	0.002458918
FLV-204-1105	5957	16.1	0.00244946
FLV-151-093	5906.4	13.8	0.002428654
CFG-3015	5888.575	1297.775	0.002421325
FLV-123-297	5879.375	12.65	0.002417542
CAT-0310	5741.145	49.45	0.002360703
CAT-0030	5636.15	33.35	0.00231753
FLV-110-063	5478.738	14.95	0.002252804
FMB-0014	5454.45	12.65	0.002242817
FSG-0021	5336	33.35	0.002194111
FLV-163-780	5230.89	13.8	0.002150891
FMB-0076	5175	57.5	0.00212791
FLV-135-063	5162.7755	11.5	0.002122883
DBS-0014	5132.0935	22.6435	0.002110267
MM01	5106	1828.5	0.002099537
FLV-126-297	5094.5	10.35	0.002094809
FHB-0018	5085.3	37.95	0.002091026
FLV-130-063	5072.075	12.65	0.002085588
FLV-142-780	5041.4275	16.1	0.002072986
CAT-0299	4968	8.05	0.002042793
FLV-157-1105	4968	13.8	0.002042793
FLV-154-297	4945	9.2	0.002033336

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLQ-0010	4898.586	15.9045	0.002014251
CFG-0055	4761	287.5	0.001957677
FLV-124-063	4729.72	16.1	0.001944815
CAT-0379	4621.896	36.57	0.001900479
BRC-0004	4600	23	0.001891475
FLV-115-800	4600	9.2	0.001891475
DBS-0011	4460.2865	17.0775	0.001834026
FLV-142-486	4427.5	12.65	0.001820545
FLV-163-098	4393	11.5	0.001806359
CAT-0367	4370	23	0.001796901
FLV-192-090	4341.25	11.5	0.00178508
PRO-0010	4199.6965	36.3975	0.001726874
FLV-123-079	4168.75	11.5	0.001714149
FLV-181-090	4163	11.5	0.001711785
FLV-115-079	4140	11.5	0.001702328
FSG-0013	4129.65	65.55	0.001698072
FMB-0052	4098.6	42.55	0.001685304
CAT-0165	4007.75	19.55	0.001647948
DBS-0010	3956.6785	21.7695	0.001626948
FLV-123-448	3869.75	11.5	0.001591203
CAT-0053	3839.85	36.8	0.001578909
FSS-0003	3823.0255	11.5	0.001571991
CAT-0389	3795	23	0.001560467
FLV-115-1556	3795	6.9	0.001560467
FLV-123-063	3764.364	11.5	0.00154787
FLV-165-098	3694.375	11.5	0.001519091
FLV-160-090	3622.5	10.35	0.001489537
FLV-131-486	3613.875	6.9	0.00148599
CAT-0265	3611	23	0.001484808
FLV-165-800	3599.1435	8.05	0.001479933
FLV-126-098	3593.75	11.5	0.001477715
PT6-1008	3588	34.5	0.001475351
FLV-163-486	3450	6.9	0.001418606
CAT-0263	3444.25	5.75	0.001416242
FLV-131-0090	3421.25	8.05	0.001406785
DBS-0005	3405.7365	5.9455	0.001400406
PT6-1020	3277.5	34.5	0.001347676
FHB-0008	3275.0735	9.2	0.001346678
FLO-0043	3234.375	1.4375	0.001329943
FHB-0015	3228.05	12.65	0.001327343
FSG-0007	3225.75	25.3	0.001326397
P32-0017	3191.25	17.25	0.001312211
FLV-142-098	3162.5	11.5	0.001300389

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FSG-0014	3156.75	51.75	0.001298025
CAT-0368	3128	19.55	0.001286203
CAT-0077	3105	10.35	0.001276746
CAT-0237	3105	23	0.001276746
KAS003	3096.375	285.2	0.001273199
CAT-0312	3073.605	36.8	0.001263836
CAT-0384	3059.023	17.25	0.00125784
PT6-1026	3001.5	34.5	0.001234188
CAT-0364	2932.5	17.25	0.001205815
FSS-0004	2888.363	11.5	0.001187667
FLV-133-064	2875	1.15	0.001182172
PT6-1062	2875	57.5	0.001182172
DBS-0003	2859.7855	18.9175	0.001175916
CAT-0304	2857.29	35.65	0.00117489
PT6-3016	2841.075	11.5	0.001168222
FMB-0046	2840.5115	14.95	0.001167991
CAT-0078	2833.6	8.05	0.001165149
FSS-0022	2812.095	13.8	0.001156306
FLV-165-297	2783	5.75	0.001144342
CAT-0290	2760	14.95	0.001134885
FLV-142-063	2679.5	9.2	0.001101784
FHB-0006	2659.95	10.35	0.001093746
CAT-0190	2656.5	8.05	0.001092327
PT6-3023	2639.25	11.5	0.001085234
KI002	2604.175	249.55	0.001070811
FFP-0088	2553	1.15	0.001049769
FMB-0023	2547.25	5.75	0.001047404
FLV-151-297	2530	4.6	0.001040311
PT6-1028	2530	23	0.001040311
CAT-0287	2518.5	6.9	0.001035583
CAT-0208	2484	11.5	0.001021397
FLQ-0013	2446.096	2.116	0.001005811
CAT-0200	2442.37	10.35	0.001004279
FLO-0050	2337.95	1.15	0.000961342
FLV-159-1232	2308.05	4.6	0.000949048
FLV-154-090	2300	5.75	0.000945738
SM04	2290.8	190.9	0.000941955
KAR002	2285.625	204.7	0.000939827
CAT-0356	2277	9.2	0.00093628
KAR008	2273.55	203.55	0.000934862
KI006	2209.725	216.2	0.000908617
CAT-0380	2106.225	23.575	0.000866059
CAT-0144	2105.995	10.35	0.000865965

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLV-168-091	2084.375	5.75	0.000857075
CAT-0396	2012.5	5.75	0.00082752
FM02	2001	166.75	0.000822792
PT6-3045	1979.495	11.5	0.000813949
FLV-200-780	1966.5	6.9	0.000808606
CAT-0247	1965.35	4.6	0.000808133
FLV-206-1172	1955	1.15	0.000803877
FMB-0004	1955	5.75	0.000803877
FLV-123-0093	1932	4.6	0.00079442
FLQ-0002	1932	5.75	0.00079442
FSP-0002	1932	2.3	0.00079442
CAT-0376	1900.95	4.6	0.000781652
FLQ-0007	1897.5	5.75	0.000780234
FLV-159-511	1897.5	3.45	0.000780234
FLV-124-1556	1897.5	3.45	0.000780234
FLV-154-1556	1897.5	3.45	0.000780234
FSG-0002	1883.7	29.9	0.000774559
CAT-0268	1831.95	10.35	0.00075328
FLV-100-297	1820.45	3.45	0.000748551
PT6-3018	1816.425	11.5	0.000746896
FLQ-0008	1811.25	5.75	0.000744768
FSG-0015	1811.25	51.75	0.000744768
FSG-0023	1800.9	17.25	0.000740513
FLV-207-091	1796.875	5.75	0.000738857
PT6-3048	1785.375	11.5	0.000734129
CAT-0001	1782.5	5.75	0.000732947
CAT-0116	1782.5	5.75	0.000732947
CAT-0377	1782.5	11.5	0.000732947
FSG-0026	1771	5.75	0.000728218
FLQ-0012	1766.4	1.15	0.000726326
FSG-0005	1753.75	11.5	0.000721125
DBS-0013	1732.3945	6.141	0.000712344
FLV-142-1105	1725	4.6	0.000709303
PT6-1017	1725	34.5	0.000709303
PT6-1040	1725	34.5	0.000709303
PT6-3005	1715.57	11.5	0.000705426
PT6-3010	1715.57	11.5	0.000705426
PT6-3011	1715.57	11.5	0.000705426
FLV-133-0090	1667.5	3.45	0.00068566
CAT-0110	1656	6.9	0.000680931
CAT-0187	1656	2.3	0.000680931
PT6-3004	1653.47	11.5	0.000679891
PT6-3009	1653.47	11.5	0.000679891

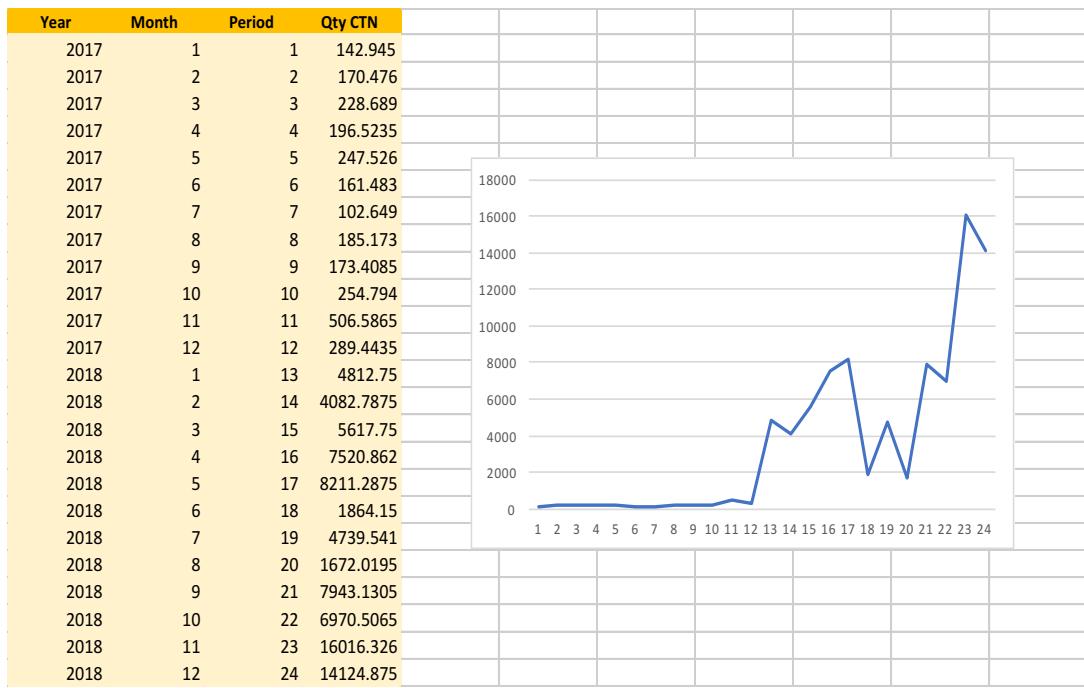
<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
PT6-3013	1653.47	11.5	0.000679891
FLV-192-1445	1610	4.6	0.000662016
PT6-3007	1583.55	11.5	0.00065114
PT6-3012	1583.55	11.5	0.00065114
PT6-3014	1583.55	11.5	0.00065114
FLV-168-1105	1577.8	4.6	0.000648776
FLV-151-1921	1552.5	3.45	0.000638373
FSG-0012	1532.375	14.95	0.000630098
FLQ-0005	1518	4.6	0.000624187
KF005	1515.7	144.9	0.000623241
FLQ-0004	1511.1	4.6	0.00062135
CAT-0358	1495	9.2	0.000614729
CAT-0313	1472.7015	17.825	0.000605561
PT6-3001	1451.645	11.5	0.000596902
FLQ-0001	1449	4.6	0.000595815
DBS-0002	1446.6885	4.784	0.000594864
FSS-0027	1437.5	5.75	0.000591086
FLQ-0006	1426	4.6	0.000586357
PT6-3006	1420.595	11.5	0.000584135
PT6-3008	1420.595	11.5	0.000584135
PT6-3021	1420.595	11.5	0.000584135
CAT-0124	1414.155	12.65	0.000581487
FSG-0017	1390.35	44.85	0.000571698
PT6-3041	1389.545	11.5	0.000571367
PT6-1011	1380	34.5	0.000567443
PT6-1018	1380	34.5	0.000567443
PT6-1022	1380	34.5	0.000567443
PT6-1031	1380	34.5	0.000567443
PT6-1037	1380	34.5	0.000567443
PT6-1046	1380	23	0.000567443
CAT-0366	1377.7	2.3	0.000566497
CAT-0314	1351.089	21.85	0.000555555
FLV-114-063	1337.68	3.45	0.000550041
PT6-3003	1319.625	11.5	0.000542617
PT6-3015	1319.625	11.5	0.000542617
CAT-0288	1306.4	9.2	0.000537179
CAT-0175	1304.1	6.9	0.000536233
PT6-3020	1288.575	11.5	0.000529849
PT6-3028	1288.575	11.5	0.000529849
PT6-3034	1288.575	11.5	0.000529849
FLV-123-1556	1265	2.3	0.000520156
FLV-126-1778	1265	4.6	0.000520156
FLV-207-1556	1265	2.3	0.000520156

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLV-208-297	1265	2.3	0.000520156
PT6-1036	1265	23	0.000520156
FSG-0004	1236.25	11.5	0.000508334
FLV-182-297	1233.375	2.3	0.000507152
DBS-0004	1211.525	6.1525	0.000498167
FSG-0011	1210.95	31.05	0.000497931
FLV-131-1288	1205.2	2.3	0.000495566
FFP-0069	1196	1.15	0.000491784
PT6-3025	1187.72	11.5	0.000488379
PT6-3027	1187.72	11.5	0.000488379
PT6-3030	1187.72	11.5	0.000488379
PT6-3031	1187.72	11.5	0.000488379
PT6-3035	1187.72	11.5	0.000488379
PT6-3038	1187.72	11.5	0.000488379
PT6-3040	1187.72	11.5	0.000488379
PT6-3047	1187.72	11.5	0.000488379
CAT-0087	1173	3.45	0.000482326
FLQ-0009	1159.2	3.45	0.000476652
FLV-171-297	1158.05	2.3	0.000476179
MM06	1156.9	208.15	0.000475706
FLO-0051	1150	5.75	0.000472869
CAT-0262	1144.25	5.75	0.000470504
FLV-142-297	1135.05	2.3	0.000466721
CAT-0357	1131.6	6.9	0.000465303
PT6-3002	1125.62	11.5	0.000462844
PT6-3019	1125.62	11.5	0.000462844
PT6-3024	1125.62	11.5	0.000462844
PT6-3029	1125.62	11.5	0.000462844
PT6-3032	1125.62	11.5	0.000462844
PT6-3033	1125.62	11.5	0.000462844
FLV-114-297	1120.1	2.3	0.000460574
DBS-0012	1117.8	4.6	0.000459628
CAT-0069	1115.5	6.9	0.000458683
FLV-133-1288	1108.6	2.3	0.000455846
CAT-0319	1104	6.9	0.000453954
FLV-133-1199	1092.5	2.3	0.000449225
CAT-0302	1086.75	32.2	0.000446861
PT6-3026	1055.7	11.5	0.000434094
PT6-3036	1055.7	11.5	0.000434094
PT6-3055	1055.7	11.5	0.000434094
CAT-0322	1048.8	4.6	0.000431256
CAT-0086	1035	2.3	0.000425582
CAT-0373	1035	3.45	0.000425582

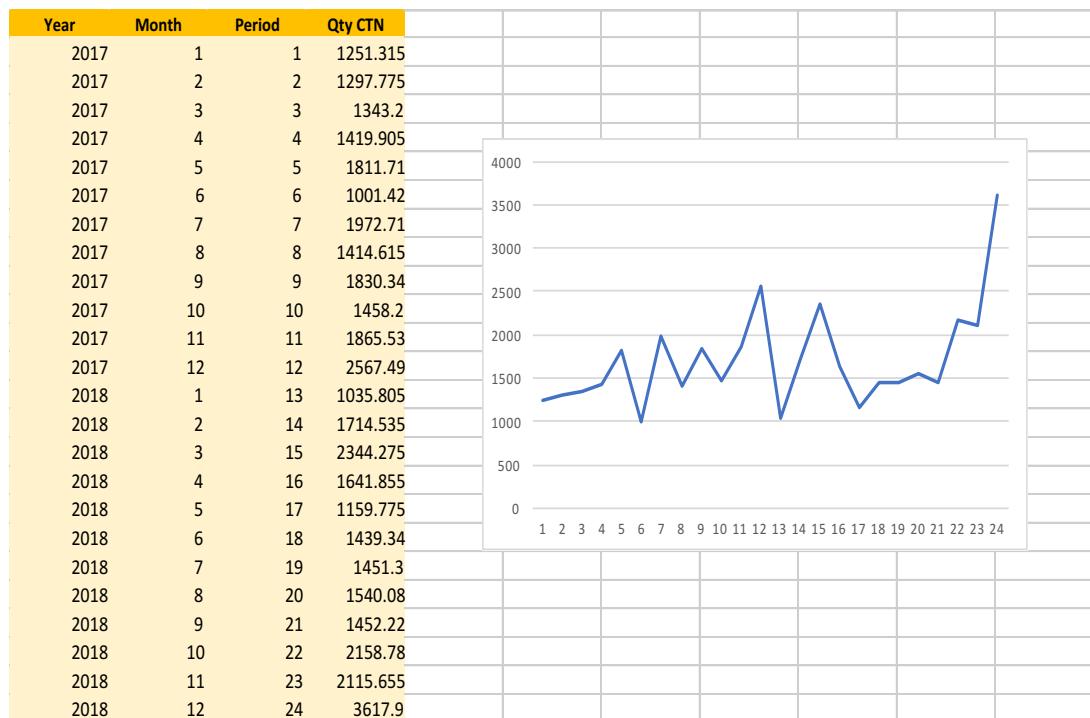
<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLV-131-1199	1035	2.3	0.000425582
PT6-3050	1024.65	11.5	0.000421326
PT6-3044	1016.945	11.5	0.000418158
PT6-3052	1016.945	11.5	0.000418158
PT6-3053	1016.945	11.5	0.000418158
MM02	1012	180.55	0.000416125
PT6-3037	993.6	11.5	0.000408559
PT6-3046	993.6	11.5	0.000408559
CAT-0361	966	3.45	0.00039721
PT6-3039	950.13	10.35	0.000390684
FSG-0010	943	9.2	0.000387752
FSG-0019	936.1	25.3	0.000384915
CAT-0359	925.75	8.05	0.000380659
PT6-3022	923.795	11.5	0.000379856
PT6-3056	923.795	11.5	0.000379856
FLV-115-1105	920	2.3	0.000378295
FLV-169-1921	920	2.3	0.000378295
MM03	908.5	5.75	0.000373566
PT6-3042	892.745	11.5	0.000367088
FLV-163-450	878.6	2.3	0.000361272
CAT-0326	845.25	16.1	0.000347559
FHB-0019	828	4.6	0.000340466
FSG-0018	819.95	26.45	0.000337155
FLV-154-1199	805	2.3	0.000331008
PT6-1051	805	23	0.000331008
FSG-0025	802.125	10.35	0.000329826
PT6-3043	791.775	11.5	0.00032557
CAT-0378	776.25	11.5	0.000319186
FLV-126-090	747.5	2.3	0.000307365
FSG-0022	736	23	0.000302636
FLV-123-1199	690	2.3	0.000283721
FLV-200-1105	690	2.3	0.000283721
CAT-0390	672.75	2.3	0.000276628
CAT-0018	665.85	3.45	0.000273791
FLV-111-1778	661.25	2.3	0.0002719
FHB-0005	660.1	2.3	0.000271427
CAT-0345	655.5	1.15	0.000269535
DBS-0001	652.1075	3.151	0.00026814
CAT-0308	652.05	10.35	0.000268117
FLV-115-1896	632.5	1.15	0.000260078
FLV-123-1896	632.5	1.15	0.000260078
FLV-123-800	632.5	1.15	0.000260078
FLV-126-1896	632.5	1.15	0.000260078

<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
FLV-142-1896	632.5	1.15	0.000260078
FLV-151-1896	632.5	1.15	0.000260078
FLV-159-1051	632.5	1.15	0.000260078
FLV-163-560	632.5	1.15	0.000260078
FLV-165-1896	632.5	1.15	0.000260078
FHB-0016	625.485	2.53	0.000257193
CAT-0298	622.15	3.45	0.000255822
CAT-0038	617.55	3.45	0.000253931
CAT-0280	598	1.15	0.000245892
PT6-3051	597.77	11.5	0.000245797
FLO-0032	589.375	6.9	0.000242345
CAT-0296	583.625	8.05	0.000239981
FLV-142-1778	575	2.3	0.000236434
CAT-0192	527.85	1.15	0.000217047
PT6-3057	527.85	11.5	0.000217047
FLV-151-865	517.5	1.15	0.000212791
FLV-163-865	517.5	1.15	0.000212791
CAT-0307	510.6	5.75	0.000209954
FLV-154-865	506	1.15	0.000208062
FLV-100-865	494.5	1.15	0.000203334
MM12	483	58.65	0.000198605
KI008	471.5	47.15	0.000193876
PT6-3049	465.75	11.5	0.000191512
CAT-0315	460	4.6	0.000189148
CAT-0067	460	2.3	0.000189148
CAT-0122	460	1.15	0.000189148
PT6-1053	460	11.5	0.000189148
FSG-0027	448.5	14.95	0.000184419
FLV-116-1894	431.25	2.3	0.000177326
CAT-0258	414	3.45	0.000170233
PRO-0087	406.755	1.15	0.000167254
FFP-0031	402.5	1.15	0.000165504
FLV-100-0101	401.35	1.15	0.000165031
CAT-0097	391	2.3	0.000160775
CAT-0014	379.5	4.6	0.000156047
CAT-0033	356.5	2.3	0.000146589
FLV-123-1220	352.1875	1.15	0.000144816
PRO-0091	349.14	1.15	0.000143563
FMB-0048	345.0345	2.3	0.000141875
CAT-0393	320.85	1.15	0.00013193
CAT-0157	299	4.6	0.000122946
MM04	299	2.3	0.000122946
PRO-0086	295.32	1.15	0.000121433

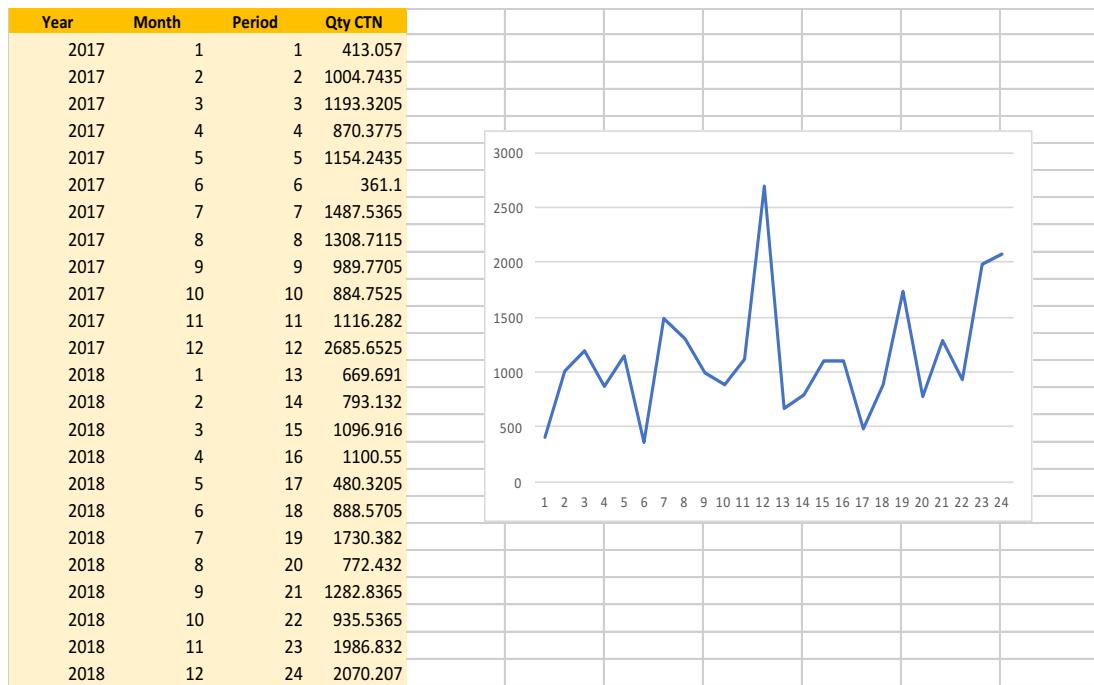
<b>Item Code</b>	<b>Total Sales</b>	<b>Qty CTN</b>	<b>% of sales</b>
CAT-0292	294.4	2.3	0.000121054
MM11	289.8	20.7	0.000119163
CAT-0383	287.5	1.15	0.000118217
FMB-0049	287.5	1.15	0.000118217
CAT-0111	276	2.3	0.000113489
MM10	276	58.65	0.000113489
PRO-0095	269.675	1.15	0.000110888
PRO-0085	262.89	1.15	0.000108098
FHB-0023	230	5.75	9.45738E-05
CAT-0285	230	1.15	9.45738E-05
FFP-0007	228.85	1.15	9.41009E-05
PRO-0083	217.81	1.15	8.95613E-05
FSG-0016	210.45	3.45	8.6535E-05
FHB-0002	207	1.15	8.51164E-05
CAT-0155	200.1	1.15	8.22792E-05
CAT-0386	189.75	1.15	7.80234E-05
CAT-0249	177.1	1.15	7.28218E-05
FHB-0011	166.75	1.15	6.8566E-05
CAT-0145	158.7	1.15	6.52559E-05
FSG-0009	155.25	3.45	6.38373E-05
CAT-0311	146.05	2.3	6.00543E-05
FHB-0012	143.75	1.15	5.91086E-05
MM08	126.5	62.1	5.20156E-05
MM09	126.5	4.6	5.20156E-05
CAT-0223	120.75	1.15	4.96512E-05
CAT-0220	103.5	1.15	4.25582E-05
CAT-0291	103.5	1.15	4.25582E-05
MM07	92	1.15	3.78295E-05
CAT-0388	80.5	2.3	3.31008E-05
MM13	57.5	57.5	2.36434E-05
FMB-0072	34.5	0.69	1.41861E-05
CAT-0189	0	1.15	0
FLV-115-262	0	4.6	0
FLV-157-1894	0	1.15	0
FLV-159-780	0	8.05	0
FLV-162-1103	0	1.15	0
FLV-163-090	0	1.15	0
FMB-0047	0	1.15	0
PRO-0122	0	16.1	0
PRO-0147	0	2.3	0
PRO-0149	0	4.6	0



