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PRICING STRATEGY IN A DUAL-CHANNEL SUPPLY-CHAIN CONSIDERING CONSIGNMENT METHOD OF PAYMENT IN MR FRONIEZ SME

REIZA PRADIPTA MAKRUF
NRP 024 1144 0000118

Supervisor
Dr. Eng. Erwin Widodo, S.T., M.Eng.
NIP. 197405171999031002

Department of Industrial Engineering
Faculty of Industrial Technology
Institut Teknologi Sepuluh Nopember
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Surabaya

Author:

REIZA PRADIPTA MAKRUF

NRP 02411440000118

Acknowledged and Approved by,

Final Project Supervisor

Dr. Eng. Erwin Widodo, S.T., M.Eng.

NIP. 197405171999031002

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Name : Reiza Pradipta Makruf

Student ID : 02411440000118

Department : Industrial Engineering – ITS

Supervisor : Dr. Eng. Erwin Widodo, S.T., M.Eng

ABSTRACT

Since the beginning of 21st century, the internet is become one of the basic needs of human in terms of supporting or even replacing human daily activities in several activities in terms of sending email, shopping, ordering food, etc. The rapid development of information technology itself has led many manufacturers to add their existing physical retail channels with an online channel (or, e-channel), which provides them with an opportunity to provide potential consumers who would otherwise have no intention to buy the manufacturers products. The platform which facilitates the online shopping and online sales mentioned in the previous paragraph is e-commerce. E-commerce refers to the paperless exchange of business information using electronic data interchange, electronic mail, electronic bulletin boards, electronic funds transfer. Then, Dual-channel Supply-chain which utilizing both online direct channel and offline retail channel, would be suitable in assessing such development of e-commerce potential needs. In this research, the author proposed a Dual-channel Supply-chain model with the addition of consignment contract condition implemented by the offline retail channel.

Consignment itself is defined as means to entrusting goods to persons or agents to be sold with a later payment.Next, in this research the construction of demand model for both channel could be divided into two (2) major groups, Dual-channel Supply-chain and Consignment terms of payment conditions, which in result generate 6 constructed scenarios varies in consignment level of product and coordinating policy of all channel. Based on the result of all scenarios optimization process. Scenario 3 which possess low-consignment level and non-cooperative condition, shows the best financial performance if consignment product is remain and either scenario 4,5, and 6 if consignment product is all being purchased in the following period, which generate most total earning compared to other scenarios.

Keyword: Consignment Method of Payment, Dual-Channel Supply Chain, Pricing Strategy.

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Surabaya, July 2018

Author

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CHAPTER 1
INTRODUCTION

In this chapter, the introduction of the report will be provided. There are several subchapter that will be elaborated such as background, problem formulation, research objectives, research benefits, research scopes, and research outlines.

1.1 Background

Since the beginning of 21st century, the internet is become one of the basic needs of human in terms of supporting or even replacing human daily activities in several activities in terms of sending email, shopping, ordering food, etc. That argument is supported by the significant increase of the internet penetration by individual in Indonesia, which will be indicated by the Figure 1.1.

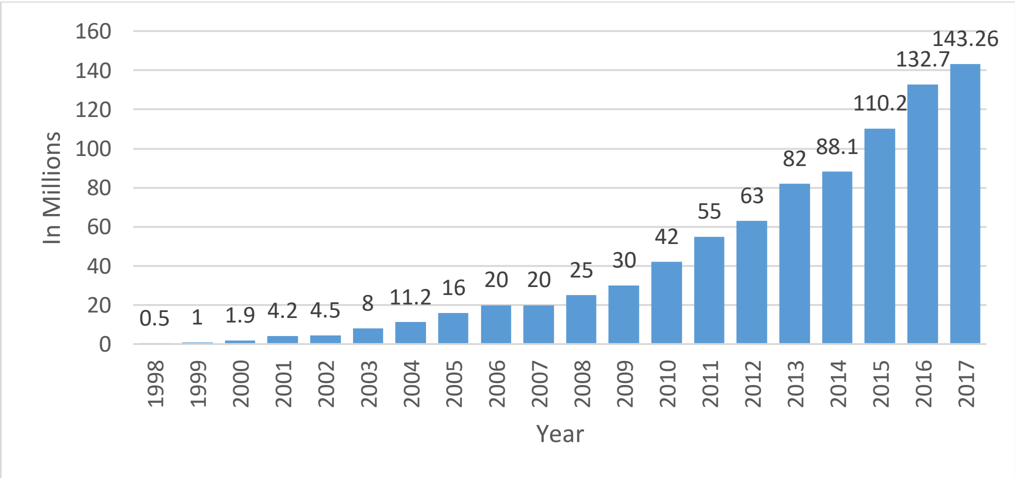

Figure 1.1 Internet User Growth in Indonesia
Source: (Asosiasi Penyelenggara Jasa Internet Indonesia, 2017)

Based on Figure 1.1 the trend of internet user in Indonesia is increasing exponentially from only 0.5 million users in 1998 to 143.26 million users in 2017. Thus, it is indicating that the internet user growth is inevitable. This is a good indicator for the online-based business which will be the main concern in this research.

Next, Figure 1.2 shows the internet utilization in economic field. Economic activities itself is defined as the activities of production, distribution, and consumption of commodities (Duhaime.org, 2018).

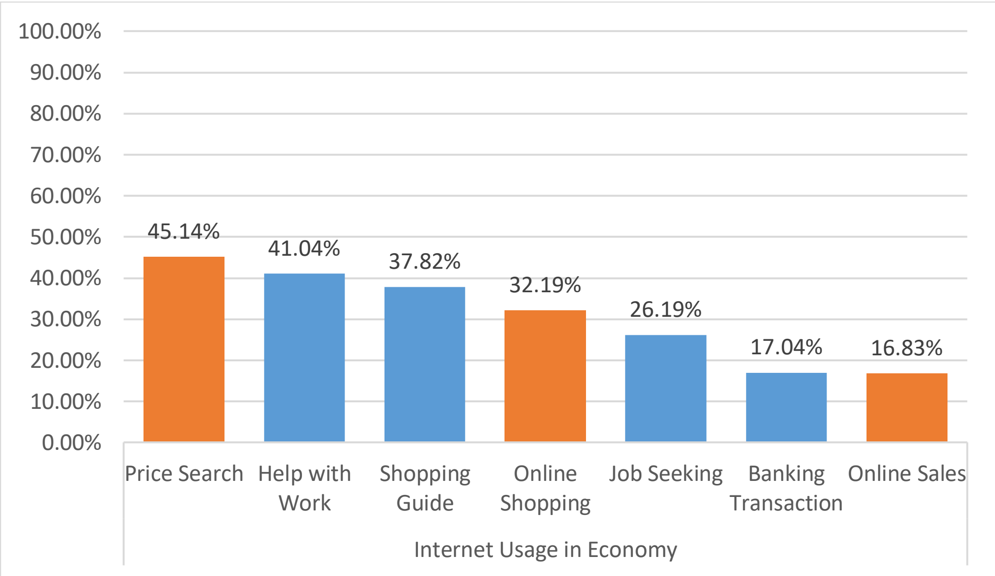

Figure 1.2 Internet Utilization in Economy
Source: (Ecommerce Foundation, 2017)

Based on Figure 1.2, the percentage of price search, online shopping, and online sales utilization compared to the total internet users are 45.14% for price search for pre-product purchase, 32.19% for online shopping, and 16.83% for online sales respectively. Although those percentages are below 50%, they indicate an opportunity for online-based business to seek more sales potential to be utilized in the future.

The platform which facilitates the online shopping and online sales mentioned in the previous paragraph is e-commerce. E-commerce refers to the paperless exchange of business information using electronic data interchange, electronic mail, electronic bulletin boards, electronic funds transfer, World Wide Web, and other network based technologies (Bhalekar, Ingle and Pathak, 2014). Until recently, e-commerce shows a significant development and popularity in emerging economy, both in the terms of number and increase in percentage. The trend also shows in the increasing amount of e-commerce service provider, such as Bobobobo, Dekoruma, Lazada, Bukalapak, etc, Those e-commerce provide various product fields (e.g. furnitures, consumer goods, and fashion product) and online services (e.g. ticketing, book and reservation, food delivery, and transportation).

Figure 1.3 Indonesian Total E-Commerce Sales
Source: (Asosiasi Penyelenggara Jasa Internet Indonesia, 2017)

From the Figure 1.3 above, the number of total e-commerce sales in Indonesia insinuated a constant increase in the number of consumer spending on e-commerce-based business.

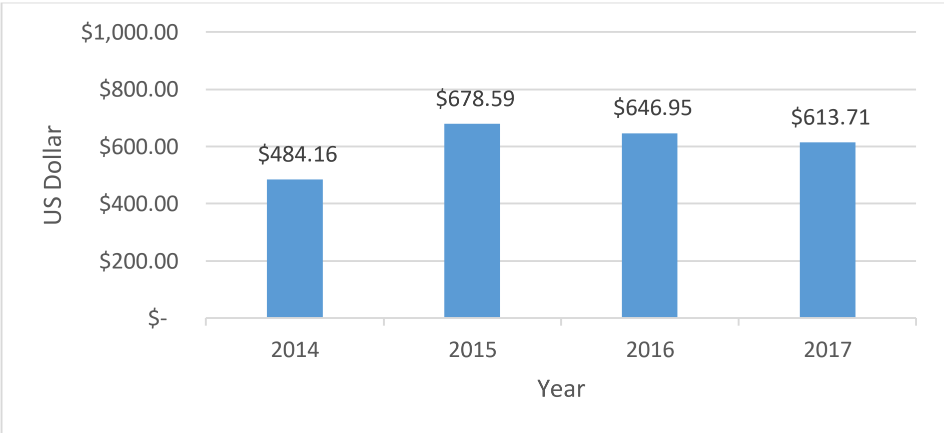

Figure 1.4 Average Spending per E-Shopper
Source: (Ecommerce Foundation, 2017)

After that, the author will the average spending per E-shopper specifically in Indonesia, which clearly stated in the Figure 1.4 which surprisingly decrease in number for the last two years with $613.71 in 2017. Although, the piece of $613.71 with increase number in internet users every year in a country with total population of 238 518,8 thousand in 2000 and projected to be 271.066,4 thousand in 2020 (Badan Pusat Statistik, 2013).

The government of Indonesia itself, as the governing and regulating body in Indonesia also shows an interest in this field by issuing Indonesia’s e-commerce road map through Presidential Regulation No. 74 of 2017 on E-Commerce Road

Map for the Year of 2017-2019. In the road map, the regulation purpose is to provide direction and strategic guidance to various government agencies to support and accelerate development of e-commerce in Indonesia, which could also being one factor that could support e-commerce and e-shopper existence in Indonesia.

The rapid development of information technology itself has led many manufacturers to add their existing physical retail channels with an online channel (or, e-channel), which provides them with an opportunity to provide potential consumers who would otherwise have no intention to buy the manufacturers products. (Huang and Swaminathan, 2009)

For this research, the author observation object is Mr Froniez Browniez, which is a food processing firm categorized as small, and medium enterprises (SME) specialized in snack with chocolate as the main ingredient, there are variety of product which are cold brownies cake branded as Mr. Froniez, baked brownies cake under the same brand, and brownies cracker branded as Bronchips. The Bronchips itself is created and was in sale in the July 2016.

However, there are several reasons on selecting this type of SME compared with the rest type of SME, which stated in the Figure 1.5. It shows, that the highest percentage of all industry contribution to Gross Domestic Product (GDP) in Indonesia is on processing industry with 21.08% far ahead compared to another top 6 contributor field of industry and service.

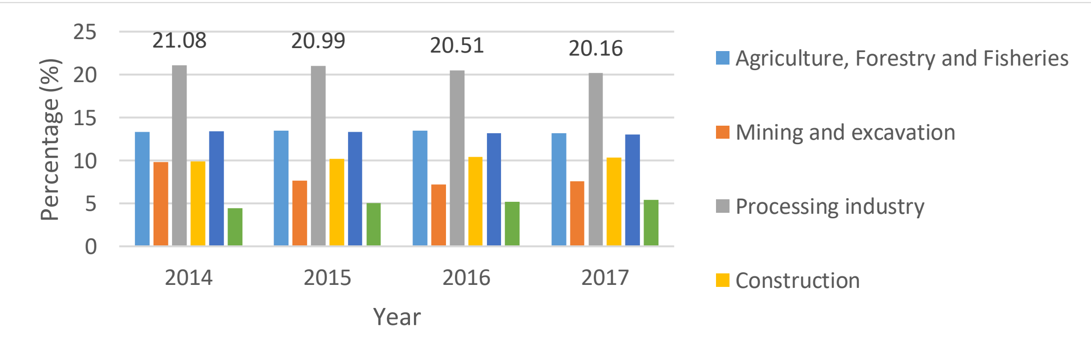

Figure 1.5 Indonesia GDP Distribution Proportion from Top 6 Field of Industry and Service
Source: (BPS - Statistics Indonesia, 2017)

Next, to be more specific, the GDP distribution of processing industry is explained furthermore in the Figure 1.6, which indicate that food and beverage industry topped the top 5 contributor of GDP in processing industry field with 6.14% in 2017.

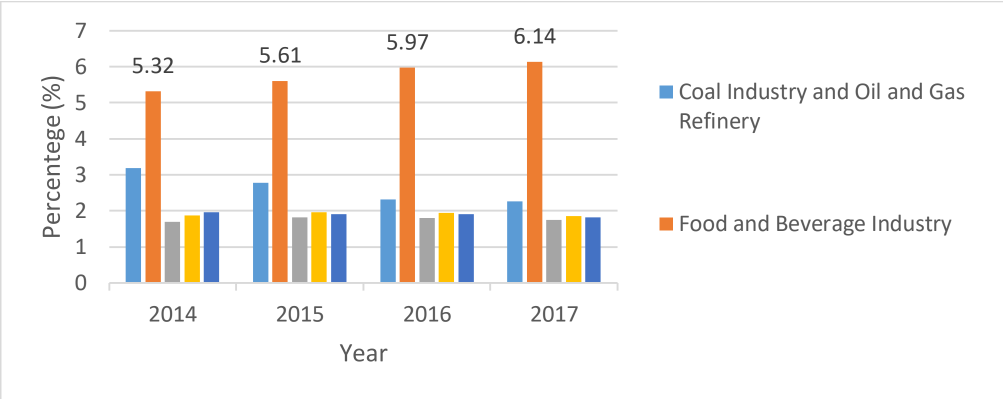

Figure 1.6 GDP Contribution Distribution in Processing Industry Field
Source: (BPS - Statistics Indonesia, 2017)

Then, according to those passage above, the author determined Mr Froniez Browniez SME, as the object of observation in this research.

Figure 1.7 Mr. Froniez Brand Logo
Source: (Mr. Froniez, 2018)

However, the product that is focused in this research is Bronchips cause, it is compose almost 80% of the total revenue of Mr. Froniez Brownies sme at total. Next, in this case, contrary to popular approach by another sme start-up business, Mr Froniez Browniez came in with the online channel first, and the offline channel or conventional store come only this year. Based on the owner statement, the consideration of it came from the branding awareness of directly open the online channel, and to open the new customer opportunity. Mr Froniez only open the offline channel due to encouragement given from Trading Department of Surabaya, with listing and connection provided to the modern market.

Therefore, the pricing decision in Mr Froniez for both channel is based only on preemptive assumption that modern market and supermarket should have at least the same price because of its variable cost such as transportation cost from production warehouse into the modern market warehouse, the payment method such as consignment, and risk of defect product which is imposed only on the supplier. Therefore, the detail of price could be seen on Table 1.1. Which lead, to the problem in the number of retailer selling rate that is much lower than the total sales combine between both channels. However, there are unique initial contract which required the manufacturer to implement the full consignment level to sell in retail channel, which would be the focused problem to be solved in this research.

Table 1.1 Existing Product Price

No	Channel Name	Channel Type	Price/package (Rp)
1	Direct Channel	Online Channel	15000
2	Retail Channel (Indomaret, Giant)	Offline Channel	15000

Thus, Dual-channel Supply-chain which utilizing both online direct channel and offline retail channel, would be suitable in assessing such development of e-commerce potential needs. Hence, conceptual model for basic Dual-channel Supply-chain is explained in Figure 1.8.

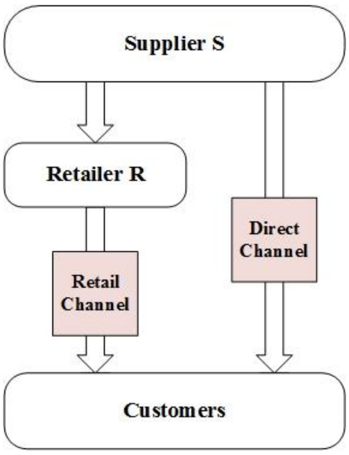

Figure 1.8 Dual Channel Supply Chain

In this research, the author proposed a Dual-channel Supply-chain model with the addition of consignment contract condition implemented by the offline retail channel. Consignment itself is defined as means to entrusting goods to persons or agents to be sold with a later payment. (Tehupeiory, 2017). Previous study of Dual-channel Supply-chain with consignment condition is already discussed in (Wang, Leng and Liang, 2018), the paper mentioned about the selection of new channel implementation for manufacturer which initially only has offline channel, to whether should opted to open online channel without consignmnet contract or with full consignment constract. Therefore, the graphical model of it will be presented in Figure 1.9 as follows.

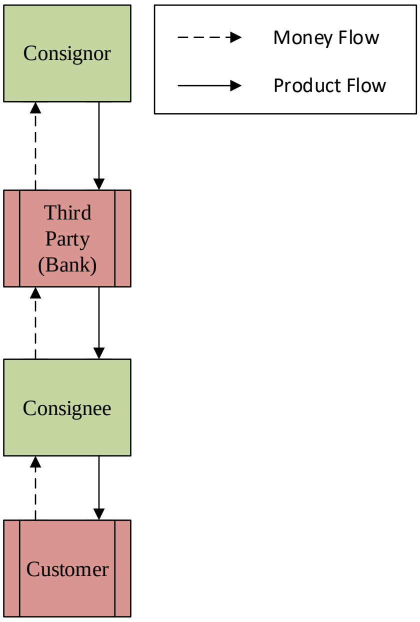

Figure 1.9 Consignment Shop Basic Model

However, in (Wang,2018) research, the research gap is if the manufacturer does not have any choice to opt out the consignment contract. However, manufacturer has an option to proposed new contract to decide consignment level of supplied product to the retailer. Hence, the model of the research would be developed using (Huang, Yang and Zhang, 2012) research model and would be developed into two basic model which are:

1. Sequential Dual-channel Supply-chain pricing decision with different consignment level
2. Simultaneous Dual-channel Supply-chain pricing decision with different consignment level

In this research, Sequential Dual-channel Supply-chain pricing decision is identical to Stackelberg game which define formally as formulation of a model of yield leadership which was applicable for homogeneous market. In the order of action, there is a difference between the manufacturers. Production decisions are based on the following sequence: the leader firm announces forward production first according to the rule of thumb, then the follower observes his action and makes production decision accordingly. Thus in planning phase, the leader must consider how the follower will react, which means the leader firm knows response function of the follower and can predict the output impact of follower roughly. (Xiao *et al.*, 2018). Next, simultaneous pricing decision is identical to Bernard competition scheme which mean that the firms should open all information needed by the other firms to be analyzed for generating the best pricing strategy

Hence, in this research Mr Froniez pricing model would be constructed for to find maximum profit between online channel, and offline retail channel with the introduction of consignment condition of both sequential pricing decison and simultaneous pricing decision.

1.2 Problem Formulation

Based on the aforemention background. The research problem will be provided as follows

1. Construction of pricing model for Mr Froniez Brownies under dual-channel supply-chain structure (including one offline retailer and one online supplier) by considering consignment payment.
2. Analysis of simultaneous or step-by-step optimization procedure in determining the optimum prices both for offline retailer and online supplier by implementing Bertrand and Stackelberg leadership scenario.

1.3 Research Objectives

This objective that will be targeted in this research will be provided as follows:

1. Obtaining analytical model of individual profit for every channel and overall profit model for DCSC in Mr Froniez Brownies.
2. Determining optimal pricing for profit maximization in dual channel supply chain for one of the, Small and Medium Enterprise of Mr Froniez Brownies, considering consignment payment method.

1.4 Research Benefits

This research is expected to provide benefits for SME, which are as follows:

1. Enterprises can measure and identify their trading position for both online and offline channel.
2. Enterprises obtain recommendation regarding pricing strategy based on assessment conducted to create maximum profit in regard to customer preferences of all channel
3. Enterprises obtain recommendation of pricing strategy of all channel based on the financial performance.

1.5 Research Scopes

The scope for this research consists of limitations and assumptions used in doing this research. Limitations' purpose is to limit the scope of research, while assumptions' purpose is to simplify the real condition within enterprises as an object.

1.5.1 Limitations

Limitations used for this research are as follow:

1. There is only one retailer and one online channel in one dual channel supply chain.
2. This research is limited to only one type of product in the enterprise with largest demand.
3. Retail channel demand of Giant, Indomaret and other retail is combined into a single entity.
4. Other limitations that have not been listed will be explained in Chapter 4.

1.5.2 Assumptions

Assumptions used for this research are as follow:

1. Product is always available in retailer or offline channel.
2. There is no inventory activity exist in online-channel.
3. Other variables which affect customer preference such as lead time and competitor product is neglected.
4. Product Price is considered to construct customers preference.
5. All of the product returned in consignment only because it is not purchased.

6. Other assumptions that have not been listed will be explained in Chapter 4.

1.6 Research Outlines

In this subchapter, the outline of the research will be presented in the report writing structure as follows:

CHAPTER I INTRODUCTION

This chapter will elaborate about background in doing research, problem identification, research objectives, research benefits for both author and enterprises, research scope including limitations and assumptions used, and report writing structure for this research.

CHAPTER II LITERATURE REVIEW

This chapter elaborate about the various list of literatures from several resources, including theories and methods used as fundamental and guidelines in this research. All of the theories and methods used will be explained in this chapter and created into systematic critical discussion.

CHAPTER III RESEARCH METHODOLOGY

This chapter provide about research methodology consist of systematical work flow, start from the first step until the last. All of the explanation of how the research is conducted from the beginning to the end can be obtained in this chapter.

CHAPTER IV MODEL FORMULATION

This chapter discusses about system description, model development from every pricing scenario based on the offline and online demand data of the observation object. It will also describe which scheme and scenario that will be utilize in analyzing pricing strategy in regard to limitation and assumption, parameter, objective function and boundary of the model itself. The result will be utilized later in next chapter.

CHAPTER V NUMERICAL EXPERIMENTS AND ANALYSIS

Based on the result from model formulation in the previous chapter, then numerical experiment will be constructed for every pricing decision scenario. Hence, the scenario which generating the highest profit or optimum. Then, output analysis and sensitivity analysis are also conducted based on the relevant result number.

CHAPTER VI CONCLUSION AND SUGGESTION

This chapter discusses about the detailed information of the research final result. Conclusions will be provided to answer the problem formulation and research objectives to ensure the work of this research are appropriate as expected before. While suggestions are given to further researchers.

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CHAPTER 2
LITERATURE REVIEW

This chapter will discuss various compilation of literatures from several resources such as books, articles, scientific journals, previous studies, and other sources. Literature review will be used as the guidelines in doing the research and would provide answers to the questions raised in the problem formulation. The literatures that will be explained are divided into critical discussion of Dual Channel Supply Chain, Pricing Determination Strategy, Sales Terms of Payment and Non-linear Programming, which is provided as follows.

2.1 Dual Channel Supply Chain (DCSC)

In this subchapter, the determination of dual channel supply chain will be covered by divide it into several subchapter consist of DCSC definition and explanation, and type of demand in DCSC. Hence, the explanation will be constructed as follows.

2.1.1 Dual Channel Supply Chain Definition and Explanation

Based on the explanation of the dual-channel supply chain which already stated in the previous chapter, it is defined as the sales combination between the online channel and traditional retail channel simultaneously.

Hence, the fundamental model of dual channel which is presented in Figure 2.1, that is previously described in the previous chapter is stated below, which shows the relation of the supplier and customer through the channels.

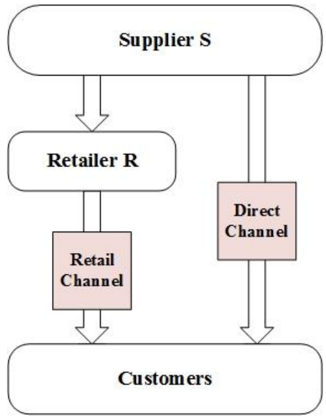

Figure 2.1 Dual-Channel Supply Chain
Source: (Batarfi, Jaber, and Zanomi, 2016)

Yet, the idea of implementing dual-channel supply chain is considered as important nowadays, however several manufacturer and supplier seems hesitate to implement it due to popular belief that adoption of online channel would create complicated relation or conflict between initial and new channel created. However, the fact is the adoption would reduce the wholesale price of the product, which lead to increase both firms profit in many occasion. Hence, the reduction of the wholesale price would affect either seller total cost or its markup margin which means the retailer should redefine its markup margin for both channel. (Batarfi, Jaber and Zanoni, 2016)

2.1.2 Type of Demand in Dual Channel Supply Chain

Before providing about the demand type existed in the dual channel supply channel, the demand is defined as the customer rate to buy product. Hence, there are two important factors which affect the demand rate of product defined as ability to buy (1) interpreted as customer requirement of possessing sufficient money for buying product, and taste (2) interpreted as desire of a product, also interfering with the term of customer willingness to pay. (Whelan and Forrester, 1996)

Although, apart from the two factors previously mentioned, demand also heavily influenced by the market price by contradictory relation. Interpreted as while demand is high the price is low, and vice versa. Hence, the relation of market price could be develop for the relation for two factors that previously mentioned before which are if the market price decrease the demand of the product would limited by only taste and not ability to buy. This condition would also happened in contradictive approach which is if the market price is increased the ability for buy product will be the only factor for demand of product. Those condition is an extreme condition for both spectrum. Hence, the figure of the relation of the condition mentioned before will be described in the Figure 2.2 as follows. Noted that, the figure is known as simple demand curve.

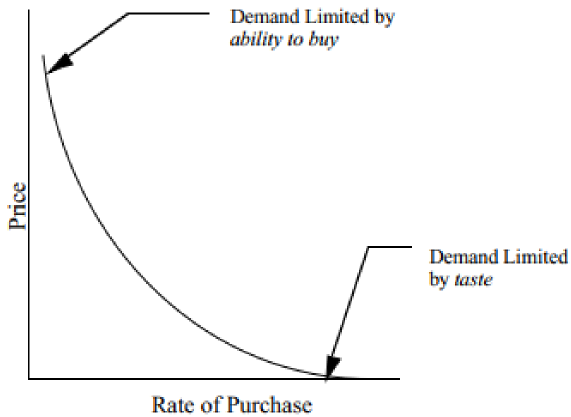

Figure 2.2 Simple Demand Curve
Source: (Whelan and Forrester, 1996)

Next, the discussion of type of demand in dual-channel supply chain will be based on the consideration provided by (Huang, Yang and Zhang, 2012) consist of model for conventional demand and online demand provided as follows.

- Conventional Demand

Conventional demand is basically the demand obtained by the demand in retail store, usually before the installment of the online channel. Hence, the developed demand model for conventional demand in dual-channel supply chain will be provided equation 2.1 follows:

$$D_s = (1 - \rho)d_s^{max} - a_1 ps + \beta_1 po \tag{2.1}$$

Information:

D_s = Demand at retail (offline) store

d_s^{max} = Maximum demand at (offline) retail store if price is minimum

ρ = Customer acceptance ratio for online channel compared to retailer store

a = elasticity coefficient self-price from D_s and D_o

β = sensitivity coefficient cross-price from D_s and D_o

(Huang, Yang and Zhang, 2012).

- Online Demand

Online demand is interpreted as the demand existed through the installment of the online channel. Most of the time, it is installed after the initial offline channel exist. However, exception also exist in the new business model of several firm which popular in the latest year and also in the case of this research.

$$D_o = \rho d_s^{max} - a_2 po + \beta_2 ps \quad (2.2)$$

Information:

D_o = Demand at online store

d_s^{max} = Maximum demand at (offline) retail store if price is minimum

ρ = customer preference for online product compare to offline product

a = elasticity coefficient self-price from D_s and D_o

β = sensitivity coefficient cross-price from D_s and D_o

(Huang, Yang and Zhang, 2012).