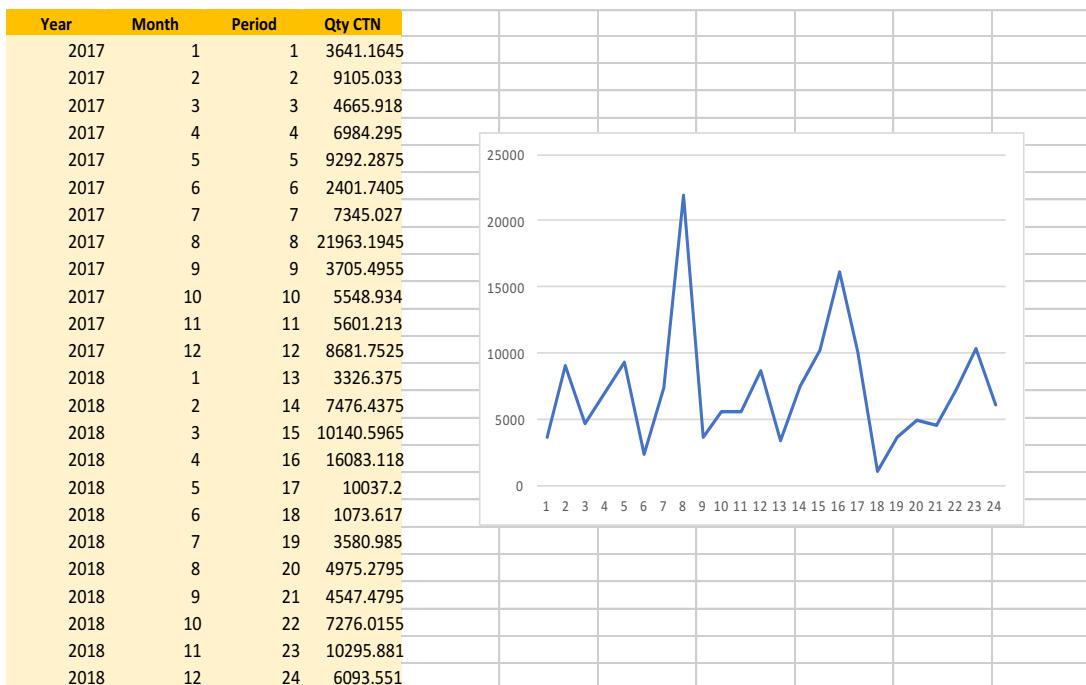
**Figure A-1:** The data of TUN-0001



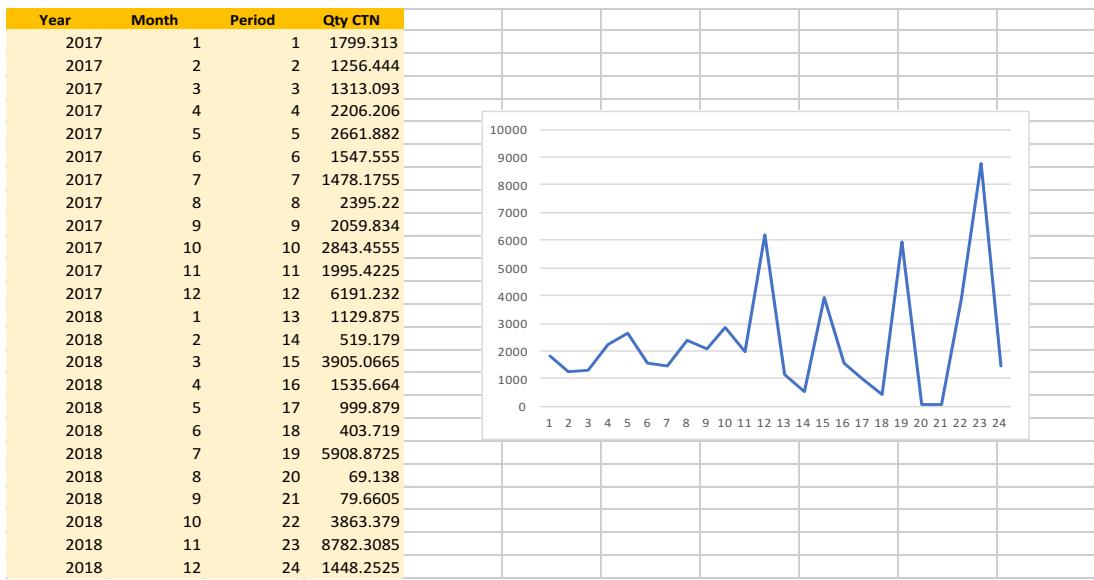
**Figure A-2:** The data of FMB-0008



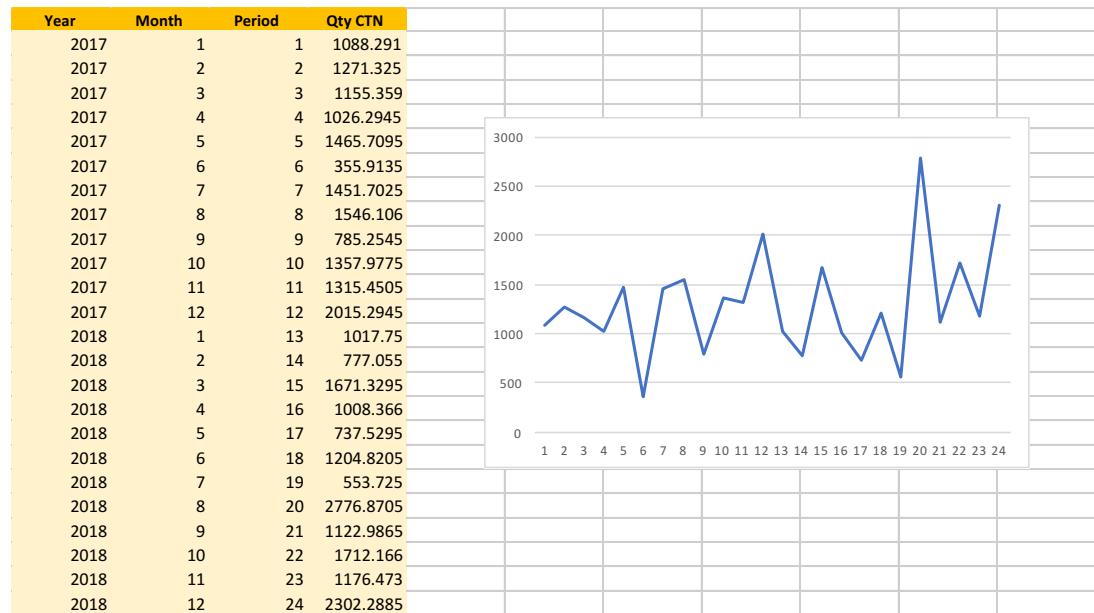
**Figure A-3:** The data of FMB-0002



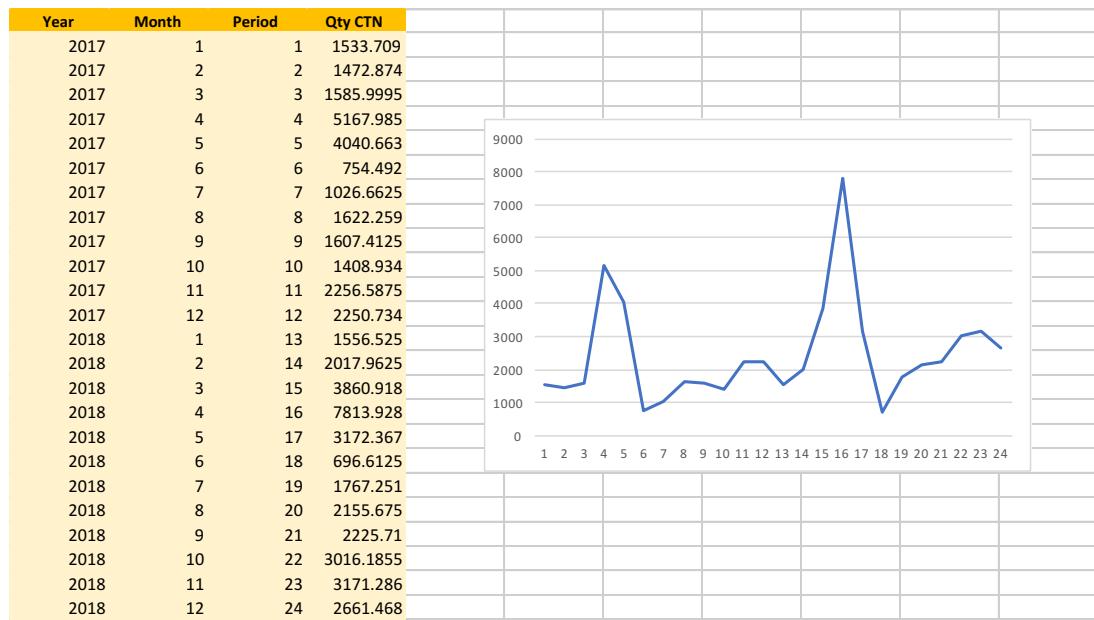
**Figure A-4:** The data of CSC-0001



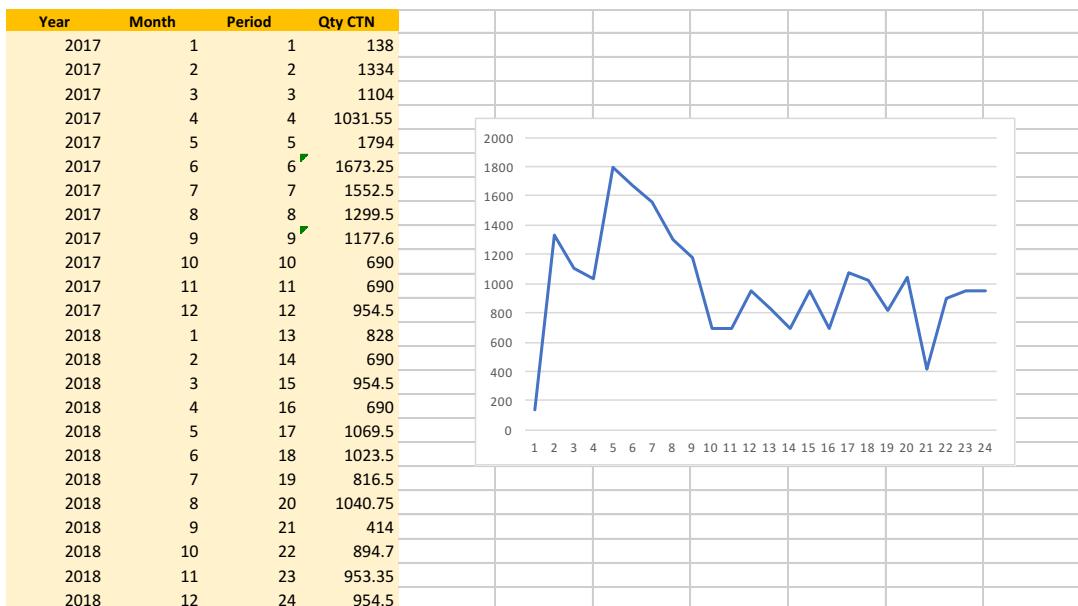
**Figure A-5:** The data of TUN-0003



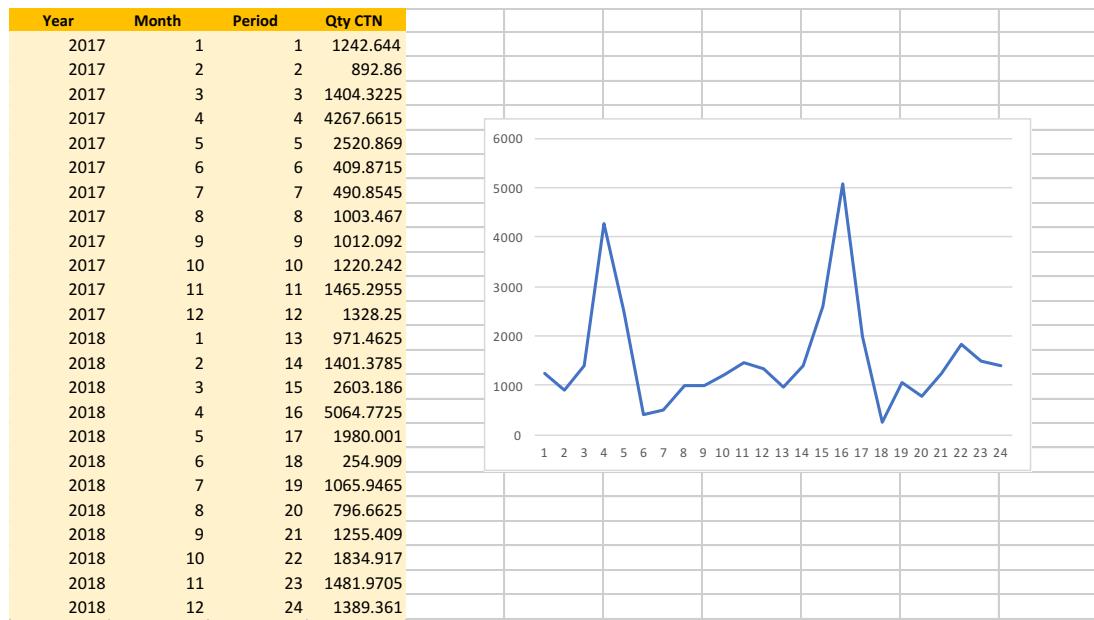
**Figure A-6:** The data of FMB-0011



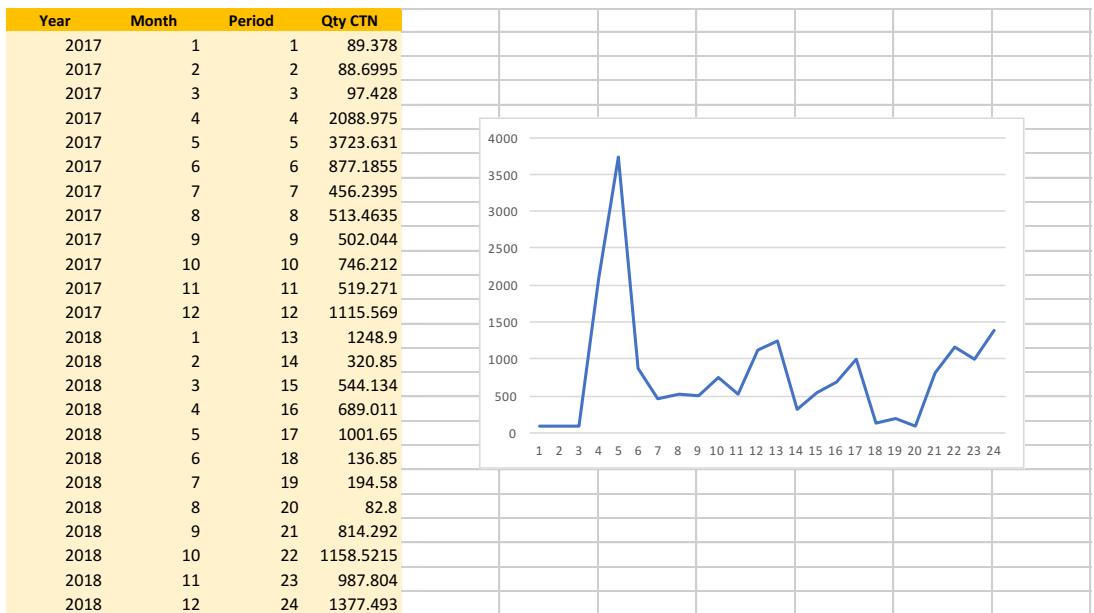
**Figure A-7:** The data of FMB-0002



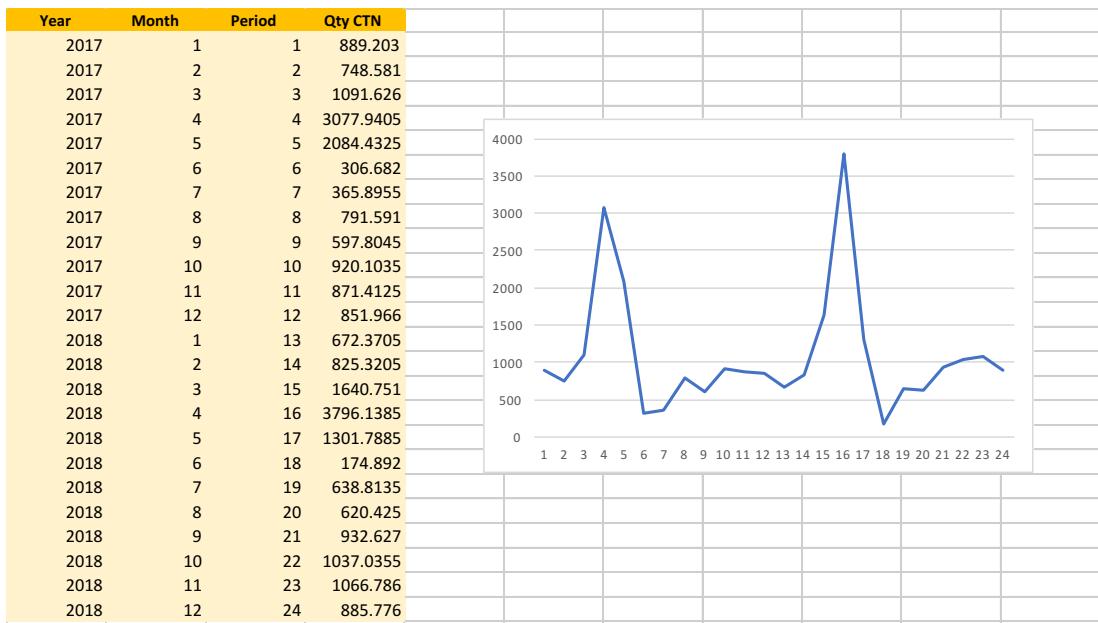
**Figure A-8:** The data of FMB-0012



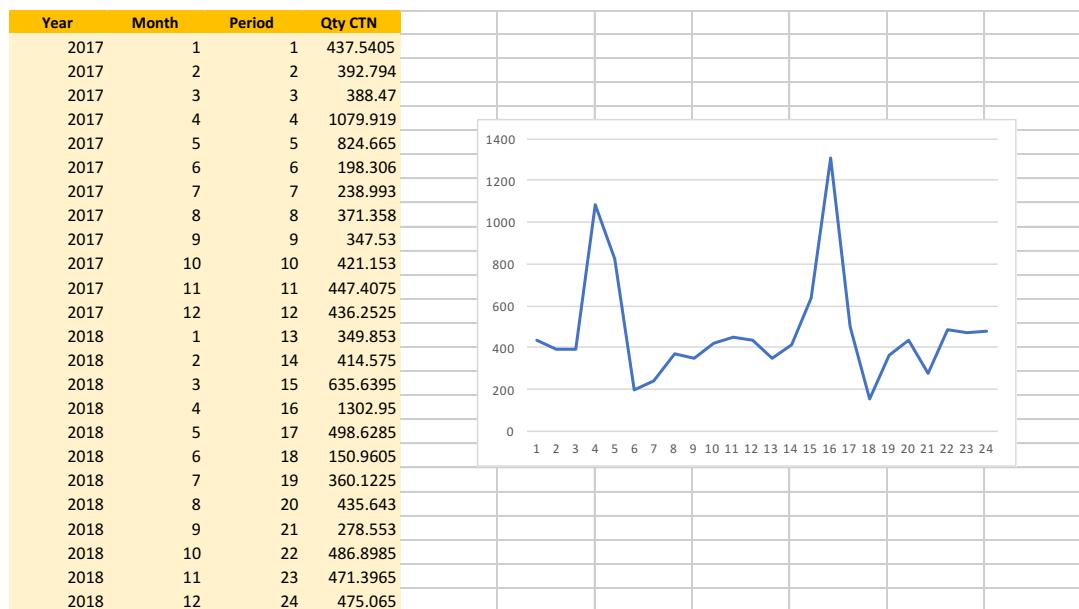
**Figure A-9:** The data of CCB-0017



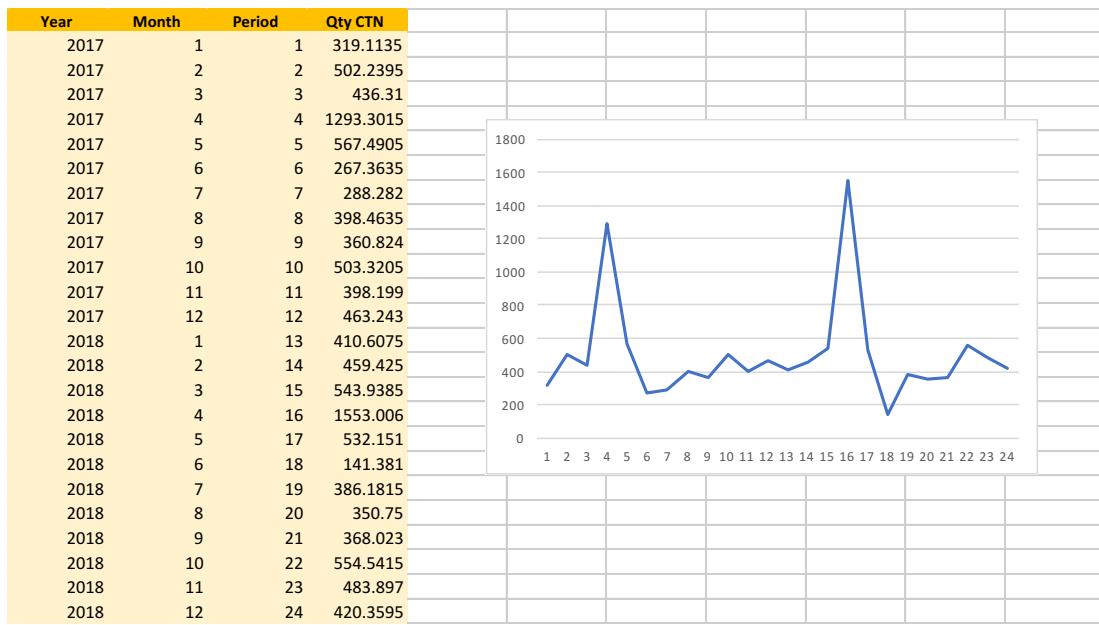
**Figure A-10:** The data of TUN-0011



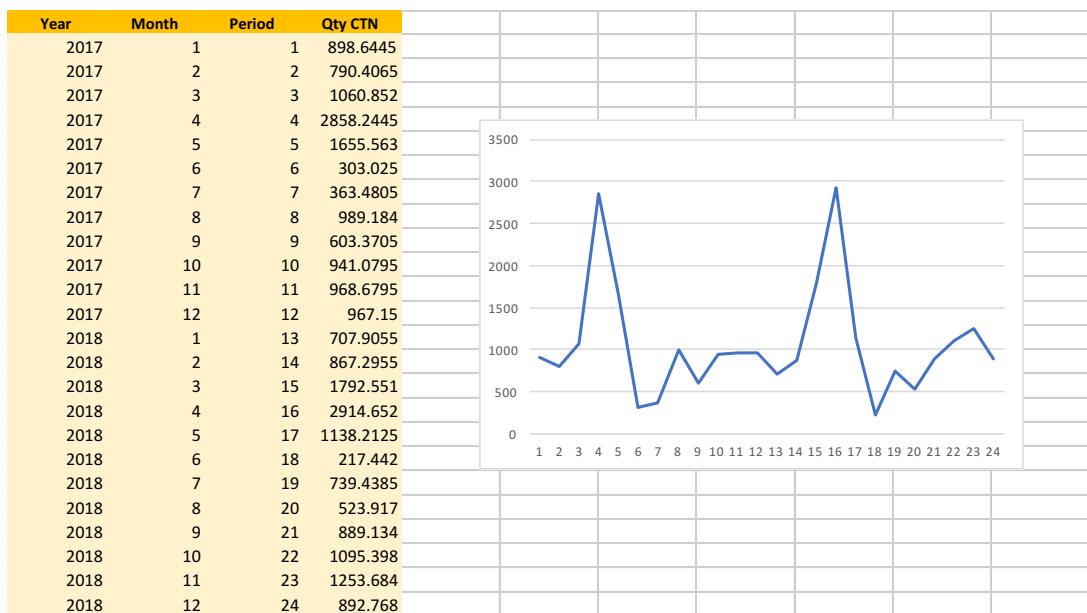
**Figure A-11:** The data of CCB-0015



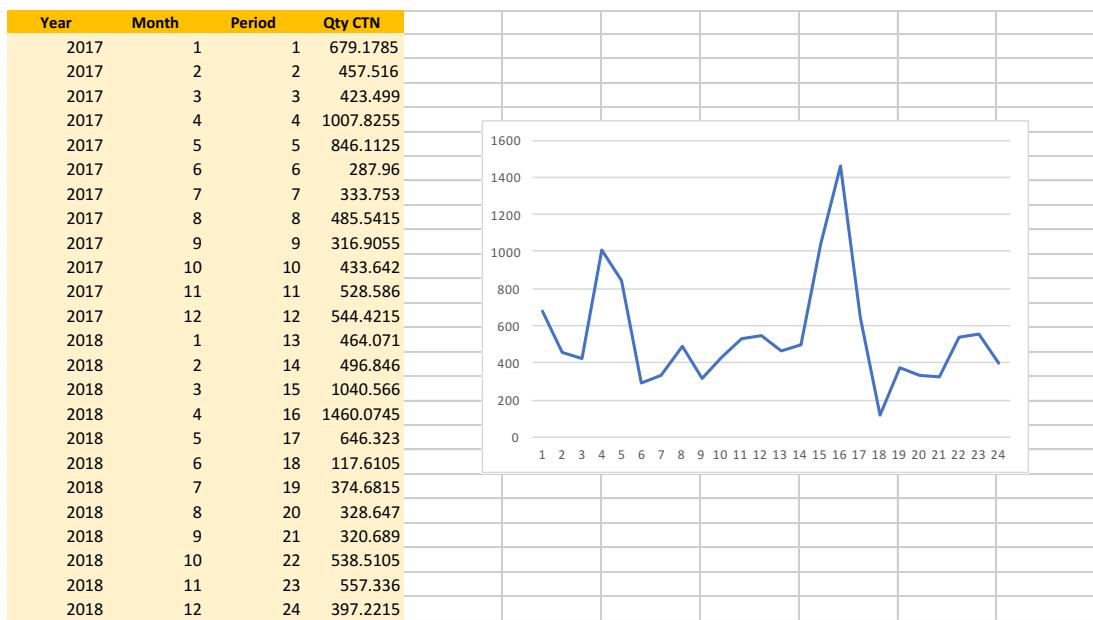
**Figure A-12:** The data of CPB-0008



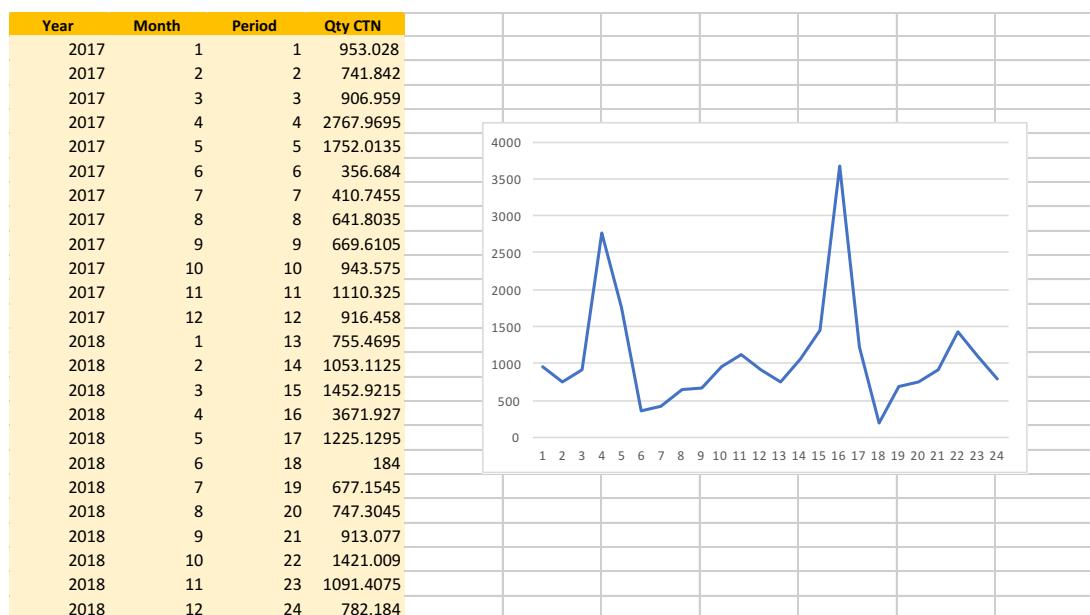
**Figure A-13:** The data of CPB-0009



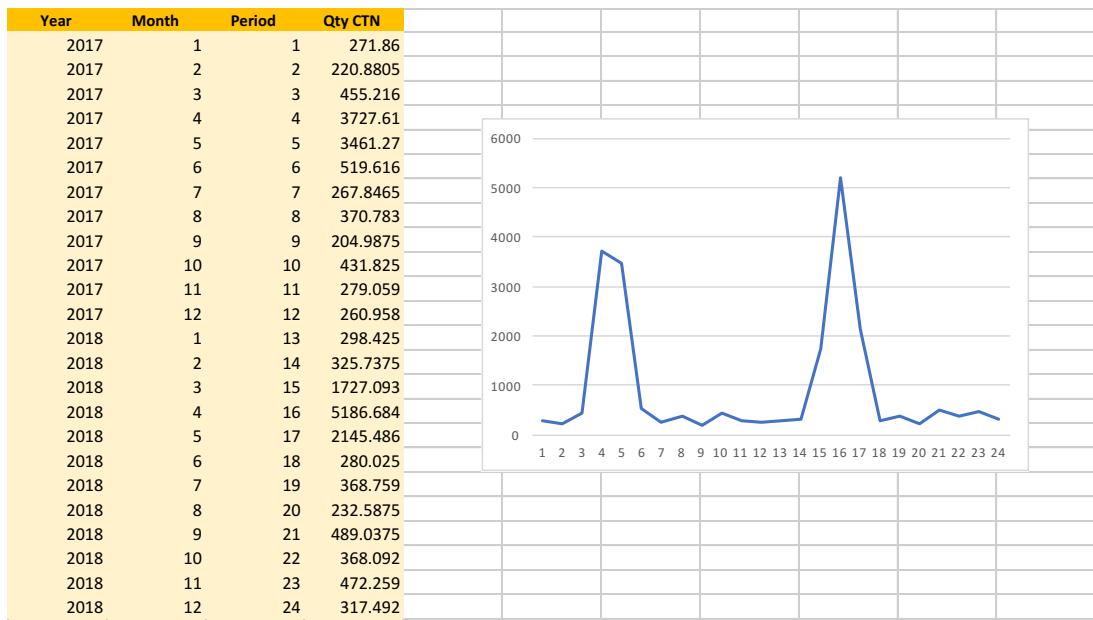
**Figure A-14:** The data of CCB-0006



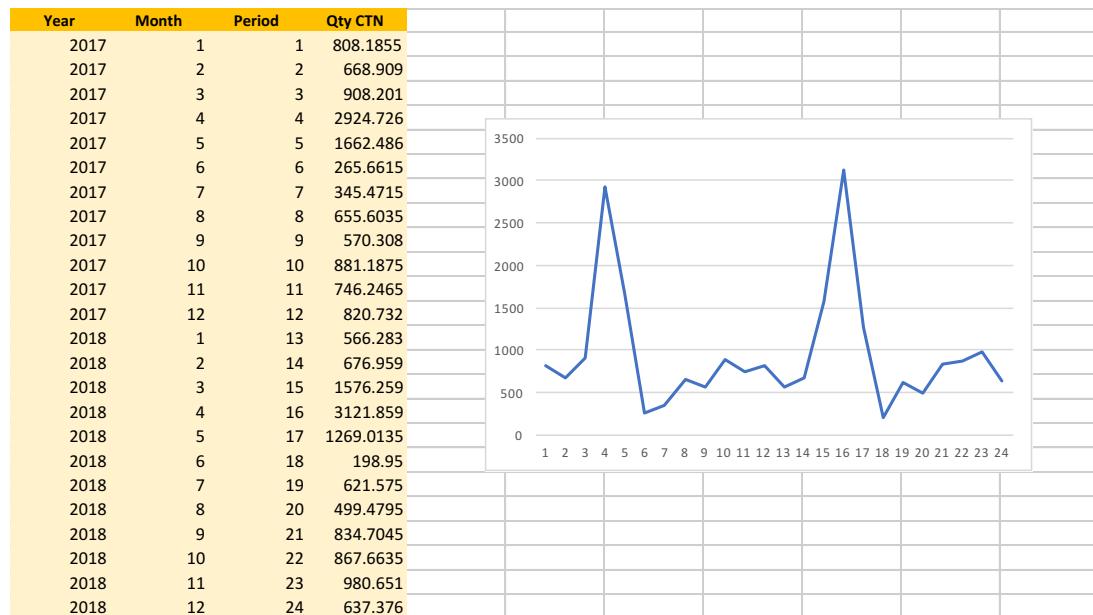
**Figure A-15:** The data of CPB-0026



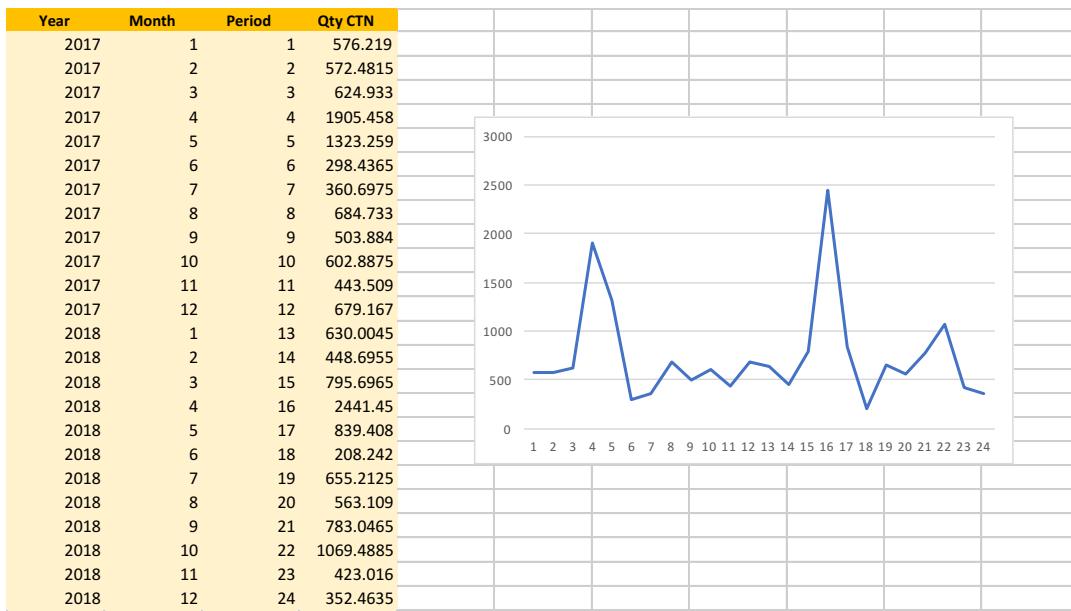
**Figure A-16:** The data of CCB-0003



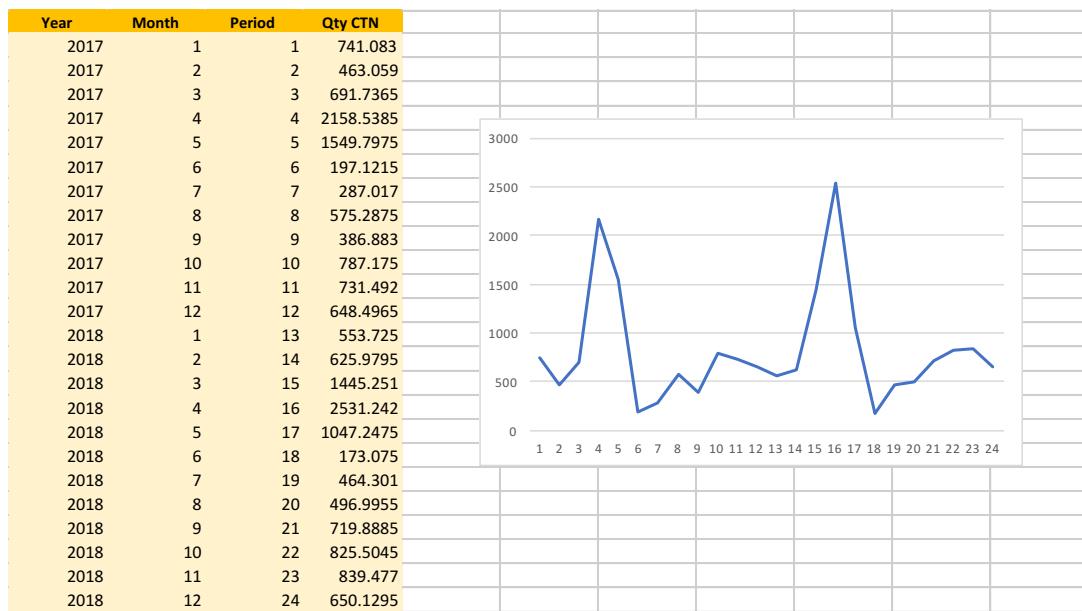
**Figure A-17:** The data of CCB-0010



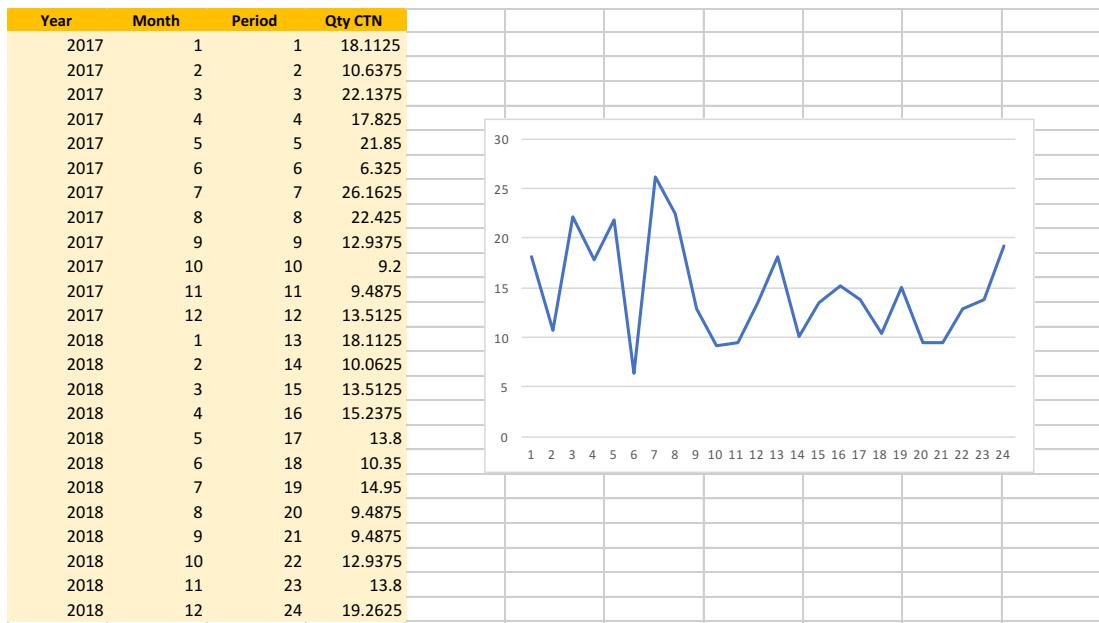
**Figure A-18:** The data of CCB-0009



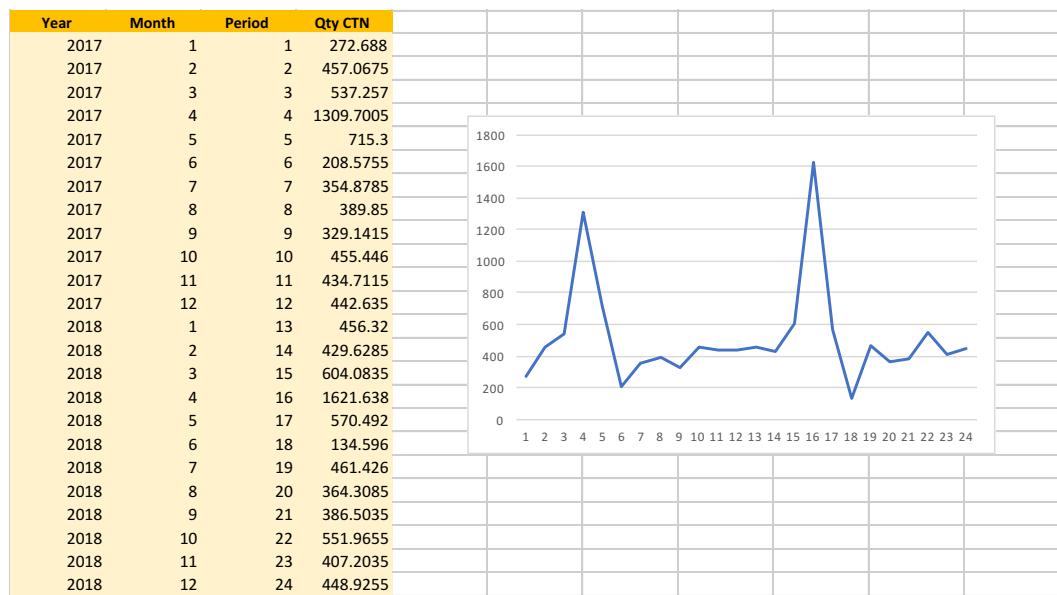
**Figure A-19:** The data of CPB-0016



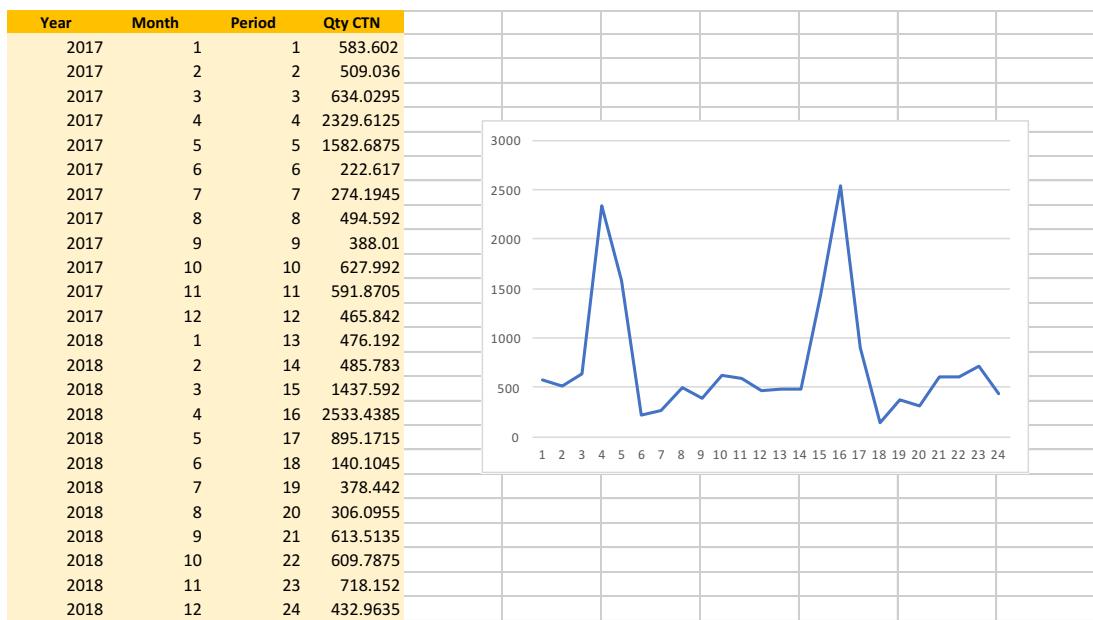
**Figure A-20:** The data of CCB-0016



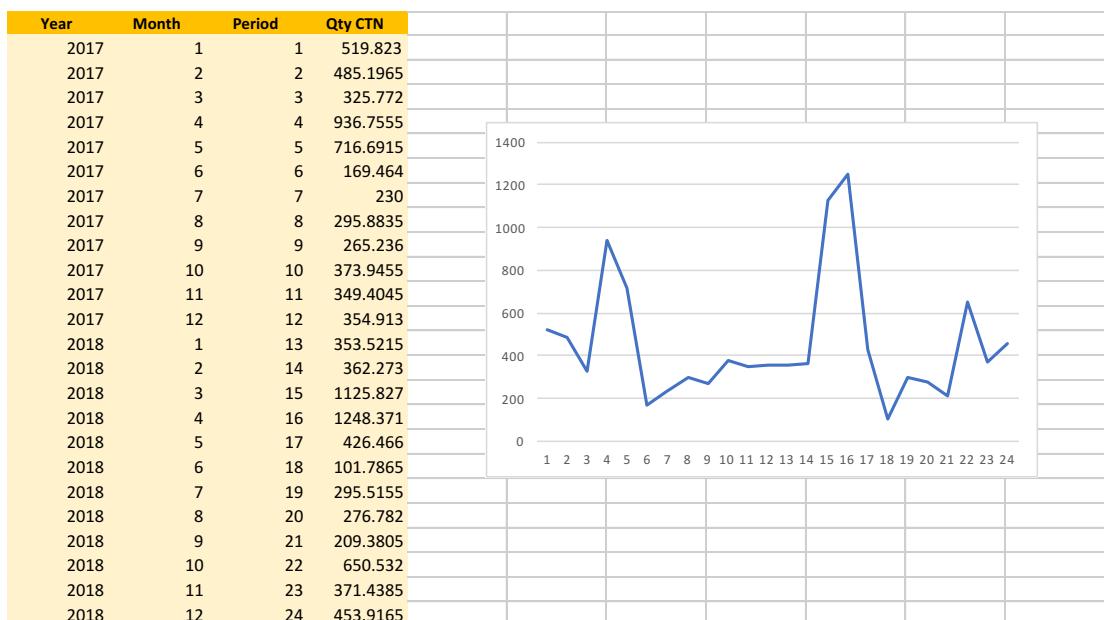
**Figure A-21:** The data of FLO-0022



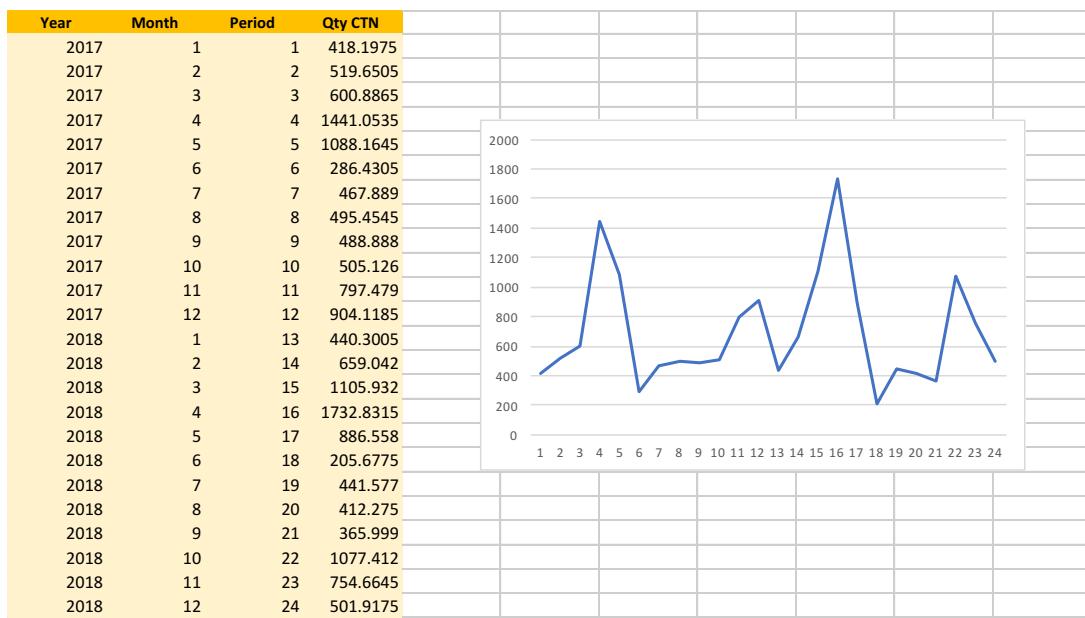
**Figure A-22:** The data of CPB-0015



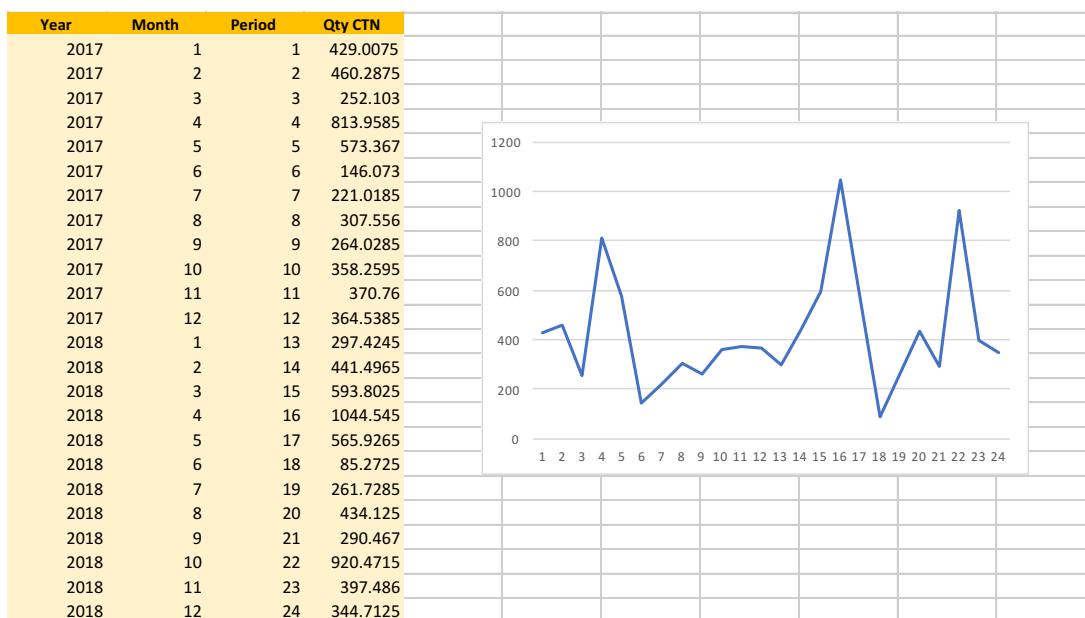