- Total Demand

Total demand is interpreted as the total demand existed through both channel simultaneously. Hence, the developed demand model for total demand in dual-channel supply chain will be provided in equation 2.3.

$$D_t = d_s^{max} - (a_1 - \beta_2)ps - (\alpha_2 - \beta_1)po \quad (2.3)$$

Notation:

D_t = Total demand at both channel

d_s^{max} = Maximum demand at (offline) retail store if price is minimum

ρ = customer preference for online product compare to offline product

a = elasticity coefficient self-price from D_s and D_o

β = sensitivity coefficient cross-price from D_s and D_o

(Huang, Yang and Zhang, 2012)

2.2 Pricing Determination Strategy

This chapter will discuss the topic of pricing determination strategy purpose, and pricing scheme method the explanation will be covering pricing determination strategy purpose, pricing strategy, and pricing scheme method

2.2.1 Pricing Determination Strategy Purpose

In the discussion of pricing, the importance of pricing could be divided into the 2 major topics of relation which are marketing effectiveness (1) and social viewpoint (2) (Agarwal, 1982).

In the discussion for marketing effectiveness (1), pricing influence the marketing effectiveness in a point that if firm is higher than what the market reasonable price or another term named customer willingness to pay which is defined as "the highest price is the highest price an individual is willing to accept to pay for some good or service" (Breidert, 2007). In the opposite, if the firm set the price below the market reasonable price the firm will suffer loses on revenue. Explicitly price will affect the sales revenue and also cost, which is the main factor to determine firm's success. The cost will determine the profit since profit is revenue minus cost, hence if the margin is low a firm is most likely will cut its quality, features development or marketing promotion expenditure in the future.

Next, from the social viewpoint (2), if the firm set prices over the reach of customer preferable price, it could trigger customer resistance, social disapprove, or govenrment regulation. Thus, price also important economic function in allocating scarce resources (Agarwal, 1982).

2.2.2 Pricing Scheme Method

In the pricing scheme method, the explanation will be divided into 2 subtopics which are Bertrand competition scheme, and Stackelberg competition scheme. Noted that, the division of competition scheme is based mainly on the time of channel decision made which are simultaneous for Bertrand competition scheme and in sequential order for Stackelberg competition scheme.

2.2.2.1 Bertrand Competition Scheme

In the introduction for the subchapter, Bertrand competition scheme already mentioned, the Bertrand competition scheme is done by firms in simultaneous time or at the same time, by using what is called strategic interaction in price settings (Andrés and Burriel, 2018). It means that, the firms should open all information needed by the other firms to be analyzed for generating the best pricing strategy.

Next, there are also exist the concept of Bertrand Equilibrium, which is interpreted as "an equilibrium in which each firm chooses a profit maximizing price given the price set by other firms" (Besanko and Braeutigam, 2010).

After that, to put in into perspective, the example of Bertrand model will be provided as follows. First, the assumption of the model are provided. The assumptions of the model are:

1. 2 firms in the market, i $\in \{1,2\}$
2. Goods produced are homogenous, products are perfect substitutes.
3. Firms set prices simultaneously.
4. Each firm has the same constant marginal cost of c. (Leo, 2010)

From the reference, the best strategy would be best described as perfectly competitive outcome, indicated by same prices $p_1 = p_2 = p$. By using logical arguments:

1. Firm's will never price above the monopoly's price
2. In equilibrium, all firm's prices are the same
3. In equilibrium, prices must be at the marginal cost

Hence, based on the argument above, in equilibrium there will be exist a reaction function which is indicated by stating the firm's choice as a function of other firm's choice as a function of other firm's choice $p_i^*(p_j)$, where $i \neq j$, and $i, j \in \{1,2\}$. Hence, to conclude the graphical model of Bertrand competition scheme will be provided in the Figure 2.3, which pointed out the equilibrium only happened in the reaction function meet, and it is generating firms best response with all firms relation, symmentric (Leo, 2010).

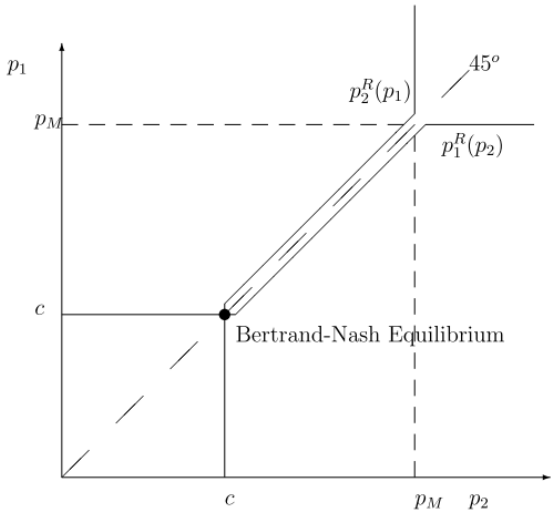

Figure 2.3 Bertrand Model and Equilibrium
Source: (Leo, 2010)

2.2.2.2 Stackelberg Competition Scheme

As already mentioned briefly in the previous chapter, stackelberg competition scheme is defined as “formulation of a model of yield leadership which was applicable for homogenous market.”(Xiao *et al.*, 2018).

There are two types of decision maker consideration which are leader and follower, which will be expressed in detail later. For the detailed information, the implementation procedure of stackelberg competition model is mainly determine into following sequence (1) the leader will provide information of production/supply first according to their internal consideration, then (2) the follower will response based on the decision of the leader for their own production/supply decision. Thus, to conclude the leader should forecast the future decision of follower and predict the output impact of follower roughly. This is performed for profit maximizing yield for the leader. Hence, leader isn’t necessarily to create his own response function.(Xiao *et al.*, 2018)

Therefore, the general model of stackelberg competition scheme will be provided as follows:

$$\underset{z_p \in X_p}{maximize} \prod_p = P\left(\sum_{k=1}^{l} q_k + \sum_{k=l+1}^{m} q_k\right) q_p - f_p y_p - c_p q_p, \qquad (2.4)$$

where, for each k ∈ $\mathcal{F}$, q_k solves the follower’s problem:

$$\underset{z_k \in X_k}{maximize} \prod k = P\left(\sum_{k=1}^{l} q_k + \sum_{k=l+1}^{m} q_k\right) q_k - f_k y_k + \sum_{p=1}^{l} h_k^p \, y_p y_k - c_k q_k$$

(2.5)

Information:

Subscript $_p$ denote leader perspective, while subscript $_k$ denote follower perspective

h_k^p = reduction in player k setup cost due to observation of the investment (technology) of the leaders.

$X_{p,k}$ = each player p or k the set of feasible strategies

$q_{p,k}$ = quantity to be produced

$f_{p,k}$ = setup production cost

$c_{p,k}$ = unit production cost

P = unit market price function

$y_{p,k}$ = production plan decision either going to take place or not respectively denoted by, $y_{p,k}$ = 1,and $y_{p,k}$ = 0, (Carvalho, Pedroso and Pedroso, 2015)

2.3 Sales Terms of Payment

In this subchapter, the fundamental of several method for sales payment will be provided, into several discussion such as cash terms, open account, consignment, draft, and letter of credit, the basic method would be divided into cash and credit based payment, however there are also several modification as means to address dynamic of payment issue in the business field, which will be provided in the following subchapters. (Chandra, 2014).

2.3.1 Cash Terms

First, one of the variety of payment terms would be cash terms. In the cash terms payment method firms could settle on three major method such as (1) cash in advance, defined as advance payment conducted by the buyer the total purchasing cost before the delivery, the advantage of implementing this type of payment method in the perspective of an exporter is related with credit risk since the characteristic of advance payment itself (Export.gov, 2012), (2) cash on delivery which the buyer pays all of the total financing cost upon the goods or services is provided, and (3) permissible delay in payment which require seller to create a short-term interest-free loan for the buyer (Li *et al.*, 2018).

2.3.2 Open Account

An open account transaction is also considered as one of the payment method which are interpreted as a sale where the goods are shipped and delivered before payment is due, which is typically in 30, 60 or 90 days, usually in international trade.

The advantage of implementing open account transaction are (1) increase global market competitiveness, and (2) could maintain trade relationship in the long term. Next, in the opposite there are also several drawback in implementing this type of payment method such as (1) significant exposure to the risk of default non-payment by the buyer, which lead to exporter trust issue for the importer, (2) additional cost that would resulting to mitigate the risk that previously mentioned.

Thus, the exporter should really concern about the following prerequisite before implementing the open account transaction whether (a) it is low-risk trading relationships or markets and (b) in competitive markets to win new potential customers (Export.gov, 2012).

2.3.3 Consignment

Consignment is also considered as one of the method that is popular in usage, it mean as "the act of consigning, which is placing any material in the hand of another, but retaining ownership until the goods are sold or person is transferred" (Lakra and Bedi, 2014). The seller sides is known as consignor and the agent is known as the consignee. Consignment payment method usually implemented in shipping, transfer of goods to auction or for sale in a store which is also implemented in the case study of Mr froniez broniez.

Consignment is recommended for use in competitive environment for new-entry product to increase sales in partnership with trusted established shop or distributor. The drawback of consignment payment method would be risk beared by supplier due to payment only come to revenue when the goods purchased by the customer.

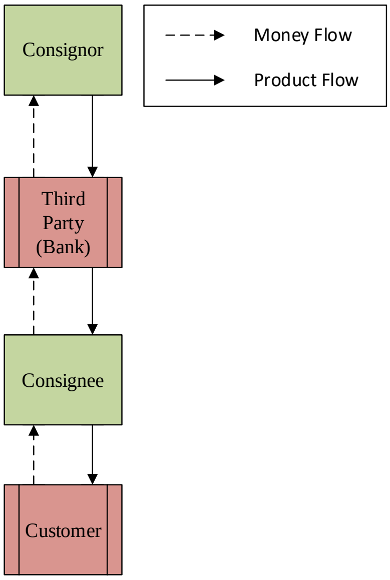

Figure 2.4 Consignment Shop Basic Model

There are several advantages generated by implementing consignment type of payment which are (1) Reduce the direct costs of storing and inventory, and (2) increase potential increase in competitiveness in greater availability of product or faster delivery of goods to the customer.

2.3.4 Draft

Draft is also colloquially known as Documentary Collection. It is a written document issued by bank which take role as an regulator of the payment. The bank then would pay sum of payment money on demand from the seller in which that orders a bank to pay a sum of money on specific date (Horder, 1965). Then, the issued date usually come in either 30, 60, 90, 120, or fixed date specified by the seller. Based on the payment method there are three parties involved which are the drawer (e,g : the buyer) (1) the drawee (e.g : bank) (2), and the payer (e.g : the seller (3)

2.3.5 Letter of Credit

Letter of credit is also one of the payment method existed. The letter of credit is defined as a bank undertaking of payment separate from the sales or other contracts on which it is based (Bank of Nova Scotia, no date). Hence, to put in into perspective it is conducted by bank requested by the beneficiary firms (e.g the seller), to instruct effect payment in either making a payment or issuing draft as previously mentioned in an agreed time and condition to the applicant firms (e.g the buyer).

Payment in letter of credit could be issued by creating buyer remitted cash in each order, documentary collection, or using open account. In the letter of payment there are features that is come with options such as (1) sight or term/usance; could be paid immediately after specified document or in future date sales contract, (2) revocable or irrevocable, (3) unconfirmed or confirmed

Letters of credit can permit the beneficiary to be paid immediately upon presentation of specified documents (sight letter of credit), or at a future date as established in the sales contract (term / usance letter of credit).(Bank of Nova Scotia, no date)

2.4 Non-linear Programming

This chapter will discuss the topic of non-linear programming. Hence, the explanation would be provided into non-linear programming basic model, and Matlab non-linear programming fmincon solver.

2.4.1 Non-linear Programming Basic Model

In many interesting maximization and minimization problems, the objective function could be determined as a linear function. However, in reality there are also problem found in the field of non-linear function, or some of the constraints may not be linear constraints. Such an optimization problem is called a nonlinear programming problem (NLP). (Winston and Goldberg, 2004)

Next, the general optimization problem of non-linear programming is to select n decision variables $x_1, x_2,.., x_n$ from a given feasible region in such a way as to optimize (minimize or maximize) a given objective function $f(x_1, x_2,.., x_n)$ of the decision variables. The problem is considered as nonlinear programming problem (NLP) if the objective function is nonlinear and/or the feasible region is determined by nonlinear constraints (Orlin, 2018). Thus, for both minimization and maximization, the general nonlinear program is stated as:(Winston and Goldberg, 2004)

Find the values of decision variables $x_1, x_2, \ldots, x_n$ that

$$\max(or\ \min)\ z = f(x_1, x_2, \ldots, x_n)$$
$$s.t\ g_1(x_1, x_2, \ldots, x_n)(\leq, =, \geq)b_1$$
$$s.t\ g_1(x_1, x_2, \ldots, x_n)(\leq, =, \geq)b_2$$
$$\vdots$$
$$g_m(x_1, x_2, \ldots, x_{n)})(\leq, =, \geq)b_m$$
$$x_1 \geq 0 \tag{2.6}$$

Based on the equation above, it is shown that $f(x_1, x_2, \ldots, x_n)$ is the decision function and $g_1(x_1, x_2, \ldots, x_n)$ is considered as constraint function with b_i represent its constraint condition value. Noted that, $f(x_1, x_2, \ldots, x_n)$ and $g_1(x_1, x_2, \ldots, x_n)$ each are function with n-variable i = 1,2,...,n that solve the constraint and minimize or maximize the objective function, with $f(x_1, x_2, \ldots, x_n)$ and $g_1(x_1, x_2, \ldots, x_n)$ non linear or if only $f(x_1, x_2, \ldots, x_n)$ non-linear. (Sinha, 2005)

Next, many of the nonlinear-programming solution procedures that have been developed do not solve the general problem that previously mentioned

However, there are also several case which is provided as follows, noted that it is considered as special case but rather some special case. For reference, let us list some of these special cases:

- Unconstrained optimization:

$$f\ general, m\ =\ 0\ (no\ constraints). \tag{2.7}$$

- Linear programming:

$$f(x) = \sum_{j=1}^{n} c_j x_j,\ g_i(x) = \sum_{j=1}^{n} a_{ij} x_j\ \ (i\ = 1,2, \ldots, m) \tag{2.8}$$

$$g_{m+i}(x) = -x_i(i\ = 1,2, \ldots, m \tag{2.9}$$

- Quadratic programming:

$$f(x) = \sum_{j=1}^{n} c_j x_j + \frac{1}{2} \sum_{i=1}^{n} x \sum_{j=1}^{n} q_{ij} x_i x_j, \tag{2.10}$$

- Linear constrained problem:

$$f(\mathrm{x})\mathrm{general}\ \ g_i(x) = \sum_{j=1}^{n} a_{ij} x_j\ (\mathrm{i}\ =\ 1, 2, \ldots, \mathrm{m}),$$

(Possibly $x_j \geq 0$ will be included as well) (2.11)

- Separable programming

$$f(x) = \sum_{j=1}^{n} f_j(x_j), \;\; g_i(x) = \sum_{j=1}^{n} g_{ij}(x_j) \;\; (i = 1,2, \dots, m) \qquad (2.12)$$

i.e., the problem ‘‘separates’’ into functions of single variables. The functions f_j and g_{ij} are given

- Convex programming:

f is a concave function. (In a minimization problem, f would be a convex function.). Next, the functions g_i(i = 1, 2,..., m) are all convex.(Orlin, 2018)

However, the problem in this research is considered as quadratic programming which model has been provided before. Next, for detailed information a “quadratic programming is one of the optimization problem wherein one either minimizes or maximizes a quadratic objective function of a finite number of decision variable subject to a finite number of linear inequality and/or equality constraints”(Burke, 2014).

2.4.2 Matlab Non-linear Programming Fmincon Solver

Hence, in this research the author considered the solution process to be conducted by using built-in solver of *fmincon* provided in MATLAB software. Therefore, the explanation of *fmincon* syntax will be provided.fmincon which stands for Find minimum of constrained nonlinear multivariable function. It is one of the nonlinear programming solver which function as to finds the minimum of a problem specified by following syntax

```
x = fmincon(fun,x0,A,b)
x = fmincon(fun,x0,A,b,Aeq,beq)
x = fmincon(fun,x0,A,b,Aeq,beq,lb,ub)
x = fmincon(fun,x0,A,b,Aeq,beq,lb,ub,nonlcon)
x = fmincon(fun,x0,A,b,Aeq,beq,lb,ub,nonlcon,options)
x = fmincon(problem)
[x,fval] = fmincon(___)
[x,fval,exitflag,output] = fmincon(___)
[x,fval,exitflag,output,lambda,grad,hessian] = fmincon(___)
```

Next, there are input and output that would be generated by using this solver which will be provided and explained as follows:

A. Input

fun = Function to minimize

x0 = Initial point

A = Linear inequality constraints (left-hand side)

b = Linear inequality constraints (right-hand side)

Aeq = Linear equality constraints (left-hand side)

beq = Linear equality constraints (right-hand side)

lb = Lower bounds

ub = Upper bounds

nonlcon = Nonlinear constraints

options = Optimization options

problem = Problem structure

B. Output

x = Solution

fval = Objective function value at solution

exitflag = Reason fmincon stopped

output = Information about the optimization process

lambda = Lagrange multipliers at the solution

grad = Gradient at the solution

hessian = Approximate Hessian

Therefore, the explanation of exitflag which is one of the output in fmincon software will be explained in detail due to its crucial use as the indicator of why the solver stop. Noted that, all of the result of exitflag is provided in number, which will be categorized and grouped in detail as follows:

1 = First-order optimality measure was less than options. and maximum constraint violation was less than options.

0 = Number of iterations exceeded options. or number of function evaluations exceeded options.

-1 = Stopped by an output function or plot function.

-2 = No feasible point was found.

2 = Change in x was less than options and maximum constraint violation was less than options.

3 = Change in the objective function value was less than options. and maximum constraint violation was less than options.

4 = Magnitude of the search direction was less than 2*options. and maximum constraint violation was less than options.

5 = Magnitude of directional derivative in search direction was less than 2*options and maximum constraint violation was less than options.

-3 = Objective function at current iteration went below options and maximum constraint violation was less than options (The MathWorks Inc., 2018).

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CHAPTER 3

RESEARCH METHODOLOGY

In this subchapter, the explanation of methodology which applied for the research which are pricing strategy in a Dual-channel Supply-chain considering Consignment method of payment in Mr Froniez SME. First, the flowchart of research methodology of the research is provided in Figure 3.1

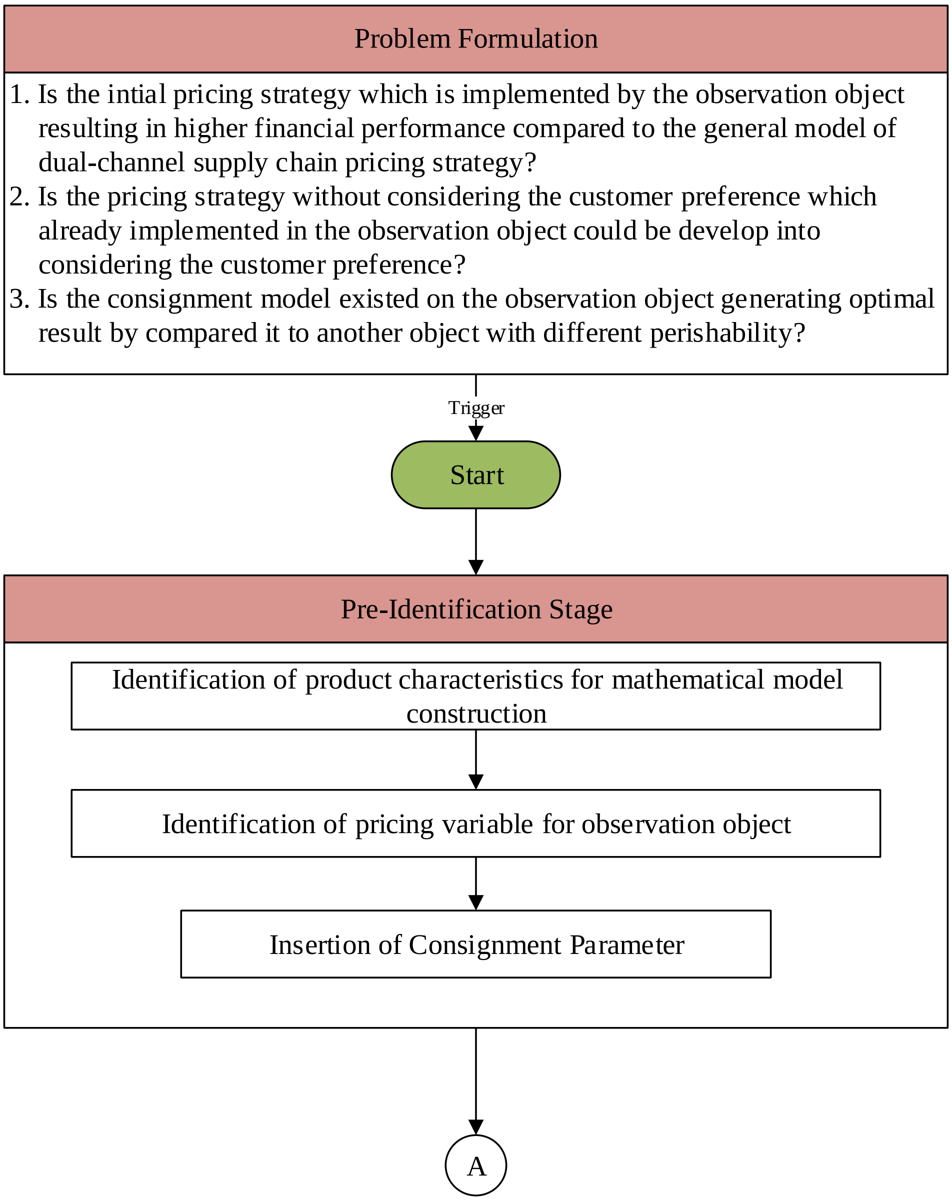

Figure 3.1 Flowchart Methodology

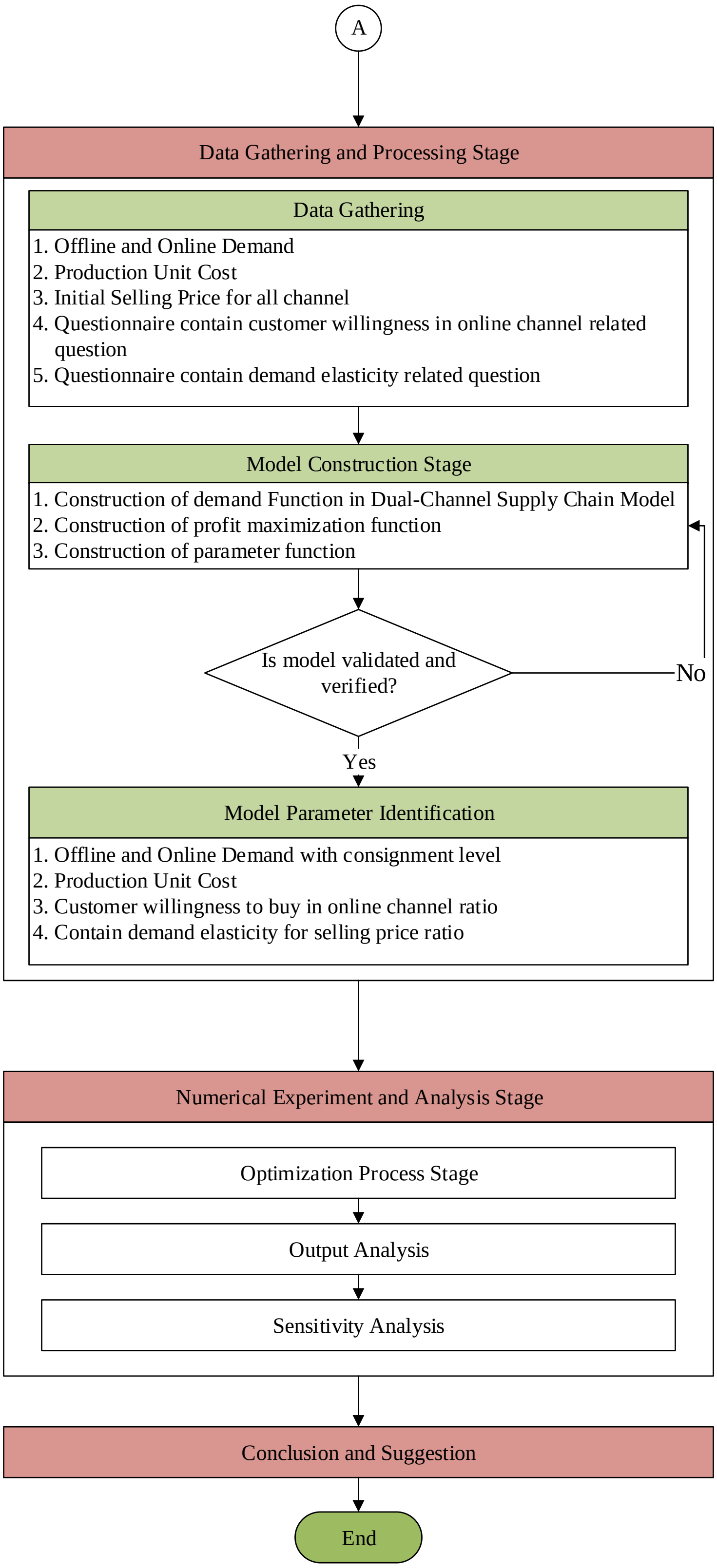

Figure 3.2 Flowchart Methodology (Continue)

3.1 Pre-Identification Stage

In the pre-identification stage, the problem formulation that previously mentioned will be the basis of the pre-identification stage. In this stage, there are three main discussion which are start from the identification of product characteristics for mathematical model construction which will assess the crucial product characteristics needed for the mathematical model such as the product with largest proportion of revenue. Next, identification of price variable for observation object will be determined, by performing this the price variable should be already known from the observation object. After that, the insertion of consignment variable which are contribute as the decision variable for this research.

3.2 Data Gathering and Processing Stage

At this phase, there are several activity that will be conducted such as dara gathering, model construction, verification and validation stage and model parameter identification. Therefore, the explanation will be provided in the following subchapters.

3.2.1 Data Gathering

First activity that will be performed on this stage would be data gathering. The data that would be gathered will consist of primary data such as questionnaire and secondary data such as historical data of product demand. Those data would be obtained as input to determine the offline and online demand with consignment level, manufacturing unit cost, customer willingness to buy in online channel ratio, and demand elasticity for selling price ratio.

3.2.2 Model Construction Stage

Once the data relating to the research are collected, the next phase which is model construction will be performed. There are three kind of model that would be constructed lay out as demand function with each two conditions whether consignment product are remain or not, which is deployed into offline demand function, and online demand channel. After that, objective function which are profit maximization function is constructed. Last but not least, construction of parameter function will also needed in this research.

3.2.3 Verification and Validation Stage

At this phase verification will be done by correcting whether there is an error in the model when it is processed in MATLAB software, while validation is done by way of comparing between models compiled with the real condition of the observational system. If there are differences or errors in verification and validation phase, the model will be either rebuild or adjusted, so it must be done modeling which is adapted to the actual system conditions or should correction is made on the model made if there is a current error performed input process in MATLAB software.

3.2.4 Model Parameter Identification

In this stage, after the desired data consist of secondary data (demand, production unit cost, selling price) and primary data (questionnaire result) is obtained, then the customer willingness to buy in online channel ratio, and demand elasticity for selling price ratio, and offline-channel demand for next selling period will be obtained to be further processes in the next step of the research.

3.3 Numerical Experimental Phase and Analysis

Some of the things done in the numerical experimental phase are doing profit optimization to get prices for each channel by applying nonlinear programming using MATLAB software built-in syntax of solver fmincon. Then, the comparison analysis between existing scenarios and research results is determined to find highest profiting scenario. The last step is to conduct sensitivity analysis to determine which parameters are critical to profit change.

3.4 Conclusion and Suggestion Stage

The final phase in this study is the preparation of conclusions based on the results obtained from the research. The conclusions drawn up will answer the objective from doing research. In addition to conclusions, suggestion will also be given for research as well as for observed companies.

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CHAPTER 4

MODEL DEVELOPMENT

In this chapter, there are several subtopics will be discusssed, such as system description, reference model, research model, and parameter data collection and processing.