**Figure A-23:** The data of CCB-0021



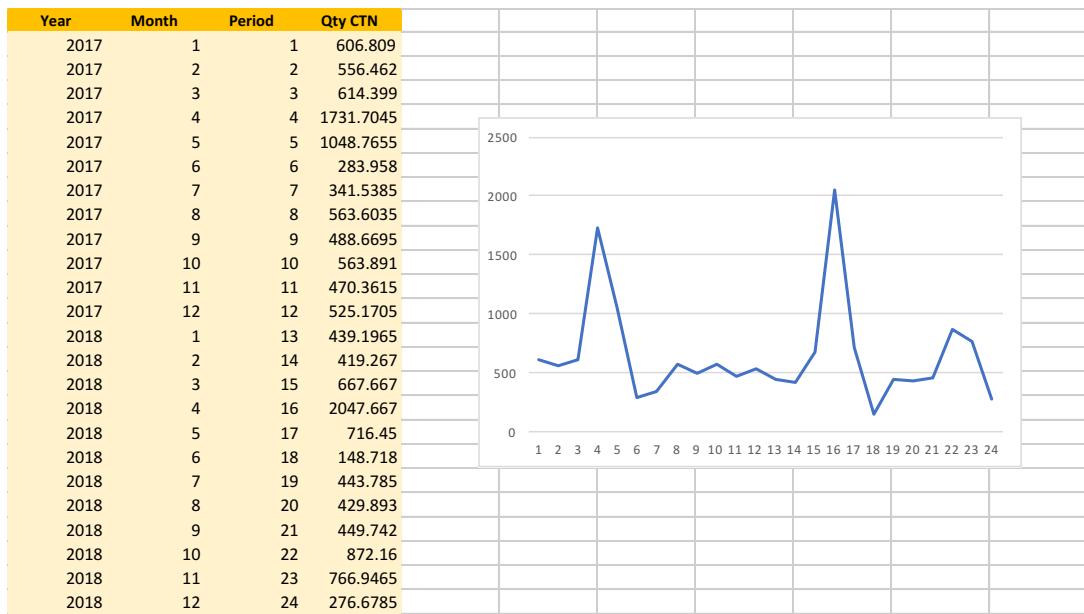
**Figure A-24:** The data of CPB-0014



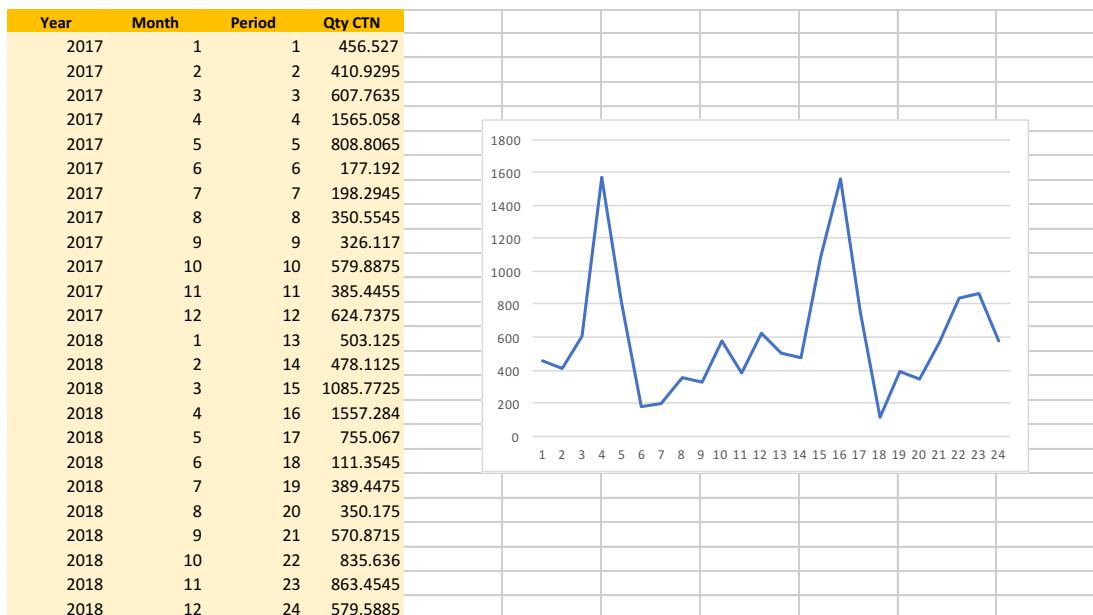
**Figure A-25:** The data of FMB-0058



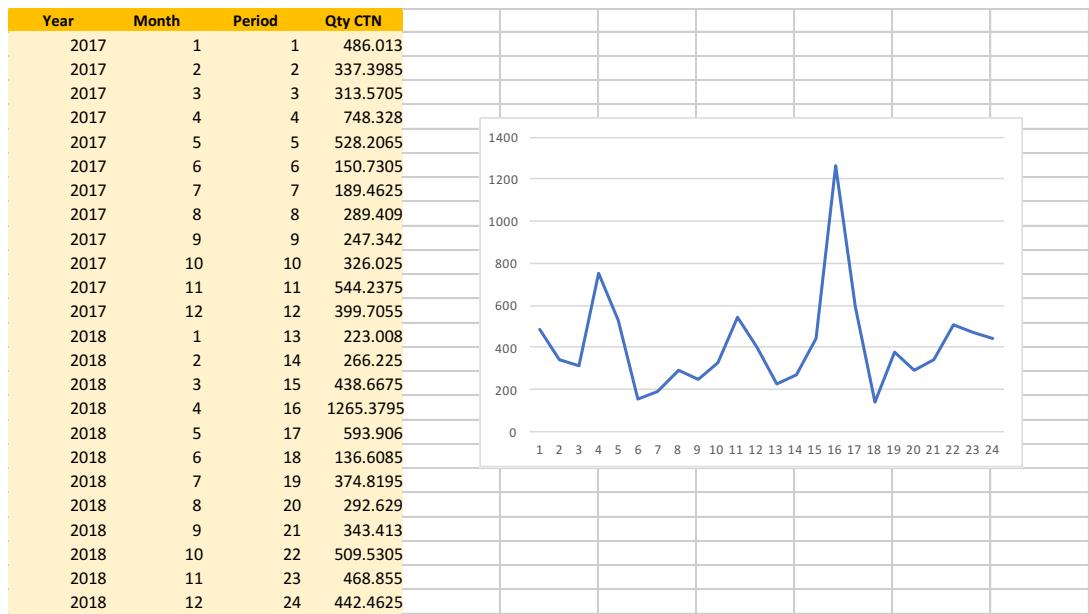
**Figure A-26:** The data of CPB-0001



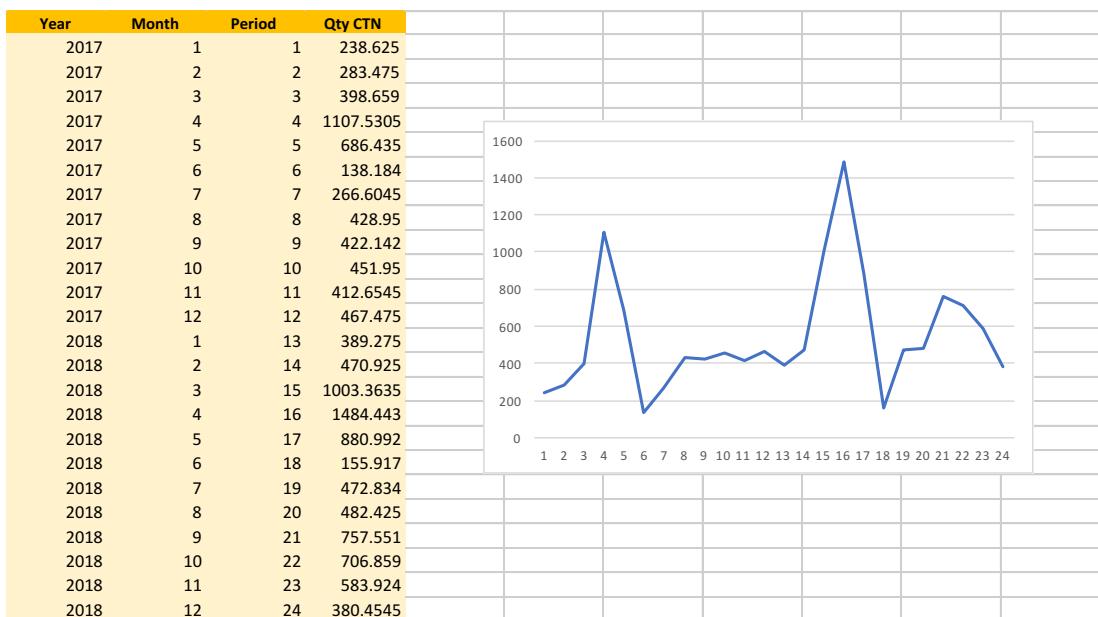
**Figure A-27:** The data of CPB-0022



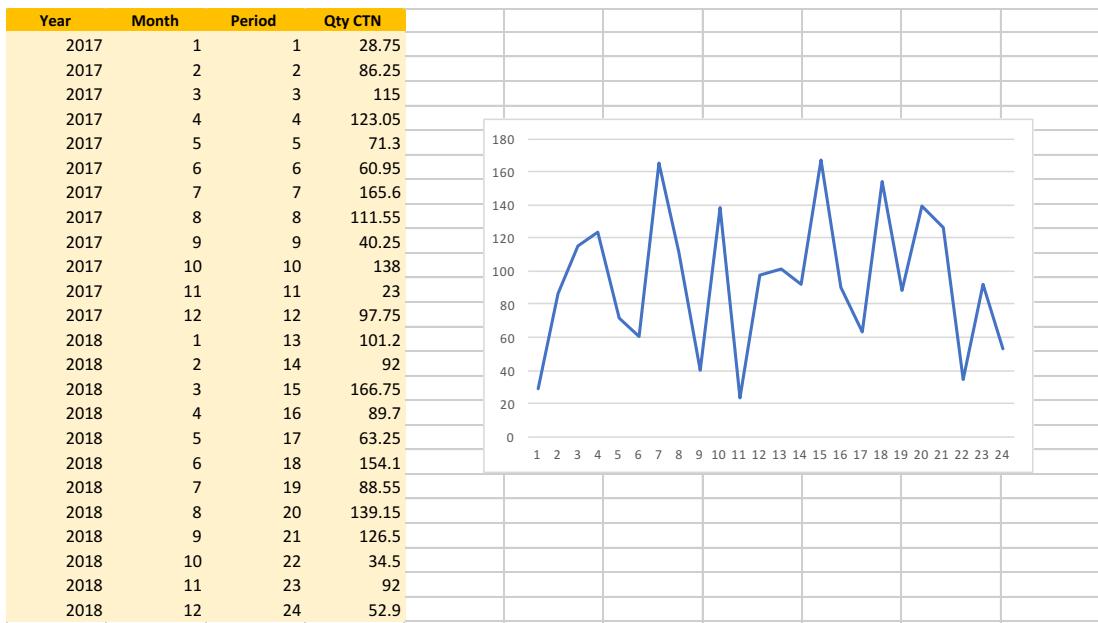
**Figure A-28:** The data of CCB-0002



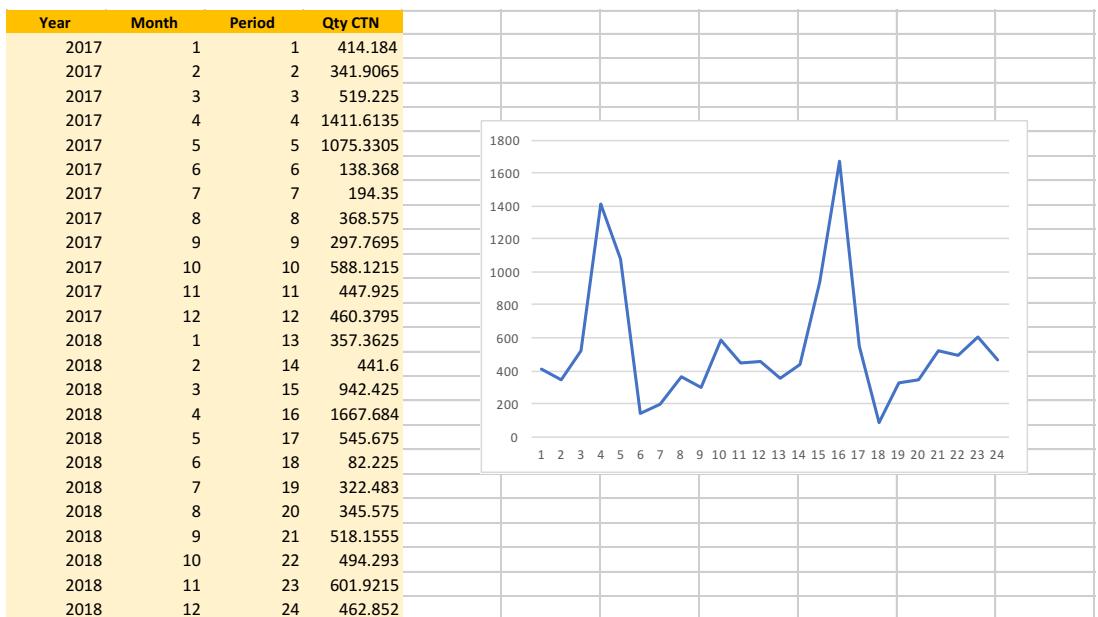
**Figure A-29:** The data of CPB-0002



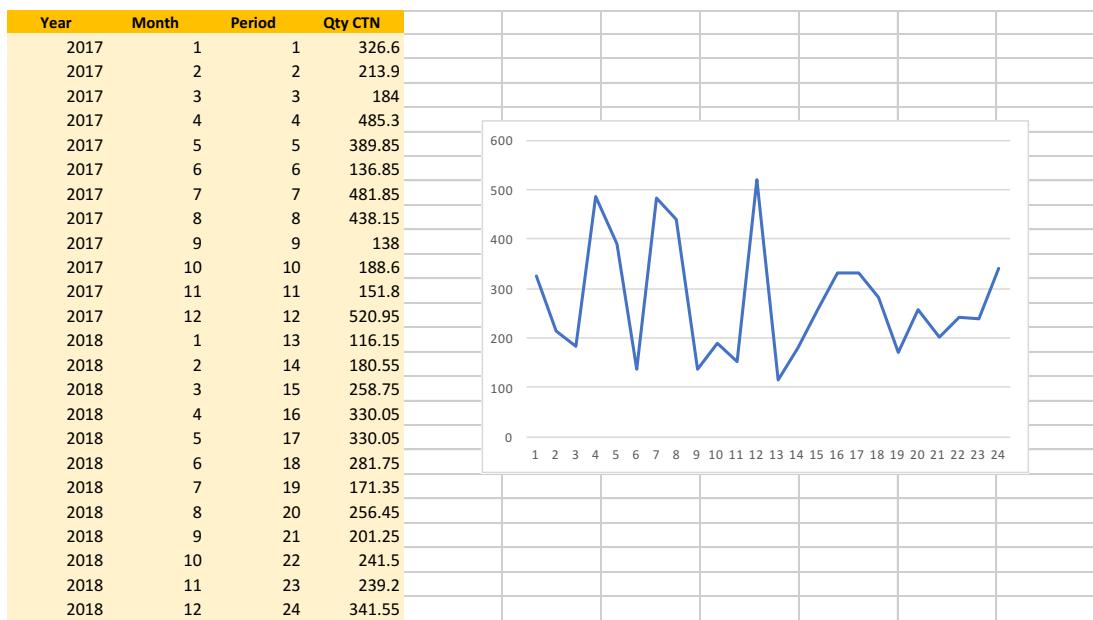
**Figure A-30:** The data of CCB-0007



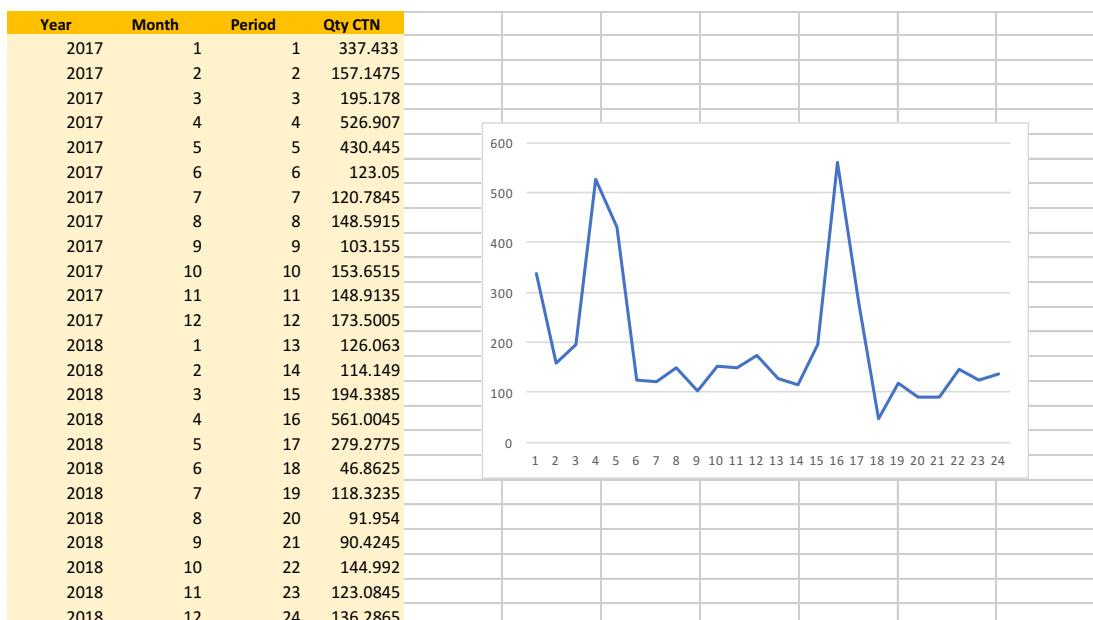
**Figure A-31:** The data of FSS-0016



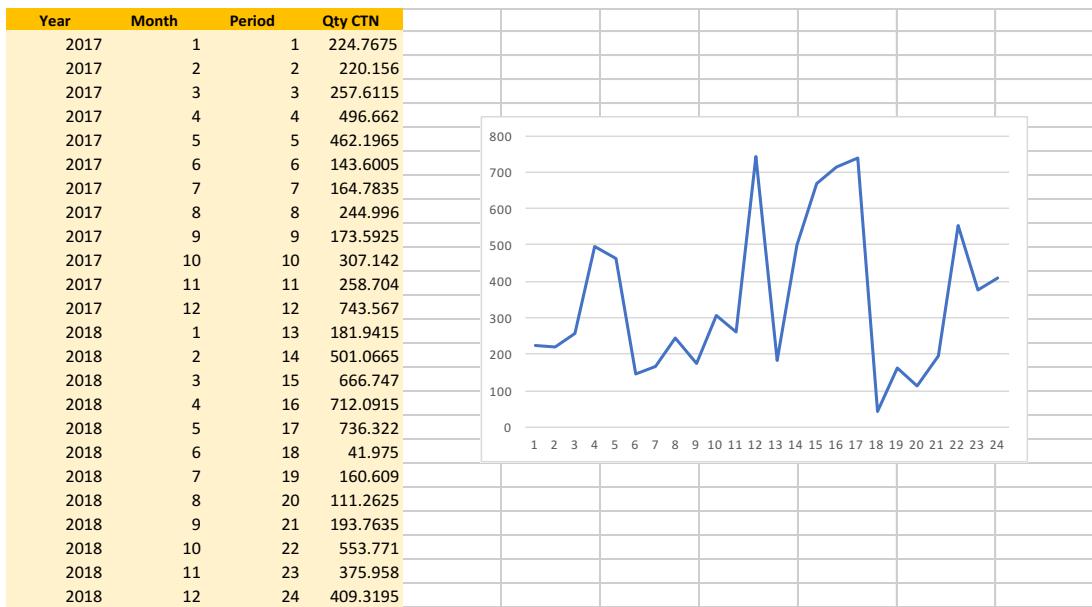
**Figure A-32:** The data of CCB-0013



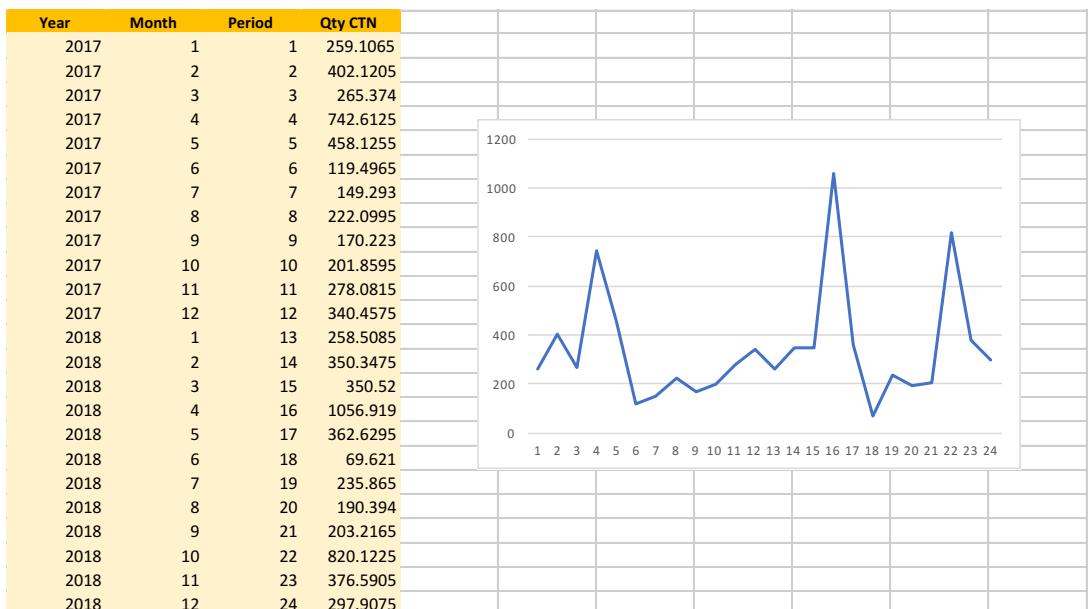
**Figure A-33:** The data of CAT-0034



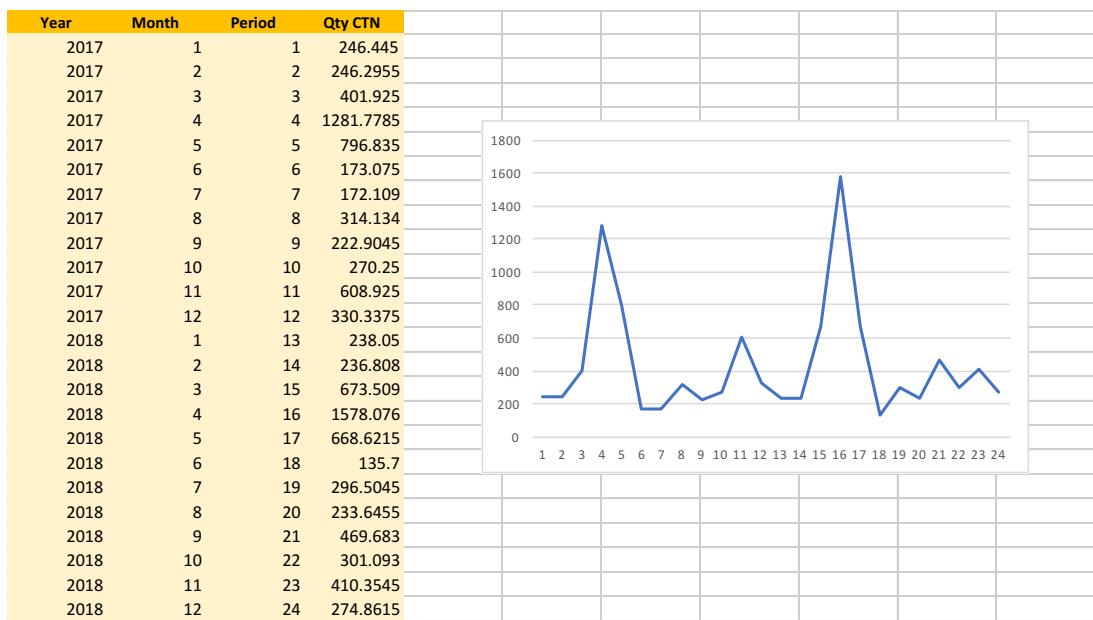
**Figure A-34:** The data of CPB-0024



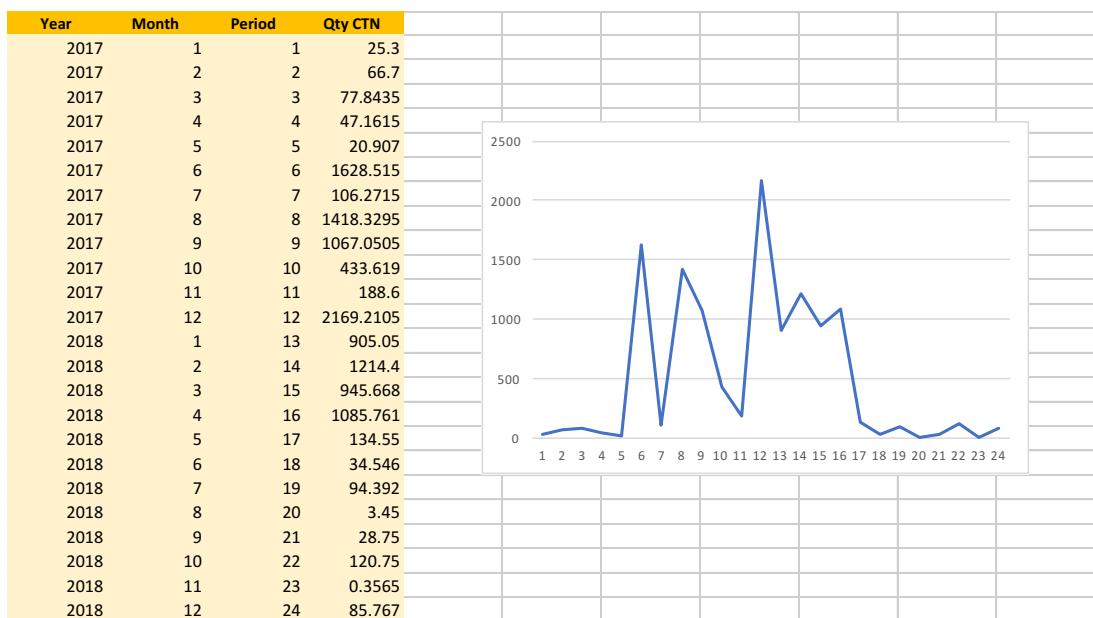
**Figure A-35:** The data of FSP-0005



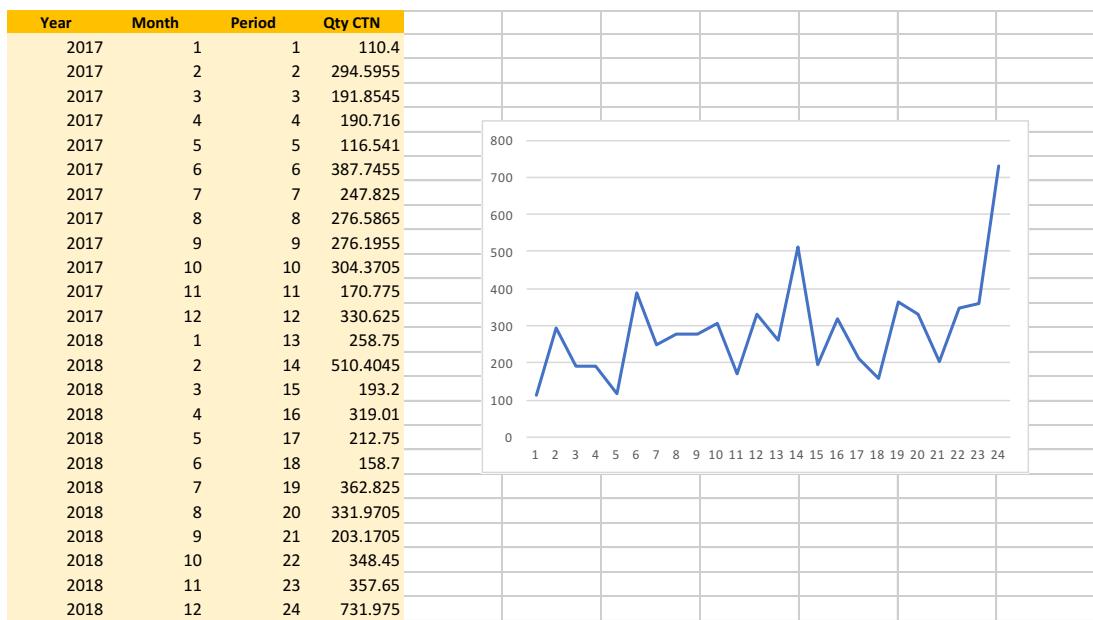
**Figure A-36:** The data of CPB-0017



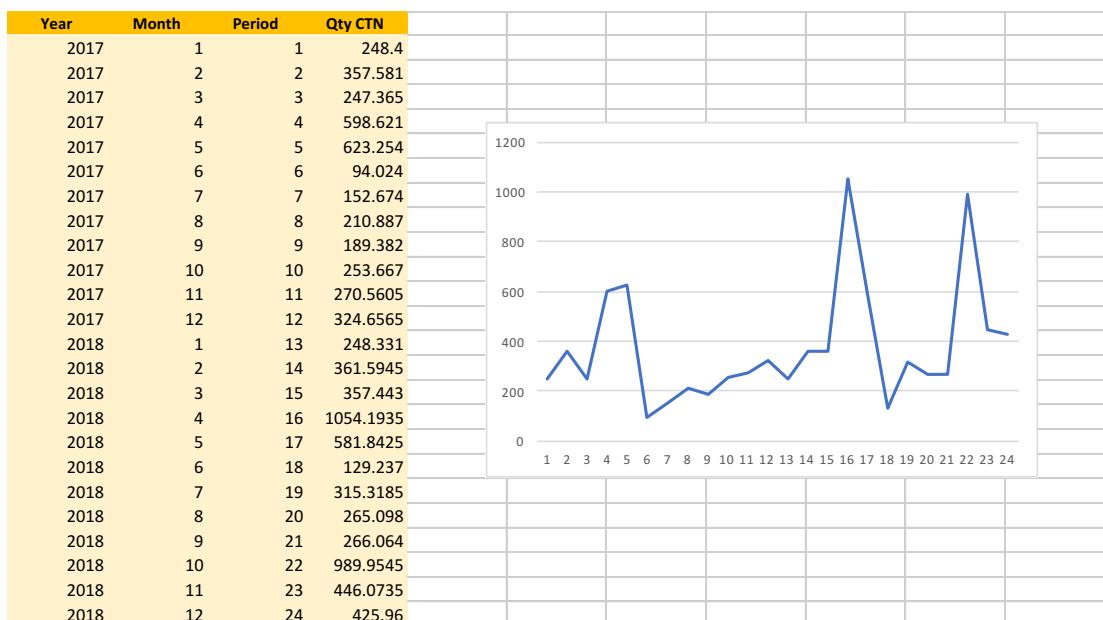
**Figure A-37:** The data of CCB-0005



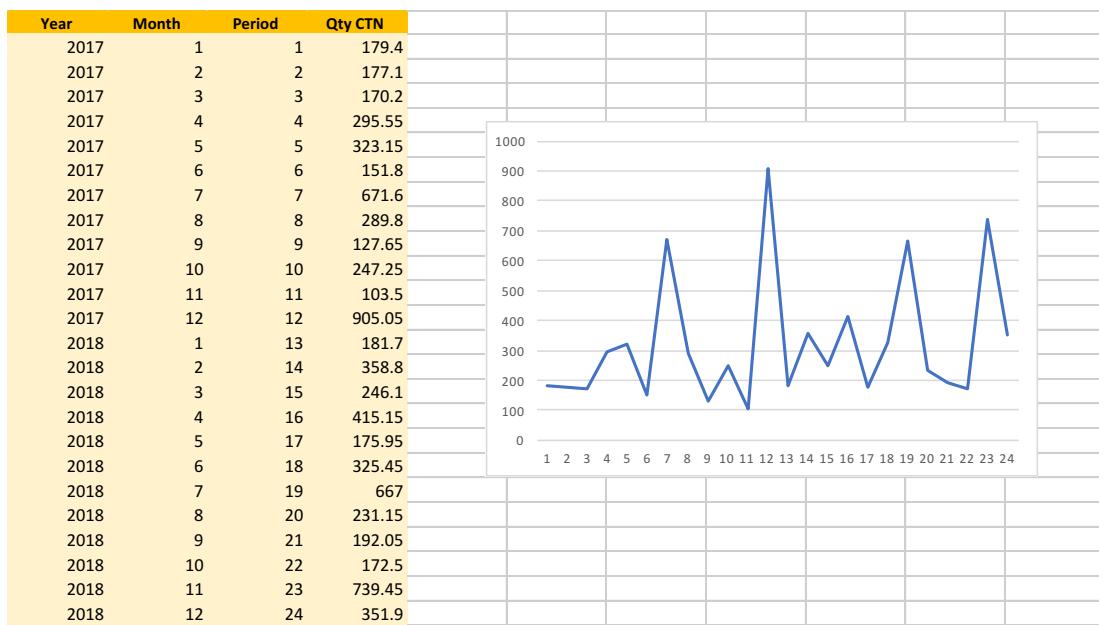
**Figure A-38:** The data of TUN-0016



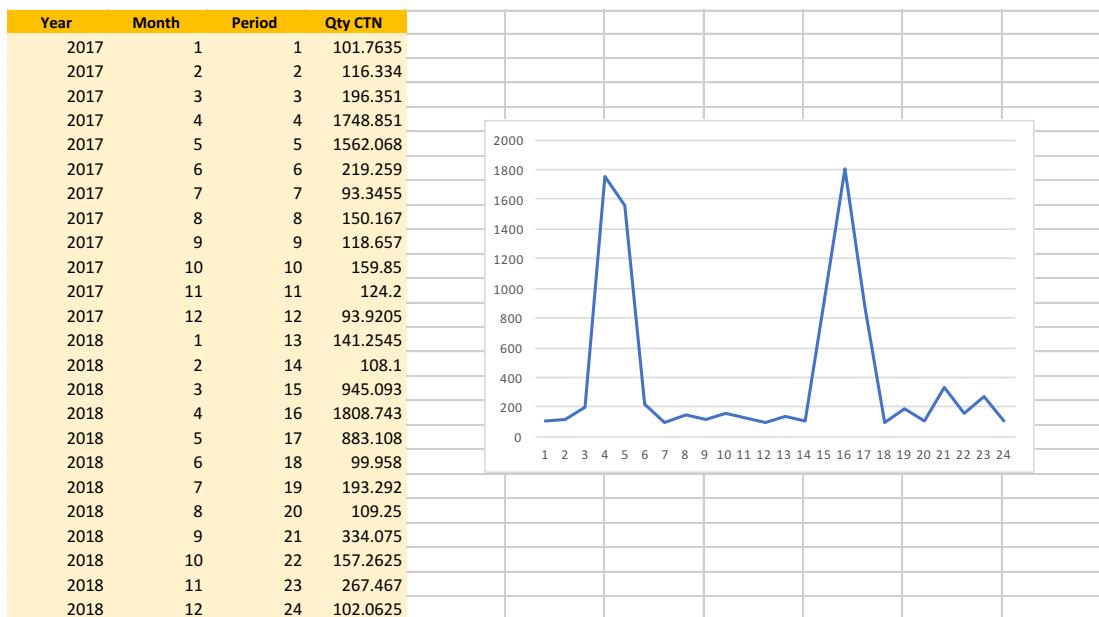
**Figure A-39:** The data of FSG-0001



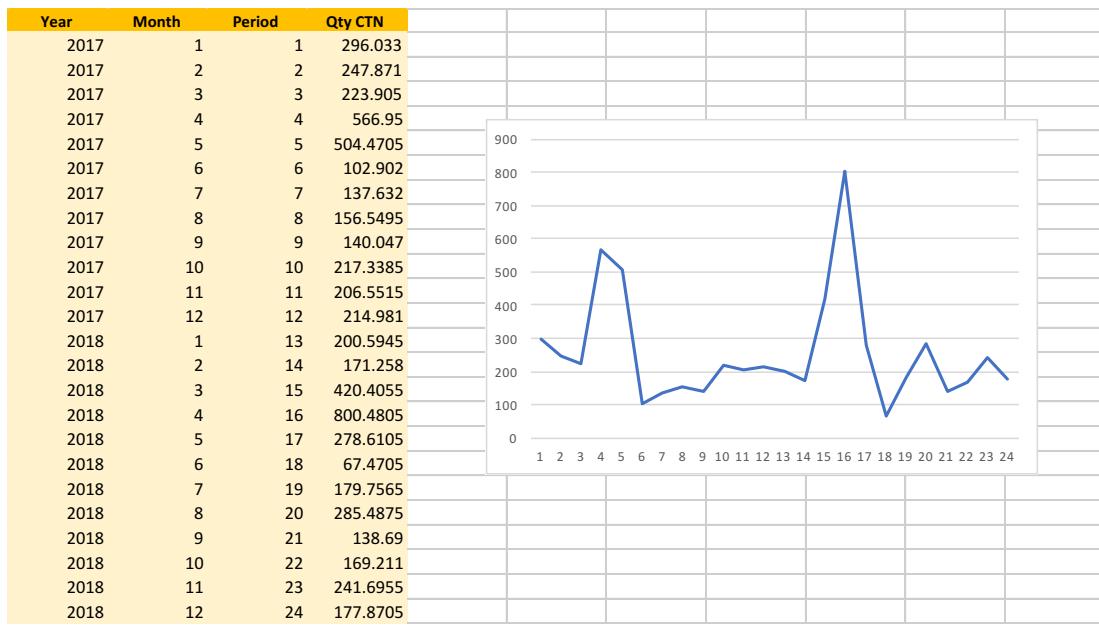
**Figure A-40:** The data of CPB-0021



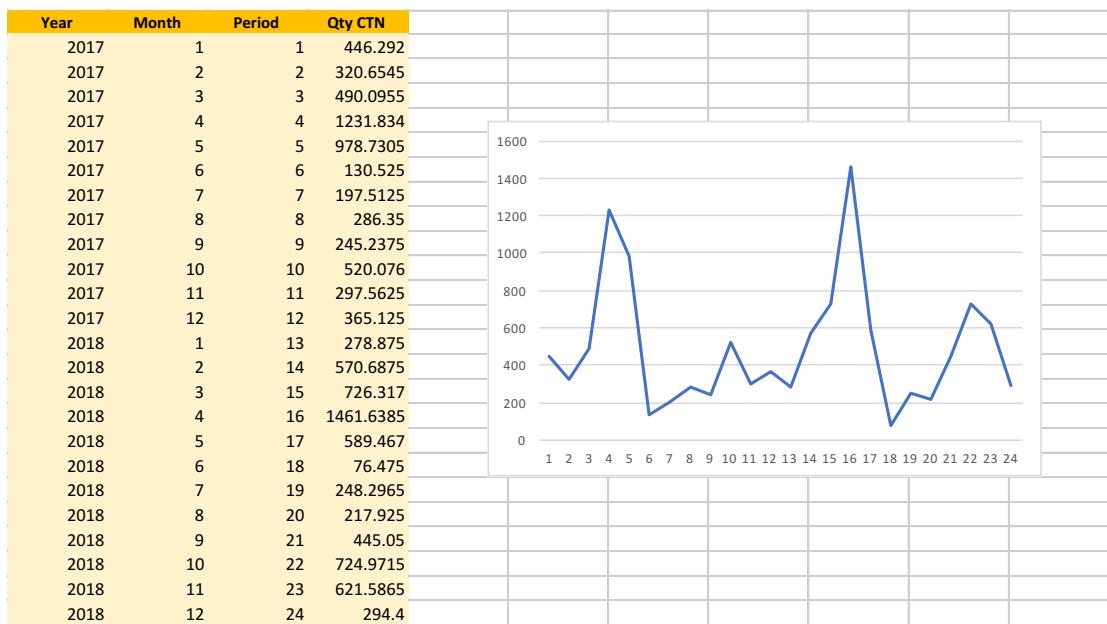
**Figure A-41:** The data of FMB-0050



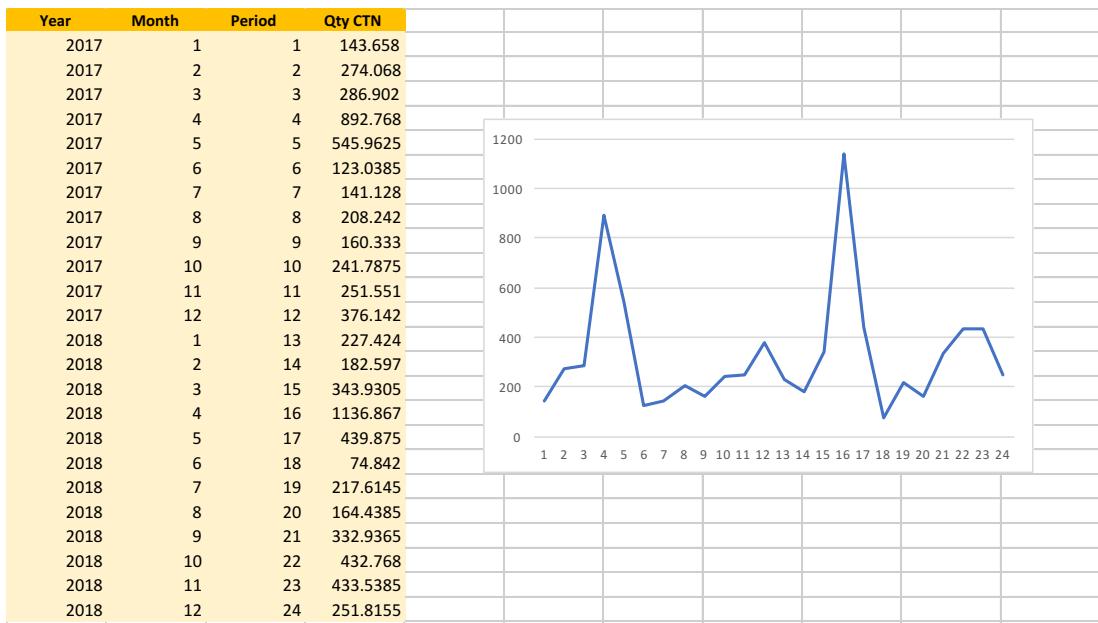
**Figure A-42:** The data of CCB-0014



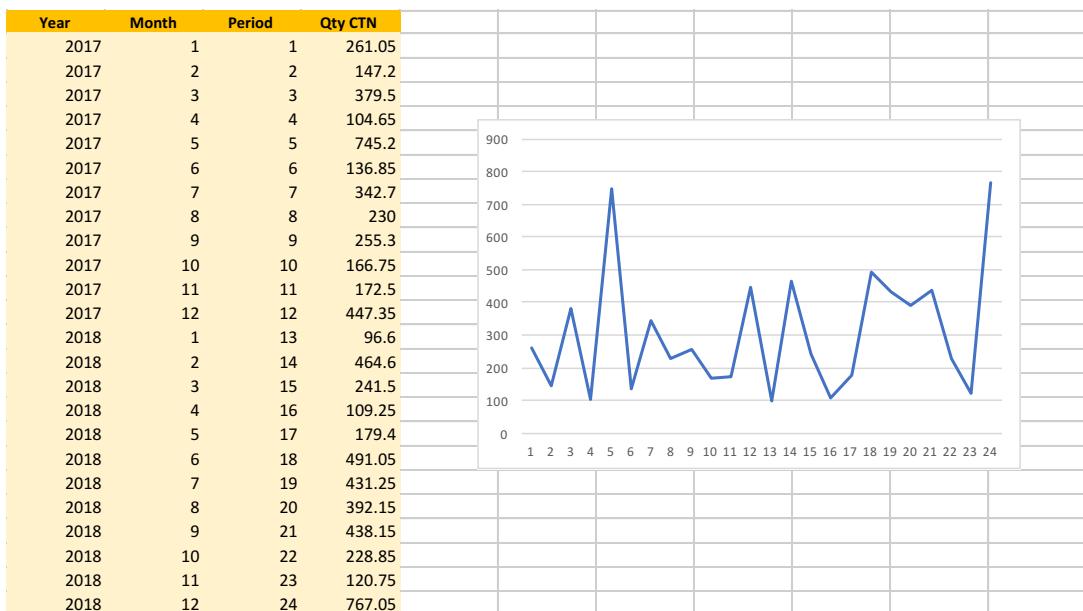
**Figure A-43:** The data of CPB-0027



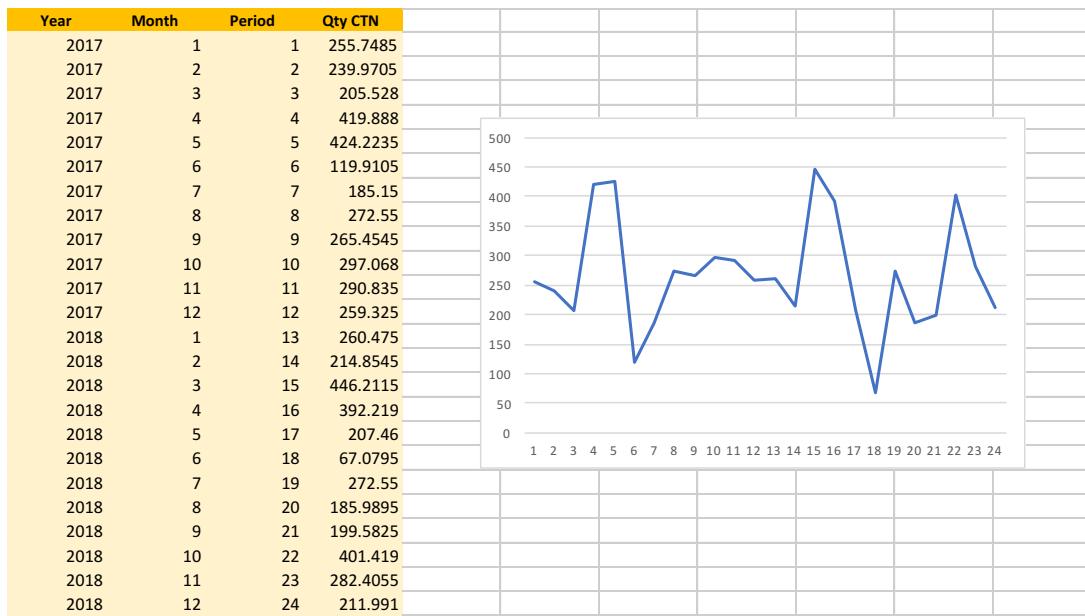
**Figure A-44:** The data of CCB-0022



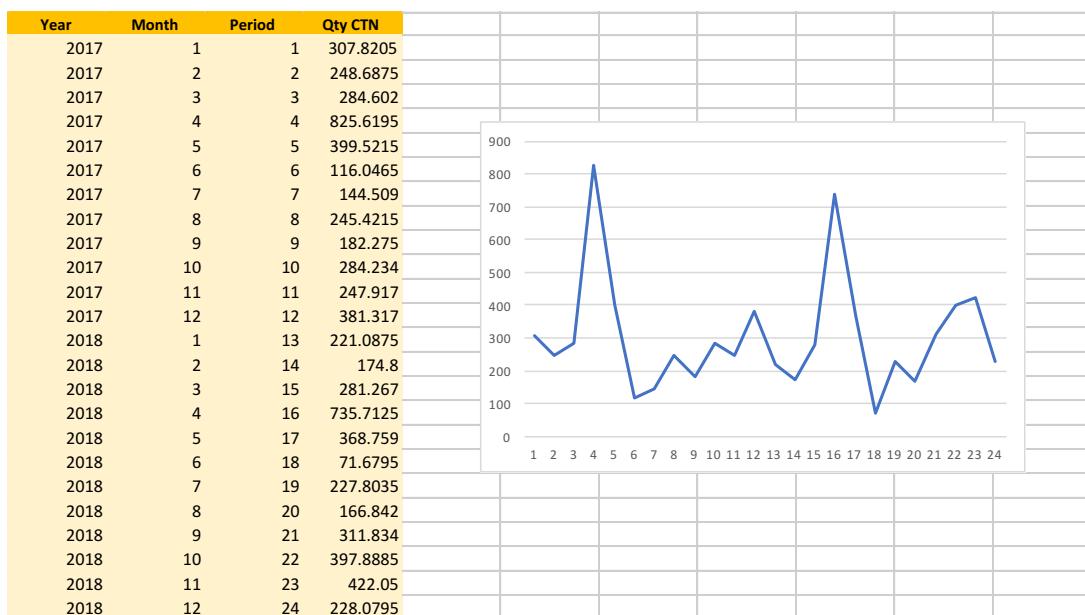