4.1 System Description

In this research, the system of supply-chain of the product that would be predetermined as the observation object is a firm that implement dual-channel supply chain. Hence, the Bronchips supply chain, which is the product by Mr Froniez SME supply-chain is provided in Figure 4.1

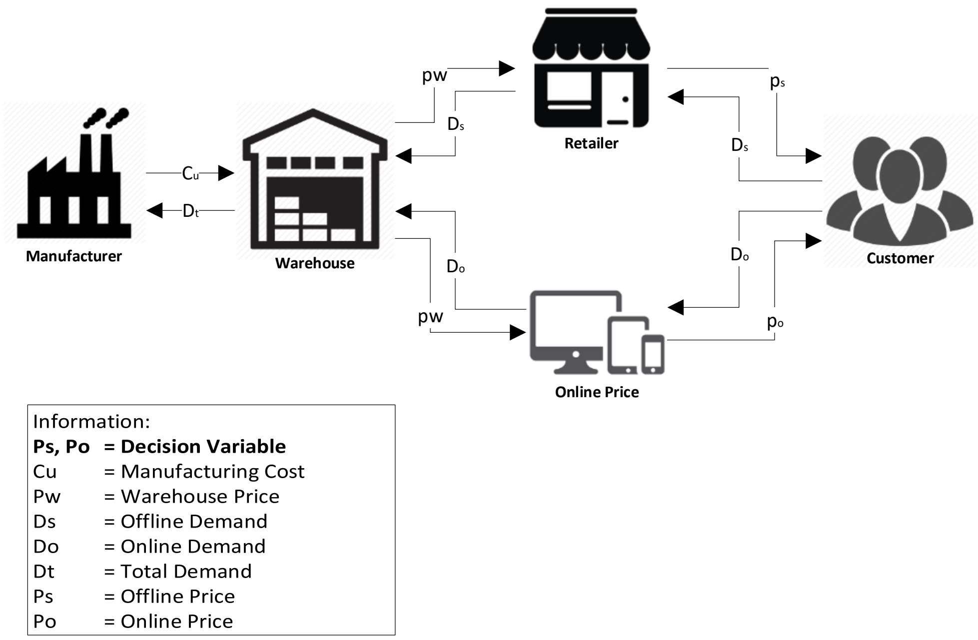

Figure 4.1 Bronchips Conceptual Model Supply-Chain System

Mr Froniez, which are the observation object of the author is one of the small, medium enterprises established in Surabaya, which specialized in Brownies products. They have various type of brownies product under the Mr Froniez such as *Brownies Panggang Surabaya* (Roasted Brownies), Bronchips (Brownies Chips), Mr Froniez (Frozen Brownies) and Brownies Souvenirs. Mr Froniez business starts in late 2011 with Frozen Brownies as its first product. There are three basic reason of opening the business, because of limited time possessed by the urban people, hence the demand of instant snack is existed. Next, brownies is already categorized as well-known snack in Indonesia. Thus, no need to make much effort in product marketing anymore. Last but not least, Indonesian people habit to bring/buy souvenirs if they are visiting relatives or going out of town is also one of the supporting reason. The initial selling channel of this business is the online channel. Thus, after being introduced to the *Dinas Perdagangan* of Surabaya, and being provided by its incentive and program, the product of Mr Froniez, especially Bronchips is also available in several big retail shop in Surabaya, such as several Indomaret retailer and Giant retail chain. Hence, in this research the author only consider one of the product by Mr Froniez which are Bronchips. Then, Bronchips are selected due to it comprise about 75-80% of revenue for whole Mr Froniez business.

Hence, based on the initial conceptual model of Bronchips product supply chain, there are two types of supply chain channel of the product which are explained as follows:

- Online Channel

  In the online/direct channel, which is the initial supply chain stream of the product before other channel is introduced. The price for single item in online channel is Rp 15.000,00 per 60 gram package. However, there are incentive that would be grant for several buying condition. Hence, this incentive that is support the online channel sustainability. In this research, online channel is considered for all of the non-retail sales, there are many channel exist in this SME, but it all would end up in Whatsapp, according to the explanation of the owner of Mr. Froniez

- Offline Channel

  In the offline channel, which is existed after the Mr Froniez owner is introduced to the *Dinas Perdagangan* of Surabaya, there are two already-established retailer, which already sell Bronchips product which are Giant and Indomaret retail chain. Even though, not all Giant and Indomaret in Surabaya already sell Bronchips product, only limited Indomaret and Giant that affiliated with *Dinas Perdagangan* of Surabaya that already make the product available.

However, in this research the offline-channel would consider all retail-based sales. Thus, all retailer which sells Bronchips product selling data would be included.

Next, based on the result of interview with the owner of Bronchips, there are several reason of why Bronchips that already settled with online channel only is trying to do business while implementing the offline channels are to increase brand awareness to the potential customer, to cope with the government program to increase competitive awareness of the brand, and also to facilitate customer with direct inspection feature of product in order to increase customer willingness to pay. However, the initial pricing method of both channel is done centralized by the manufacturer of the product only. However, the consideration of pricing in Bronchips is similar with traditional pricing method that usually implemented in start-up SME which is equal pricing in all channel. Even though, the consideration of equal pricing only based on several cost and risk that only exist in the offline channel such as transportation cost, defect product risk, or not based on the consideration in Dual-channel Supply-chain and consignment risk.

4.1.1 System Limitation

The system limitation that is utilize in this research is determined in the following list:

1. The observation is conducted only for the product which generated most revenue in Mr Froniez business.
2. The historical data of product demand is collected from May 2016 until May 2018.
3. The offline channel is determined as the retail channel consist of Indomaret, Giant, and traditional retail shop in selected area which the product available in the shop.
4. The online channel is determined as the all non-retail selling channel.

4.1.2 System Assumption

The system boundary that is utilize in this research is determined in the following list.

1. Transportation cost is already calculated in cost of manufacture of product and approximated by average tranportation cost, and not determined per transport.
2. The customer is not segmented to each channel, thus preference of channel selection by customer mainly determined by the selling price of the product.
3. Inventory cost per product is neglected, because the product is directly sent after the production process is done.
4. The price for the product is determined as Rp 15.000,00 per package for all channel.

4.2 Referenced Model

In this research, the model which is referenced as the basis for demand function is Huang et al. (2012).

- Offline demand function

$$D_s = (1-\rho)d_s^{max} - a_1 ps + \beta_1 po \tag{4.1}$$

- Online demand function

$$D_o = \rho d_s^{max} - a_2 po + \beta_2 ps \tag{4.2}$$

- Total demand function

$$D_t = d_s^{max} - (a_1 - \beta)ps - (\alpha_2 - \beta)po \tag{4.3}$$

Notation:

D_s = Demand offline

D_o = Demand online

D_t = Demand total

d_s^{max} = Maximum D_s when price is minimum

ps = offline price

po = online price

ρ = customer preference for online product compare to offline product

a = elasticity coefficient self-price from D_s and D_o

β = sensitivity coefficient cross-price from D_s and D_o

4.3 Research Model

In this subchapter, the explanation of all model development scenario will be provided based on the pricing strategy scenario that is conducted. Based on the literature review there are six scenarios that will be develop using the combination of whether the game is cooperative or not, and the consignment level. Hence, the several scenarios that will be experimented in this research would be explained in detail.

1. 1st scenario (high-level consignment with non-cooperative strategy)

   In this research, the 1st scenario is resembling the initial condition of selling process in Bronchips of Mr Froniez business. However, the pricing determination done mainly with no coordination from Mr.Froniez internal business, which handle the online-channel selling and with high-level consignment to the all offline-channel (retailer). The determination process itself mainly done by intutitive process with no regard to customer preference on every channel, and further data analysis. The analysis only done by direct information of possible customer which would have snack in price range of Rp 10000- Rp 15000, according to the owner. Hence, the model of first scenario would be presented in Figure 4.2 as follow:

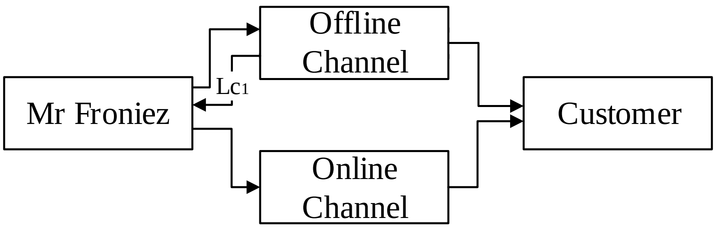

Figure 4.2 Scenario 1 (initial) Pricing Determination Process

Information:

LC_i = Parameter

LC_i = Consignment Level

$$LC_i = \begin{cases} when\ i; 1 = High - level\ consignment\ (100\%) \\ when\ i;\ 2 = Medium - level\ consignment\ (60\%) \\ when\ i;\ 3 = Low - level\ consignment\ (20\%) \end{cases}$$

Thus, to conclude, in this scenario the characteristics are high-level consignment indicated by (LC_1), and non-coordinative which mean optimization of pricing is done in separate channel.

2. 2nd scenario (medium-level consignment with non-cooperative strategy)

   In this scenario, the level of consignment in medium-level which determined as 60% of all product in offline-channel is considered as consignment product, while the rest is considered as non-consignment product. However, the coordination scheme between these channels are still the same with no coordination whatsoever. Thus, detail model of 2nd scenario is provided in Figure 4.3.

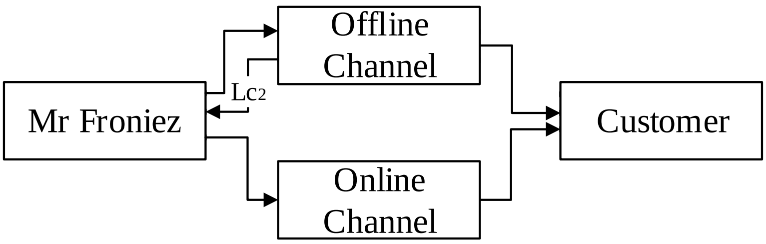

Figure 4.3 Scenario 2 Pricing Determination Process

Information:

LC_i = Parameter

LC_i = Consignment Level

$$LC_i = \begin{cases} when\ i; 1 = High - level\ consignment\ (100\%) \\ when\ i;\ 2 = Medium - level\ consignment\ (60\%) \\ when\ i;\ 3 = Low - level\ consignment\ (20\%) \end{cases}$$

Thus, to conclude, in this scenario the characteristics are medium-level consignment indicated by (LC_2), and non-coordinative which mean optimization of pricing is done in separate channel.

3. 3rd scenario (low-level consignment with non-cooperative strategy)

   In this scenario, the level of consignment in low-level which determined as only 20% of all product in offline-channel is considered as consignment product, while the rest is considered as non-consignment product.. However, the coordination scheme between these channels are still the same with no coordination whatsoever. Thus, detail model of 3rd scenario is provided in Figure 4.4.

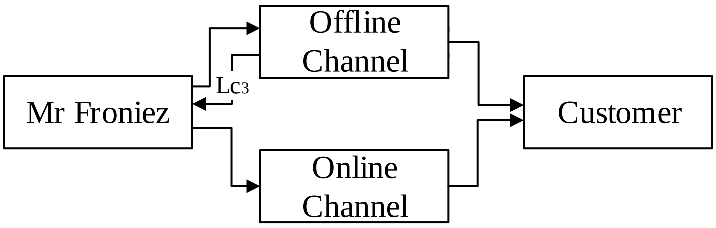

Figure 4.4 Scenario 3 Pricing Determination Process

Information:

LC_i = Parameter

LC_i = Consignment Level

$$LC_i = \begin{cases} when\ i; 1 = High - level\ consignment\ (100\%) \\ when\ i;\ 2 = Medium - level\ consignment\ (60\%) \\ when\ i;\ 3 = Low - level\ consignment\ (20\%) \end{cases}$$

Thus, to conclude, in this scenario the characteristics are low level consignment indicated by (LC_3), and non-coordinative which mean optimization of pricing is done in separate channel.

4. 4th scenario (high-level consignment with cooperative strategy)

In this scenario, the level of consignment in high-level which determined as 100% of product in offline-channel is considered as consignment product. However, the coordination scheme between these channels are full-coordination to fulfill the demand of the customer. Thus, detail model of 4th scenario is provided in Figure 4.5.

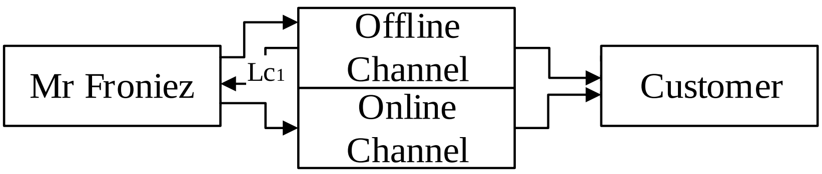

Figure 4.5 Scenario 4 Pricing Determination Process

Information:

LC_i = Parameter

LC_i = Consignment Level

$$LC_i = \begin{cases} when\ i; 1 = High - level\ consignment\ (100\%) \\ when\ i;\ 2 = Medium - level\ consignment\ (60\%) \\ when\ i;\ 3 = Low - level\ consignment\ (20\%) \end{cases}$$

Thus, to conclude, in this scenario the characteristics are high-level consignment indicated by (LC_1), and coordinative which mean optimization of pricing is done in all channel simultaneously.

5. 5th scenario (medium-level consignment with cooperative strategy)

In this scenario, the level of consignment in medium-level which determined as 60% of all product in offline-channel is considered as consignment product, while the rest is considered as non-consignment product. However, the coordination scheme between these channels are full-coordination to fulfill the demand of the customer. Thus, detail model of 5th scenario is provided in Figure 4.6.

Figure 4.6 Scenario 5 Pricing Determination Process

Information:

LC_i = Parameter

LC_i = Consignment Level

$$LC_i = \begin{cases} when\ i; 1 = High - level\ consignment\ (100\%) \\ when\ i;\ 2 = Medium - level\ consignment\ (60\%) \\ when\ i;\ 3 = Low - level\ consignment\ (20\%) \end{cases}$$

Thus, to conclude, in this scenario the characteristics are medium-level consignment indicated by (LC_2), and coordinative which mean optimization of pricing is done in all channel simultaneously.

6. 6th scenario (low-level consignment with cooperative strategy)

In this scenario, the level of consignment in low-level which determined as only 20% of all product in offline-channel is considered as consignment product, while the rest is considered as non-consignment product. However, full-coordination is applied to fulfill the demand of the customer. Thus, detail model of 6th scenario is provided in Figure 4.7.

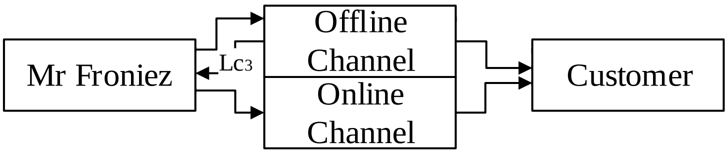

Figure 4.7 Scenario 6 Pricing Determination Process

Information:

LC_i = Parameter

LC_i = Consignment Level

$$LC_i = \begin{cases} when\ i; 1 = High - level\ consignment\ (100\%) \\ when\ i;\ 2 = Medium - level\ consignment\ (60\%) \\ when\ i;\ 3 = Low - level\ consignment\ (20\%) \end{cases}$$

Thus, to conclude, in this scenario the characteristics are low level consignment indicated by (LC_3), and coordinative which mean optimization of pricing is done in all channel simultaneously.