**Figure A-45:** The data of CPB-0018



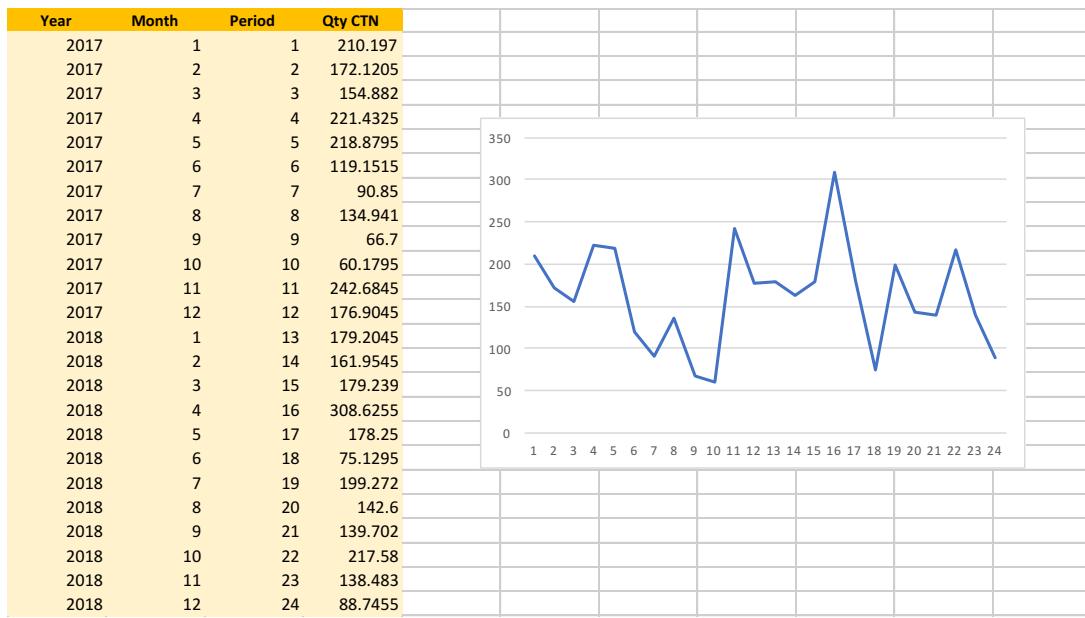
**Figure A-46:** The data of FMB-0003



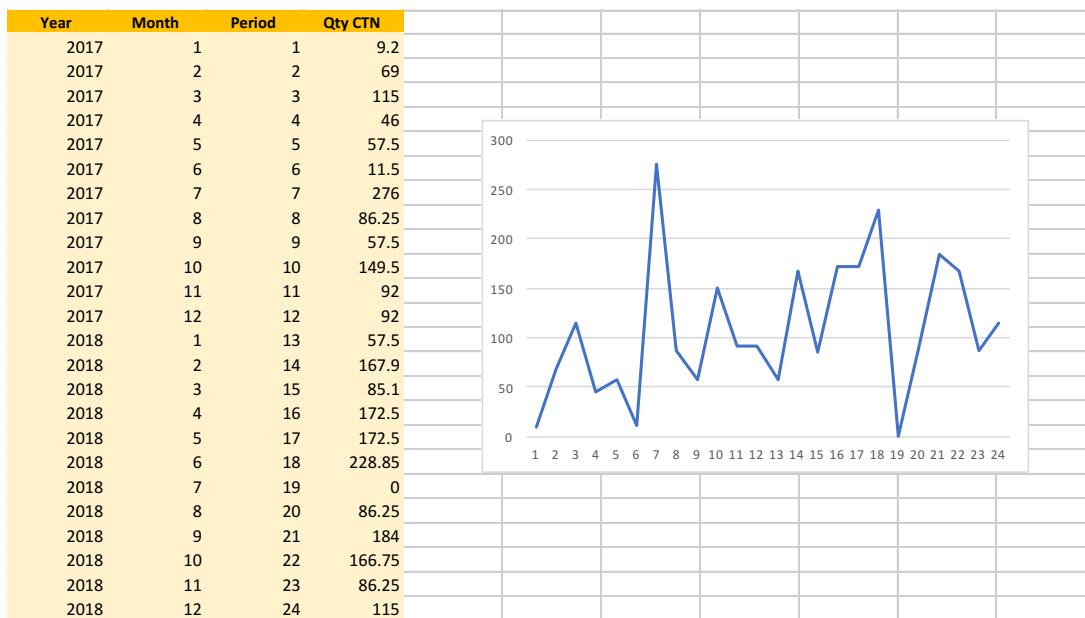
**Figure A-47:** The data of PT6-0008



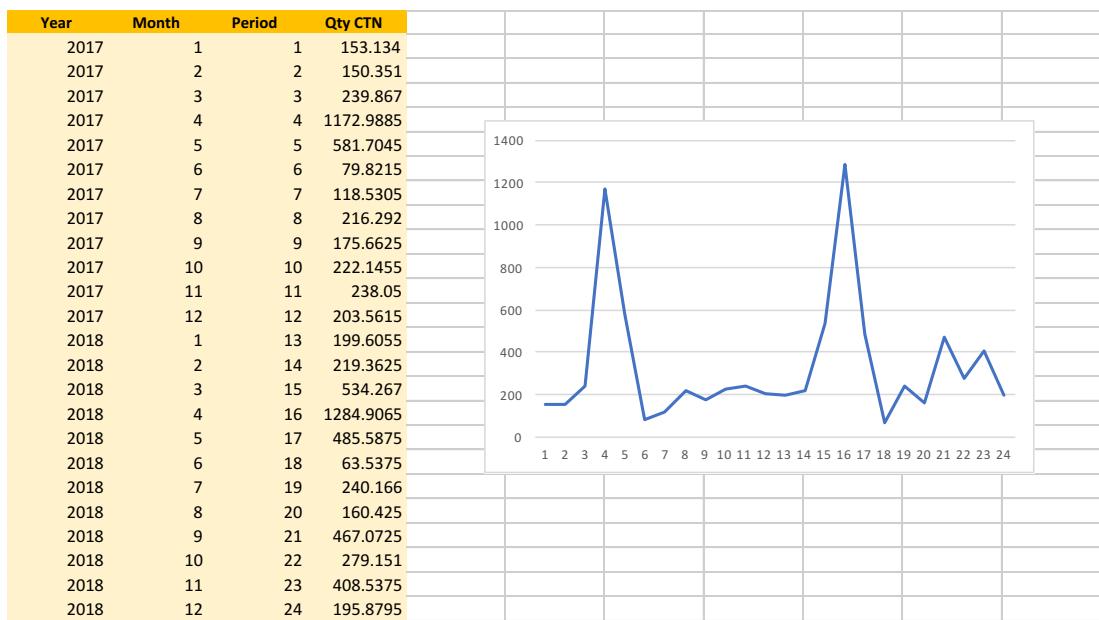
**Figure A-48:** The data of CPB-0003



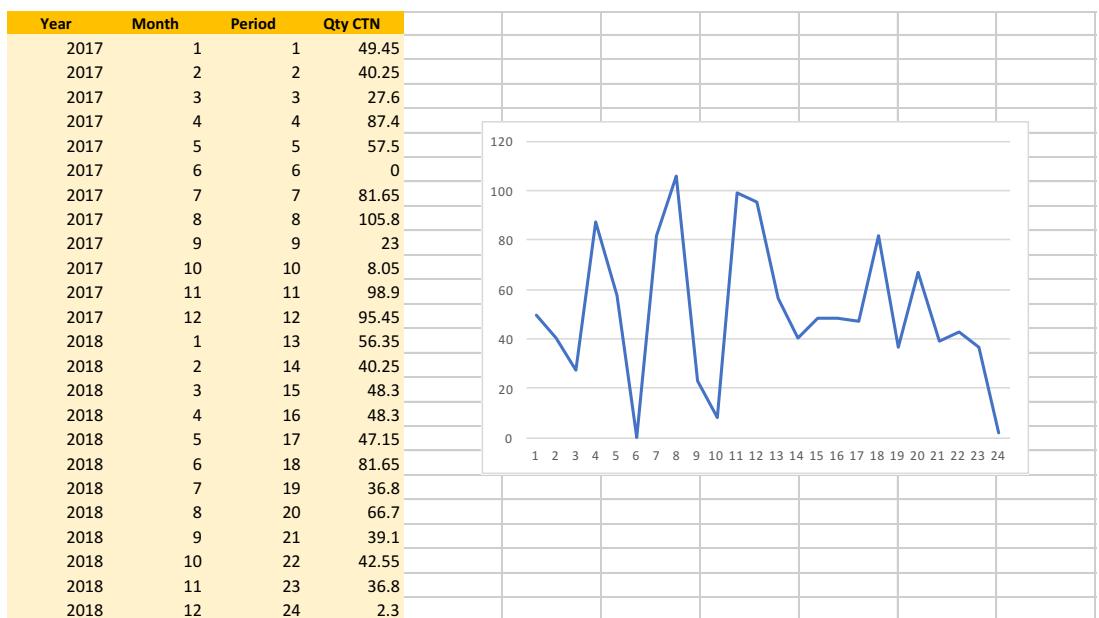
**Figure A-49:** The data of PT6-1002



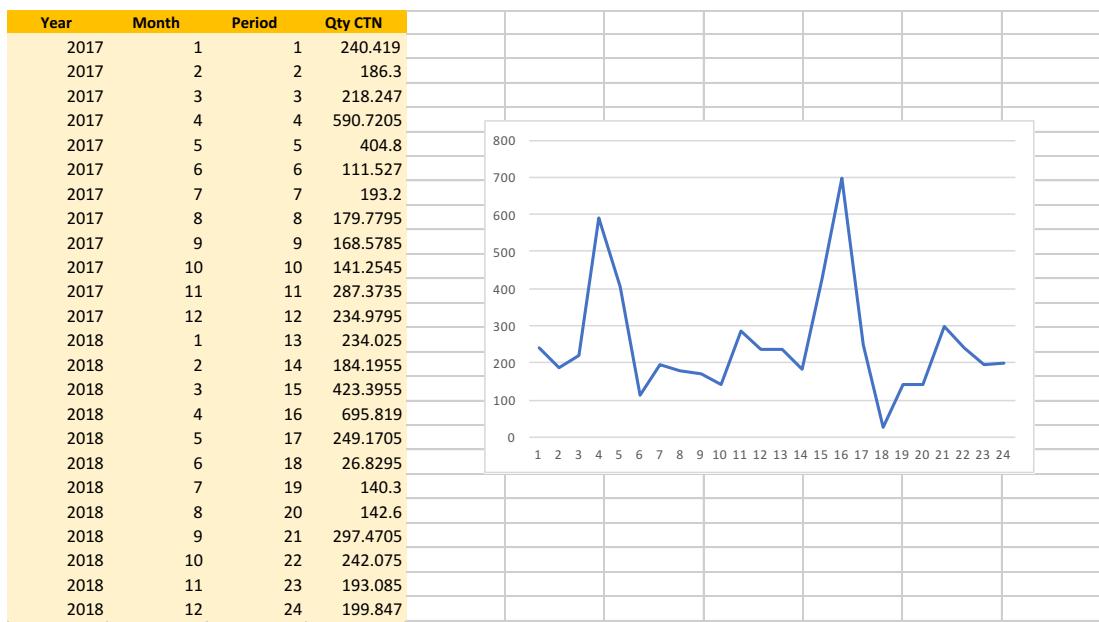
**Figure A-50:** The data of FSP-0007



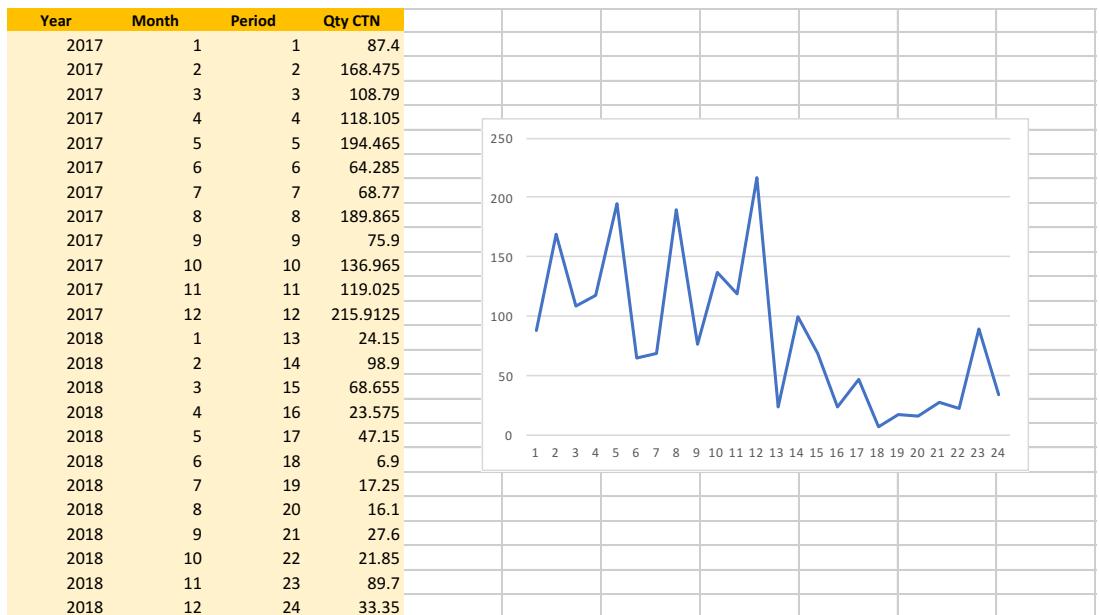
**Figure A-51:** The data of CCB-0008



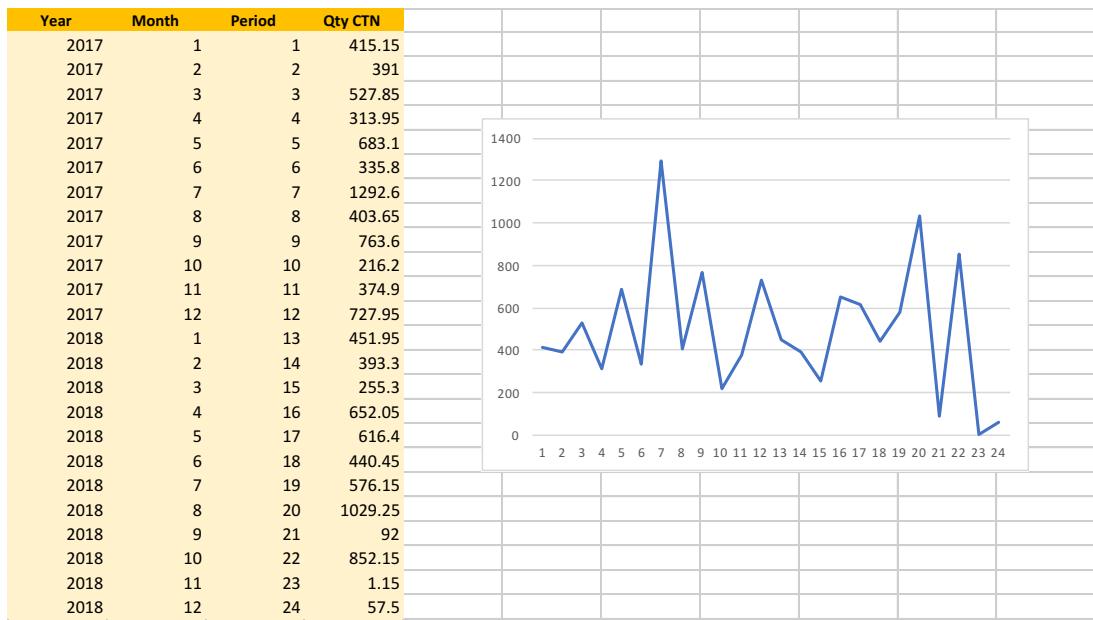
**Figure A-52:** The data of FLO-0011



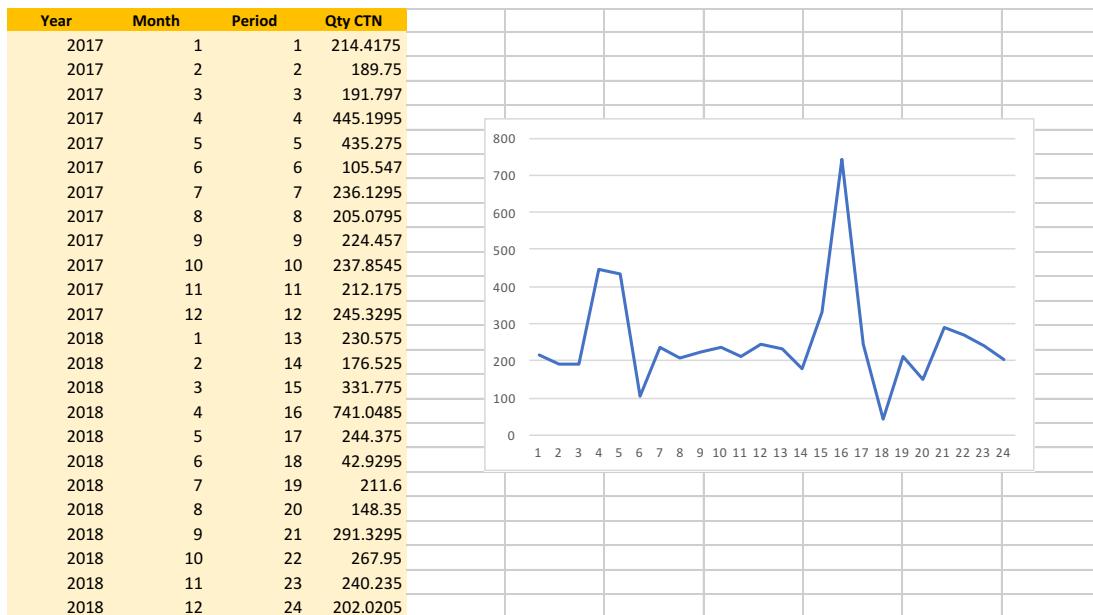
**Figure A-53:** The data of PT6-0001



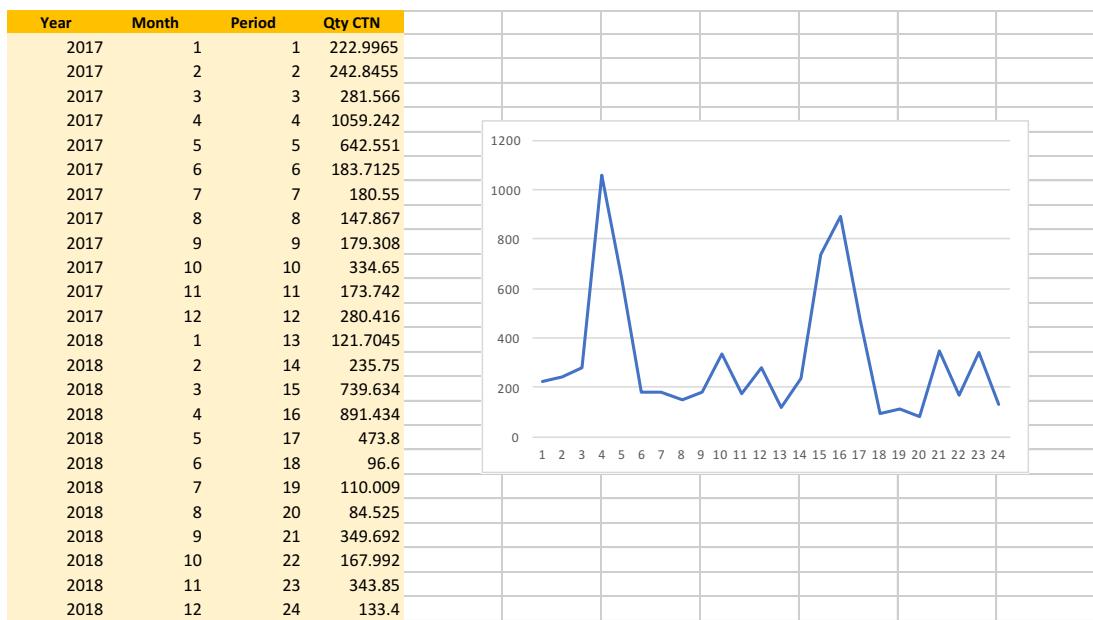
**Figure A-54:** The data of FMB-0060



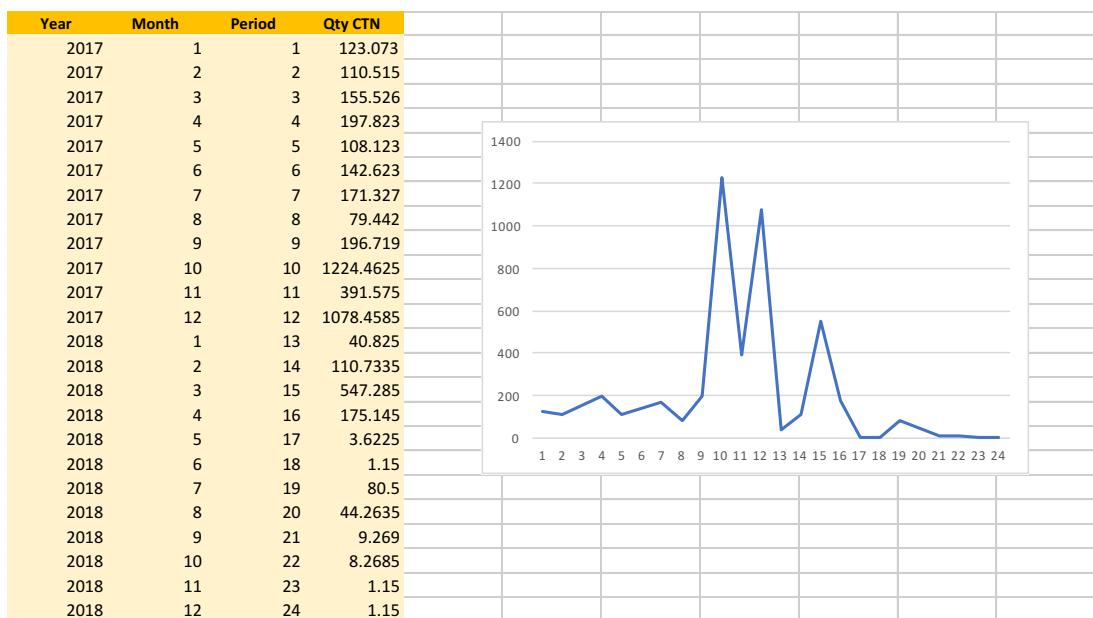
**Figure A-55:** The data of FSP-0006



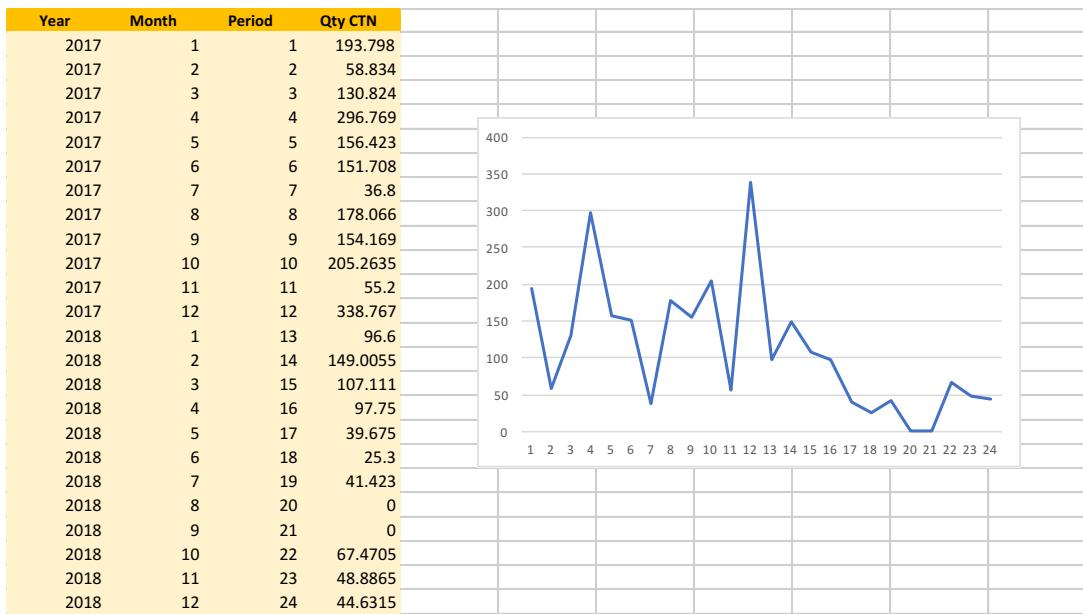
**Figure A-56:** The data of PT6-0009



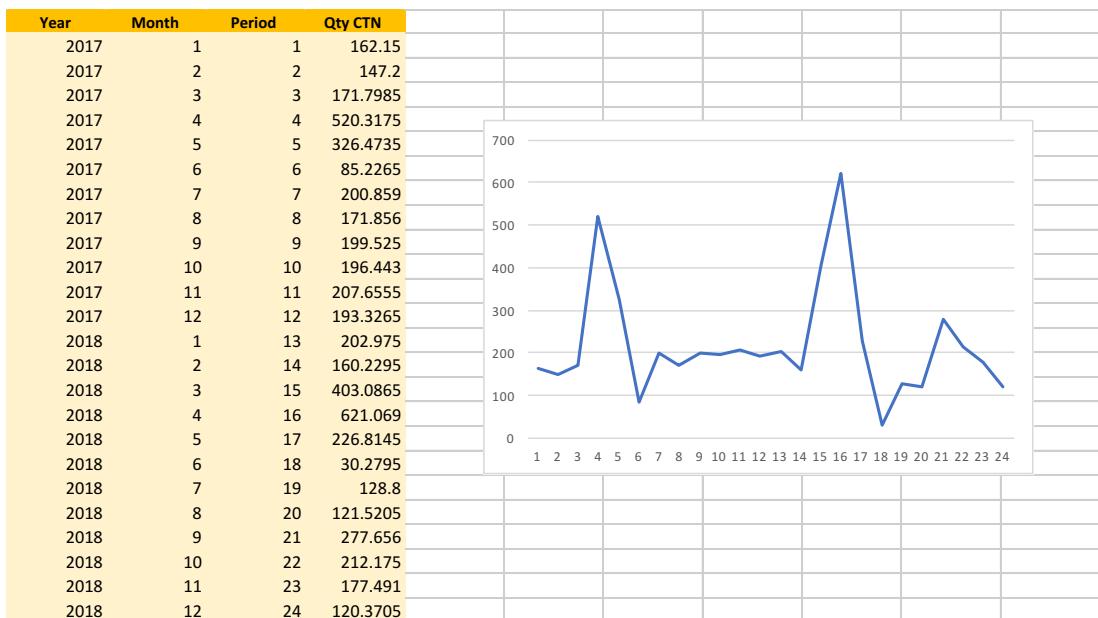
**Figure A-57:** The data of CCB-0011



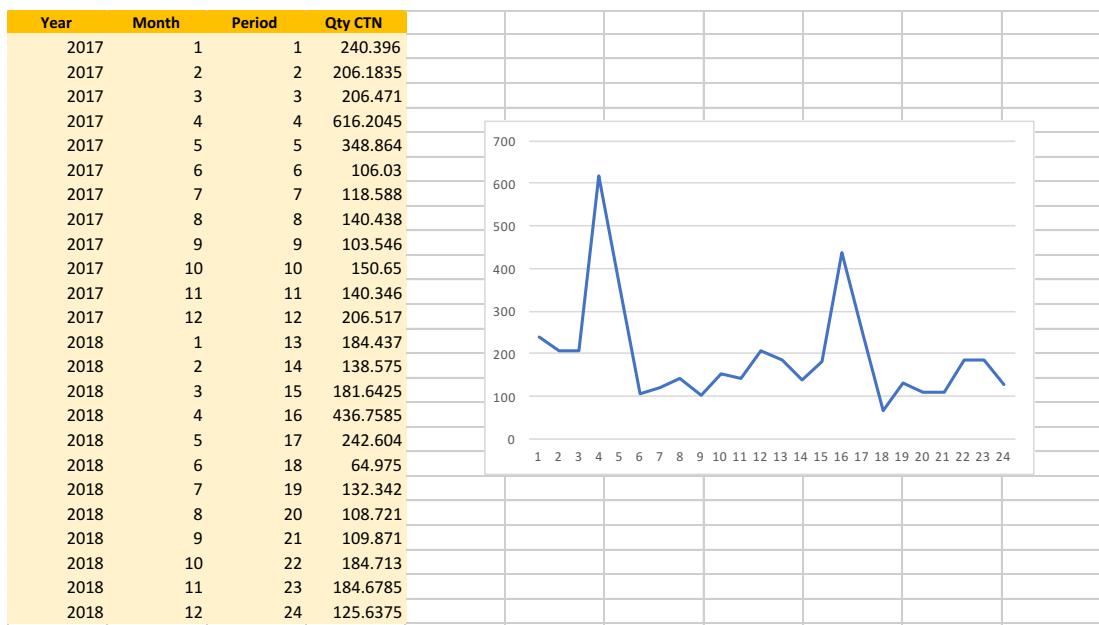
**Figure A-58:** The data of TUN-0013



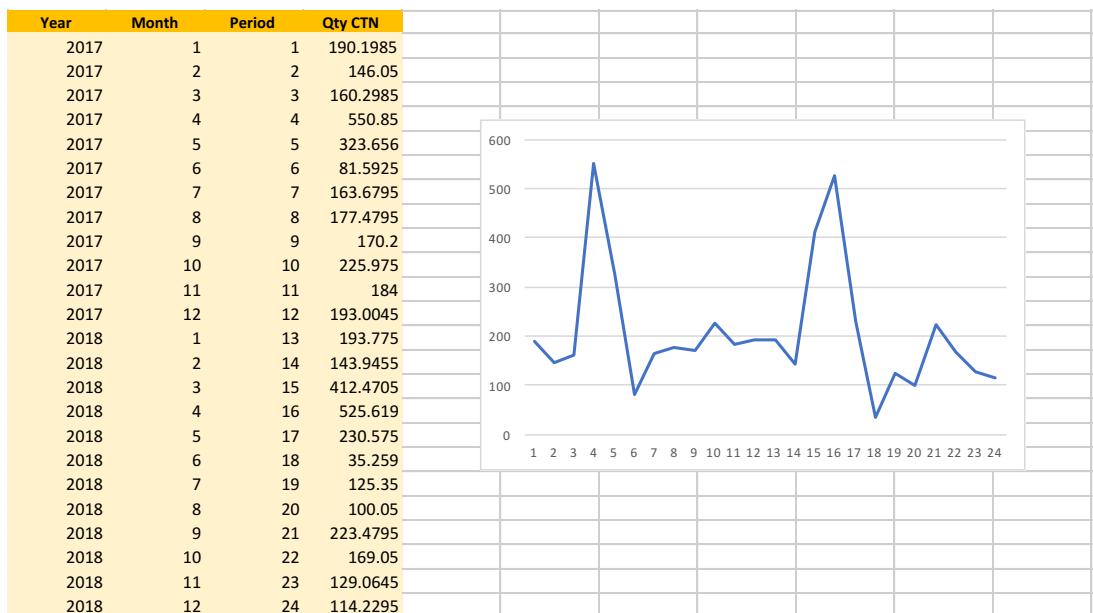
**Figure A-59:** The data of TUN-0012



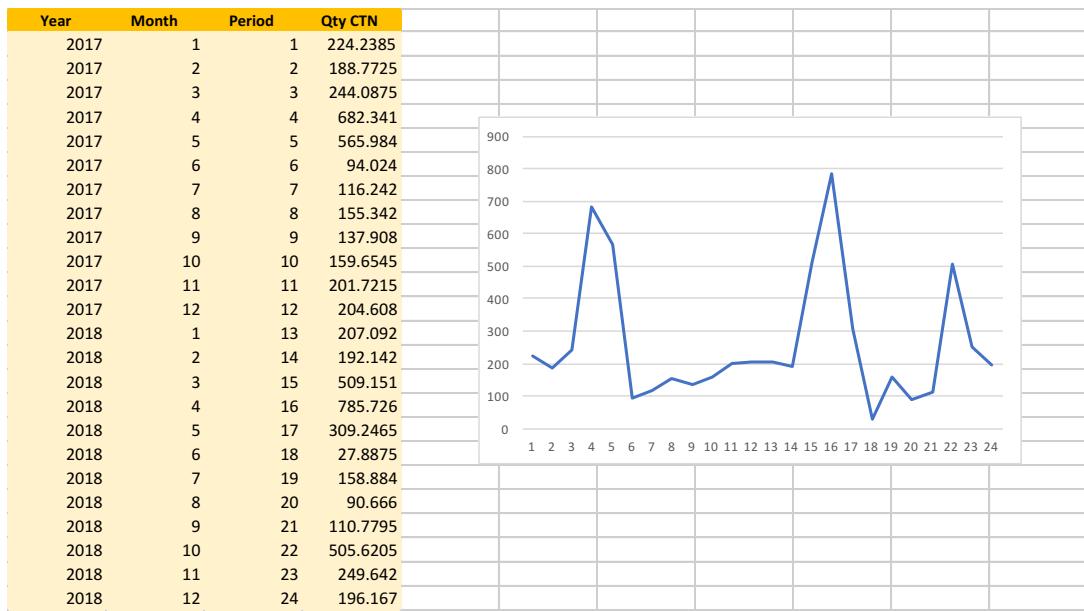
**Figure A-60:** The data of PT6-0007



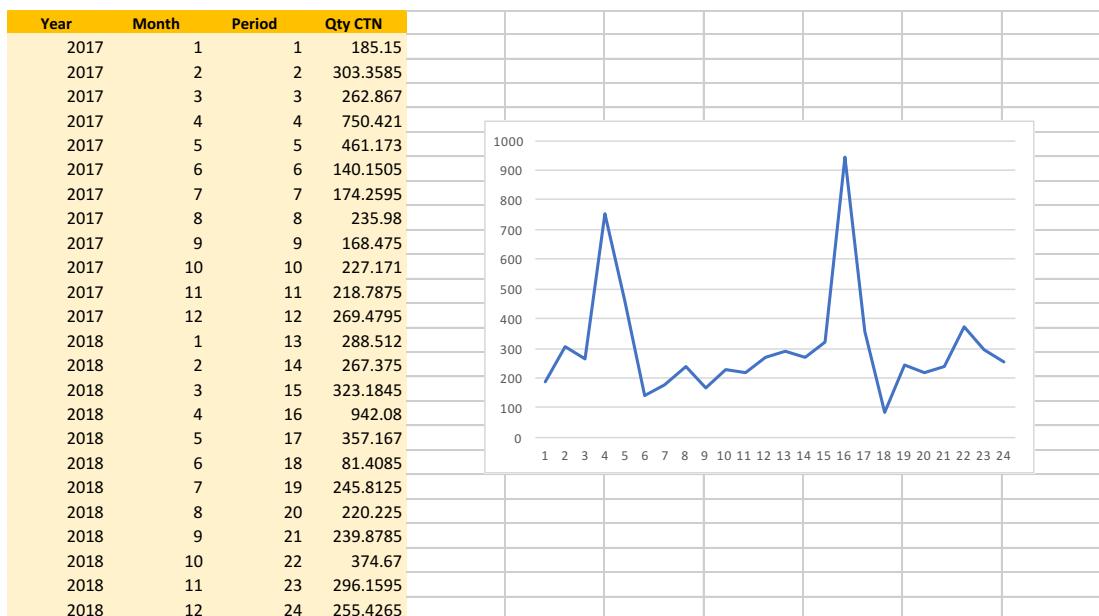
**Figure A-61:** The data of CPB-0011



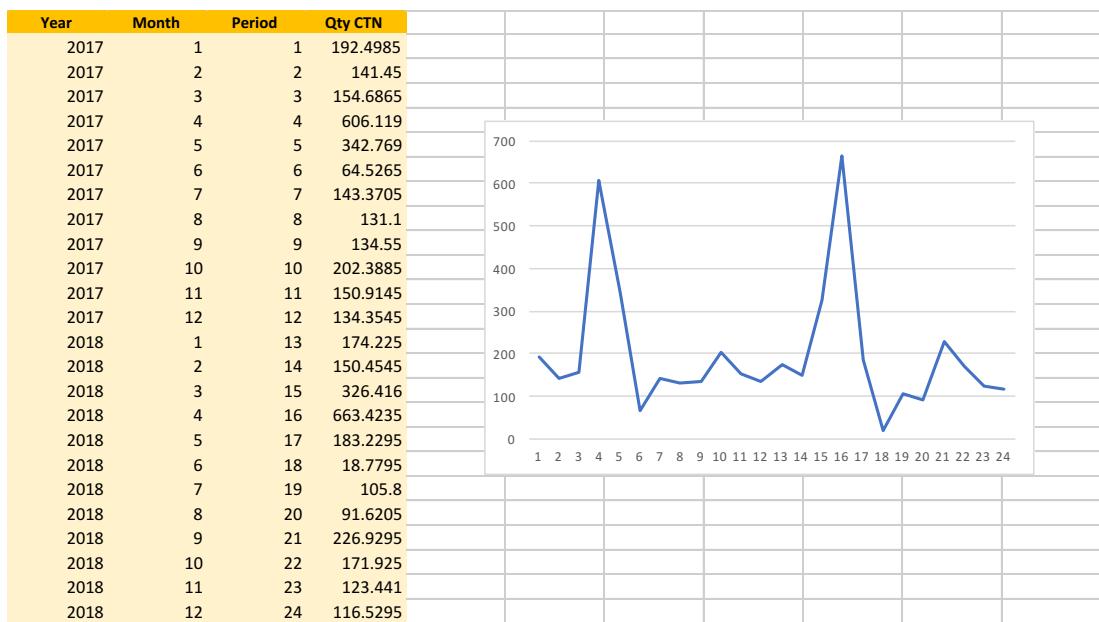
**Figure A-62:** The data of PT6-0005



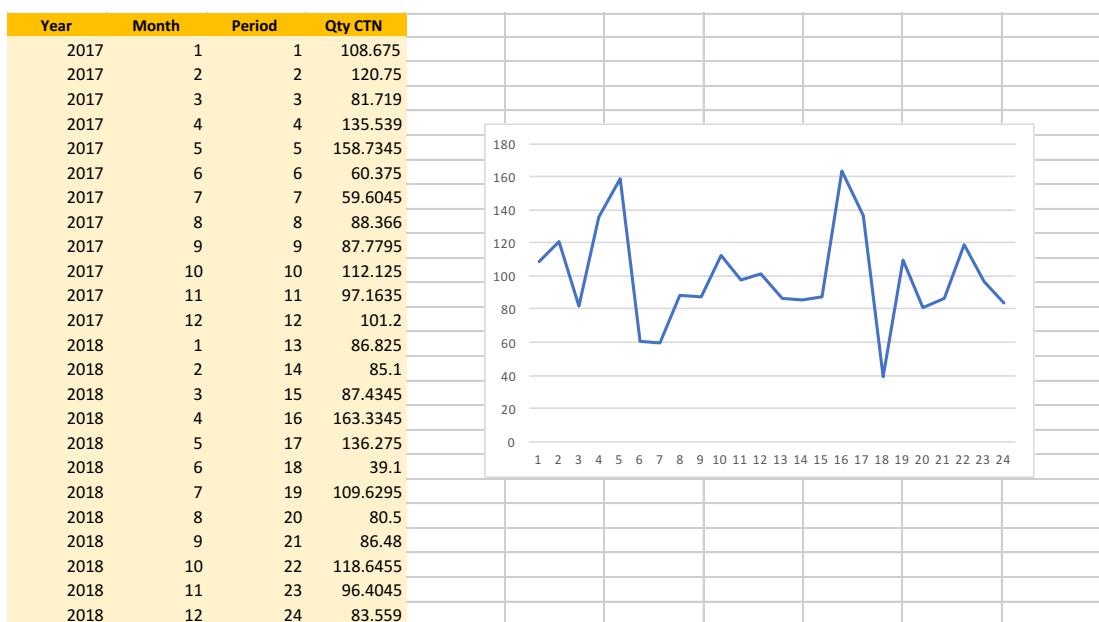
**Figure A-63:** The data of CCB-0001



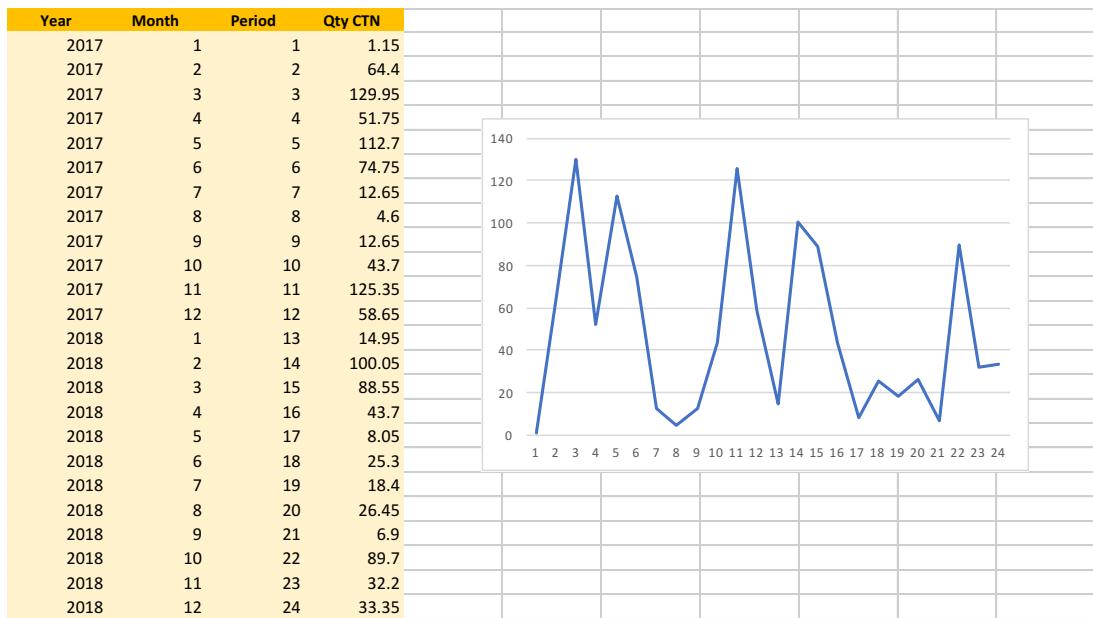
**Figure A-64:** The data of CPB-0005



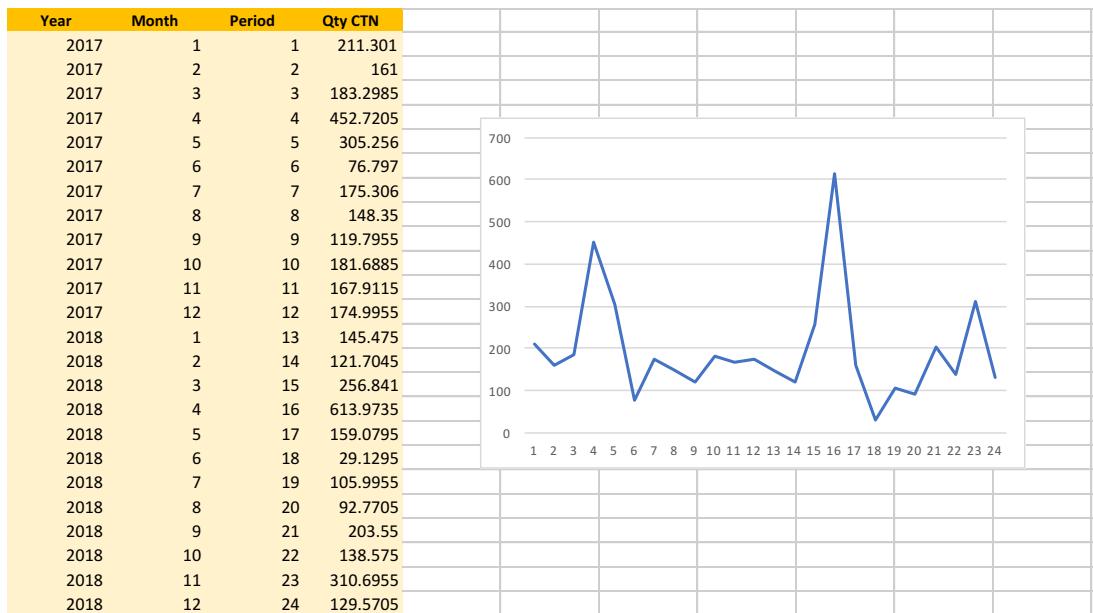
**Figure A-65:** The data of PT6-0011



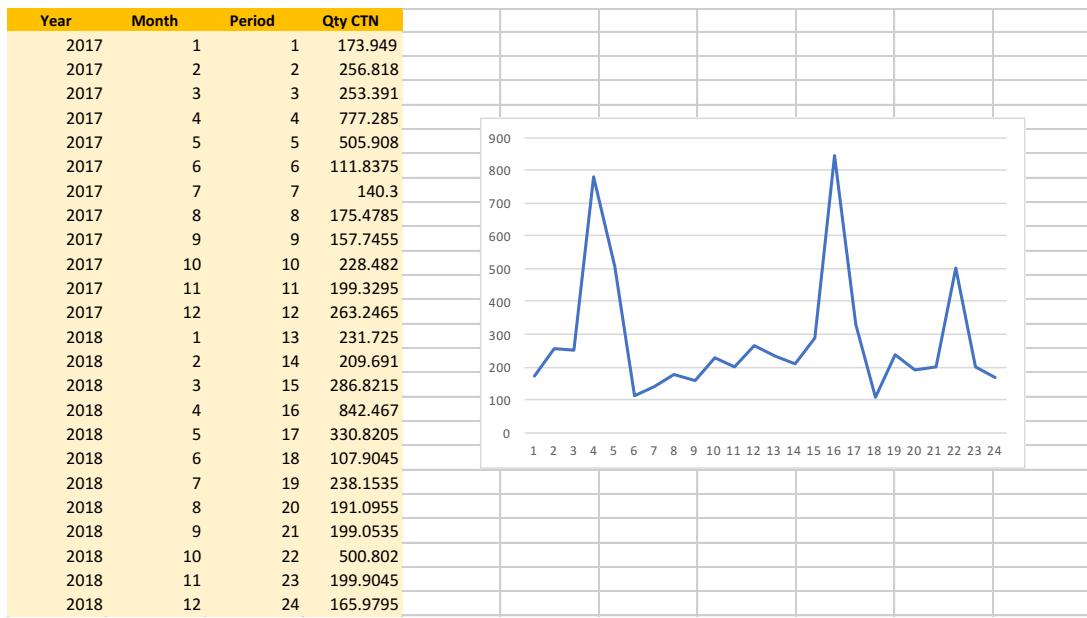
**Figure A-66:** The data of PT6-1003



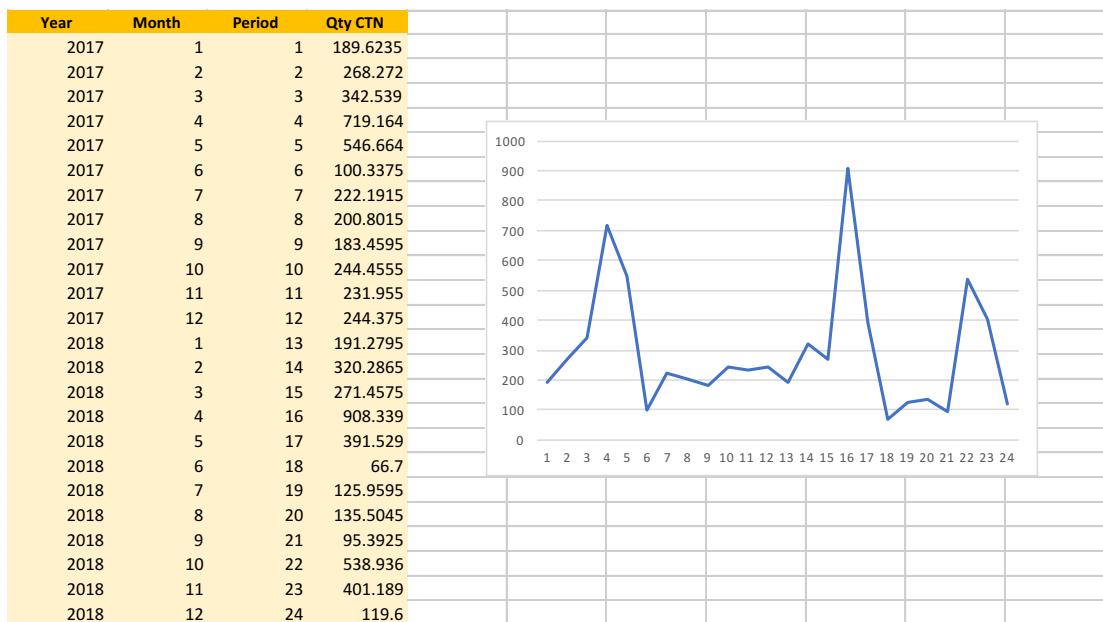
**Figure A-67:** The data of FLV-131-262



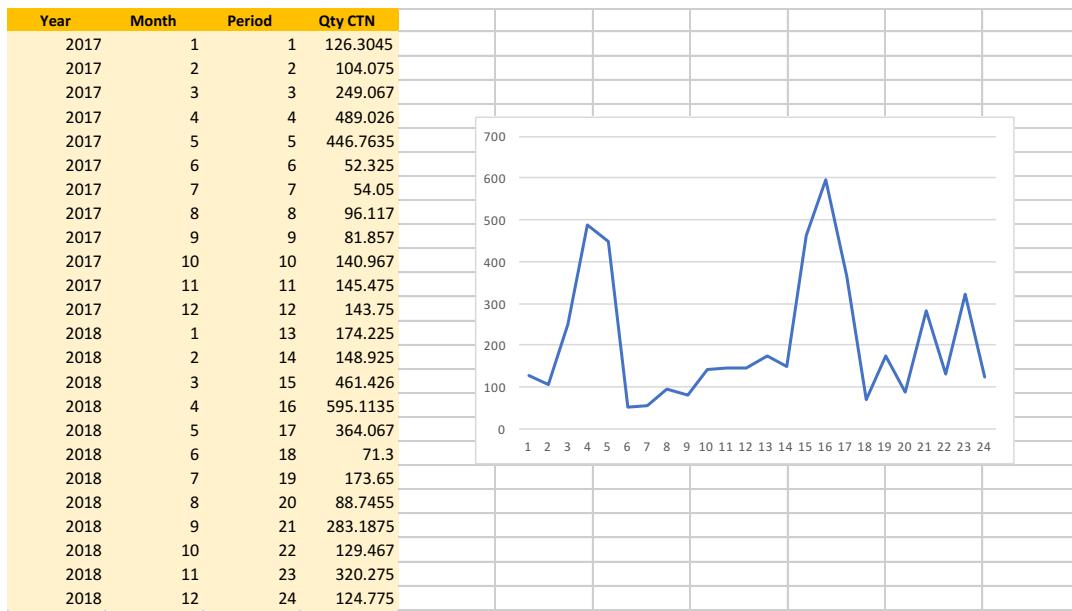
**Figure A-68:** The data of PT6-0013



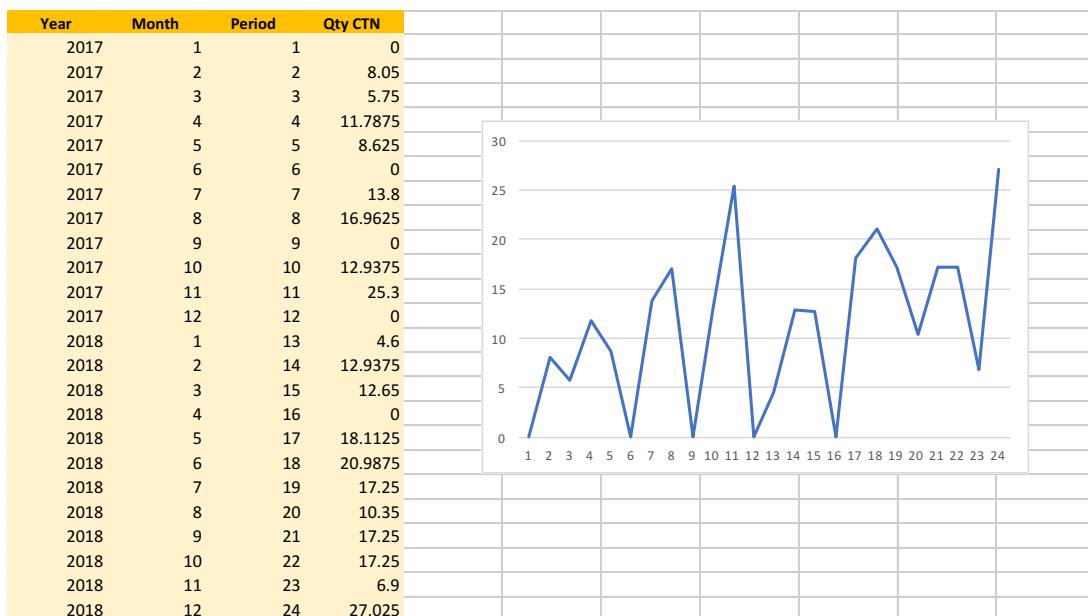
**Figure A-69:** The data of CPB-0006



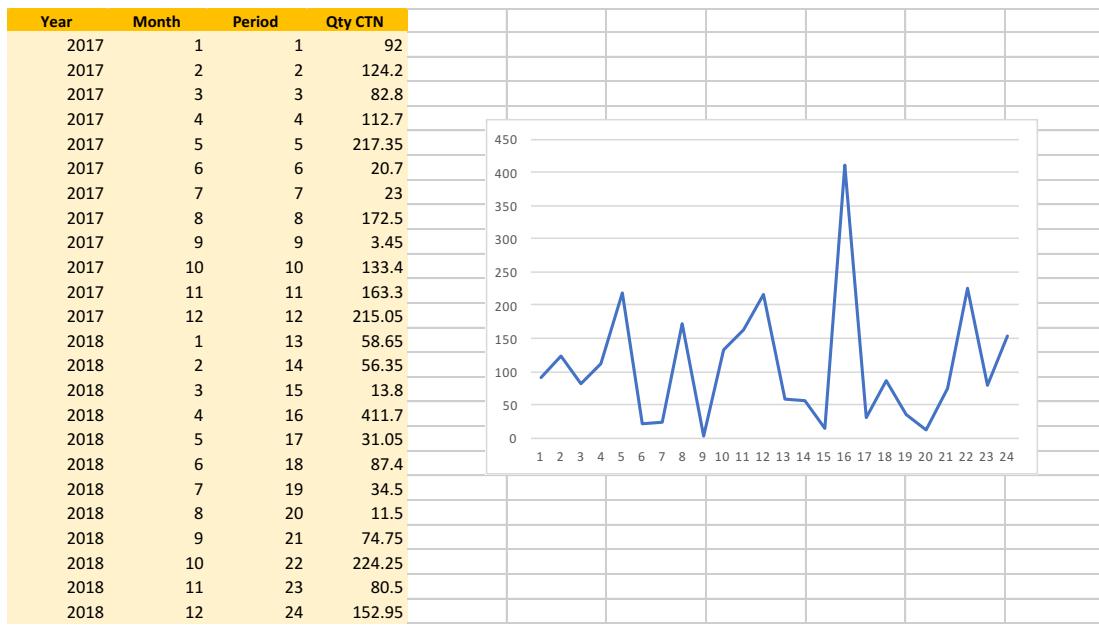
**Figure A-70:** The data of FMB-0059



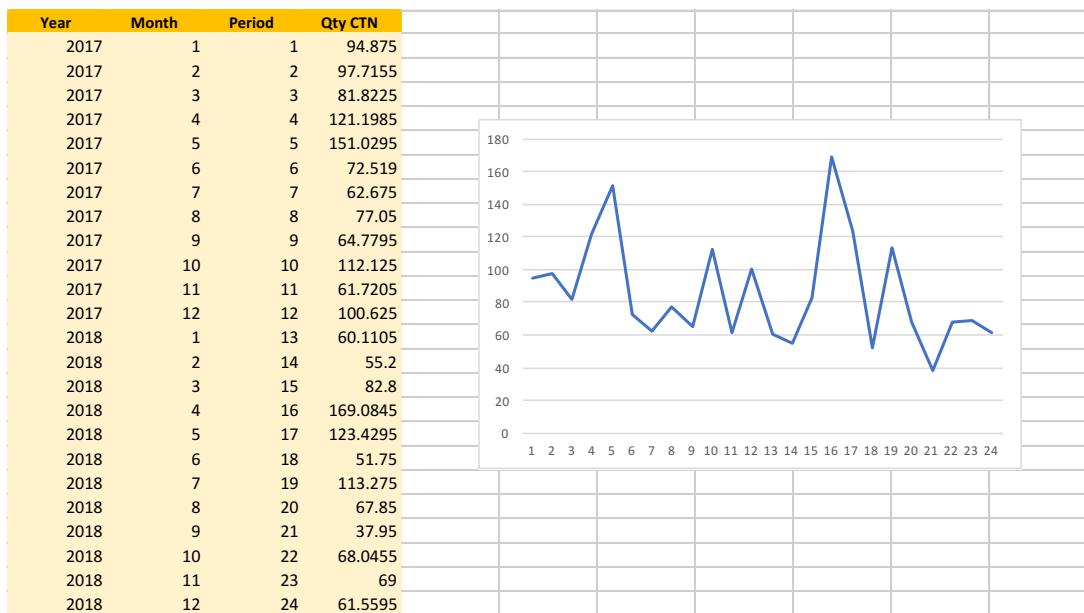
**Figure A-71:** The data of CCB-0020



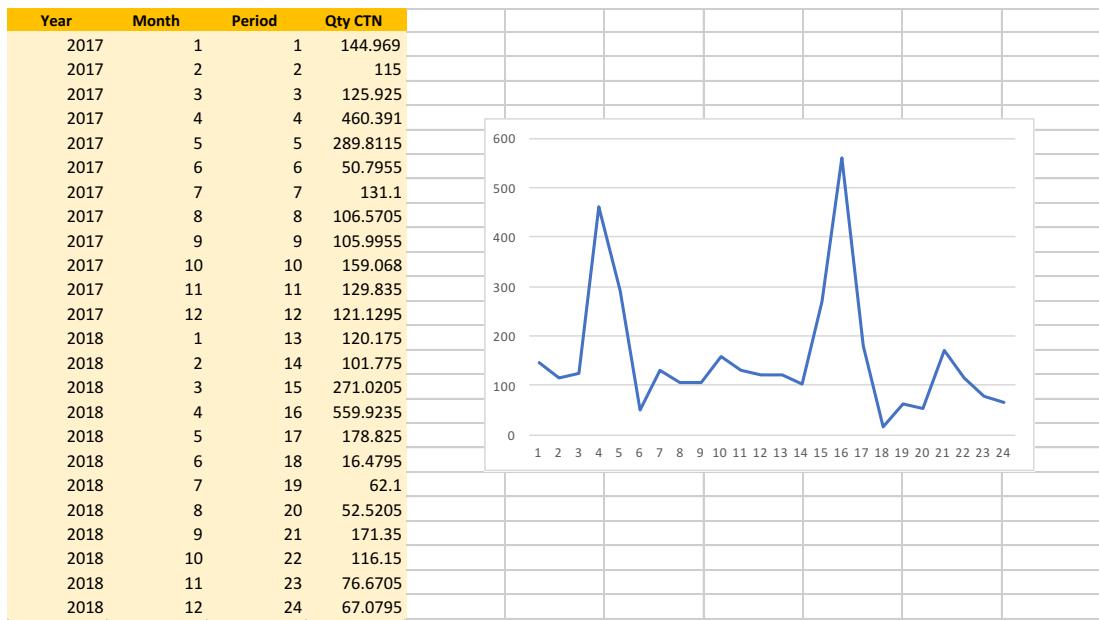
**Figure A-72:** The data of FLO-0029



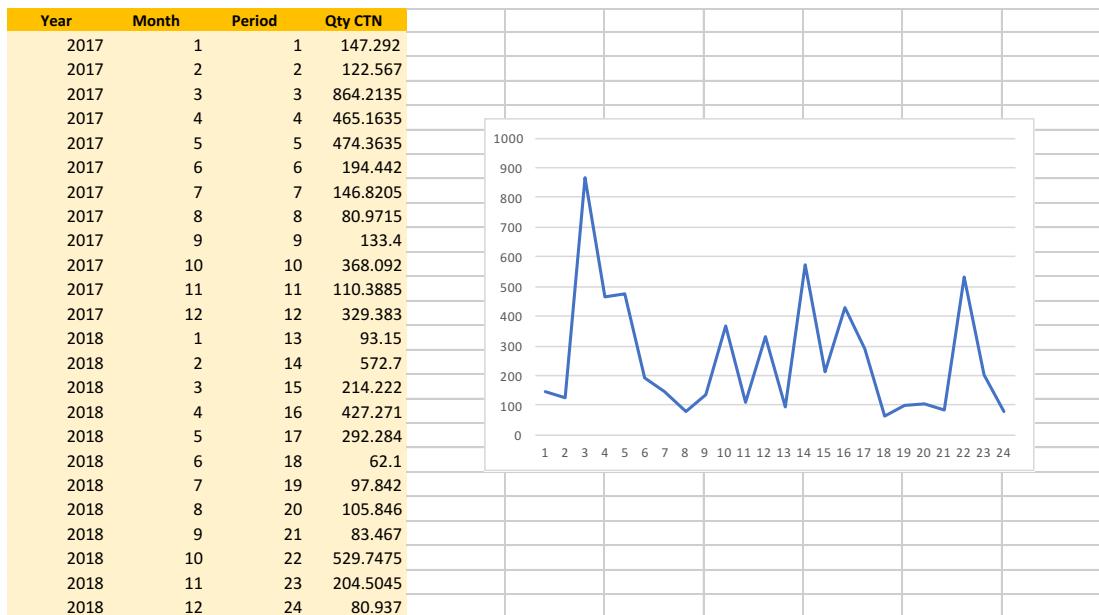
**Figure A-73:** The data of CAT-0102



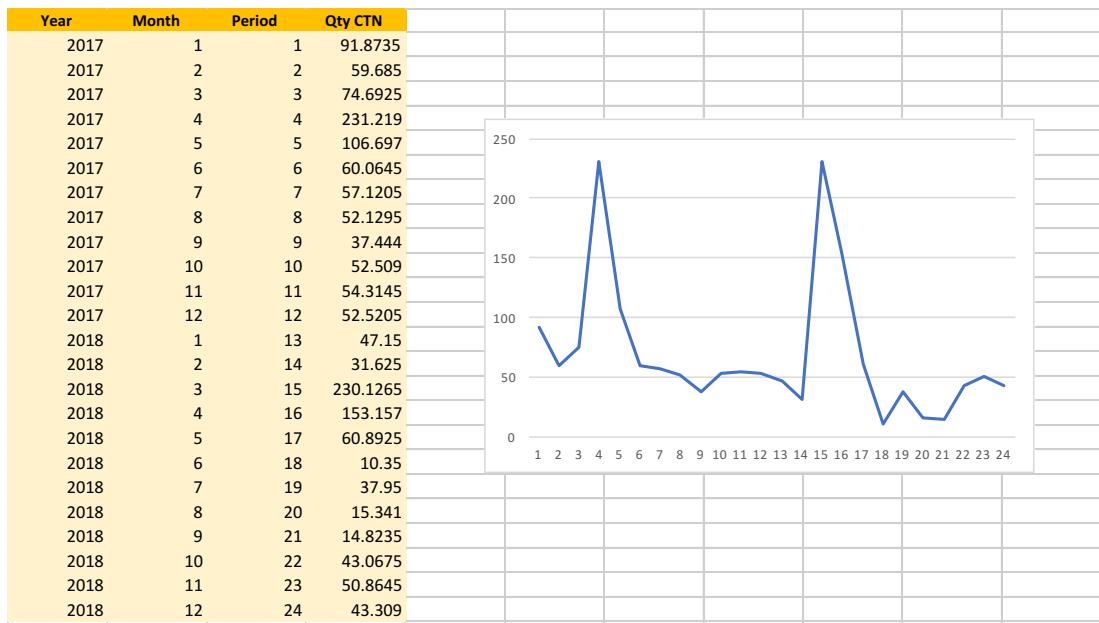
**Figure 74:** The data of PT6-1004



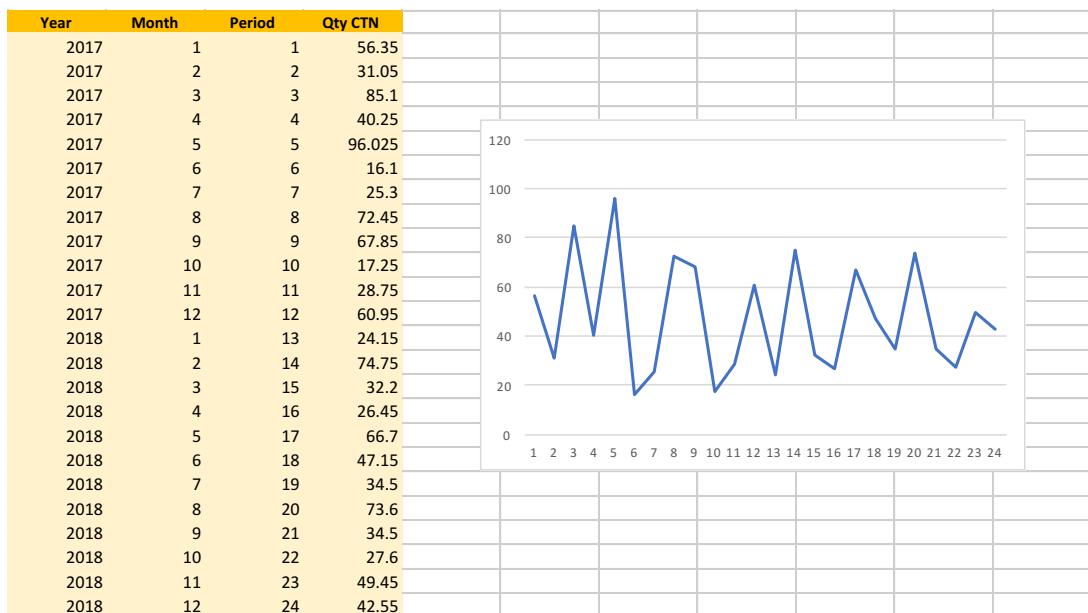
**Figure A-75:** The data of PT6-0012



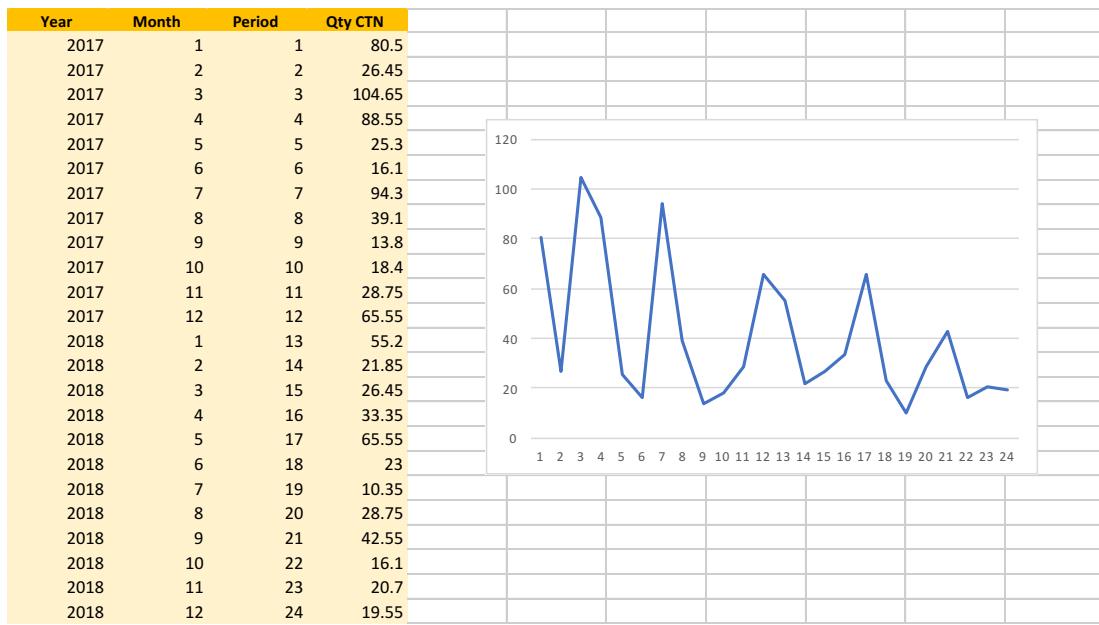
**Figure A-76:** The data of FSS-0017



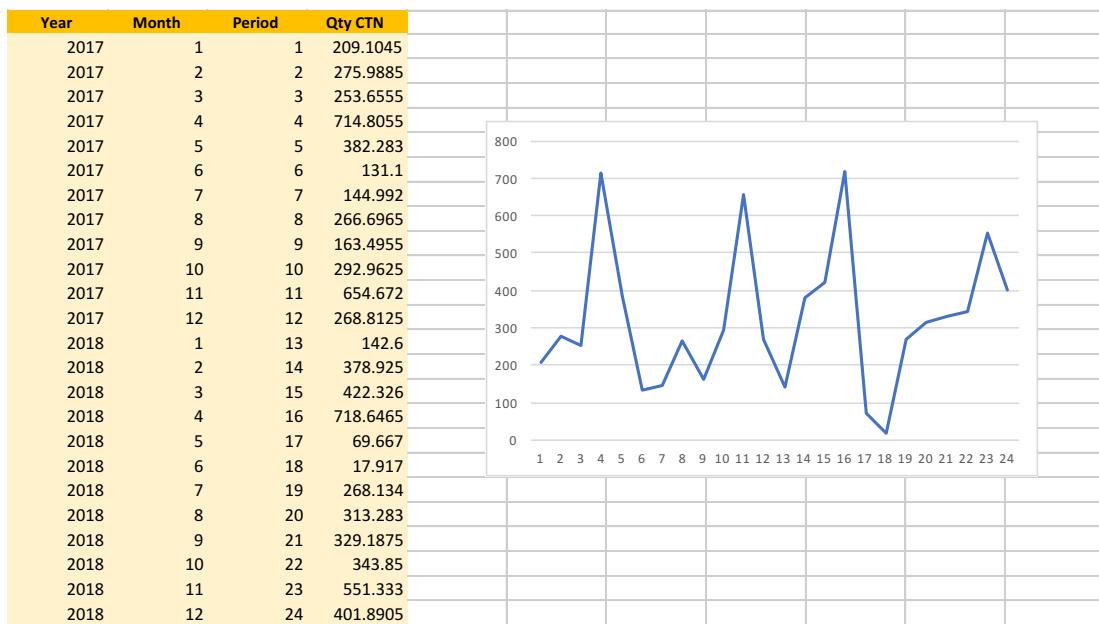
**Figure A-77:** The data of PT6-0003



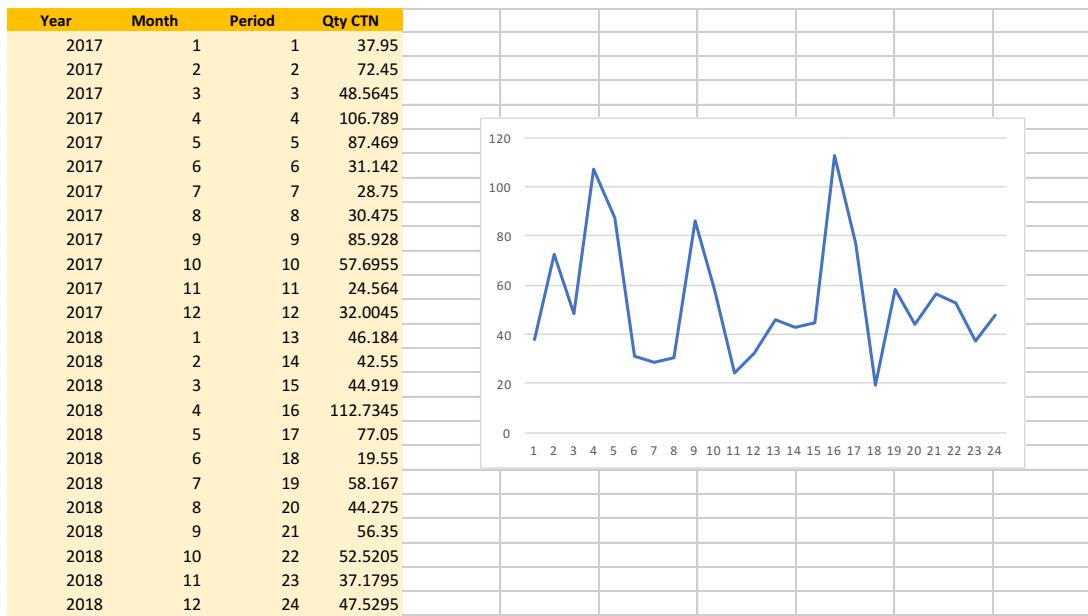
**Figure A-78:** The data of FMB-0001



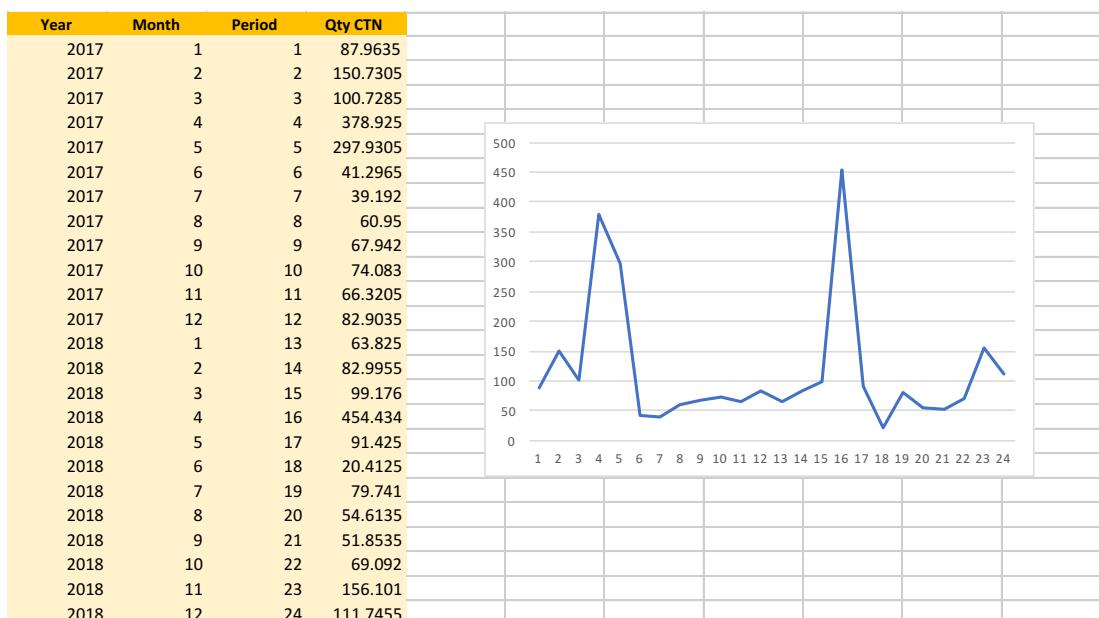
**Figure A-79:** The data of CAT-0019



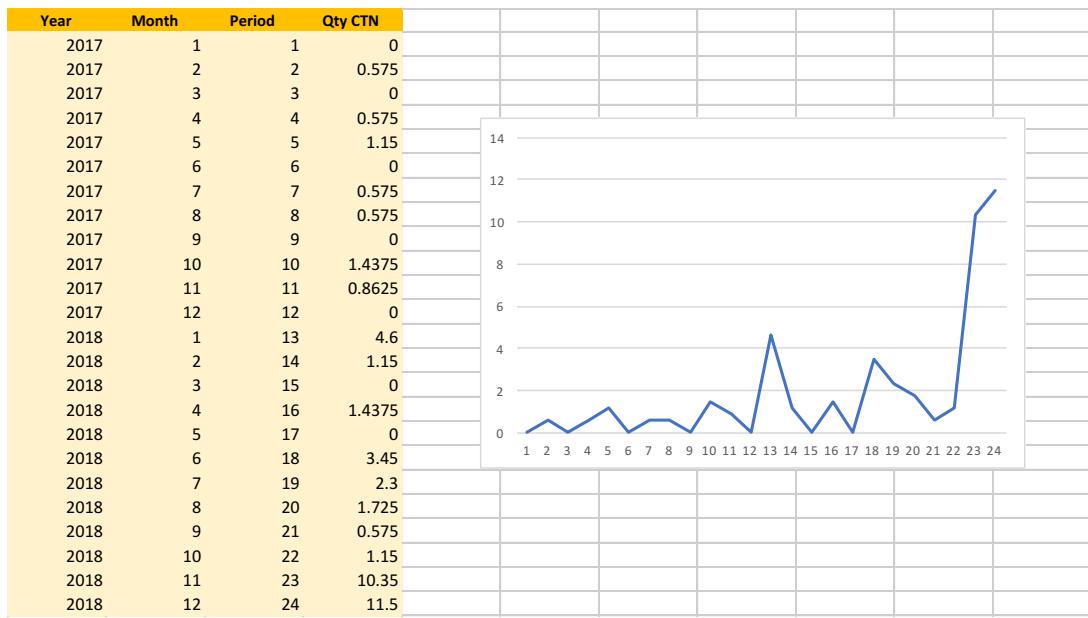
**Figure A-80:** The data of BRC-0001



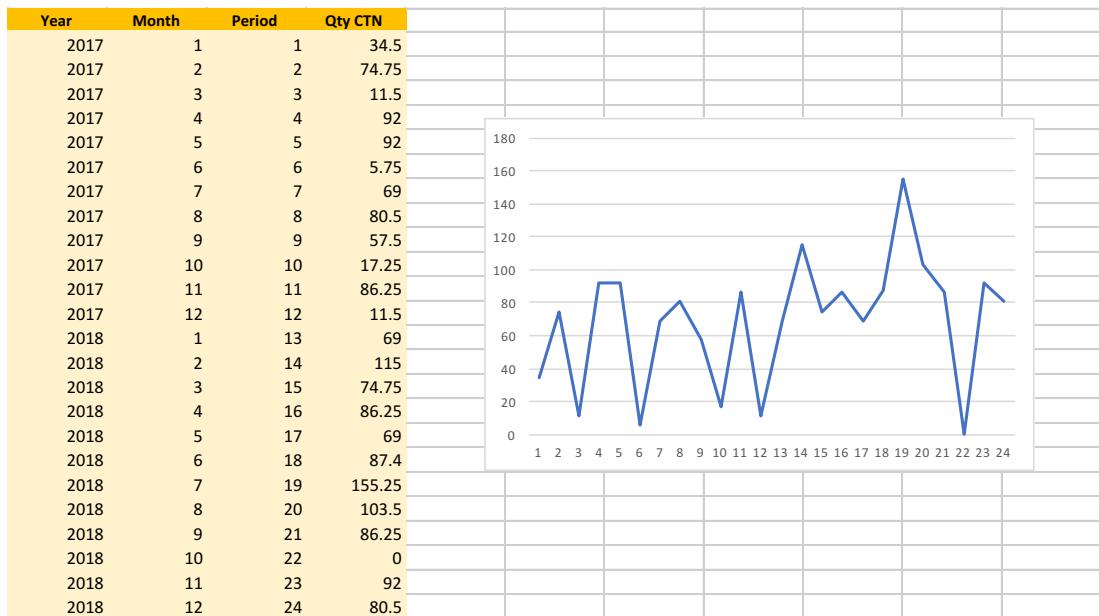
**Figure A-81:** The data of PT6-1001



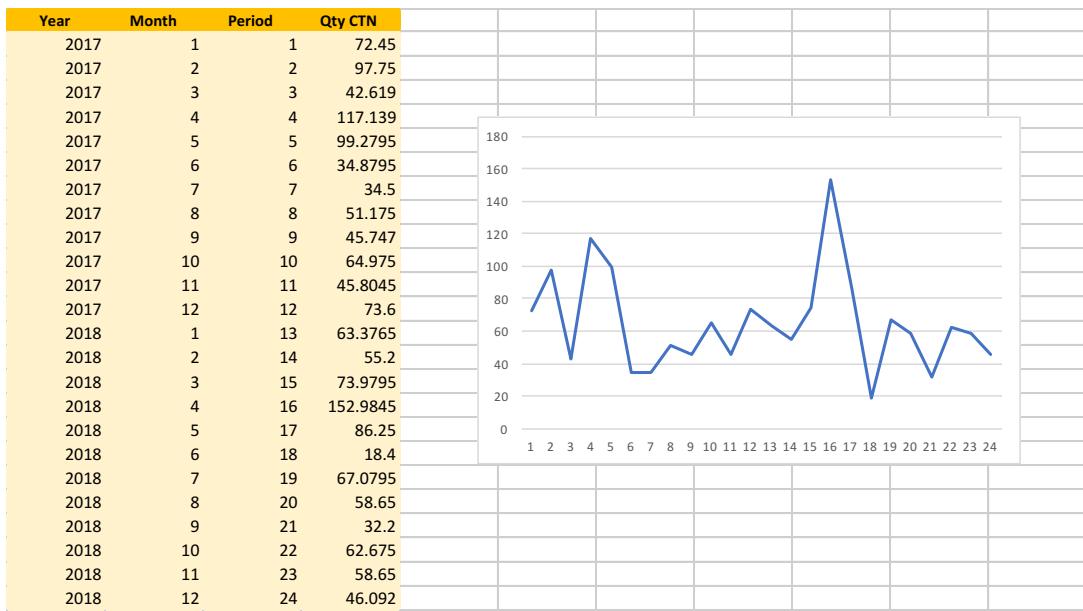
**Figure A-82:** The data of CPB-0012



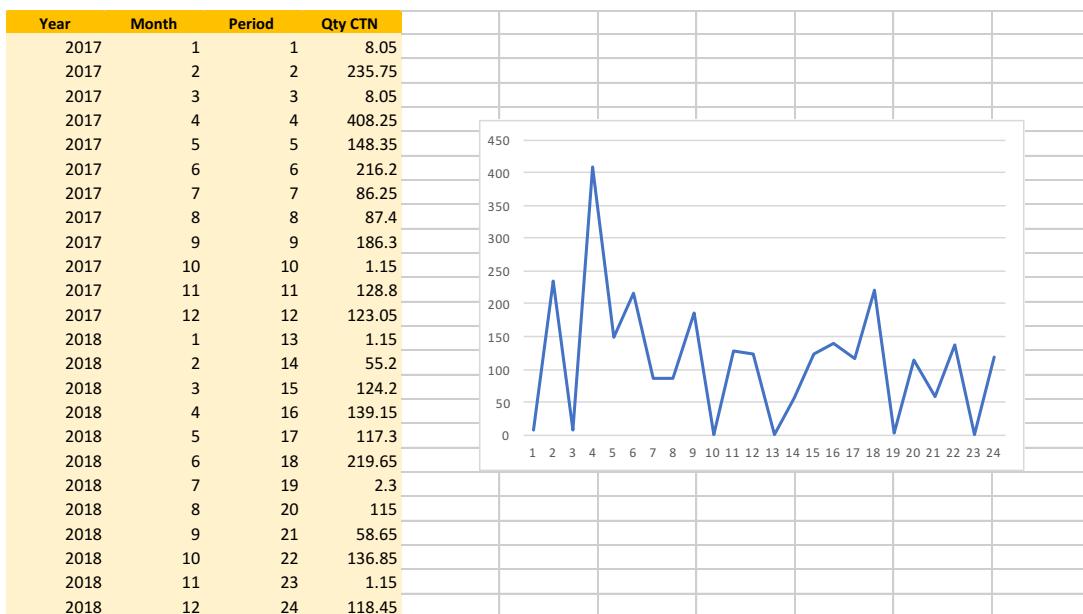
**Figure A-83:** The data of FLO-0007



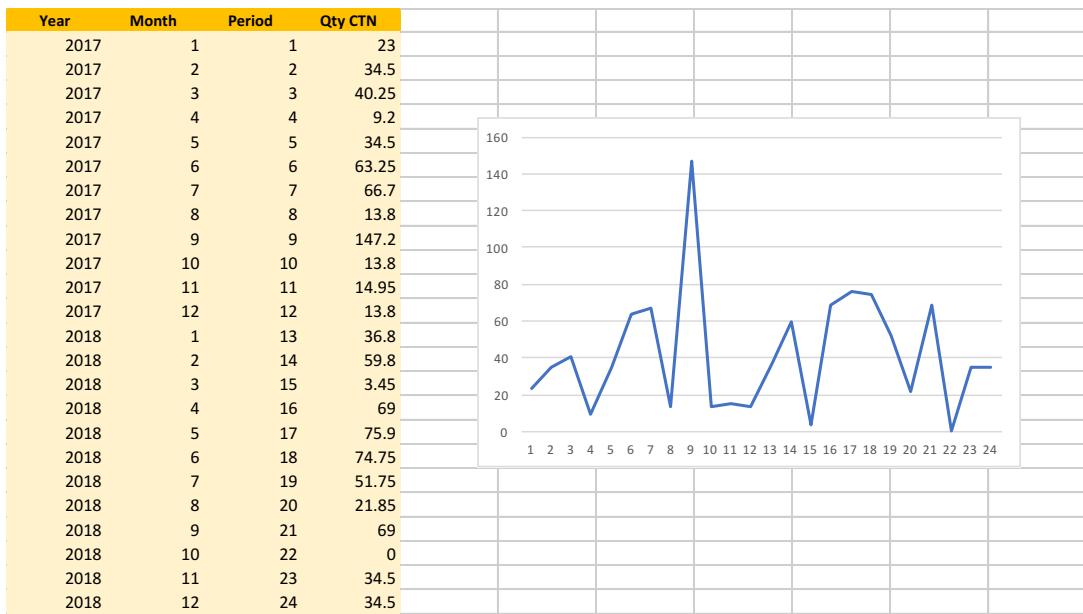
**Figure A-84:** The data of CAT-0259



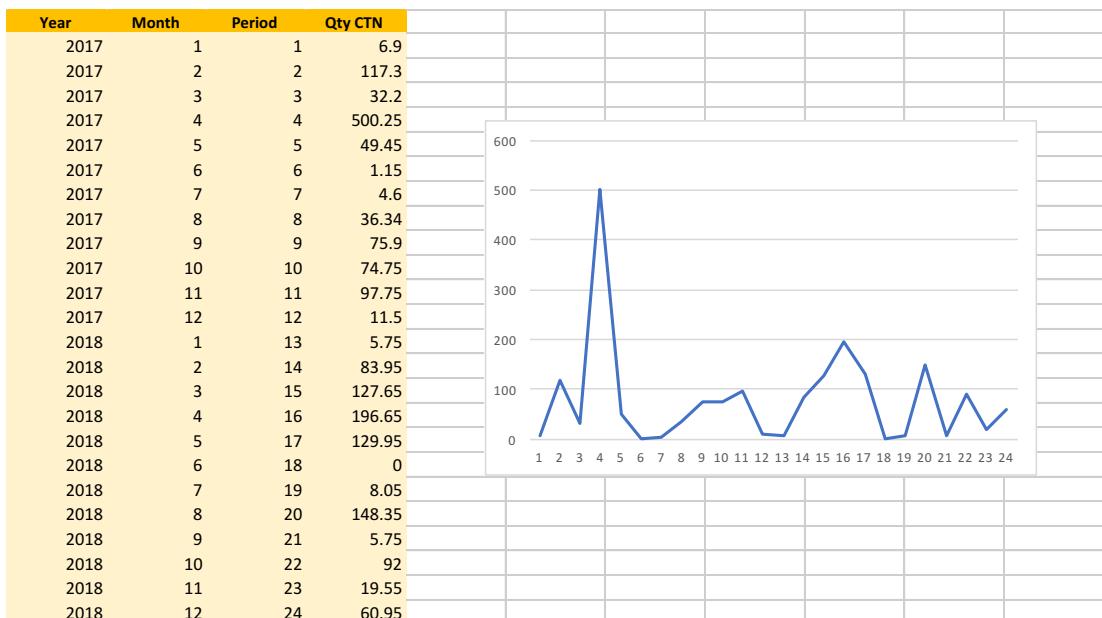
**Figure A-85:** The data of PT6-1005



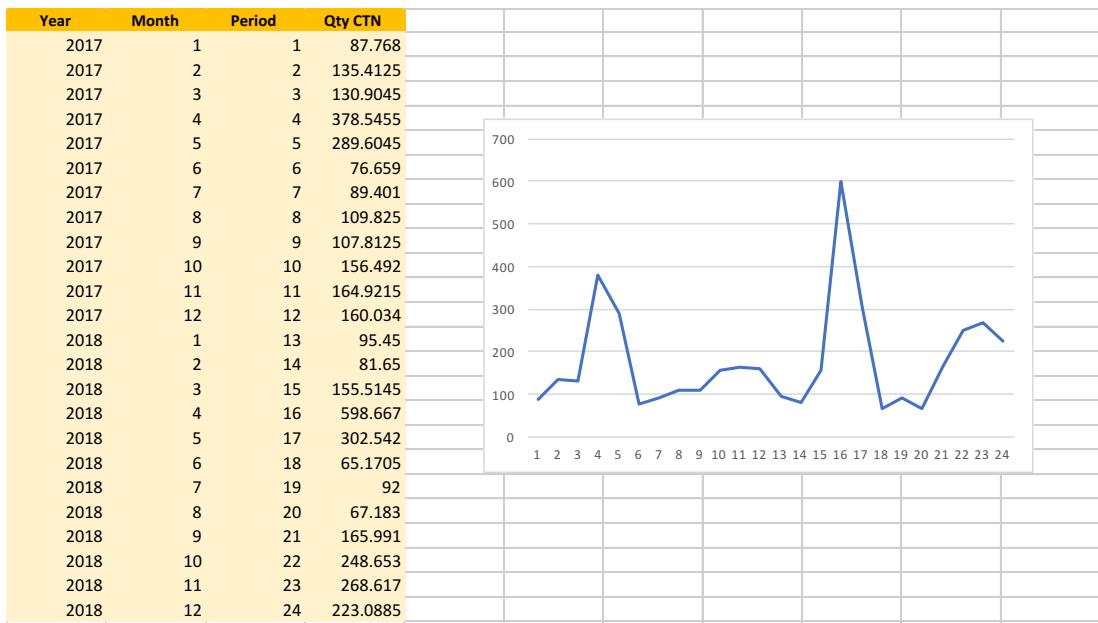
**Figure A-86:** The data of CAT-0042



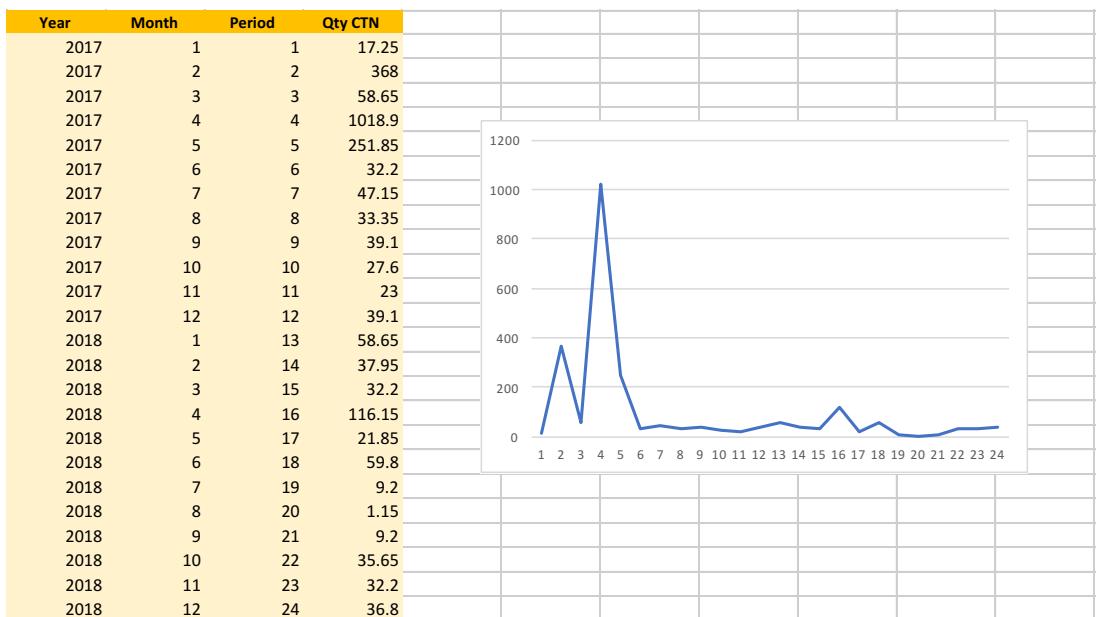