4.3.1 Model Notation

Notation that will be utilize in this research will be divided into several categories, such as demand function, objective function, and boundary function. Thus, all the notation use in this research will be provided as follows:

- Demand Function

  D_s = offline demand

  D_o = online demand

  D_t = total demand

- Objective function

  E_s= Earning from offline channel

  E_o= Earning from online channel

  E_{os}=Earning from online and offline channel

  E_{scen1}=Total earning obtained from scenario 1

  E_{scen2}=Total earning obtained from scenario 2

  E_{scen3}=Total earning obtained from scenario 3

  E_{scen4}=Total earning obtained from scenario 4

E_{scen5}=Total earning obtained from scenario 5

E_{scen6}=Total earning obtained from scenario 6

- Decision variable

  Ps = offline price

  Po = online price

- Parameter

  d_s^{max} = Maximum D_s when price is minimum

  ρ = customer preference for online product compare to offline product

  a = elasticity coefficient self-price from D_s and D_o

  β = sensitivity coefficient cross-price from D_s and D_o

  C_m = manufacturing cost

  LC_i = consignment level

  $D_{s_{t+1}}$= offline demand in the following period

4.3.2 Demand Function

In this subchapter, all of the demand function on every channel would be provided in further detail. Note that, all of the demand functions are developed by referencing from model that could be found in Huang et al (2012).

4.3.2.1 Offline-Demand Function

The offline demand function is obtained and developed from the model (4.1) with adding new parameter of $(LC_iD_s - D_{s_{t+1}})$, which represent the remaining product resulting from when not all consignment product purchased. Then, there are hypothesis that the higher the level of consignment level is, the offline-demand of product will be higher. Thus, as the result of the new parameter, the condition of the offline-channel demand would be divided into 2 conditions. First, is when there are remaining product symbolize with $(D_{s_{t+1}} < LC_iD_{s_t})$, and if there are no remaining consignment product left symbolize with $(D_{s_{t+1}} \geq LC_iD_{s_t})$. Notice that, if there are no remaining consignment product left, the model for offline demand function is the identical with Huang et al (2012). Hence, the formula for offline-channel function is provided in Equation (4.4)

$$D_s = \begin{cases} \dfrac{(1-\rho)d_s^{max} - a_1 ps + \beta_1 po + D_{s_{t+1}}}{1 + LC_i} & (D_{s_{t+1}} < LC_i D_{s_t}) \\ (1-\rho)d_s^{max} - a_1 ps + \beta_1 po & (D_{s_{t+1}} \geq LC_i D_{s_t}) \end{cases}$$

(4.4)

4.3.2.2 Online-Demand Function

For online-demand function, it is developed from Equation (4.2), with the additional difference when there are remaining offline demand exist. Because, there will be added product retour from offline-channel which would generate 2 conditions. First, when there are offline-channel demand exist symbolize by $(D_{s_{t+1}} < LCD_{s_t})$ and if there are no remaining consignment product left.. Notice that, if there are no remaining consignment product left symbolize with $(D_{s_{t+1}} \geq LC_i D_{s_t})$. The model for offline demand function is the identical with Huang et al (2012). Hence, the formula for offline-channel function is provided in Equation (4.5)

$$D_o = \begin{cases} \dfrac{\rho d_s^{max} LC_i + d_s^{max} - \ a_2 PoLC_i + \beta_2 PsLC_i - D_{s_{t+1}} LC_i}{(1 + LC_i)} & (D_{s_{t+1}} < LC_i D_{s_t}) \\ \rho d_s^{max} - a_2 po + \beta_2 ps & (D_{s_{t+1}} \geq LC_i D_{s_t}) \end{cases}$$

(4.5)

4.3.3 Objective Function

Objective function is defined as a mathematical program is what an optimization procedure uses to select better solutions over poorer solutions. If objective is to maximize profit, then the procedure tries to move in the direction of solutions that increase profit while still remaining feasible. (King and Wallace, 2012). Hence, in this research all of the scenario would develop each objective function according to each condition of it. Thus, the basic model that become the reference model for developing further objective function for each scenario is provided by Equation (4.6).

$$Earning = Number\ of\ Product\ purchased\ x\ (Income - Cost)$$

$$Earning = Demand\ x\ (price - cost\ of\ manufacture) \qquad (4.6)$$

4.3.3.1 Scenario 1 Total Earning

For scenario 1, which have characteristics of high-consignment level and non-coordinative of all channel the developed formula would be given in Equation (4.7) for offline channel, Equation (4.8) for online channel, and Equation (4.9) for total earning.

$$E_s(Ps) = D_s\ (Ps - Cm)$$

$$E_s(Ps) = \begin{cases} \left(\dfrac{(1-\rho)d_s^{max} - a_1 Ps + \beta_1 Po + D_{s_{t+1}}}{1 + LC_1}\right)(Ps - Cm), if\ (D_{s_{t+1}} < LC_1 D_{s_t}) \\ \left((1-\rho)d_s^{max} - a_1 Ps + \beta_1 Po\ \right)(Ps - Cm)\ \ , if\ (D_{s_{t+1}} \geq LC_1 D_{s_t}) \end{cases}$$

(4.7)

$$E_o(Po) = D_o\ (Po - Cm)$$

$$E_o(Po) = \begin{cases} \left(\dfrac{\rho d_s^{max} LC_i + d_s^{max} -\ a_2 Po LC_1 + \beta_2 Ps LC_1 - D_{s_{t+1}} LC_1}{(1 + LC_1)}\right)(Po - Cm) \\ \qquad , if\ (D_{s_{t+1}} < LC_1 D_{s_t}) \\ (\rho d_s^{max} - a_2 Po + \beta_2 Ps\ )(Po - Cm), if\ (D_{s_{t+1}} \geq LC_1 D_{s_t}) \end{cases}$$

(4.8)

$$E_{scen1} = E_s + E_o \qquad (4.9)$$

Based on the objective function above, the equation (4.7) would represent how to calculate the total earning obtained from offline-channel. Next, the equation (4.8) would represent on how to calculate the total earning obtained from the online-channel. Last, Equation (4.9) would represent how to calculate the total earning obtained from all of the channel. These condition is required since there are no coordination, thus make the total earning calculation being done in sequential way. Thus, the total earning would be calculated at the end. Notice that, since there are several conditions derived from the condition in demand function there are each 2 conditions for each channels total earning function.

4.3.3.2 Scenario 2 Total Earning

For scenario 2, which have characteristics of medium-consignment level and non-coordinative of all channel the developed formula would be given in Equation (4.10) for offline channel, Equation (4.11) for online channel, and Equation (4.12) for total earning.

$$E_s(Ps) = D_s\ (Ps - Cm)$$

$$E_s(Ps) = \begin{cases} \left(\dfrac{(1-\rho)d_s^{max} - a_1Ps + \beta_1Po + D_{s_{t+1}}}{1+LC_2}\right)(Ps - Cm), if\ (D_{s_{t+1}} < LC_2D_{s_t}) \\ \left((1-\rho)d_s^{max} - a_1Ps + \beta_1Po\ \right)(Ps - Cm)\ \ , if\ (D_{s_{t+1}} \geq LC_2D_{s_t}) \end{cases}$$

(4.10)

$$E_o(Po) = D_o\ (Po - Cm)$$

$$E_o(Po) = \begin{cases} \left(\dfrac{\rho d_s^{max}LC_i + d_s^{max} - \ a_2PoLC_2 + \beta_2PsLC_2 - D_{s_{t+1}}LC_2}{(1+LC_2)}\right)(Po - Cm) \\ , if\ (D_{s_{t+1}} < LC_2D_{s_t}) \\ (\rho d_s^{max} - a_2Po + \beta_2Ps\ )(Po - Cm), if\ (D_{s_{t+1}} \geq LC_2D_{s_t}) \end{cases}$$

(4.11)

$$E_{scen2} = E_s + E_o \qquad (4.12)$$

Based on the objective function above, the equation (4.10) would represent how to calculate the total earning obtained from offline-channel. Next, the equation (4.11) would represent on how to calculate the total earning obtained from the online-channel. Last, Equation (4.12) would represent how to calculate the total earning obtained from all of the channel. These condition is required since there are no coordination, thus make the total earning calculation being done in sequential. Thus, the total earning would be calculated at the end. Notice that, since there are several conditions derived from the condition in demand function there are each 2 conditions for each channels total earning function.

4.3.3.3 Scenario 3 Total Earning

For scenario 3, which have characteristics of high-consignment level and non-coordinative of all channel the developed formula would be given in Equation (4.13) for offline channel, Equation (4.14) for online channel, and Equation (4.15) for total earning.

$$E_s(Ps) = D_s\ (Ps - Cm)$$

$$E_s(Ps) = \begin{cases} \left(\dfrac{(1-\rho)d_s^{max} - a_1 Ps + \beta_1 Po + D_{s_{t+1}}}{1 + LC_3}\right)(Ps - Cm), if\ (D_{s_{t+1}} < LC_3 D_{s_t}) \\ \big((1-\rho)d_s^{max} - a_1 Ps + \beta_1 Po\big)(Ps - Cm)\ \ , if\ (D_{s_{t+1}} \geq LC_3 D_{s_t}) \end{cases}$$

(4.13)

$$E_o(Po) = D_o\ (Po - Cm)$$

$$E_o(Po) = \begin{cases} \left(\dfrac{\rho d_s^{max} LC_i + d_s^{max} - a_2 Po LC_3 + \beta_2 Ps LC_3 - D_{s_{t+1}} LC_3}{(1 + LC_3)}\right)(Po - Cm) \\ , if\ (D_{s_{t+1}} < LC_3 D_{s_t}) \\ (\rho d_s^{max} - a_2 Po + \beta_2 Ps)(Po - Cm), if\ (D_{s_{t+1}} \geq LC_3 D_{s_t}) \end{cases}$$

(4.14)

$$E_{scen3} = E_s + E_o \tag{4.15}$$

Based on the objective function above, the equation (4.13) would represent how to calculate the total earning obtained from offline-channel. Next, the equation (4.14) would represent on how to calculate the total earning obtained from the online-channel. Last, Equation (4.15) would represent how to calculate the total earning obtained from all of the channel. These condition is required since there are no coordination, thus make the total earning calculation being done in sequential. Thus, the total earning would be calculated at the end. Notice that, since there are several conditions derived from the condition in demand function there are each 2 conditions for each channels total earning function.

4.3.3.4 Scenario 4 Total Earning

For scenario 4, which have characteristics of high-consignment level and coordinative of all channel the developed formula would be given in Equation (4.16), and Equation (4.17) for total earning.

$$E_{os}(Po, Ps) = D_s\ (Ps - Cm) + D_o\ (Po - Cm)$$

$$E_{os}(Po, Ps)$$
$$= \begin{cases} \left(\dfrac{(1-\rho)d_s^{max} - a_1 Ps + \beta_1 Po + D_{s_{t+1}}}{1 + LC_1}\right)(Ps - Cm) \\ + \left(\dfrac{\rho d_s^{max} LC_i + d_s^{max} - \ a_2 PoLC_1 + \beta_2 PsLC_1 - D_{s_{t+1}} LC_1}{(1 + LC_1)}\right)(Po - Cm) \\ , if\ (D_{s_{t+1}} < LC_1 D_{s_t}) \\ \left[\left((1-\rho)d_s^{max} - a_1 Ps + \beta_1 Po\right)(Ps - Cm) + (\rho d_s^{max} - a_2 Po + \beta_2 Ps\ )(Po - Cm)\right] \\ , if\ \left(D_{s_{t+1}} \geq LC_1 D_{s_t}\right)\ (4.16) \end{cases}$$

$$E_{scen4} = E_{os} \tag{4.17}$$

Based on the objective function above, the equation (4.16) would represent how to calculate the total earning obtained from all channel in simultaneous way. Next, the equation (4.17) would represent on how to calculate the total earning obtained from all channel. These condition is exist since all channel existed in Mr Froniez business already have coordination between them. Notice that, since there are several conditions derived from the condition in demand function there are in total 2 combinations to calculate each channels total earning function.

4.3.3.5 Scenario 5 Total Earning

For scenario 5, which have characteristics of medium-consignment level and coordinative of all channel the developed formula would be given in Equation (4.18), and Equation (4.19) for total earning

$$E_{os}(Ps, Po) = D_s\ (Ps - Cm) + D_o\ (Po - Cm)$$

$$E_{os}(Ps,Po) = \begin{cases} \left(\frac{(1-\rho)d_s^{max} - a_1Ps + \beta_1Po + D_{s_{t+1}}}{1+LC_2}\right)(Ps-Cm) \\ + \left(\frac{\rho d_s^{max}LC_i + d_s^{max} - a_2PoLC_2 + \beta_2PsLC_2 - D_{s_{t+1}}LC_2}{(1+LC_2)}\right)(Po-Cm) \\ , if\ (D_{s_{t+1}} < LC_2D_{s_t}) \\ \left[\left((1-\rho)d_s^{max} - a_1Ps + \beta_1Po\right)(Ps-Cm) + (\rho d_s^{max} - a_2Po + \beta_2Ps)(Po-Cm)\right] \\ , if\ \left(D_{s_{t+1}} \geq LC_2D_{s_t}\right) \end{cases} \quad (4.18)$$

$$E_{scen5} = E_{os} \quad (4.19)$$

Based on the objective function above, the equation (4.18) would represent how to calculate the total earning obtained from all channel in simultanous way. Next, the equation (4.19) would represent on how to calculate the total earning obtained from all channel. These condition is exist since all channel existed in Mr Froniez business already have coordination between them. Notice that, since there are several conditions derived from the condition in demand function there are in total 2 combinations to calculate each channels total earning function.

4.3.3.6 Scenario 6 Total Earning

For scenario 6, which have characteristics of high-consignment level and coordinative of all channel the developed formula would be given in Equation (4.20), and Equation (4.21) for total earning

$$E_{os}(Ps,Po) = D_s\ (Ps-Cm) + D_o\ (Po-Cm)$$

$$E_{os}(Ps,Po) = \begin{cases} \left(\frac{(1-\rho)d_s^{max} - a_1Ps + \beta_1Po + D_{s_{t+1}}}{1+LC_3}\right)(Ps-Cm) \\ + \left(\frac{\rho d_s^{max}LC_i + d_s^{max} - a_2PoLC_3 + \beta_2PsLC_3 - D_{s_{t+1}}LC_3}{(1+LC_3)}\right)(Po-Cm) \\ , if\ (D_{s_{t+1}} < LC_3D_{s_t}) \\ \left[\left((1-\rho)d_s^{max} - a_1Ps + \beta_1Po\right)(Ps-Cm) + (\rho d_s^{max} - a_2Po + \beta_2Ps)(Po-Cm)\right] \\ , if\ \left(D_{s_{t+1}} \geq LC_3D_{s_t}\right) \end{cases} \quad (4.20)$$

$$E_{scen6} = E_{os} \quad (4.21)$$

Based on the objective function above, the equation (4.20) would represent how to calculate the total earning obtained from all channel in simultanous way. Next, the equation (4.21) would represent on how to calculate the total earning obtained from all channel. These condition is exist since all channel existed in Mr Froniez business already have coordination between them. Notice that, since there are several conditions derived from the condition in demand function there are in total 2 combinations to calculate each channels total earning function.

4.3.4 Constraint Function

In this research, there are several constraints that being utilized, such as:

1. $Ps, Po \geq Cm$

   This constraint has a function to ensure that the selling price is at least the same with the cost of manufacture of Bronchips product in order to generate profit in Mr Froniez business.

2. $Ds, Do, \geq 0$

   This constrainst has a purpose to ensure that demand on all channel is not negative.

3. $Ps \geq Po$

   This constraint has a purpose to ensure that the highest selling price is on offline channel, thus at least Ps should in the same point as Po.

4. $\alpha_1 = \beta_2$

   This constraint has a purpose that customer has constant preference in terms of selling channel selection on offline channel, eventhough the possibilities to switch channel is exist.

5. $\alpha_2 = \beta_1$

   This constraint has a purpose that customer has constant preference in terms of selling channel selection on online channel, eventhough the possibilities to switch channel is exist.

4.4 Data Collection and Processing Parameter

In this subchapter, the parameters needed for this research will be presented and explained thoroughly.

4.4.1 Online Customer Preference Parameter (ρ)

In this research, ρ parameter is defined as the customer preference of selling channel of online product compared to offline product. It ranging from 0-100, every value would be collected by question number 3 in the questionnaire. Hence, there are assumption which the offline-channel is valued with 100 while, the online-channel is valued varying with the result of the questionnaire filled by the respondent/customer of the product. Therefore, the result of questionnaire would be presented in Table 4.1.

Table 4.1 Customer Preference of Online-channel Product Recapitulation

Respondents No.	Value	Respondents No.	Value	Respondents No.	Value
1	80	18	85	35	50
2	80	19	75	36	90
3	40	20	100	37	70
4	80	21	50	38	75
5	50	22	30	39	80
6	40	23	85	40	79
7	50	24	75	41	75
8	75	25	80	42	80
9	80	26	90	43	100
10	100	27	80	44	90
11	35	28	85	45	40
12	65	29	70	46	75
13	70	30	70	47	80
14	75	31	80	48	50
15	90	32	50	49	50
16	100	33	80	50	75
17	50	34	85	51	90
Mean				72.134	
Std dev				1.810.968.758	

In the Table 4.1, customer preference of online-channel product recapitulation is presented. The ρ parameter then would be obtained by dividing mean that is available in Table 4.1 by 100, due to ρ value is ranging from 0-1. Consequently, ρ is 0.72134.

After that, the confidence interval of the mean symbolized by μ, would be determine by using Student's t-test. This method is selected due to the condition of the population standard deviation that is unknown. Hence, it would be estimated by using Student's t-test parameters of $\bar{x}$ and s, respectively. (Groebner *et al.*, 2010). Therefore, the expression of Student's t-test is provided in Equation 4.22.

$$\bar{x} - t_{\frac{a}{2},n-1}\frac{s}{\sqrt{n}} \le \mu \le \bar{x} + t_{\frac{a}{2},n-1}\frac{s}{\sqrt{n}} \tag{4.22}$$

Information:

$\bar{x}$ = sample mean

s = sample standard deviation

a = chance of error (1-d_f)

$t_{\frac{a}{2}}$ = Critical value from the t-distribution with n-1 degrees of freedom for the desired confidence level

n = Sample size

$n-1$ = degree of freedom (d_f)

Hence the calculation process would be performed by setting the confidence level by 95%, and degree of freedom (n-1) with 50, as follows:

$$\bar{x} - t_{\frac{a}{2},n-1}\frac{s}{\sqrt{n}} \le \mu \le \bar{x} + t_{\frac{a}{2},n-1}\frac{s}{\sqrt{n}}$$

$$72.13725 - 2.0086\,\frac{18.10968758}{\sqrt{51}} \le \mu \le 72.13725 + 2.0086\,\frac{18.10968758}{\sqrt{51}}$$

$$72.13725 - 2.0086\,\frac{18.10968758}{\sqrt{51}} \le \mu \le 72.13725 + 2.0086\,\frac{18.10968758}{\sqrt{51}}$$

$$72.13725 - 5.0935 \le \mu \le 72.13725 + 5.0935$$

$$67.0437195 \le \mu \le 77.2307195$$

Hence, the ρ parameter could be selected from that range if it doesn't generate the optimal solution.

4.4.2 Demand Price Elasticity Parameter ($\boldsymbol{a}$ and $\boldsymbol{\beta}$)

In this research, demand price elasticity are consist of two parameters, the first one is a parameter which symbolize self-price elasticity of demand, and β parameter which symbolize cross-price elasticity of demand. According to Huang et al (2012), parameter a describe the demand elasticity ratio which show the change in demand against the price of the product alone. Next, the parameter β will will represent the coefficient that display the change in demand of product in one channel that is resulting from the change in price of other channel. Consequently, in this research there are 2 (two) a parameter that would be included which are listed as follows:

1. a_1= self-price elasticity againts demand in offline-channel
2. a_2= self price elasticity againts demand in online-channel

After that, there are 2 (two) β parameter that would be included in this research, which are listed as follows:

1. β_1= cross-price elasticity of online-channel price change into offline-channel demand
2. β_2= cross-price elasticity of offline-channel price change into online-channel demand

Note that, for model simplicity, the channel demand functions in the two channels are linear in self-price and cross-price effects, but with different parameters for each channel. Hence, the a_1 and β_2 is grouped because it is both are resulted from offline channel price change, thus the value would be identical. So as a_2 and β_1 is grouped because it is both resulted from online channel price change, thus the value would also be identical.

Next, all of the data for demand price elasticity parameter is obtained through the questionnaire question number 4 for offline-channel and number 5 for online-channel. The respondent could fill the question for by inputing any value from 0-10000 rupiah. The lower limit of 0 means that the respondent/customer needs no price reduction to buy more product, while the upper limit of 10000 is determine by the difference between the selling price and cost of manufacturing of the product. First, the price elasticity data recapitulation in offline-channel is specified in Table 4.2, and the price elasticity data recapitulation in online-channel is spefied in Table 4.3 as follows:

Table 4.2 Price Elasticity Data Recapitulation in Offline-Channel

Respondents Number	Questionnaire Input	Proportion	Respondents Number	Questionnaire Input	Proportion
1	5000	0.33	28	3500	0.23
2	5000	0.33	29	4000	0.27
3	5000	0.33	30	5000	0.33
4	6000	0.40	31	7000	0.47
5	7000	0.47	32	7000	0.47
6	5000	0.33	33	6000	0.40
7	5000	0.33	34	6000	0.40
8	5000	0.33	35	5000	0.33
9	2000	0.13	36	5000	0.33
10	3000	0.20	37	6000	0.40
11	5000	0.33	38	5000	0.33
12	5000	0.33	39	5000	0.33
13	5000	0.33	40	3000	0.20
14	4000	0.27	41	2500	0.17
15	1000	0.07	42	6000	0.40
16	2000	0.13	43	5000	0.33
17	4000	0.27	44	3000	0.20
18	5000	0.33	45	5000	0.33
19	6000	0.40	46	5000	0.33
20	7000	0.47	47	5000	0.33
21	7000	0.47	48	4000	0.27
22	9000	0.60	49	3000	0.20
23	3000	0.20	50	5000	0.33
24	6000	0.40	51	2000	0.13
25	5000	0.33			
26	5000	0.33	Mean		0.32
27	6000	0.40			

According to Table 4.2, the price elasticity value for offline channel (a_1 and β_2) is 0.32.

Table 4.3 Price Elasticity Data Recapitulation in Online-Channel

Respondents Number	Questionnaire Input	Proportion	Respondents Number	Questionnaire Input	Proportion
1	7000	0.47	28	5000	0.33
2	5000	0.33	29	5000	0.33
3	7000	0.47	30	7000	0.47
4	5500	0.37	31	5000	0.33
5	7000	0.47	32	0	0.00
6	6000	0.40	33	5500	0.37
7	5000	0.33	34	5000	0.33
8	5000	0.33	35	5000	0.33
9	2500	0.17	36	7000	0.47
10	3000	0.20	37	6000	0.40
11	3500	0.23	38	7000	0.47
12	5000	0.33	39	7000	0.47
13	5000	0.33	40	2000	0.13
14	4000	0.27	41	2500	0.17
15	1000	0.07	42	6000	0.40

Table 4.3 Price Elasticity Data Recapitulation in Online-Channel (continue)

Respondents Number	Questionnaire Input	Proportion	Respondents Number	Questionnaire Input	Proportion
16	5000	0.333	43	5000	0.333
17	5000	0.333	44	3000	0.200
18	7000	0.467	45	5000	0.333
19	6000	0.400	46	5000	0.333
20	7000	0.467	47	5000	0.333
21	7000	0.467	48	5000	0.333
22	9000	0.600	49	4000	0.267
23	5000	0.333	50	4000	0.267
24	7000	0.467	51	3000	0.200
25	5000	0.333			
26	5000	0.333	Mean		0.34
27	6000	0.400			

According to Table 4.3, the price elasticity value for online channel ($a_2$and β_1) is 0.34.

Based on the result of data processing, the value of all a and β parameters are in 0.32 and 0.34 range. Thus, there are prettty significant price elasticity against demand.

4.4.3 Manufacturing Cost Parameter (Cm)

In this research. manufacturing cost parameter is responsible for obtaining the total earning for every scenario in the research. Manufacturing cost parameter is obtained through secondary data by direct interview with the owner of the Mr Froniez itself. The owner explains that there are several ingredients or raw materials needed such as egg, sugar, chocolate, liquid fat, powder milk, flour, topping, and additional ingredient. Next, there are also foil packaging, cardbox, bubble wrap, and adhesive tape which needed for the whole packaging of the product. Last but not least, there are also other cost such as overhead cost, and transportation cost for both offline and online-channel. Hence, further detail of the cost components of bronchips is provided in Table 4.4

Table 4.4 Bronchips Manufacturing Cost Price Component Detail

No	Component	Cost
1	Egg	Rp160
2	Sugar	Rp364
3	Chocolate	Rp440
4	Liquid Fat	Rp208
5	Powder Milk	Rp96

Table 4.4 Bronchips Manufacturing Cost Price Component Detail (continue)

No	Component	Cost
6	Flour	Rp105
7	Topping	Rp660
8	Additional	Rp20
9	Foil Packaging and Card box	Rp110
10	Bubble Wrap and Adhesive Tape	Rp200
11	Other Cost (overhead)	Rp165
Total Cost		Rp5.000

According to Table 4.4 the total cost of manufacturing of the Bronchips product is about Rp 5,000.00

4.4.4 Offline-Channel Demand for Next Selling Period ($D_{s_{t+1}}$)

In this research, the offline channel demand for next selling period is significant for several things, such as the selection of the demand function since there are 2 conditions that exist in demand model function. It will be compared then with the decision variable of consignment level and the coordination of the channel whether it is non-coordinative or coordinative. Hence, the time series plot of the data to assess whether there are trend or season in data is provide in Figure 4.8 below.

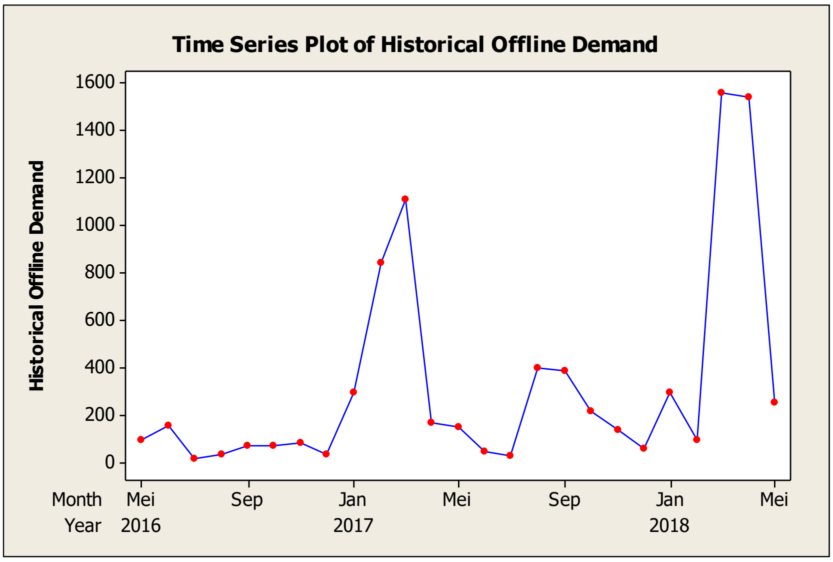

Figure 4.8 Offline Demand Chart

Linear forecast equation function, usually calculates a new y-value by utilizing simple straight line as follows:

$$y = a + bx \tag{4.23}$$

where,

$$a = \bar{y} - b\bar{x} \tag{4.24}$$

and

$$b = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sum(x-\bar{x})^2} \tag{4.25}$$

While, the values of x and y are the sample mean (the averages) of the known x- and the known y-values. However, in this case, the author generate time-series forecast by utilizing Forecast.Linear Function It is use because the data of offline demand doesn't shows trend in from time-to-time, and the data considered as non-seasonal data since there are no clear determination Hence, the result of demand forecast using Forecast.Linear Function and further analysis of determination of seasonal data is utilized using Forecast.Ets.Seasonality function provided in Table 4.5.

Table 4.5 Offline Demand Forecast Result and Analysis

Year	Month	Period in Number	Offline
2016	May	1	97
	June	2	159
	July	3	19
2016	August	4	37
	September	5	70
	October	6	73
	November	7	83
	December	8	34
2017	January	9	295
	February	10	841
2017	March	11	1106
	April	12	167
	May	13	149
	June	14	47
	July	15	31
	August	16	401
	September	17	388
	October	18	220
	November	19	138
	December	20	60
2018	January	21	298
	February	22	99
	March	23	1556
	April	24	1539
	May	25	252
Forecast		26	653,79
Forecast.Ets.Seasonality			0

Based on the result of calculation above, using Forecast.Linear function in Excel software the forecast would be 653,79. Then, based on the result of

Forecast.Ets.Seasonality function it generates 0 value which mean there is no seasonal pattern of historical offline demand data of Bronchips However, since there are two types/condition in demand function, to fulfill 2nd condition of the demand function, hence the forecast is recalculated by deleting historical offline demand that has demand above 1000. Those historical could be found in march 2017, march 2018, and april 2018. Thus, the modified historical offline-demand data and the forecast demand is provided in Table 4.6.