**Figure A-87:** The data of CAT-0154



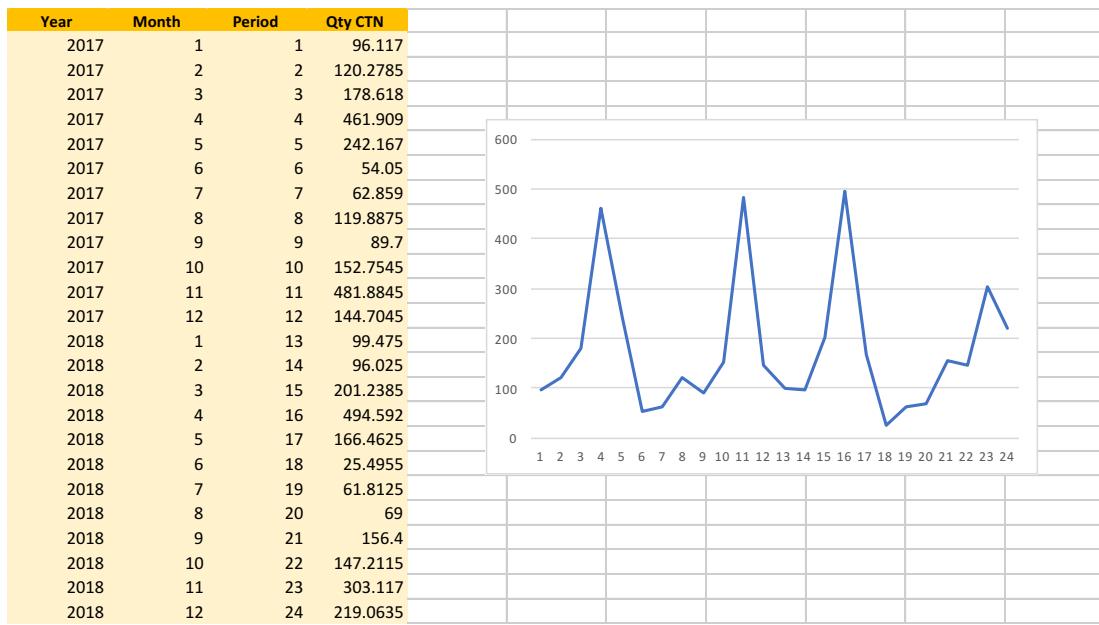
**Figure A-88:** The data of CAT-0032



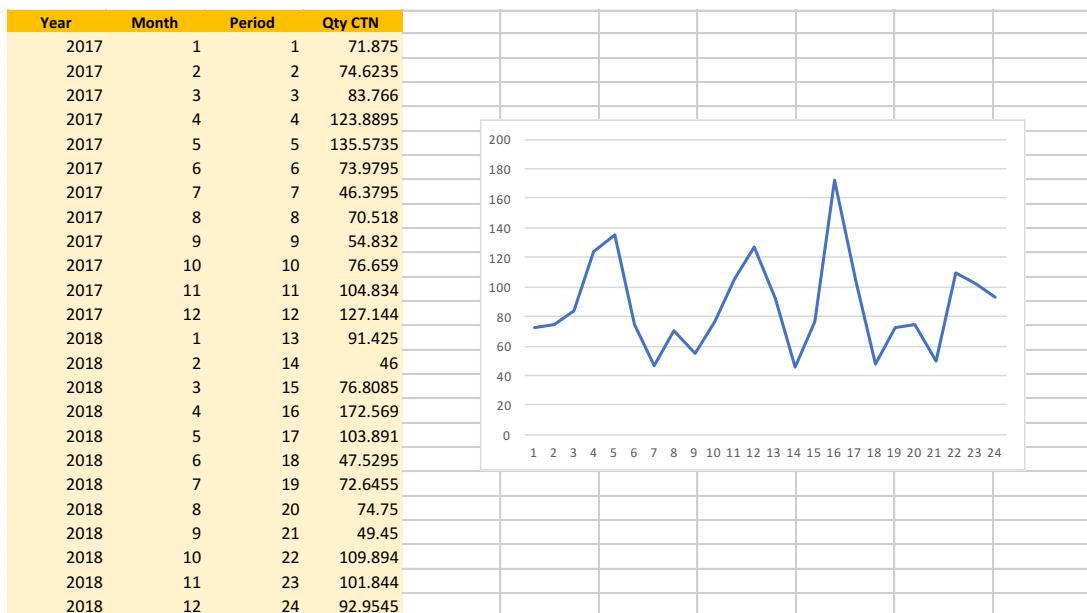
**Figure A-89:** The data of BRC-0003



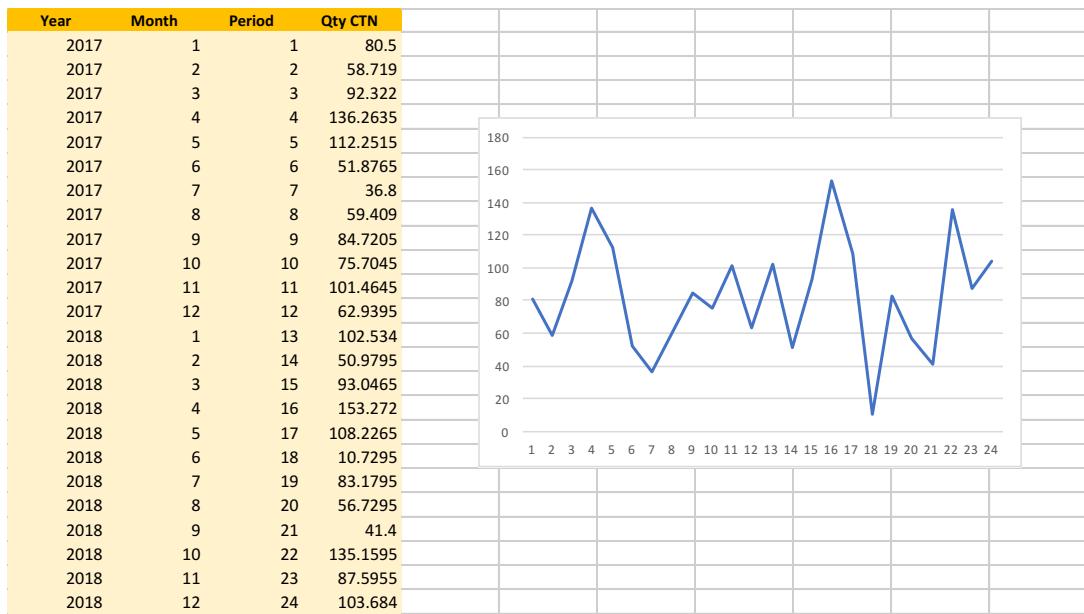
**Figure A-90:** The data of CAT-0050



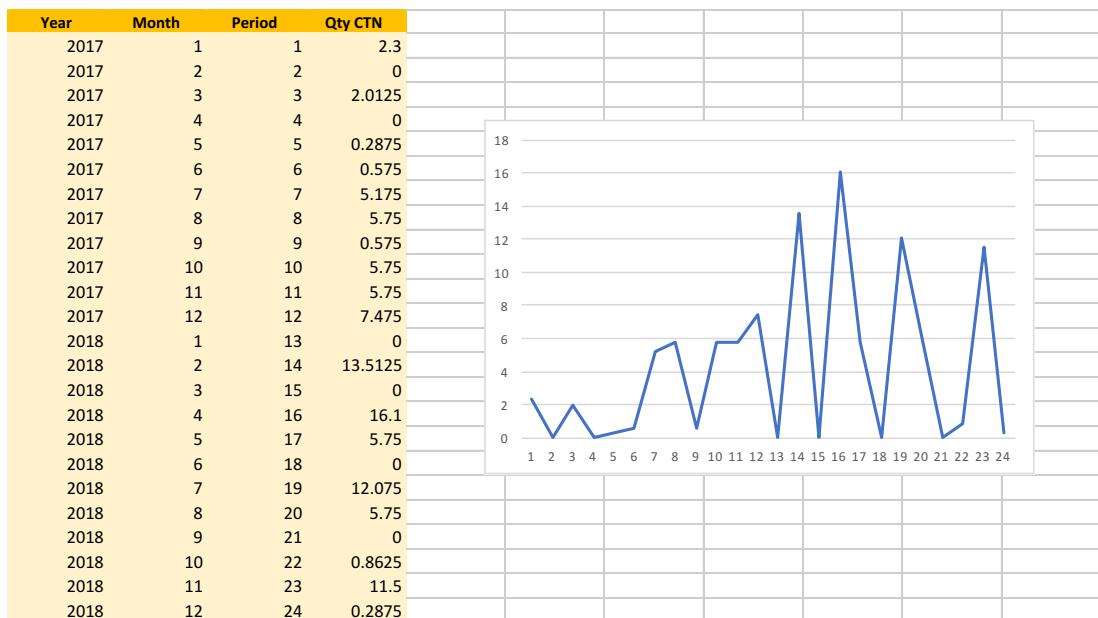
**Figure A-91:** The data of BRC-0002



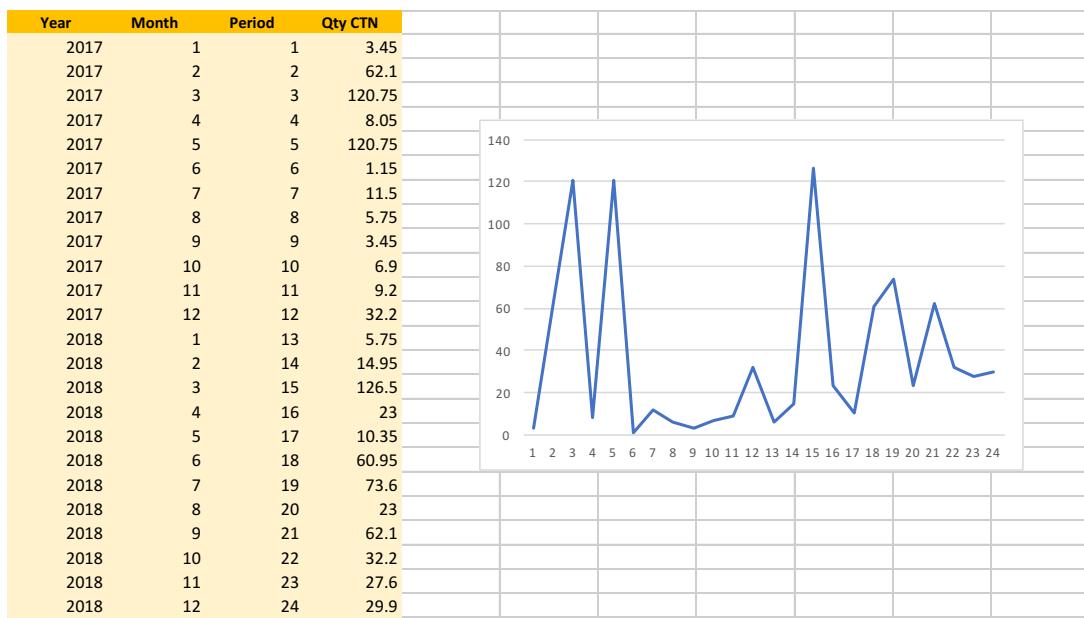
**Figure A-92:** The data of PT6-0010



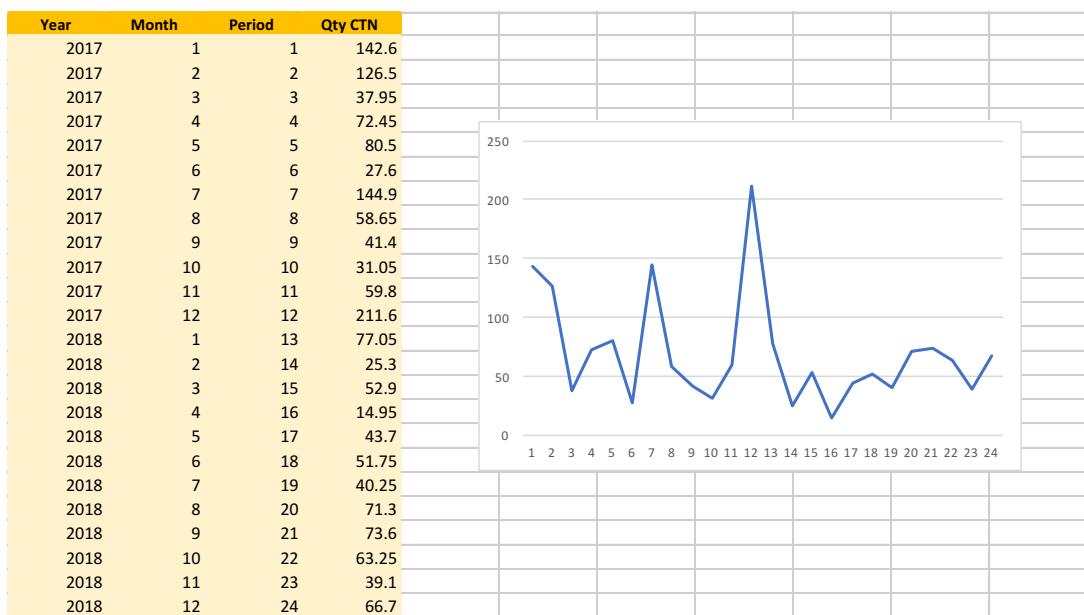
**Figure A-93:** The data of PT6-0022



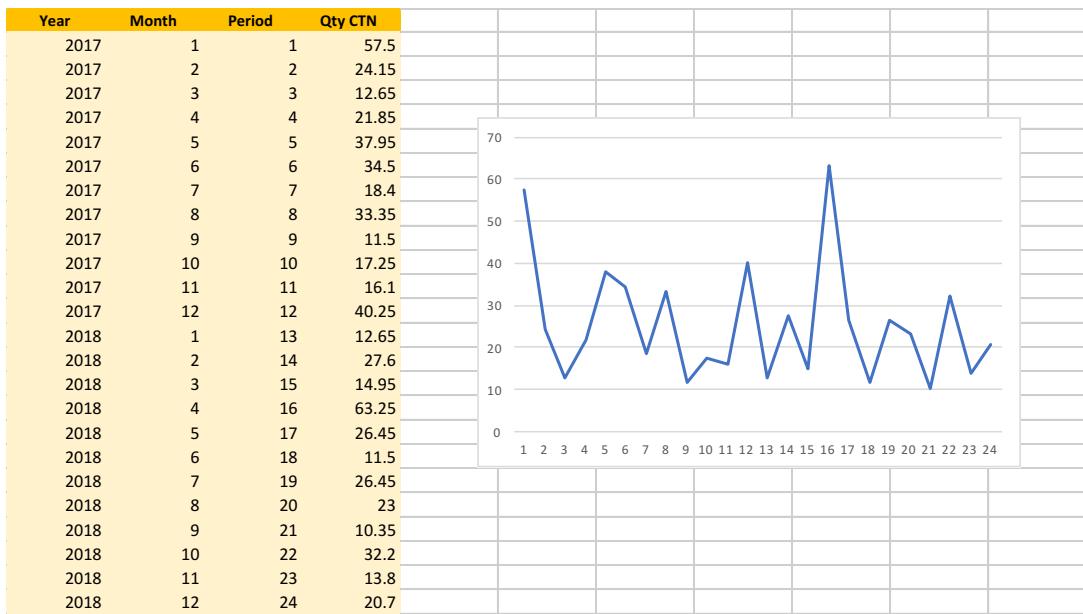
**Figure A-94:** The data of FLO-0002



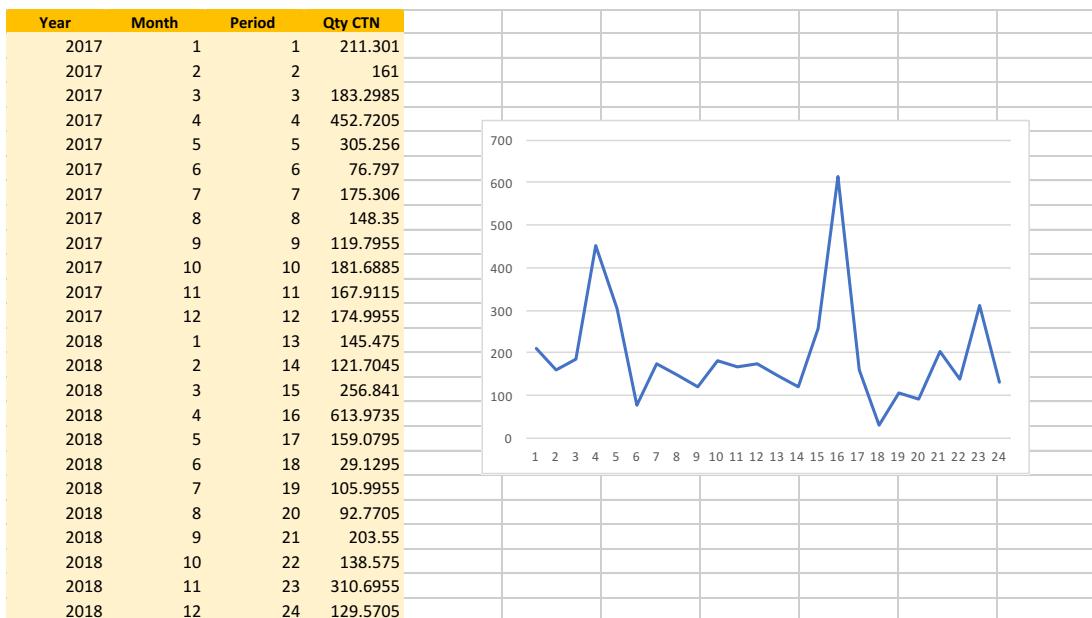
**Figure A-95:** The data of CAT-0091



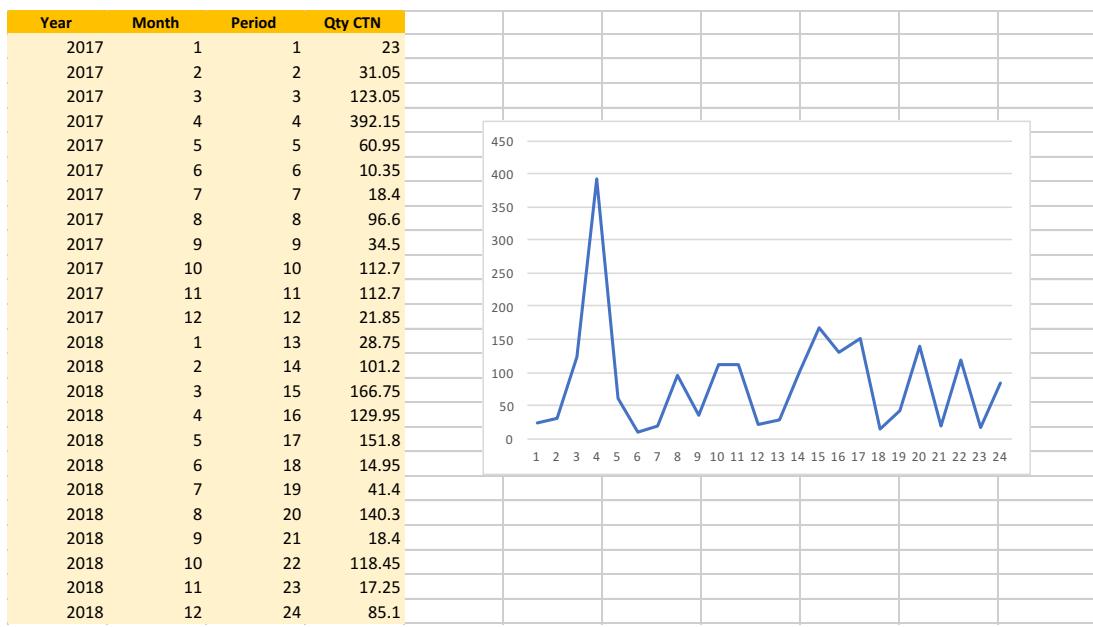
**Figure A-96:** The data of FMB-0037



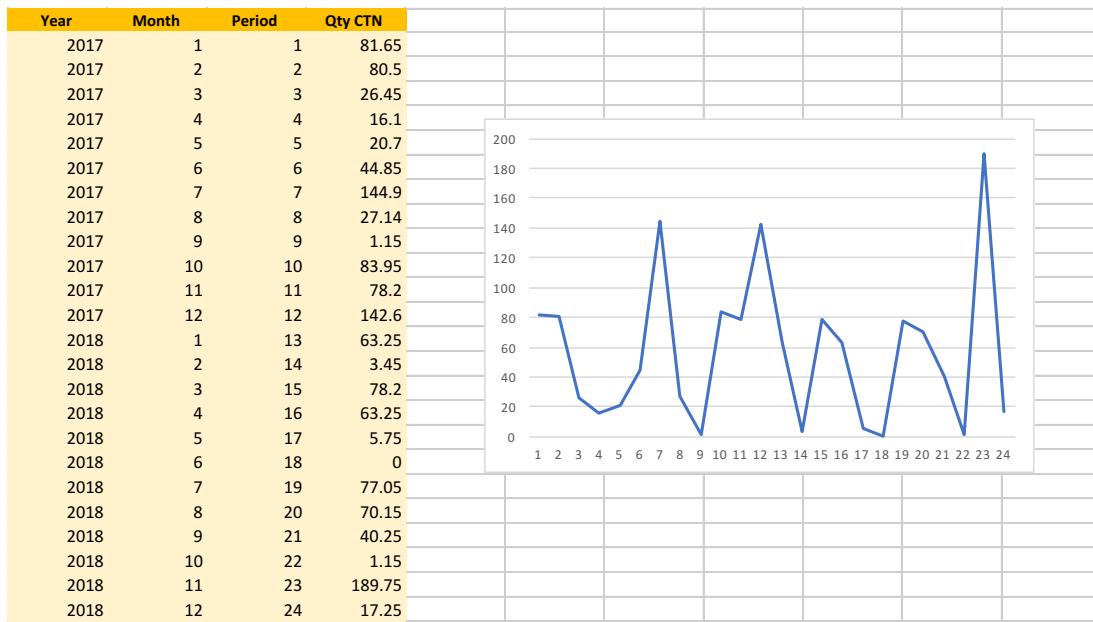
**Figure A-97:** The data of CAT-0020



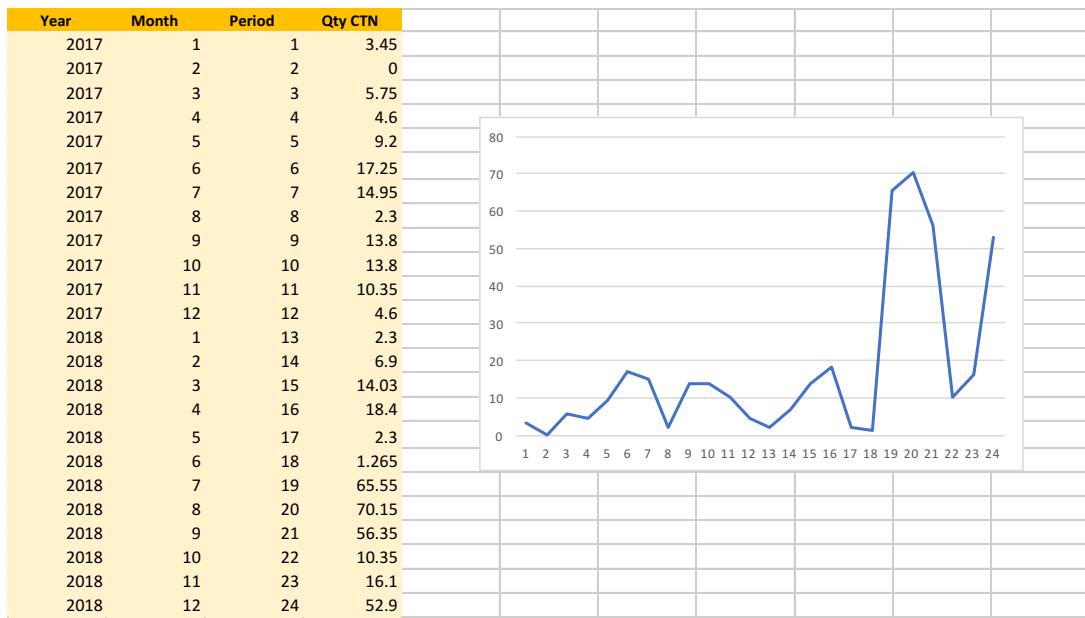
**Figure A-98:** The data of PT6-0013



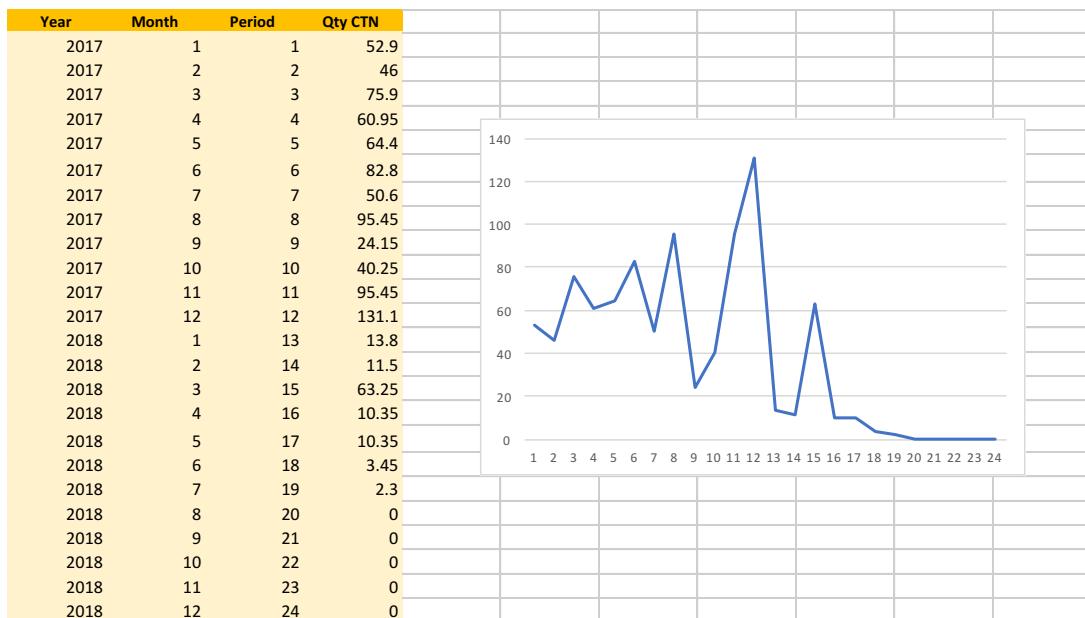
**Figure A-99:** The data of CAT-0024



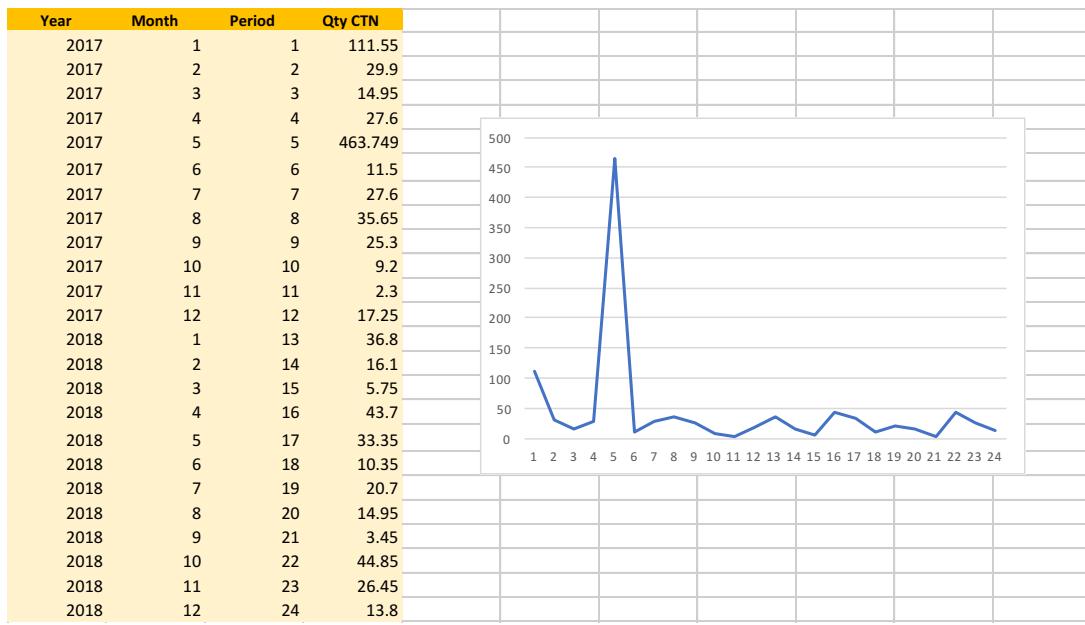
**Figure A-100:** The data of CAT-0028



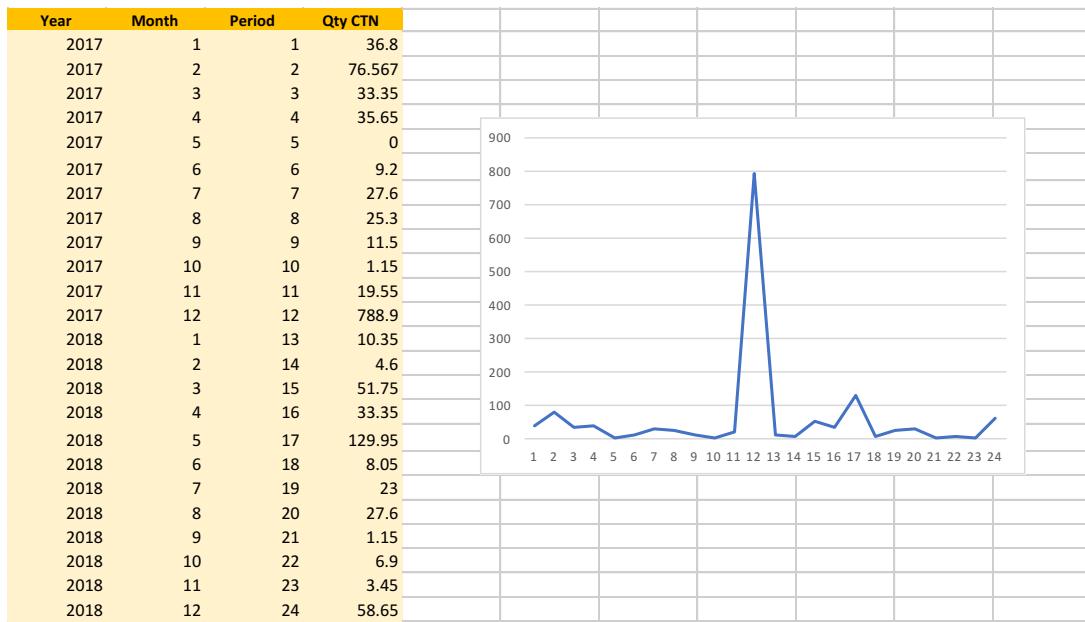
**Figure A-101:** The data of CAT-0230



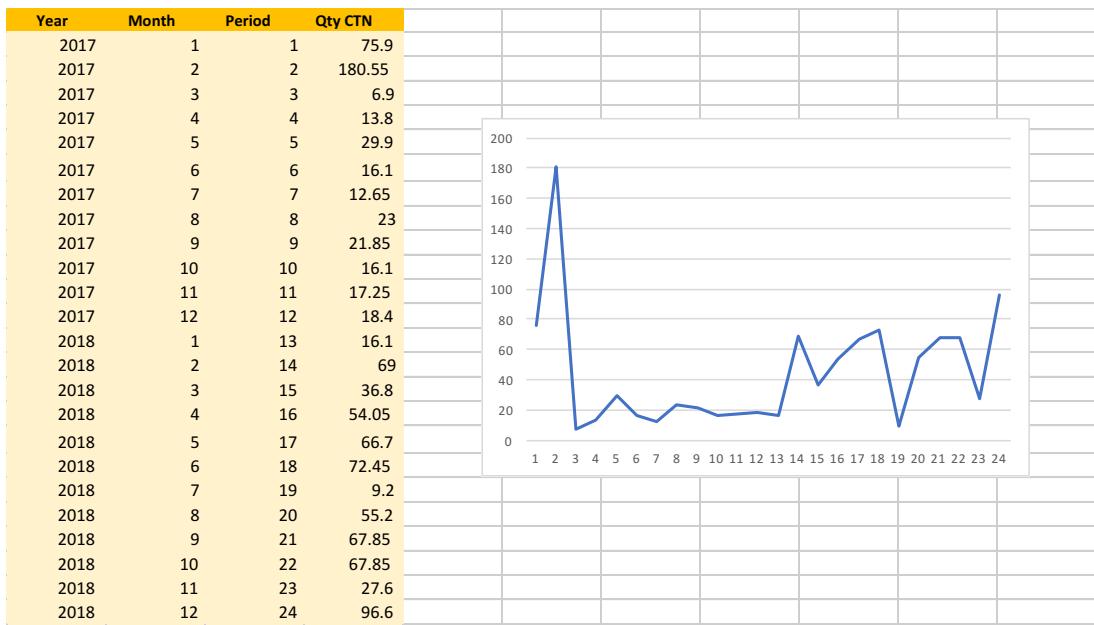
**Figure A-102:** The data of CAT-0166



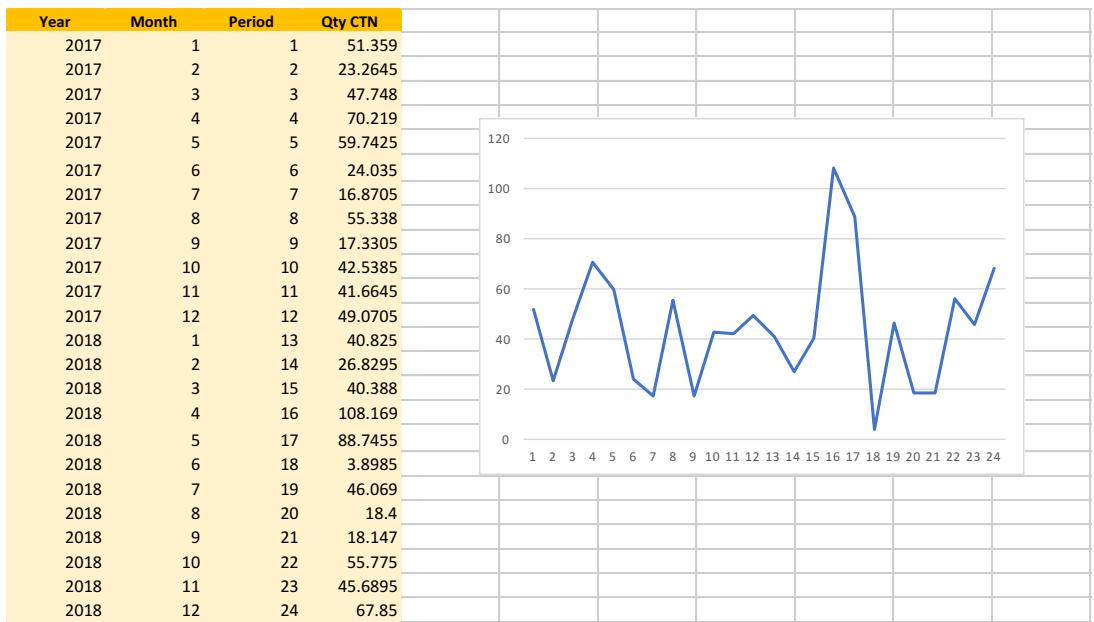
**Figure A-103:** The data of CAT-0021



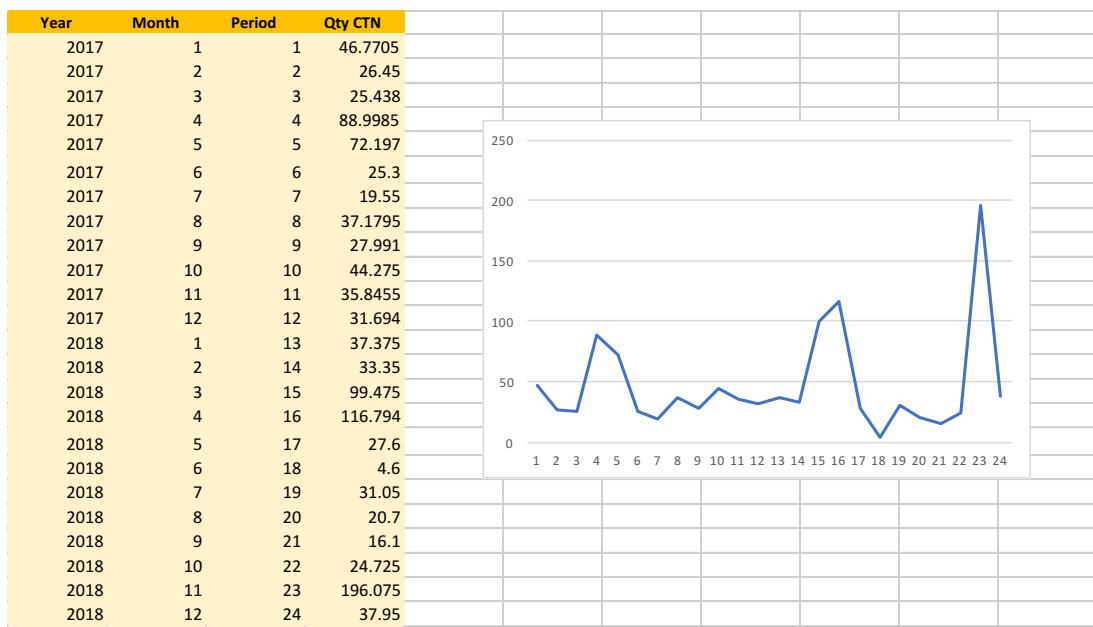
**Figure A-104:** The data of FMB-0054



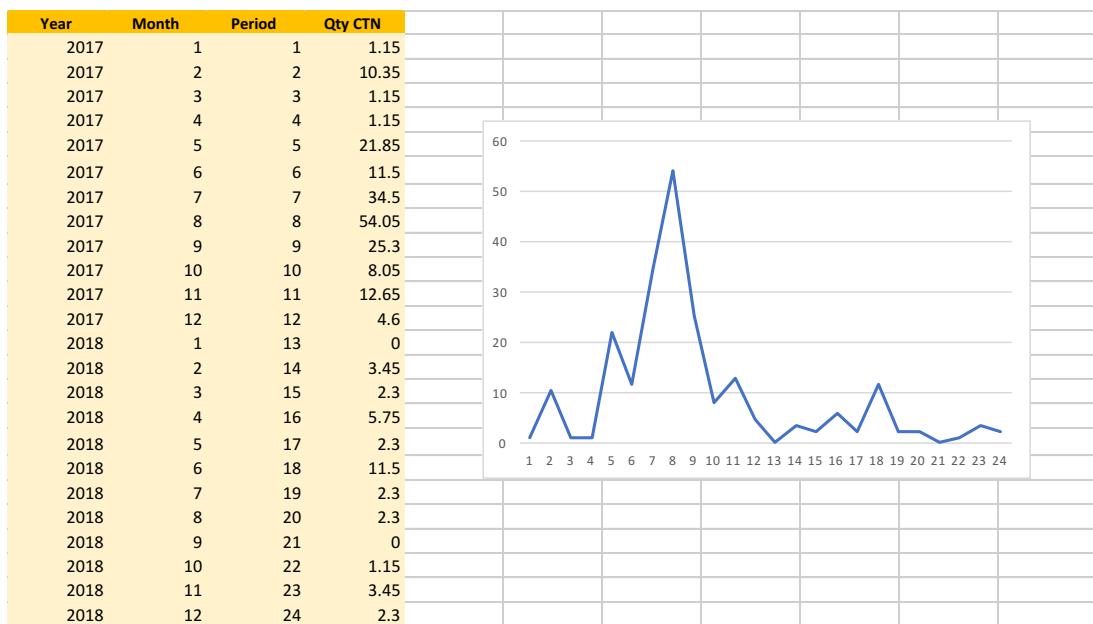
**Figure A-105:** The data of CAT-0072



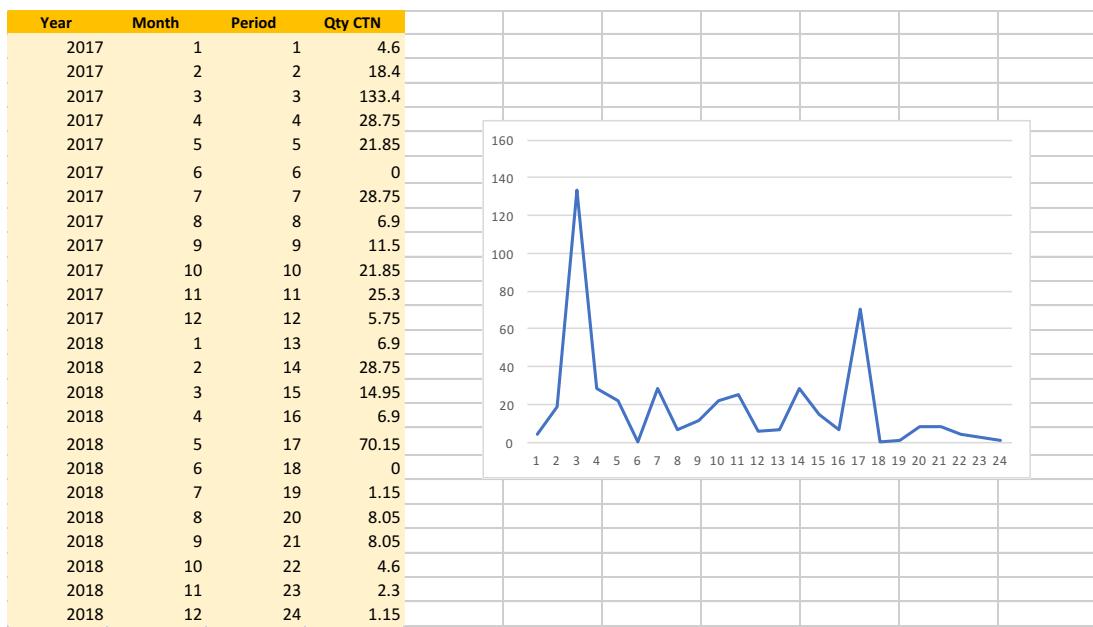
**Figure A-106:** The data of PT6-0004



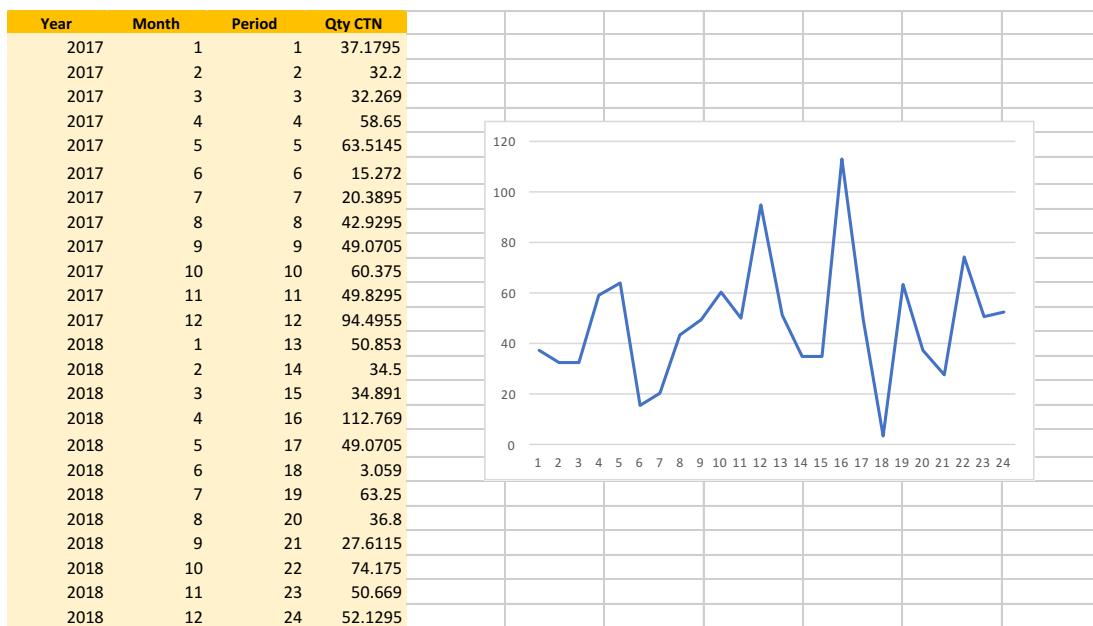
**Figure A-107:** The data of PT6-0024



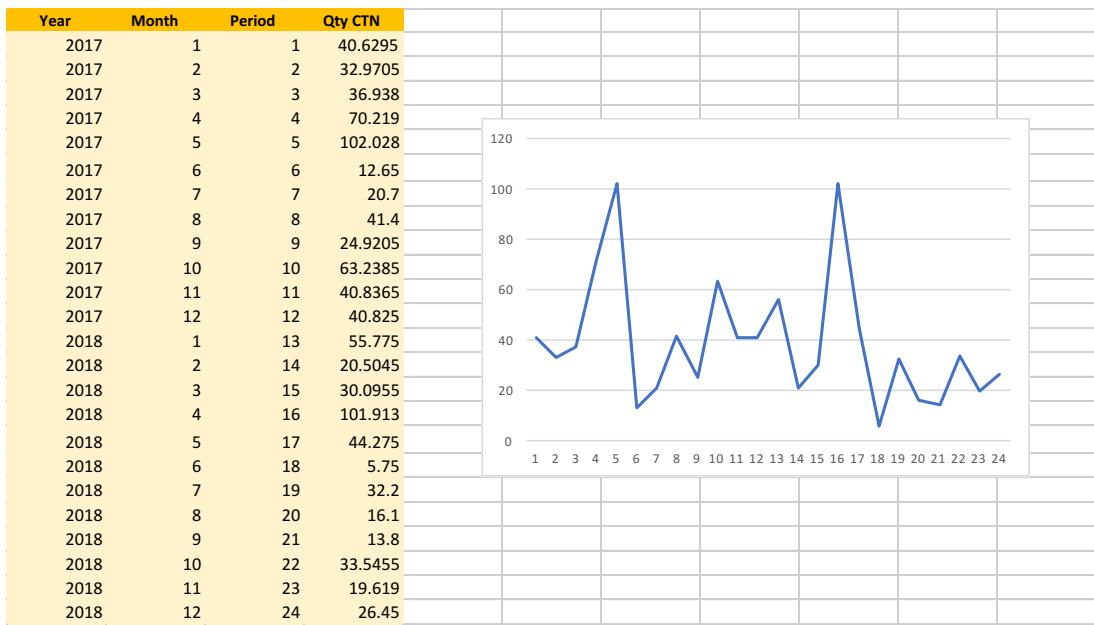
**Figure A-108:** The data of CAT-0136



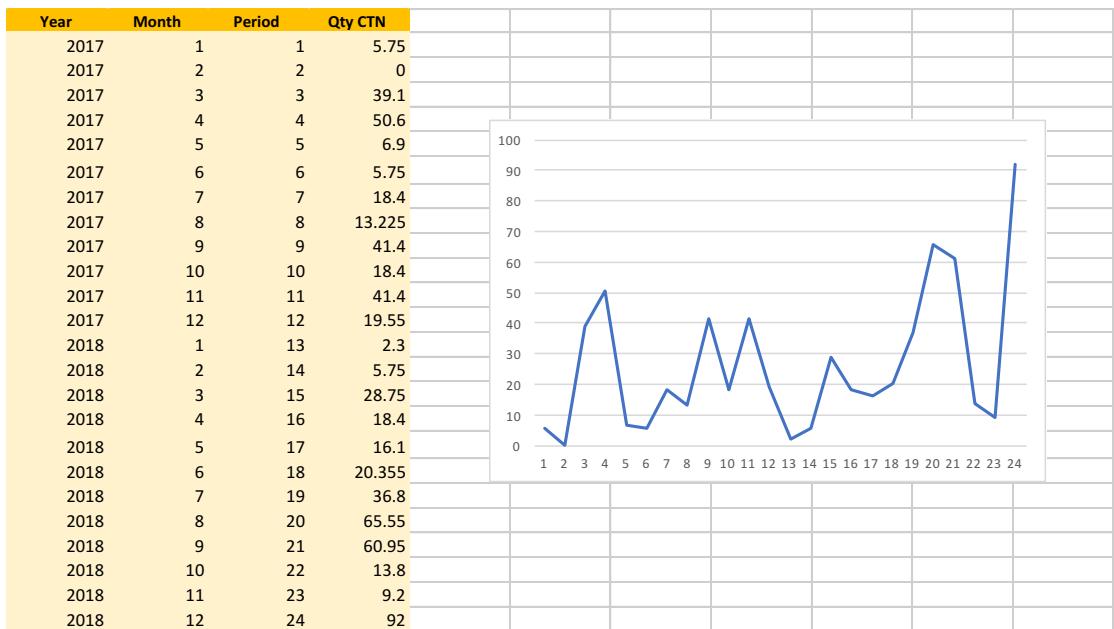
**Figure A-109:** The data of CAT-0096



**Figure A-110:** The data of PT6-0006



**Figure A-111:** The data of PT6-0023



**Figure A-112:** The data of CAT-0266

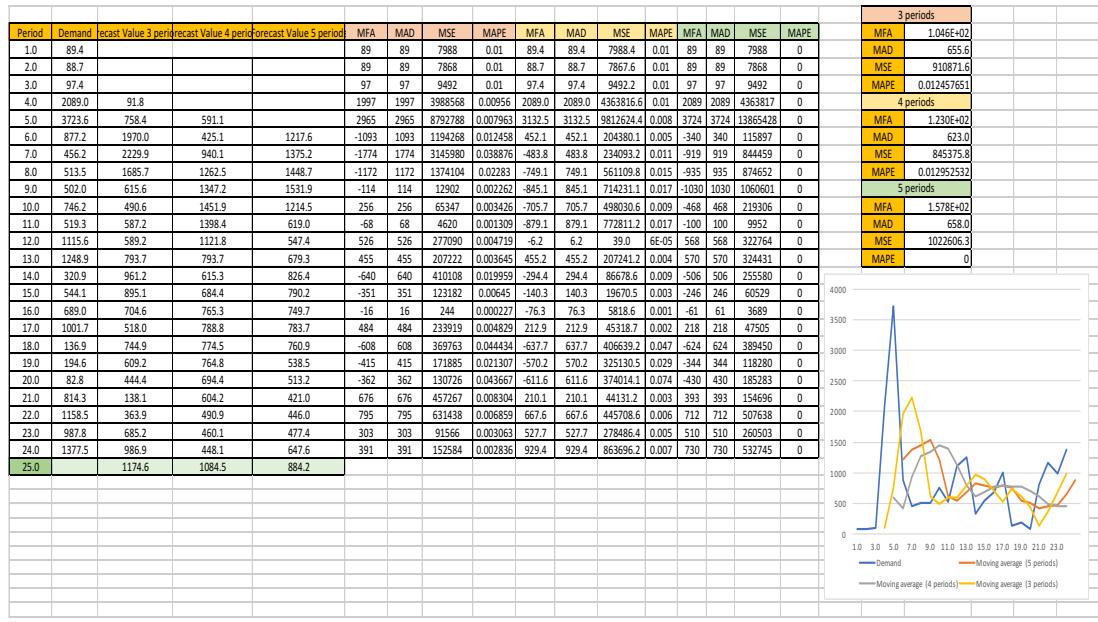


Figure A-113: TUN-0001 Simple Moving Average Calculations

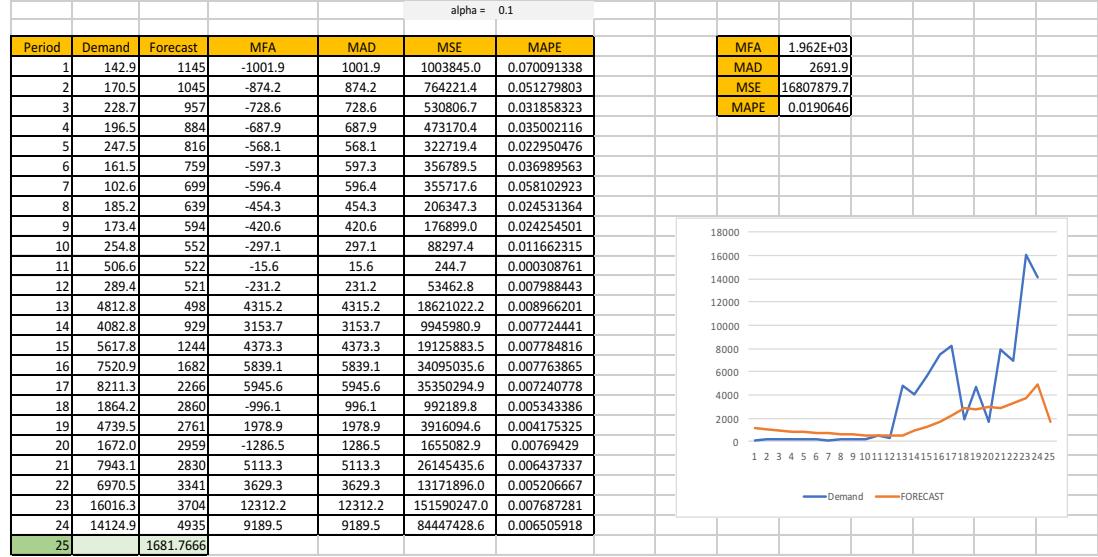
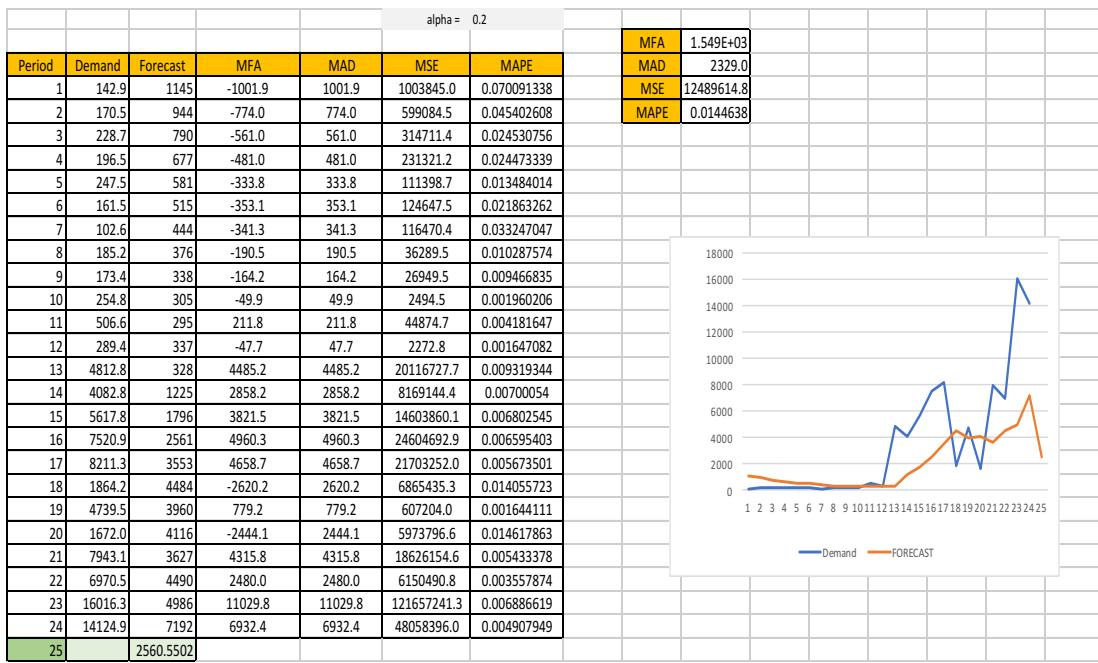
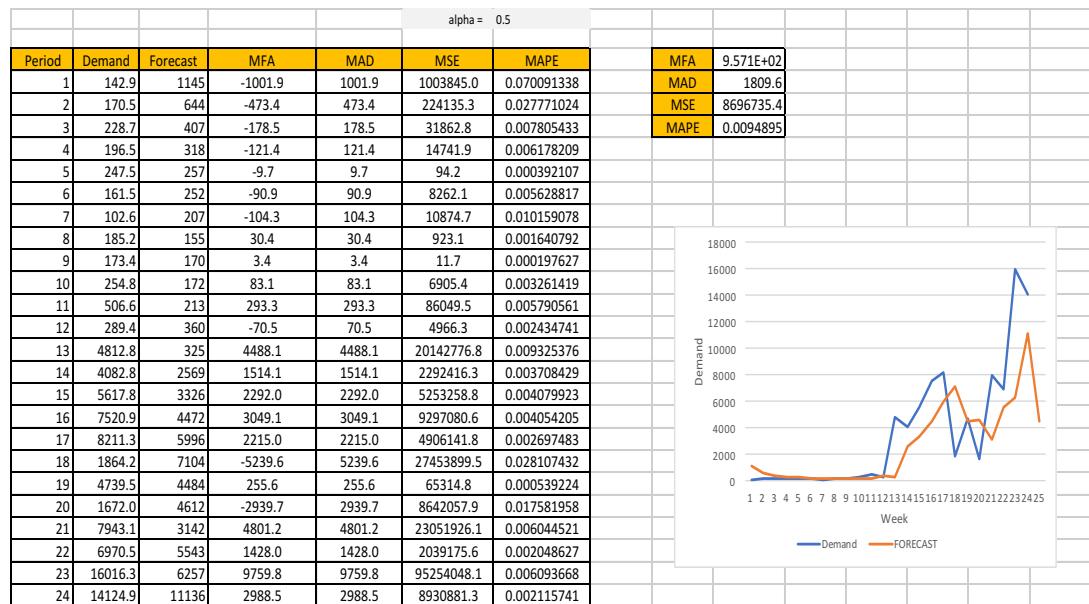


Figure A-114: TUN-0001 Exponential Smoothing Calculations (0.1 $\alpha$ )



**Figure A-115:** TUN-0001 Exponential Smoothing Calculations (0.2 $\alpha$ )



**Figure A-116:** TUN-0001 Exponential Smoothing Calculations (0.5 $\alpha$ )

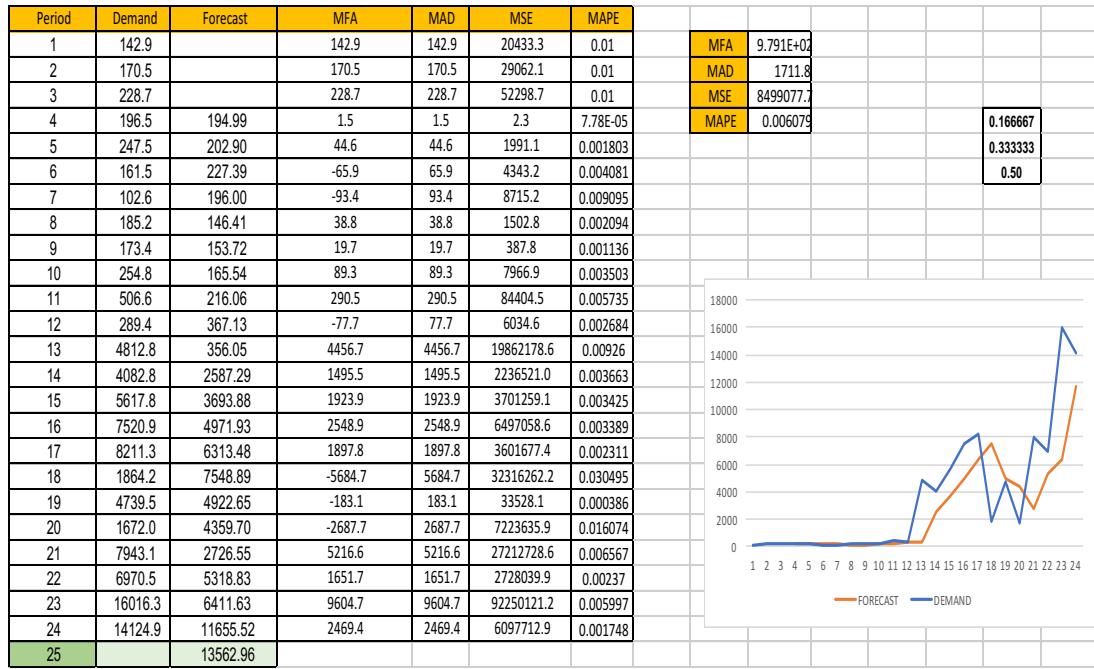


Figure A-117: TUN-0001 Weighted Moving Average Calculations

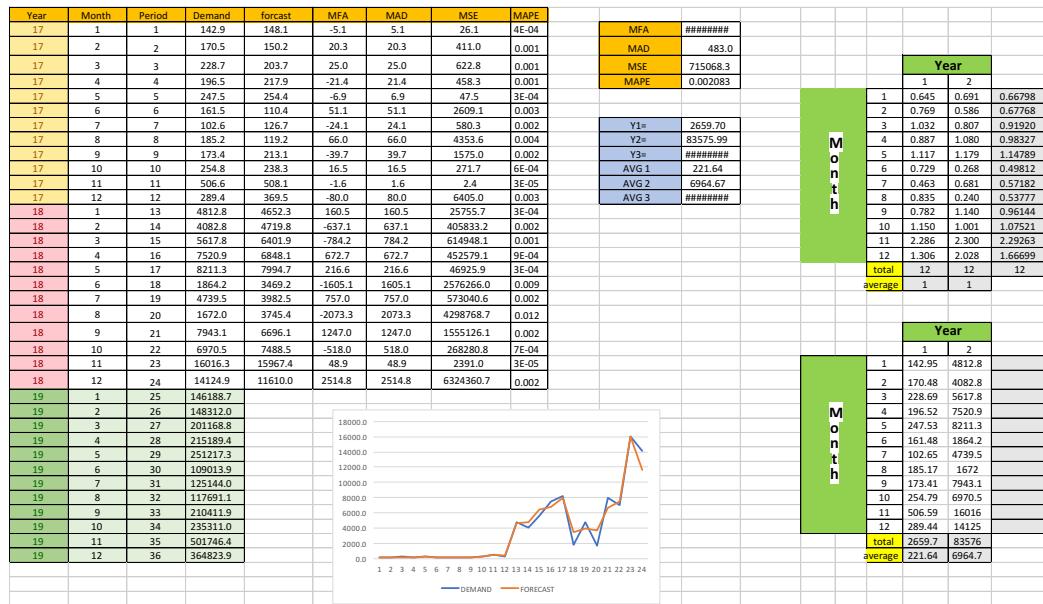


Figure A-118: TUN-0001 Seasonality Without Trend Calculations

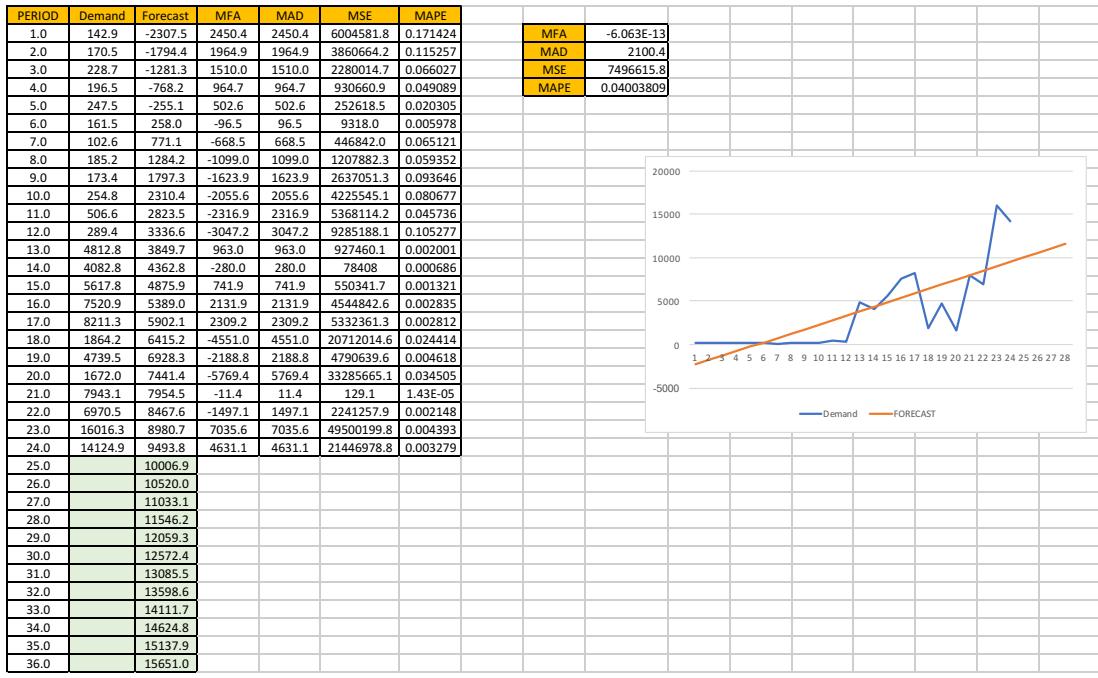


Figure A-119: TUN-0001 Linear Regression Calculations

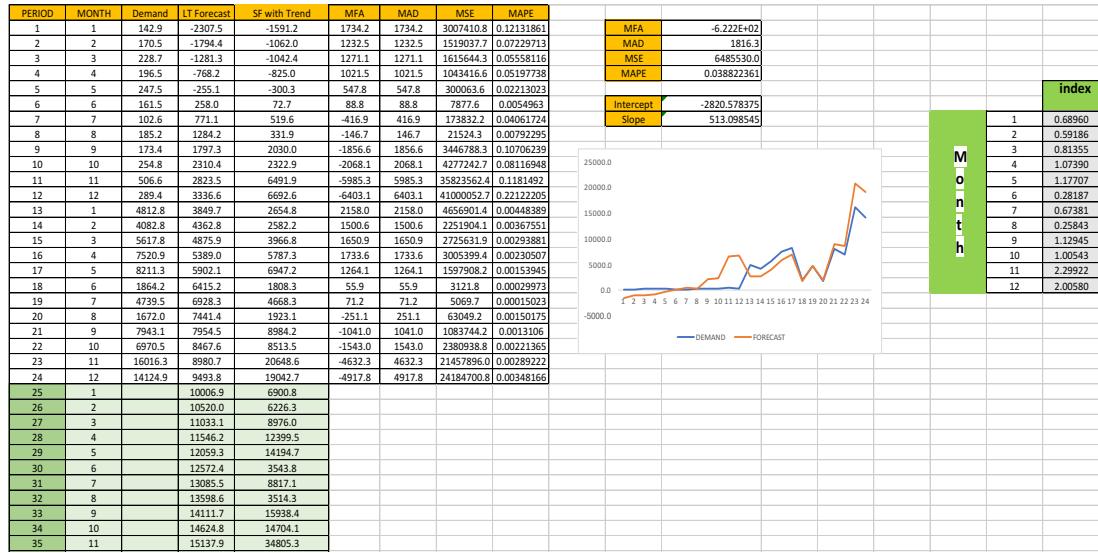


Figure A-120: TUN-0001 Trend Projected Adjusted Calculations

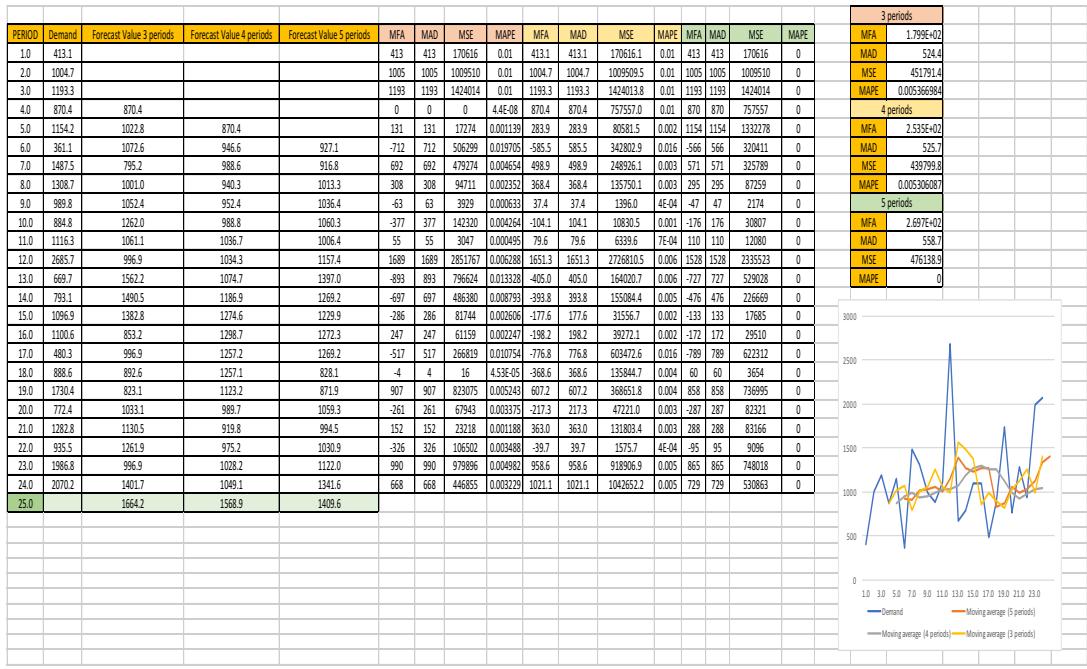


Figure A-121: FMB-0002 Simple Moving Average Calculations

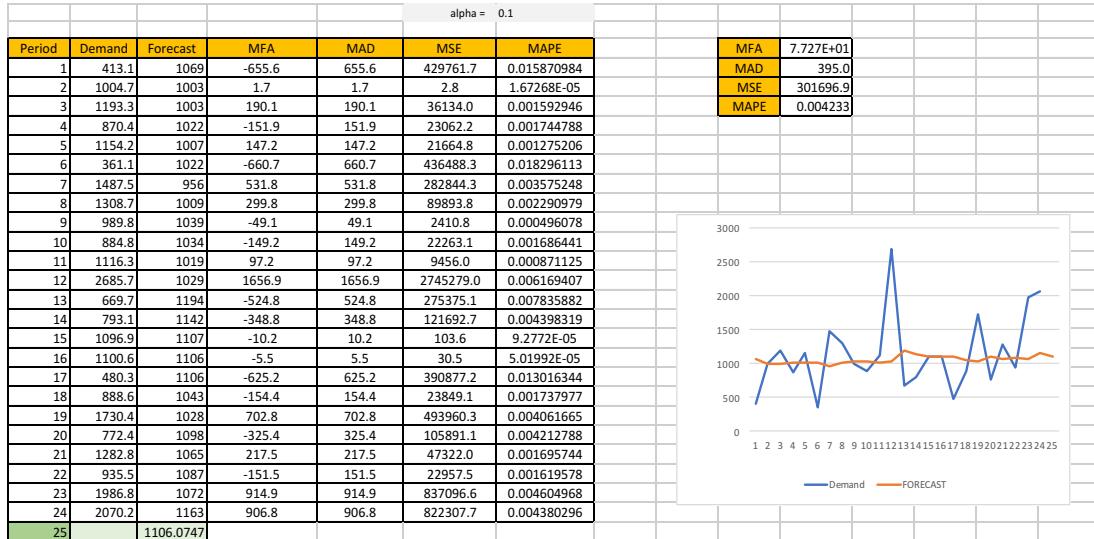
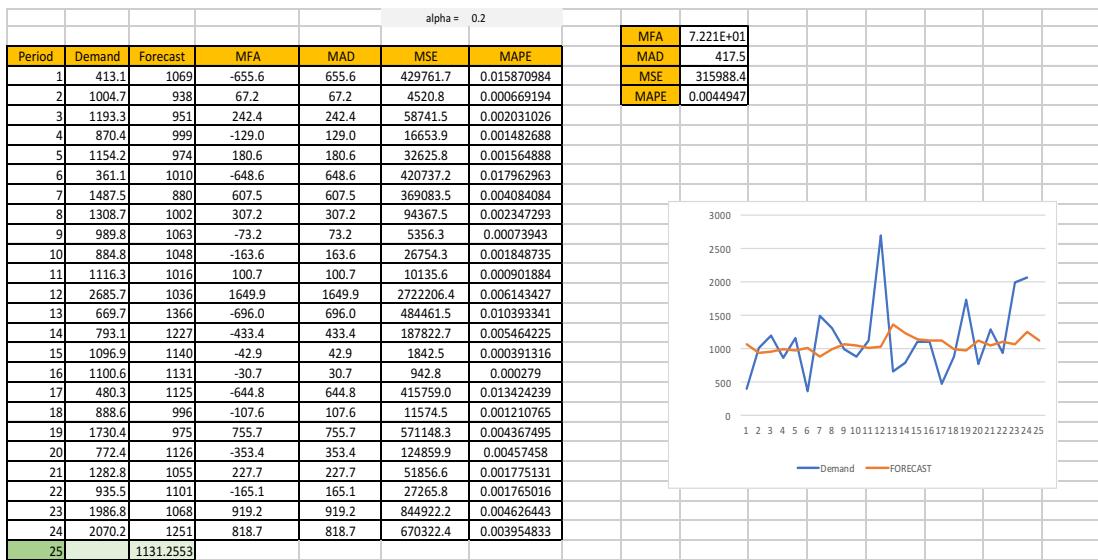
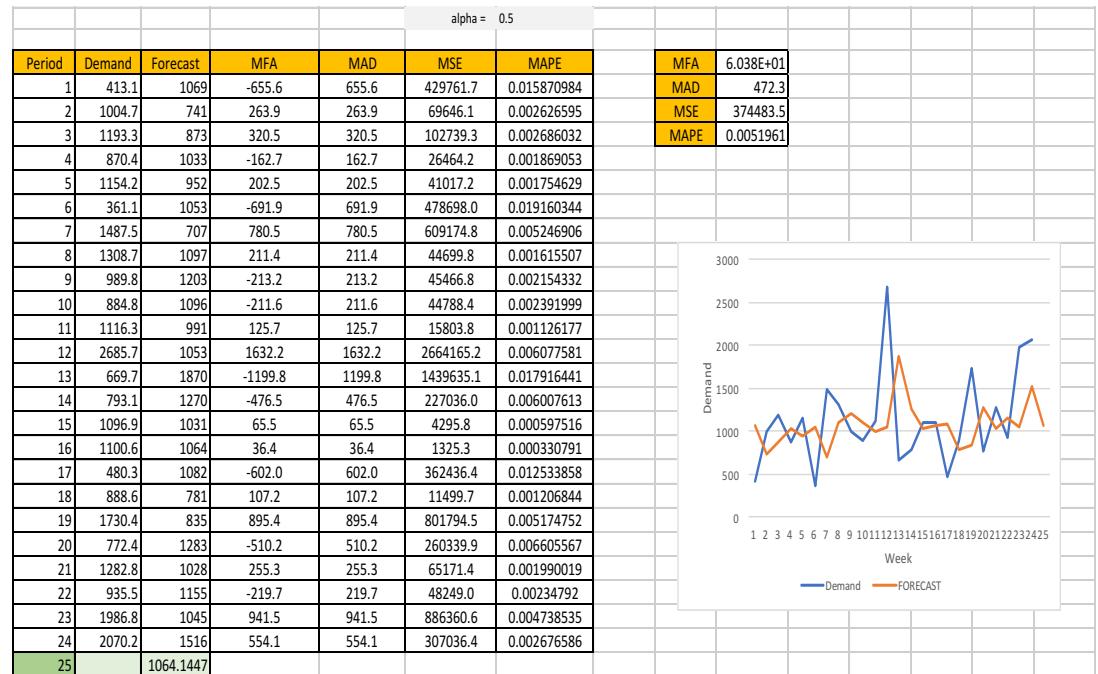


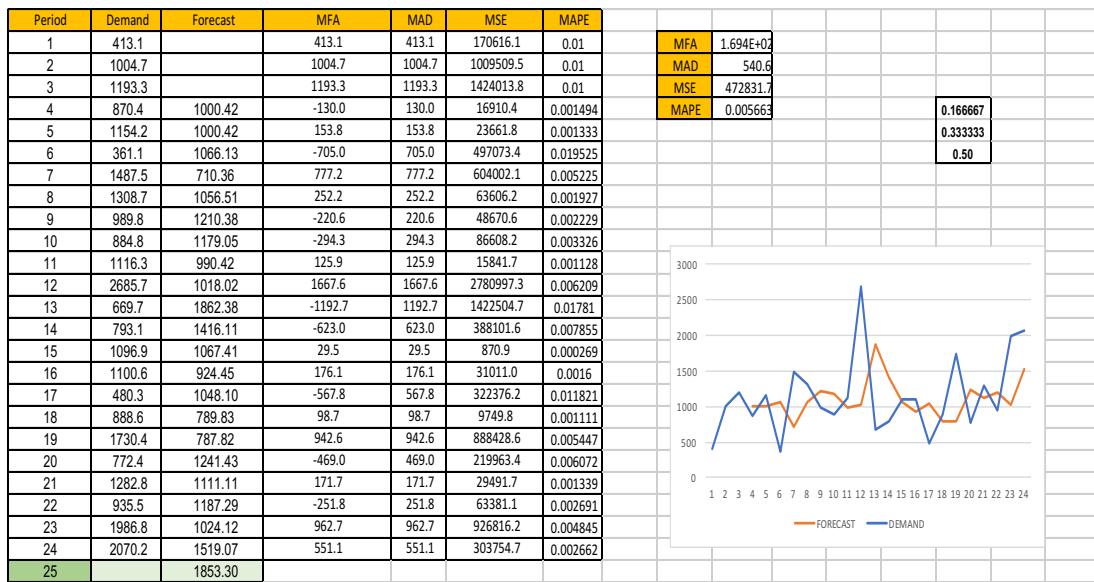
Figure A-122: FMB-0002 Exponential Smoothing Calculations (0.1α)



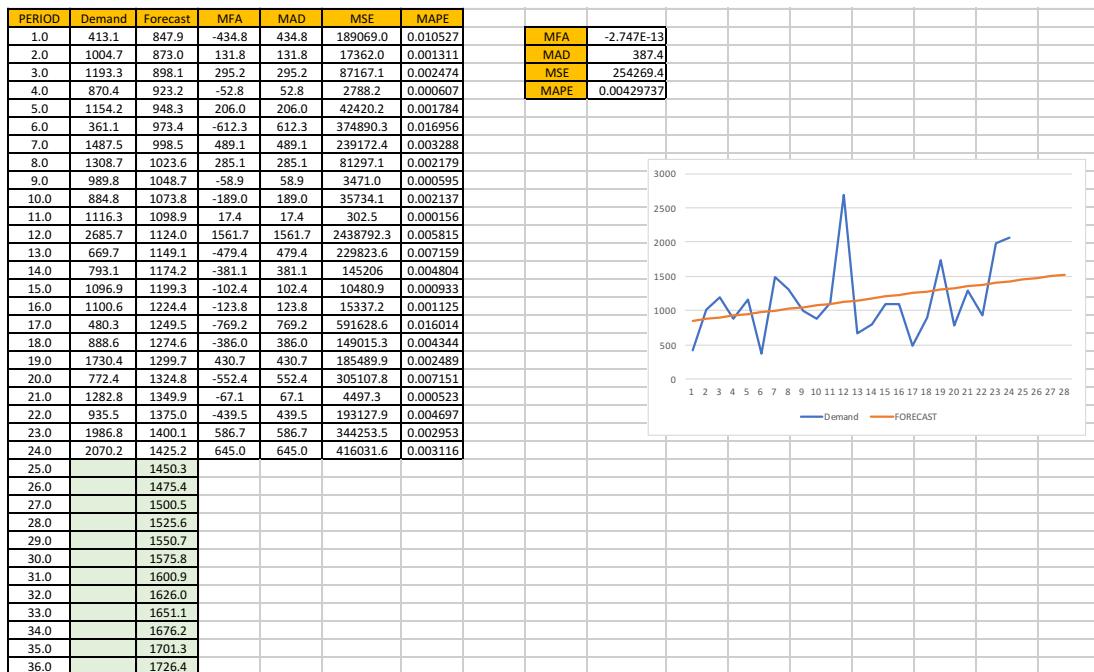
**Figure A-123: FMB-0002 Exponential Smoothing Calculations (0.2α)**



**Figure A-124: FMB-0002 Exponential Smoothing Calculations (0.5α)**



**Figure A-125: FMB-0002 Weighted Moving Average Calculations**



**Figure A-126: FMB-0002 Linear Regression Calculations**

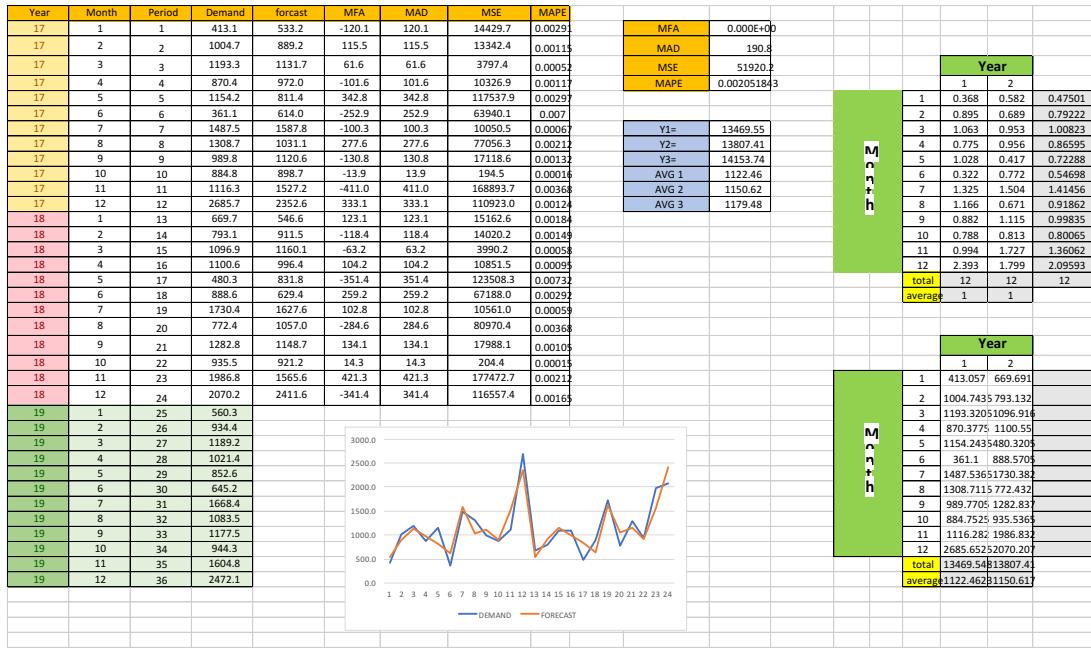


Figure A-127: FMB-0002 Seasonality Without Trend Calculations

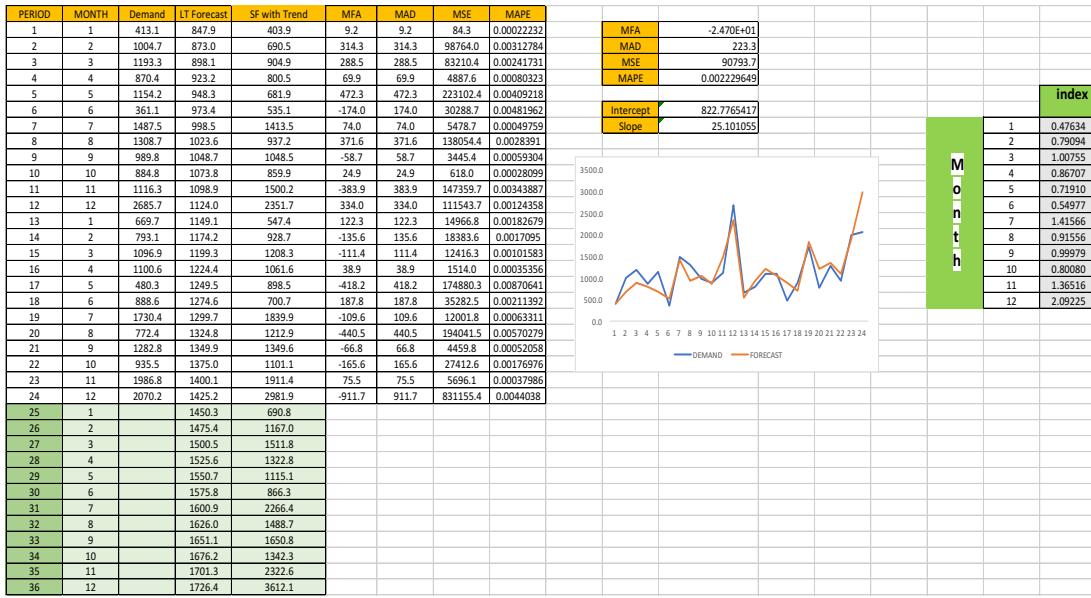


Figure A-127: FMB-0002 Trend Projected Adjusted Calculations

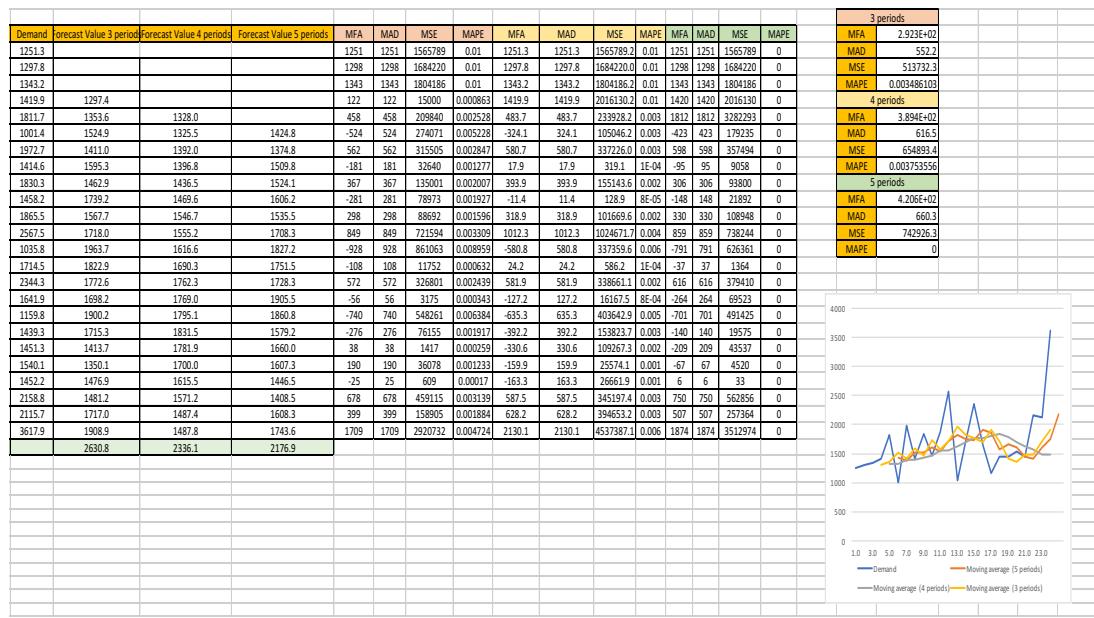


Figure A-129: FMB-0008 Simple Moving Average Calculations

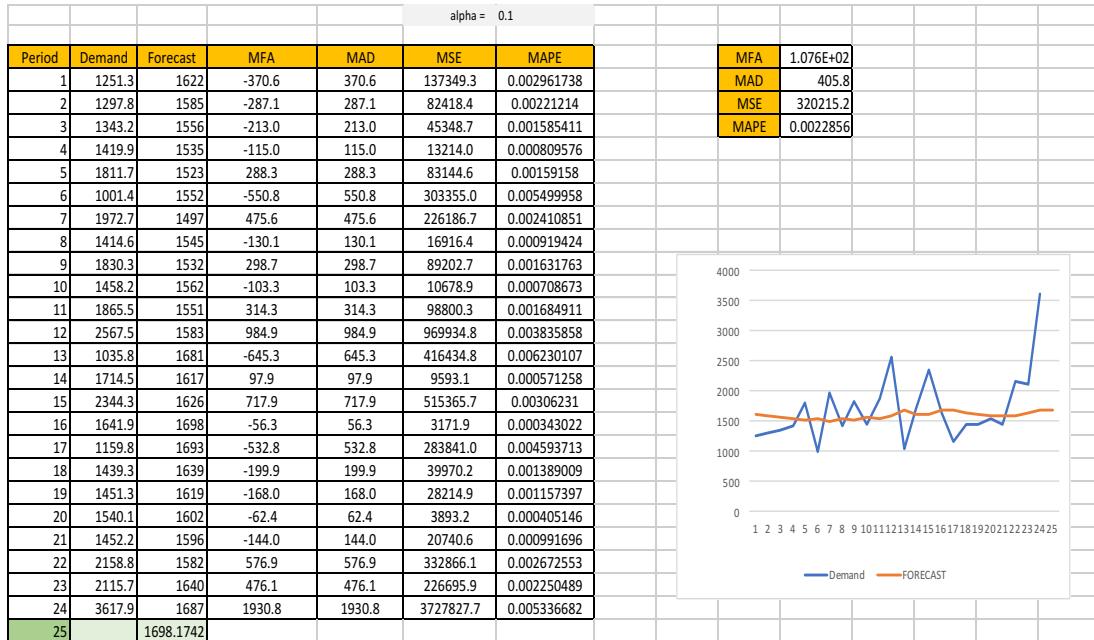
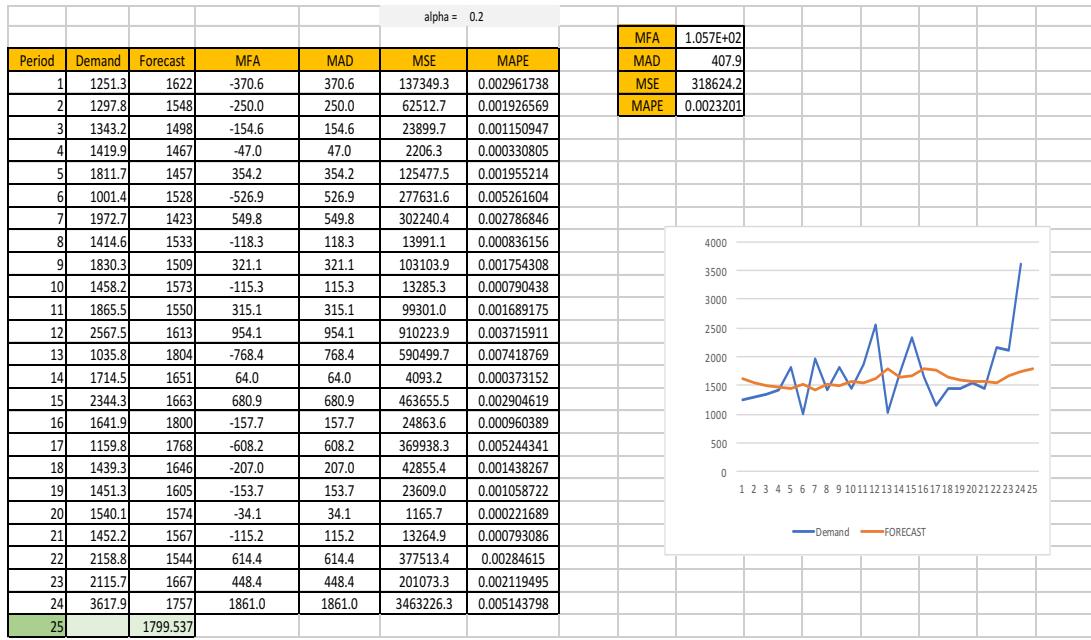
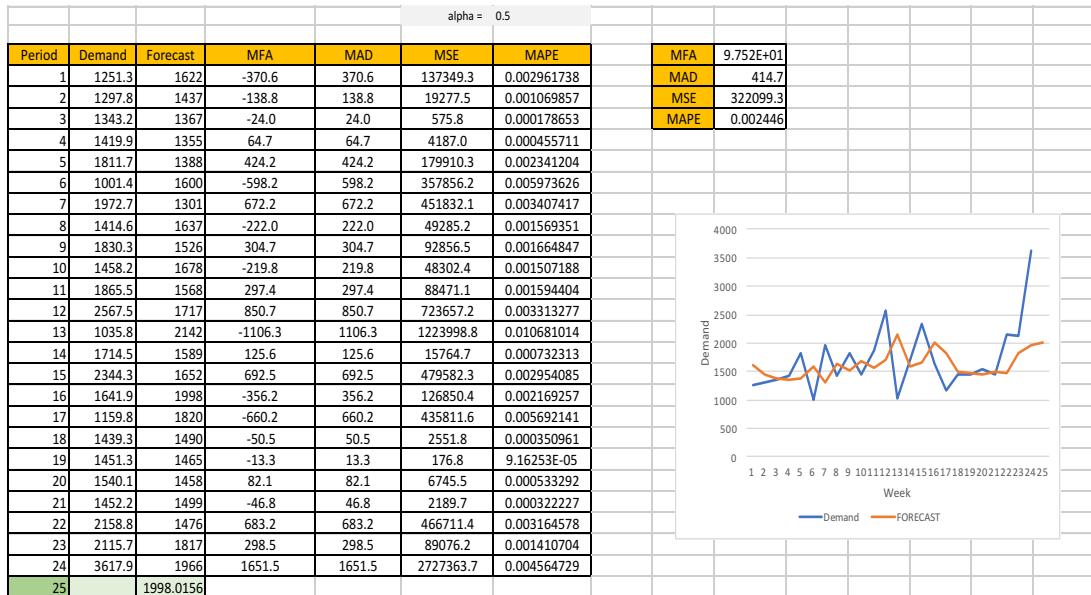


Figure A-130: FMB-0008 Exponential Smoothing Calculations (0.1 $\alpha$ )



**Figure A-131: FMB-0008 Exponential Smoothing Calculations (0.2 $\alpha$ )**



**Figure A-132: FMB-0008 Exponential Smoothing Calculations (0.5 $\alpha$ )**

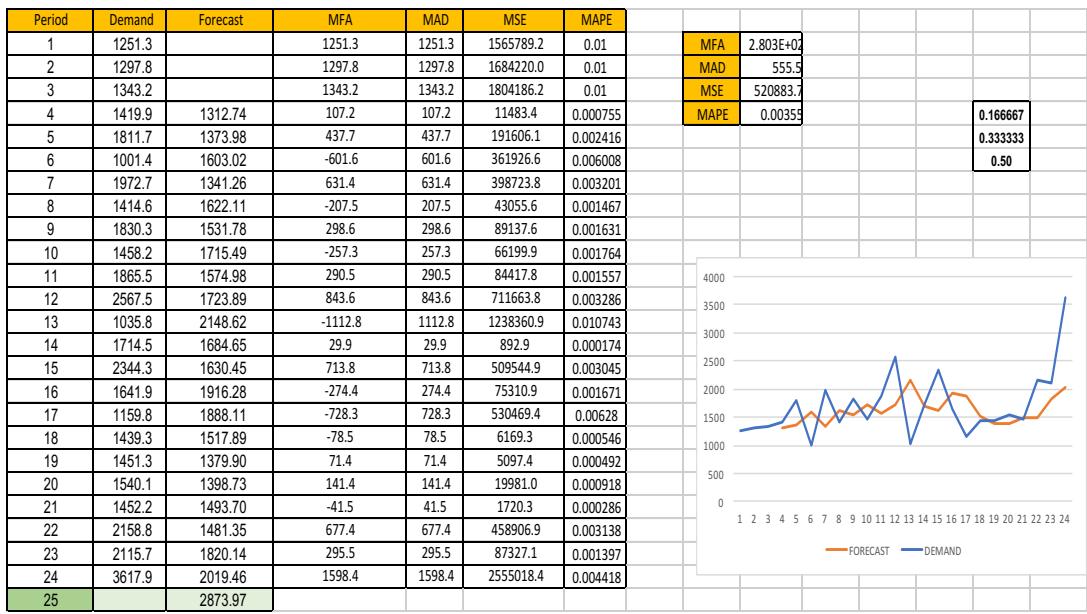


Figure A-133: FMB-0008 Weighted Moving Average Calculations

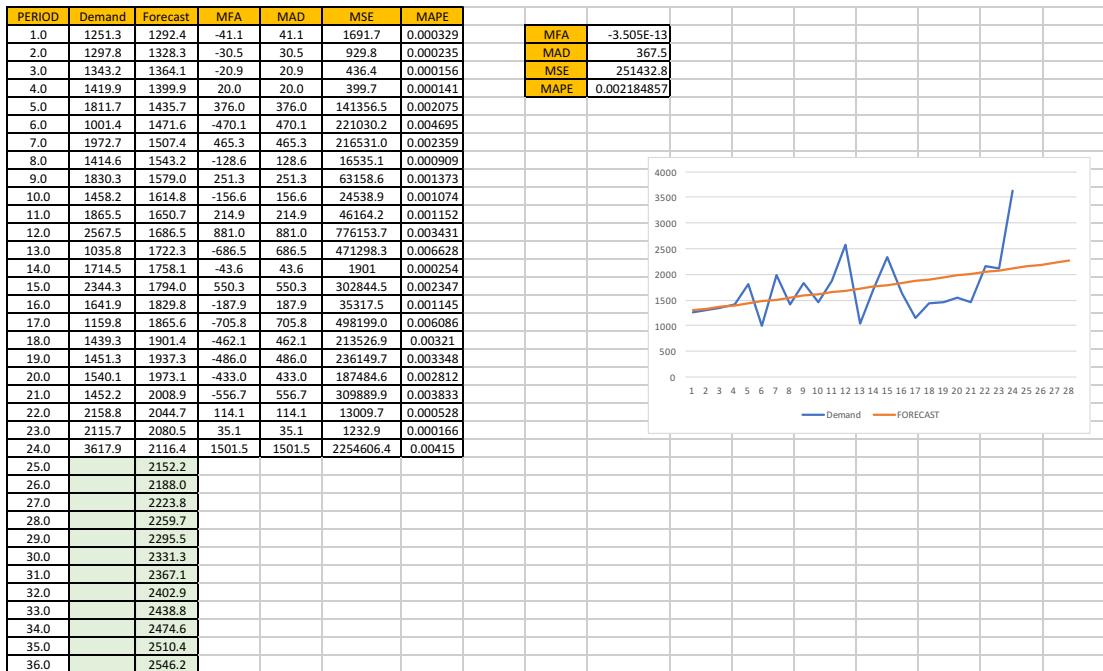


Figure A-134: FMB-0008 Linear Regression Calculations

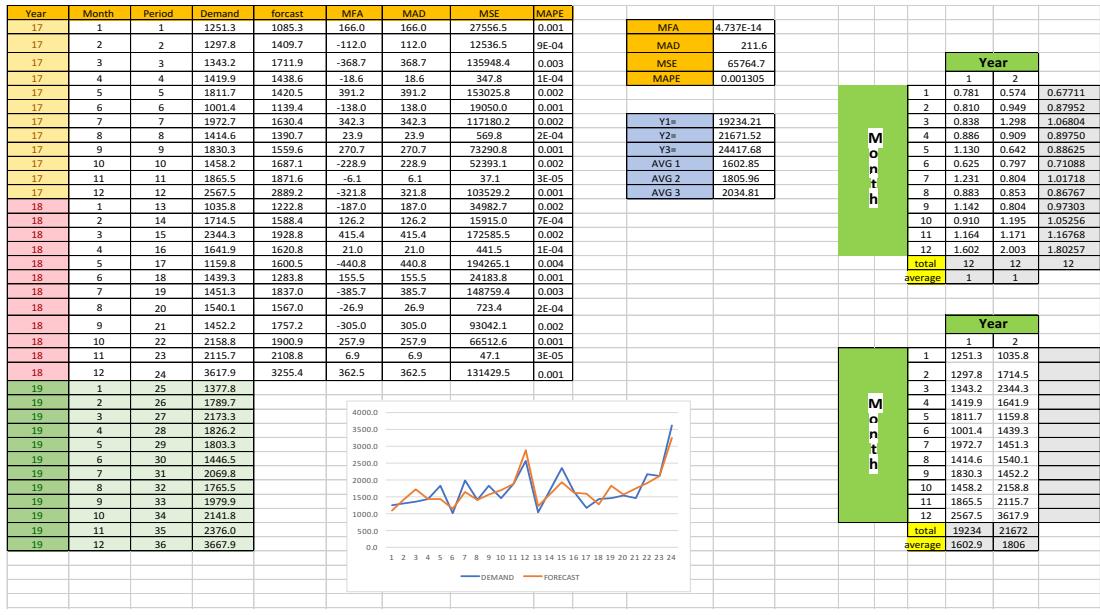


Figure A-135: FMB-0008 Seasonality Without Trend Calculations

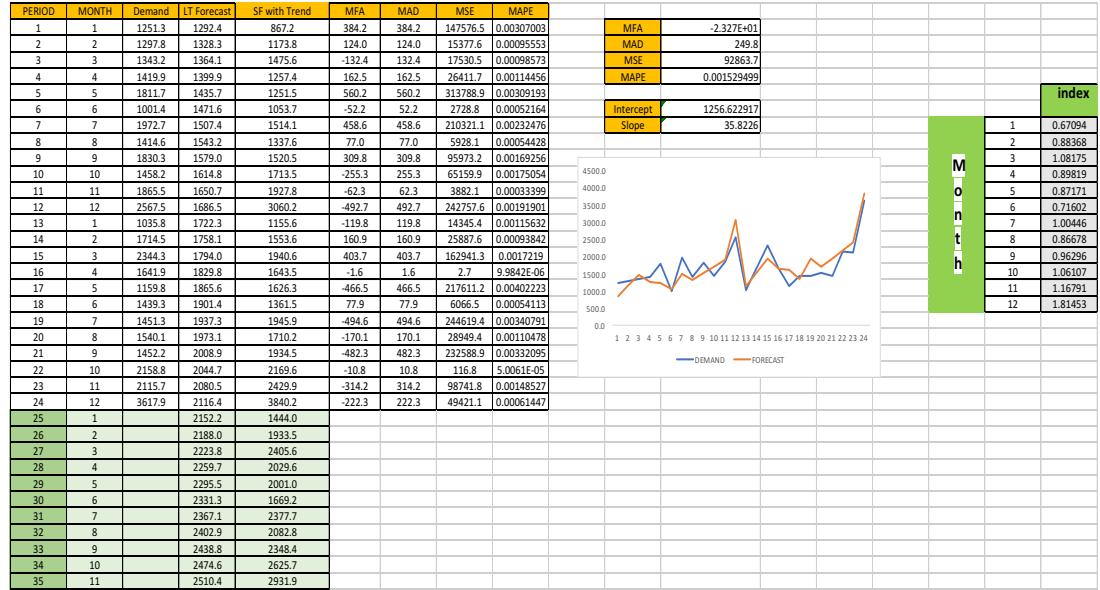


Figure A-136: FMB-0008 Trend Projected Adjusted Calculations

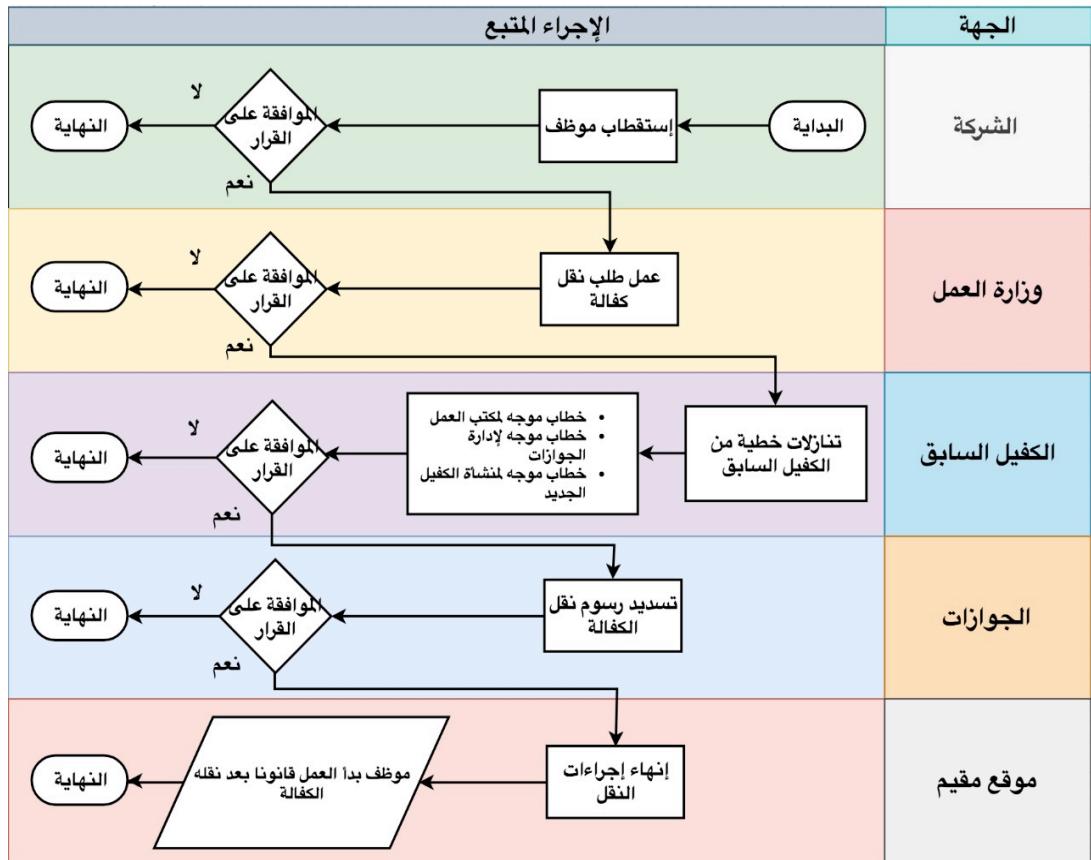


Figure A-137: Social Insurance Flowchart Diagram (Arabic)

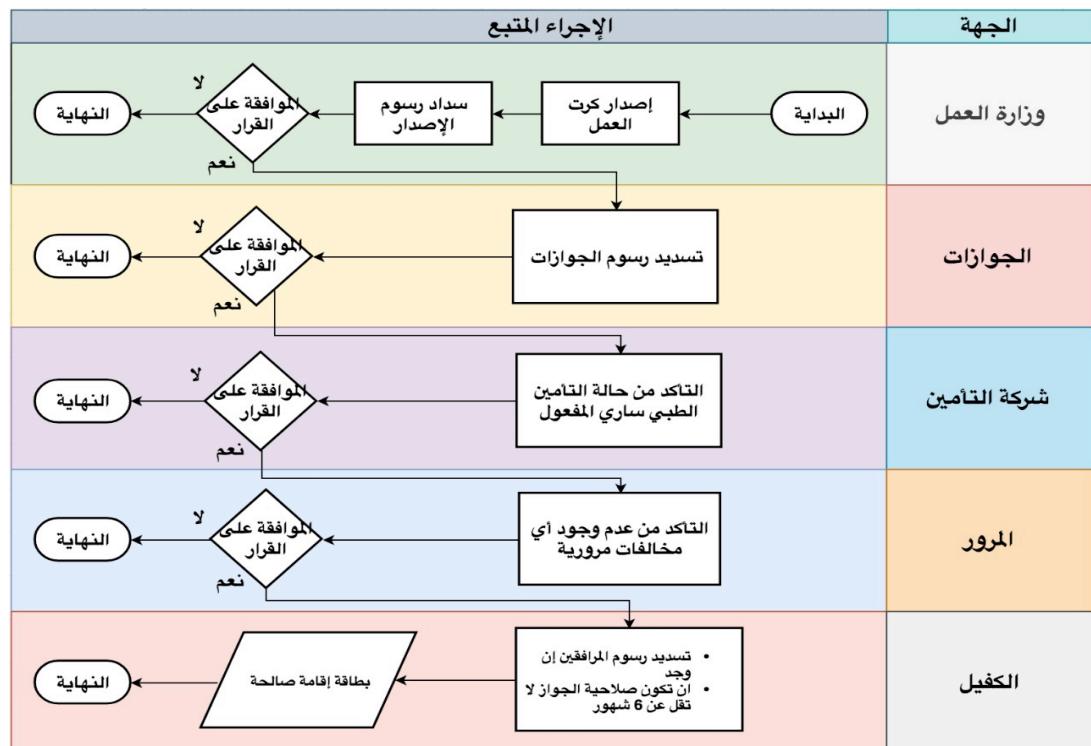


Figure A-138: Social Insurance Flowchart Diagram (Arabic)

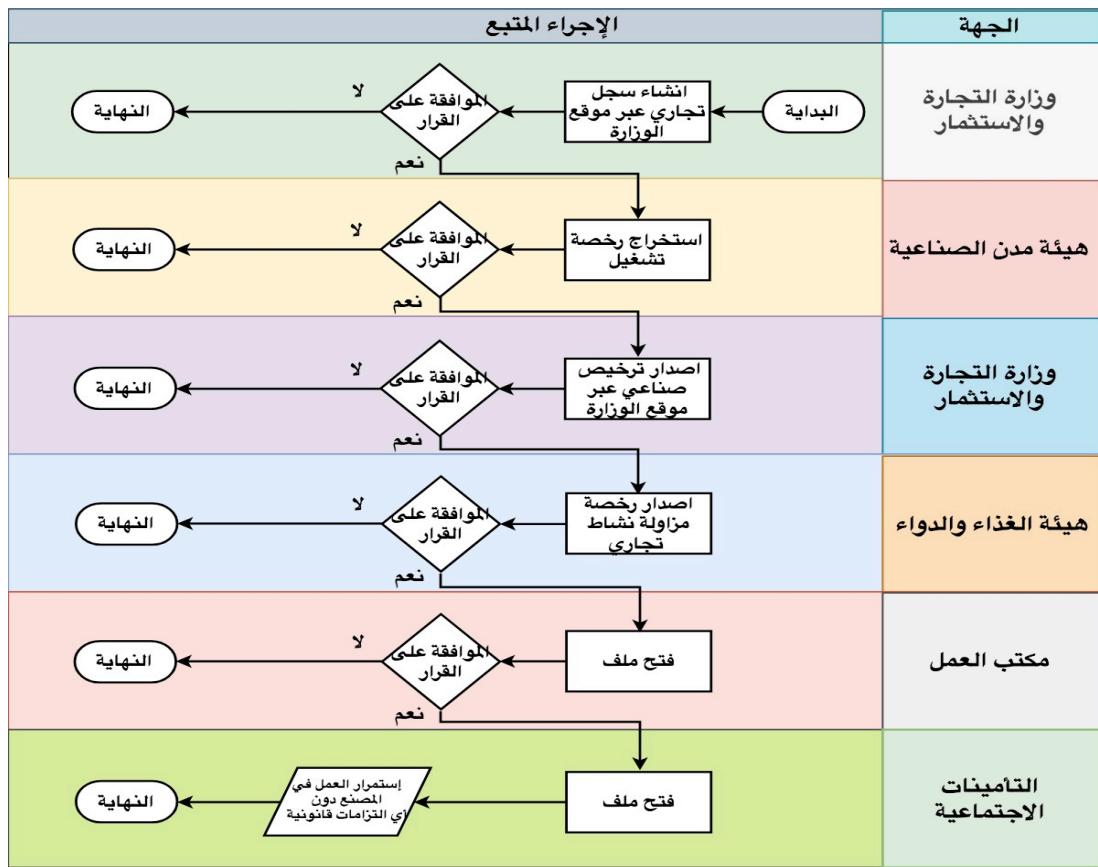


Figure A-139: Social Insurance Flowchart Diagram (Arabic)

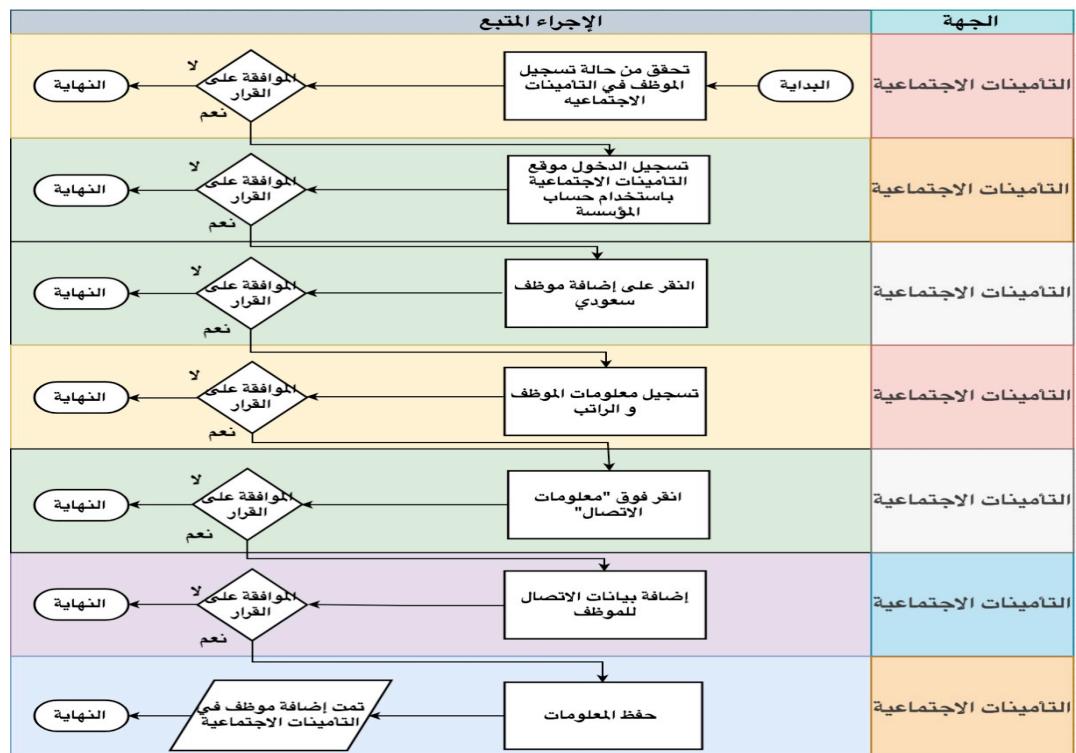


Figure A-140: Social Insurance Flowchart Diagram (Arabic)

## APPENDIX - B

### PROJECT PLAN (GANTT CHART)



	Task	Mode	Task Name	Duratio-	Start	Finish	Predoce	Dec	Qtr 1, 2019	Jan	Feb	Mar	Apr	May	Jun	Qtr 2, 2019	Jul	Aug	Sep	Oct	Nov	Dec	
1				▼			▼																
			“CH 5 (FORECASTING)	79 days	T 7/16/19	F 11/1/19																	
			“ Data Collection	33 days	T 7/16/19	T 8/29/19																	
			Collecting data	15 days	T 7/16/19	M 8/5/19																	
			Cleaning data	5 days	T 8/6/19	M 8/12/19																	
			Data difficulties	14 days	M 8/12/19	T 8/29/19																	
			Analysis & Results	31 days	F 8/30/19	F 10/11/19																	
			Writing Chapter 5	16 days	S 10/12/19	F 11/1/19																	
			“CH 6 (GAME THEORY)	79 days	T 7/16/19	F 11/1/19																	
			Analysis & Results	50 days	T 7/16/19	M 9/23/19																	
			Writing Chapter 6	29 days	T 9/24/19	F 11/1/19																	
			“ CONCLUSION AND RECOMMENDATIONS	4 days	F 11/1/19	W 11/6/19																	
			Writing the chapter	4 days	F 11/1/19	W 11/6/19																	
			References	1 day	T 11/7/19	T 11/7/19																	
			“ Appendix	17 days	T 11/7/19	F 11/29/19																	
			Appendix A	12 days	T 11/7/19	F 11/22/19																	
			Appendix B	2 days	M 11/18/19	T 11/19/19																	
			Appendix C	2 days	W 11/20/19	T 11/21/19																	
			Appendix D	5 days	M 11/25/19	F 11/29/19																	

Add tasks with dates to the timeline

Start S 15/19 | Tues 13 | Weds 13 | Thurs 13 | Friday 13 | Saturday 13 | Sunday 13 | Monday 13 | Tuesday 13 | Wednesday 13 | Thursday 13 | Friday 13 | Saturday 13 | Sunday 13 | Monday 13 | Tuesday 13 | Wednesday 13 | Thursday 13 | Friday 13 | Saturday 13 | Sunday 13 | Monday 13 | Tuesday 13 | Wednesday 13 | Thursday 13 | Friday 13 | Saturday 13 | Sunday 13 |

Finish F 11/29/19 | Nov 13 | Dec 1 | Jan 1 | Feb 1 | Mar 1 | Apr 1 | May 1 | June 1 | July 1 | Aug 1 | Sept 1 | Oct 1 | Nov 1 | Dec 1 |

## APPENDIX - C

### TEAM MEETINGS

#### Team Meeting (1)

Member No.	Member Name	Member ID	Role
1	Suliman Saleh Alhumied	1636491	Analyst
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
4	Mautaz Ali Aljayzani	1640593	Writer
5	Abdullah Ali Alothman	1635304	Organizer

#### Agenda for meeting

**Meeting Place:** KAU Library

**Meeting Time:** 1:30 PM

**Meeting Date:** 12<sup>th</sup> Apr 2019

**Duration of Meeting:** 120 Minutes

**Meeting Subject:** Looking for a company to apply industrial engineering techniques on.

#### Discussion:

- Listing to the companies that we could have access to.

#### Decisions:

- Have chosen Esnad Company to be our targeted company.
- Classify team members, according to their strong points.

#### Task Distribution:

Member No.	Task
1	Searching about the companies that we could work on.
2	Trying to get the contact information.
3	Trying to get the contact information.
4	Search for alternatives.
5	Calling his connections at one of the factories in Jeddah.

## Team Meeting (2)

<b>Member No.</b>	<b>Member Name</b>	<b>Member ID</b>	<b>Role</b>
1	Suliman Saleh Alhumied	1636491	Analyst
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
4	Mautaz Ali Aljayzani	1640593	Writer
5	Abdullah Ali Alothman	1635304	Organizer
<b>Eng. Eyad Bawazeer</b>		<b>Company Representative</b>	
<b>Dr. Ammar Y. Alqahtani</b>		<b>Project Advisor</b>	

### **Agenda for meeting**

**Meeting Place:** Bafart Café Shop

**Meeting Time:** 9:30 PM

**Meeting Date:** 24<sup>th</sup> May 2019

**Duration of Meeting:** 90 Minutes

**Meeting Subject:** Meeting of the company's representative.

### **Discussion:**

- Brief description of the company and its facilities.
- Weaknesses points that need improvement in the company.

### **Decisions:**

- Decided to visit the factory to fully understand the process used in the factory and the actual procedures taken by Esnad Company.
- Brainstorm area of improvement in Esnad Company.

### **Task Distribution:**

<b>Member No.</b>	<b>Task</b>
1	Visiting the factory to do observation and scanning.
2	Visiting the factory to do observation and scanning.
3	Visiting the factory to do observation and scanning.
4	Collecting information about the company.
5	Collecting information about the company.

## Team Meeting (3)

<b>Member No.</b>	<b>Member Name</b>	<b>Member ID</b>	<b>Role</b>
1	Suliman Saleh Alhumied	1636491	Analyst
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
4	Mautaz Ali Aljayzani	1640593	Writer
5	Abdullah Ali Alothman	1635304	Organizer
<b>Eng. Eyad Bawazeer</b>		<b>Company Representative</b>	
<b>Dr. Ammar Y. Alqahtani</b>		<b>Project Advisor</b>	

### **Agenda for meeting**

**Meeting Place:** Esnad Company

**Meeting Time:** 10:30 AM

**Meeting Date:** 24<sup>th</sup> Jun 2019

**Duration of Meeting:** 180 Minutes

**Meeting Subject:** Visiting Company's Facilities

### **Discussion:**

- Company's Products.
- Product's processes were starting from raw materials to finished goods.
- Inventory System.

### **Decisions:**

- Brainstorm tools could be used in order to improve the process.

### **Task Distribution:**

<b>Member No.</b>	<b>Task</b>
1	Check whether the safety tool could be applied in the factory.
2	Start working on the demand forecasting tool.
3	Start working on the "Demand Forecasting" tool.
4	Start working on the "Procedure Documentation" tool.
5	Start working on the "Game Theory" tool

## Team Meeting (4)

<b>Member No.</b>	<b>Member Name</b>	<b>Member ID</b>	<b>Role</b>
1	Suliman Saleh Alhumied	1636491	Analyst
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
4	Mautaz Ali Aljayzani	1640593	Writer
5	Abdullah Ali Alothman	1635304	Organizer

### **Agenda for meeting**

**Meeting Place:** KAU Library

**Meeting Time:** 2:30 PM

**Meeting Date:** 3<sup>rd</sup> Jul 2019

**Duration of Meeting:** 120 Minutes

**Meeting Subject:** Fields of the study

### **Discussion:**

- Discuss lists of weaknesses points prepared by each team member.
- Brainstorm root causes of the weaknesses points.

### **Decisions:**

- Decided to document the governmental procedures.
- Decided to work in forecasting the demand.
- Decided to apply game theory to Esnad Company.
- Setting up a timeline for the project.

### **Task Distribution:**

<b>Member No.</b>	<b>Task</b>
1	Searching for procedures documentation case studies applied in real life.
2	Searching for forecasting case studies applied in real life.
3	Searching for forecasting case studies applied in real life.
4	Searching for procedures documentation case studies applied in real life.
5	Searching for game theory case studies

## Team Meeting (5)

<b>Member No.</b>	<b>Member Name</b>	<b>Member ID</b>	<b>Role</b>
1	Suliman Saleh Alhumied	1636491	Analyst
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
4	Mautaz Ali Aljayzani	1640593	Writer
5	Abdullah Ali Alothman	1635304	Organizer

### **Agenda for meeting**

**Meeting Place:** KAU Library

**Meeting Time:** 12:30 PM

**Meeting Date:** 9<sup>th</sup> Aug 2019

**Duration of Meeting:** 90 Minutes

**Meeting Subject:** Requirements needed

### **Discussion:**

- Discuss the requirements needed to complete the project.

### **Decisions:**

- The developing team needs to do interviews with employees responsible for governmental procedures.
- The developing team needs to get sales data from the sales department.

### **Task Distribution:**

<b>Member No.</b>	<b>Task</b>
1	Setting meetings with employees responsible for governmental procedures.
2	Asking Eng. Eyad to get the sales data from the sales department.
3	Asking Eng. Eyad to get the sales data from the sales department.
4	Setting meetings with employees responsible for governmental procedures.
5	Meeting the management representative to get some needed information.

## Team Meeting (6)

<b>Member No.</b>	<b>Member Name</b>	<b>Member ID</b>	<b>Role</b>
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
<b>Eng. Eyad Bawazeer</b>			<b>Company Representative</b>
<b>Asif Rashad</b>			<b>Sales Department Manager</b>

### **Agenda for meeting**

**Meeting Place:** Esnad Company

**Meeting Time:** 10:30 AM

**Meeting Date:** 16<sup>h</sup> Sep 2019

**Duration of Meeting:** 30 Minutes

**Meeting Subject:** Sales Data Request

### **Discussion:**

- Needed Sales Data for forecasting.

### **Decisions:**

- Sales Department Manager promised us to deliver the data within two weeks.
- Arranging meetings with employees responsible for governmental procedures.

### **Task Distribution:**

<b>Member No.</b>	<b>Task</b>
1	Preparing steps needed for procedure documentation.
2	Search for the demand forecasting methods that could be applied.
3	Search for the demand forecasting methods that could be applied.
4	Preparing steps needed for procedure documentation.
5	Edit some principles in the game theory chapter.

## Team Meeting (7)

<b>Member No.</b>	<b>Member Name</b>	<b>Member ID</b>	<b>Role</b>
1	Suliman Saleh Alhumied	1636491	Analyst
4	Mautaz Ali Aljayzani	1640593	Writer
<b>Eng. Eyad Bawazeer</b>			<b>Company Representative</b>
<b>Mohammed Alzahrani</b>			<b>Responsible for Governmental Issues</b>

### **Agenda for meeting**

**Meeting Place:** Esnad Company

**Meeting Time:** 1:30 PM

**Meeting Date:** 3<sup>rd</sup> Oct 2019

**Duration of Meeting:** 75 Minutes

**Meeting Subject:** Governmental Procedures.

### **Discussion:**

- Governmental procedures needed to be documented.
- Sales data readiness.

### **Decisions:**

- Decided to document four governmental procedures.
- Took the information needed for the four governmental procedures.
- Decide to forecast 178 products.

### **Task Distribution:**

<b>Member No.</b>	<b>Task</b>
1	Analyzing the steps needed for procedure documentation.
2	Arranging the data sent by the sales department.
3	Arranging the data sent by the sales department.
4	Analyzing the steps needed for procedure documentation.
5	Visiting the company to get some missing information and data.

## Team Meeting (8)

Member No.	Member Name	Member ID	Role
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector

### Agenda for meeting

**Meeting Place:** Sofa Lounge

**Meeting Time:** 8:30 PM

**Meeting Date:** 17<sup>h</sup> Oct 2019

**Duration of Meeting:** 50 Minutes

**Meeting Subject:** Data Arrangement.

### Discussion:

- Sales Data Arrangement.

### Decisions:

- Decided to Forecast 178 products.
- Decided to use six methods of demand forecasting.
- Decided to use the Pareto chart.
- Divided the products into Excel sheets.

### Task Distribution:

Member No.	Task
1	Analyzing steps needed for procedure documentation.
2	Responsible for searching for Pareto chart.
3	Arranging the data sent by the sales department.
4	Responsible for arranging the data into Excel sheets.
5	Visiting the company to get some missing information and data.

## Team Meeting (9)

Member No.	Member Name	Member ID	Role
1	Suliman Saleh Alhumied	1636491	Analyst
4	Mautaz Ali Aljayzani	1640593	Writer

### Agenda for meeting

**Meeting Place:** Blue Ocean

**Meeting Time:** 6:30 PM

**Meeting Date:** 3<sup>th</sup> Nov 2019

**Duration of Meeting:** 75 Minutes

**Meeting Subject:** Governmental Procedures

### Discussion:

- Governmental procedures

### Decisions:

- Decide to choose flowchart diagram as a visual document.
- Decide to use Drawio website.

### Task Distribution:

Member No.	Task
1	Responsible for explaining the flowchart and how does it work.
2	Responsible for searching for Pareto chart.
3	Arranging the data sent by the sales department.
4	Responsible for visualizing the steps of the procedure into flowchart using Drawio Website.
5	Visiting the company to get some missing information and data.

## Team Meeting (10)

Member No.	Member Name	Member ID	Role
1	Suliman Saleh Alhumied	1636491	Analyst
2	Abdullah Waleed Hawarnah	1635455	Leader
3	Bader Omar Balamash	1635669	Collector
4	Mautaz Ali Aljayzani	1640593	Writer
5	Abdullah Ali Alothman	1635304	Organizer

### Agenda for meeting

**Meeting Place:** KAU library

**Meeting Time:** 4:30 PM

**Meeting Date:** 15<sup>th</sup> Nov 2019

**Duration of Meeting:** 120 Minutes

**Meeting Subject:** Revising and finalizing the project.

### Discussion:

- Every team member will revise his chapter and make sure of the correct format.

### Decisions:

- Decided to submit the project on the 27<sup>th</sup> of Nov. 2019 at 11:00 AM

### Task Distribution:

Member No.	Task
1	Revising the content and format of the procedure documentation chapter.
2	Revising the content and the format of demand forecasting chapter
3	Revising the content and the format of demand forecasting chapter
4	Revising the content and format of the procedure documentation chapter.
5	Revising the content and the format of game theory chapter.

# APPENDIX – D

## SENIOR DESIGN PROJECT CHECKLIST



### INDUSTRIAL ENGINEERING PROGRAM

First Semester & Year Fall 2019

December 2019

**Write (1) for Yes.....(2) for No.....(3) for NA**

Item	Yes	No	NA	If "No" Cite Reason(s)	Page No.
<b>Stage #1 : Project Preparation</b>					
Is the project title towards "Design"?	1				1
Is the number of students $\geq 3$ ?	1				iv
Is the project topic multidisciplinary?	1				2
Is the project peer reviewed?	1				iv
<b>Is the executive summary or the abstract shows:</b>					
Customer needs	1				59
Methodology applied	1				13
Results obtained	1				43
<b>Is the strategy for accomplishing the project shows:</b>					
Scheduled Project tasks (Gant chart)	1				184
Project handles more than one aspect (Courses Utilized)	1				13
Students taking responsibility	1				186
<b>Stage #2 : Project Design</b>					
Is the problem defined well?	1				2
Are several alternative solutions suggested?	1				88
<b>Are alternative Solutions analyzed via Realistic Constraints?</b>					
Economic	1				59
Social impact		3			
Environmental		3			
Political		3			
Ethical		3			
Health & Safety		3			
Manufacturability		3			
Sustainability	1				26
Is the financial analysis included?		1	3		
<b>Is the recommended solution based on the following criteria?</b>					
Global		3			
Economic	1				59
Environmental		3			
Social context		3			
<b>Stage #3 : Project Closure</b>					
Are conclusions included?	1				86
Are recommendations included?	1				88
Are references included?	1				90
Are appendices included?	1				93
<b>Project Documentation</b>					
Is the project portfolio attached?		3			CD
Is the students log book attached?		3			
Is the oral Checklist used?		3			
Is the written Checklist used?		3			
Are the progress report(s) attached?		3			
Are rubrics for at least outcomes 1, 2, 3, 4, 5 and 7 attached?	1				
Is the PowerPoint presentation attached?	1				
Is the video record for final presentation attached?		3			
<b>21 0 16</b>					
<b>Percentage of Achievement</b>					
100&					
<b>HINT</b>  Before approving the project for final presentation project coordinator will sure that all the items are considered as "YES." or there are rational reasons for "NO" answers					
Advisor Name: Dr. Ammar Y. Alqahtani Signature: Date: 24/12/2019					
Approved by SPC Signature & Date: Muhammad Rehan Maqbool					