Table 4.6 Modified Demand Forecast Result

Year	Month	Period in Number	Offline Demand
2016	May	1	97
	June	2	159
	July	3	19
	August	4	37
	September	5	70
	October	6	73
	November	7	83
	December	8	34
2017	January	9	295
	February	10	841
	April	11	167
	May	12	149
	June	13	47
	July	14	31
	August	15	401
	September	16	388
	October	17	220
	November	18	138
	December	19	60
2018	January	20	298
	February	21	99
	May	22	252
Forecast		23	253,273

4.4.5 Maximum Demand Parameter (d_s^{max})

According to Huang et al (2012), d_s^{max} is a parameter that represents the forecasted potential demand if the products are free of charge. Hence, the data which represent that characterictics will be obtained from the historical sales data of Bronchips product, the data is obtained through secondary data owned by the Mr Froniez SME. Historical sales data collection is starts from May 2016 until May 2018.Consequently, the recapitulaton of historical data of Bronchips is provided in Table 4.7 as follows:

Table 4.7 Historical Sales Data of Bronchips product

Year	Month	Online Demand	Offline Demand
2016	May	617	97
	June	3519	159
	July	1830	19
	August	1740	37
	September	5147	70
	October	7771	73
	November	11230	83
	December	5945	34
2017	January	6675	295
	February	9108	841
	March	14325	1106
	April	13088	167
	May	10740	149
	June	4055	47
	July	4824	31
	August	8572	401
	September	7603	388
	October	9563	220
	November	8794	138
	December	8284	60
2018	January	11329	298
	February	11162	99
	March	13872	1556
	April	10814	1539
	May	8513	252
Mean		7964	326

From Table 4.7, all of historical data from both channel is provided in monthly basis. Since there are no change in price between those range of time, the d_s^{max} parameter could be obtained by substituting all of the known parameter to the offline-channel demand fuction, with several assumptions. The assumptions needed would be the Ps (offline-channel price) is identical with Cm (cost of manufacturing), the value of D_s is the demand mean/average in offline channel according to historical sales data.

However, since there are two condition of D_s, which where there are no consignment product is remaining ($D_{s_{t+1}} \geq CL_t D_{s_t}$), and where there are consignment product exist ($D_{s_{t+1}} < CL_t D_{s_t}$). Then, the calculation will be provided in 2 separate calculation using 2 value of $D_{s_{t+1}}$ in subchapter 4.4.4. Hence, the calculation process for the d_s^{max} parameter will be provided in two calculation process as follows:

- When there are remaining consignment product ($D_{s_{t+1}} < CL_t D_{s_t}$)

$$D_s = \frac{(1-\rho)d_s^{max} - a_1 ps + \beta_1 po + D_{s_{t+1}}}{1 + CL_i}$$

$$326 = \frac{(1-0.721372549)d_s^{max} - 0.32\text{x}15000 + 0.34\text{x}15000 + 253.273}{1+1}$$

$$d_s^{max} = 4325$$

- When there are no remaining consignment product ($D_{s_{t+1}} \geq CL_t D_{s_t}$)

However, in this research

$$D_s = (1-\rho)d_s^{max} - a_1 ps + \beta_1 po$$
$$326 = (1-0.721372549)d_s^{max} - 0{,}32\text{x}15000 + 0{,}34\text{x}15000$$
$$d_s^{max} = 796$$

Hence, based on the parameter collections and calculations which already performed. Hence, the recapitulation of parameters value are provided in Table 4.6.

Table 4.8 Parameter Value Recapitulation

No	Parameter	Value
1	ρ	0.72134
3	a_1, β_2	0.32
4	a_2, β_1	0.34
5	C_m	5000 (rupiah)
6	$D_{s_{t+1}}$	653.79
7	$D_{s_{t+1}}(dummy)$	253.273
8	d_s^{max}	796
9	d_s^{max} (dummy)	4325.75

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CHAPTER 5
NUMERICAL EXPERIMENT AND ANALYSIS

In this chapter, the explanation of all numerical experiment based on models and scenarios in previous chapter would be conducted. After the result is obtained, the analysis of result would be provided in regard to the result of the numerical experiment. Hence, there are several subchapters exist in this chapter, such as validation and verification of the model, price optimization numerical experiment for all the scenario, sensitivity analysis of the result, and managerial implication for Mr Froniez business.

5.1 Validation and Verification

Validation and verification is conducted in order to determine whether developed model is represent real condition of the observation object.

5.1.1 Validation

In this subchapter, the validation of model would be applied to the demand function for all channel including online-channel and offline channel, and for objective function for all constructed scenario. The validation process would be to investigate whether the change of considerable parameter would affect the total demand or profit obtained by Mr froniez. Hence. The validation process would be explained in further discussion.

5.1.1.1 Validation for Demand Function

In this research there are two types of demand function differentiated by the channel of the product selling, which are demand function for offline-channel (Do) and online-channel (Ds). Hence, the validation will be performed by testing the demand function for all channel by checking the demand function behavior against selling price change.

- Validation of Offline-demand Function against Selling Price Change

Since there are two condition of offline-demand function, when there are remaining consignment product, and when there are no consignment product left, thus the validation will be done twice for both condition. Hence, the validation for offline demand function with consignment is provided in Figure 5.1 and validation for offline demand function without consignment is provided in Figure 5.2 as follows:

Table 5.1 Input Data for Offline-demand Function with Consignment against Selling Price Change

ρ	a_1	β_1	$D_{s_{t+1}}$	d_s^{max}	LC_i	Po
0.72134	0.32	0.34	253	4325	1	15000

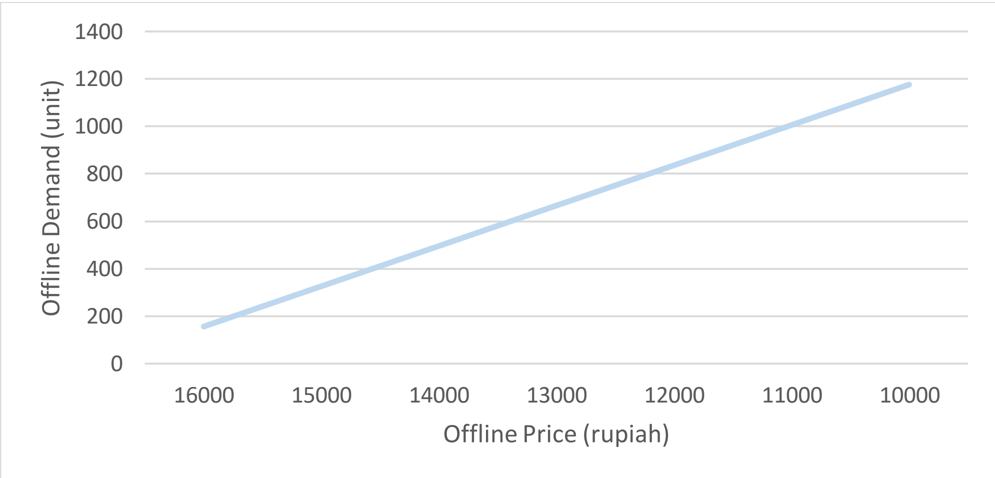

Figure 5.1 Validation for Offline Demand Function with Consignment against Price Change

Based on Figure 5.1 above, the result of validation indicate that when the selling price is reduce, the expected demand generated from it is higher. Thus, to conclude the offline demand function (with consignment) is considered as valid. Note that, the input data is provided in Table 5.1

Table 5.2 Input Data for Offline-demand Function without Consignment against Selling Price Change

ρ	a_1	β_1	$D_{s_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

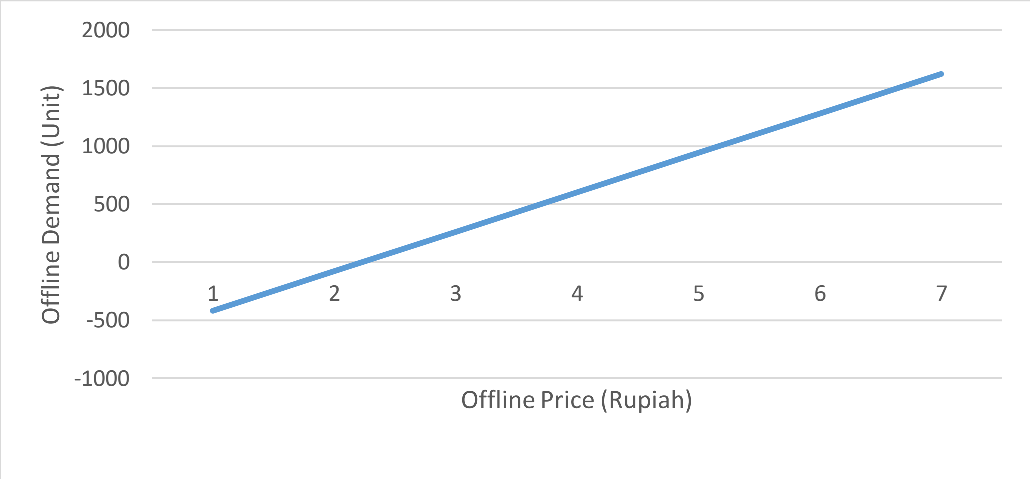

Figure 5.2 Validation for Offline Demand Function without Consignment against Price Change

Based on Figure 5.2 above, the result of validation indicate that when the selling price is reduce, the expected demand generated from it is higher. Thus, to conclude the offline demand function (without consignment) is considered as valid. Note that, the input data is provided in Table 5.2

- Validation of Online-demand Function against Selling Price Change

Next, for online-demand function, there are two condition of online-demand function, when there are remaining consignment product, and when there are no consignment product left, pretty similar with offline-demand function. Thus the validation will be done twice for both condition. Hence, the validation for online demand function with consignment is provided in Figure 5.3 and validation for online demand function without consignment is provided in Figure 5.4 as follows:

Table 5.3 Input Data for Online-demand Function with Consignment against Selling Price Change

ρ	a_2	β_2	$D_{s_{t+1}}$	d_s^{max}	LC_i	Ps
0.72134	0.34	0.33	253	4325	1	15000

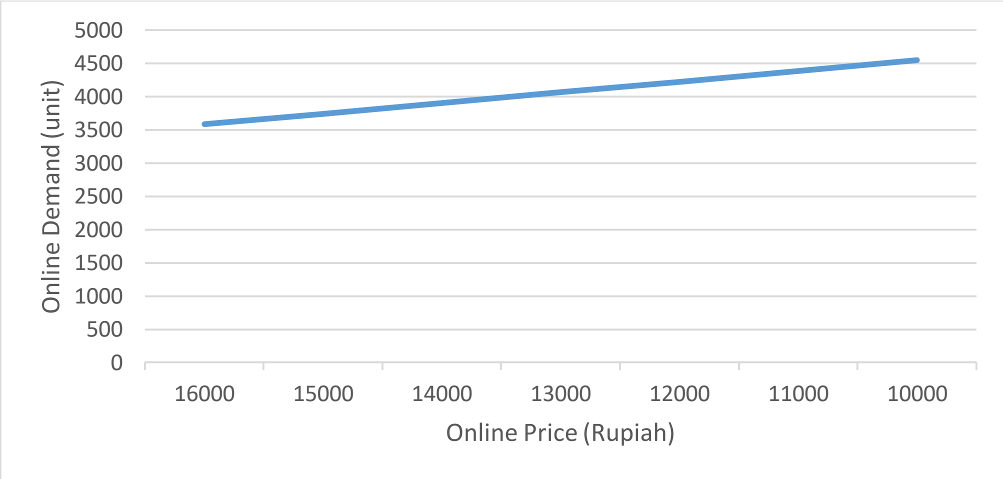

Figure 5.3 Validation for Online Demand Function with Consignment against Price Change

Based on Figure 5.3 above, the result of validation indicate that when the selling price is reduce, the expected demand generated from it is higher. Thus, to conclude the online demand function (with consignment) is considered as valid. Note that, the input data is provided in Table 5.3

Table 5.4 Input Data for Online-demand Function without Consignment against Selling Price Change

ρ	α_2	β_2	$D_{s_{t+1}}$	d_s^{max}	Ps
0.72134	0.34	0.32	653	796	15000

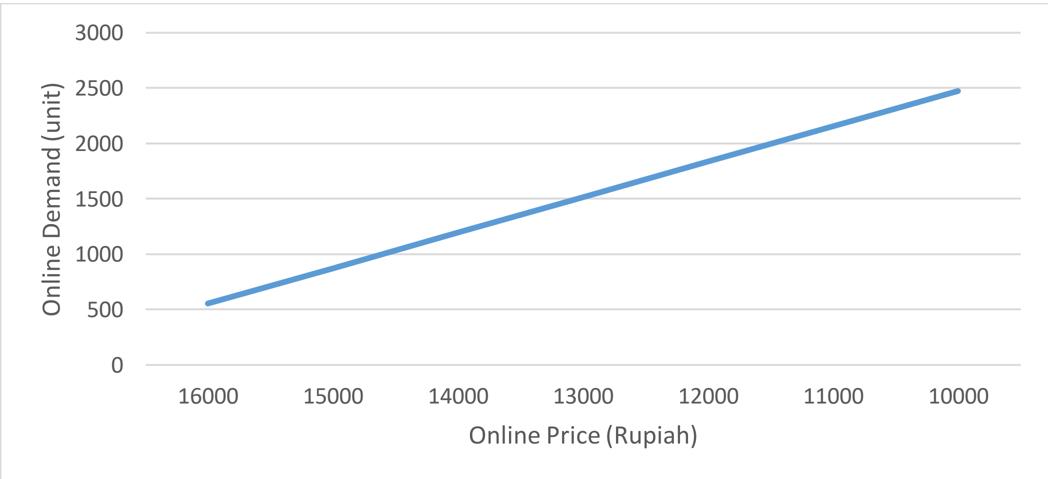

Figure 5.4 Validation for Online Demand Function without Consignment against Price Change

Based on Figure 5.4 above, the result of validation indicate that when the selling price is reduce, the expected demand generated from it is higher. Thus, to conclude the online demand function (without consignment) is considered as valid. Note that, the input data is provided in Table 5.4

5.1.1.2 Validation for Objective Function

In this research there are six scenarios which already developed of objective function. However, since there are two types of demand function that is related with either the remaining consignment product exist in the next period of product selling or not. Consequently, the total combination of objective function that will be tested are twelve scenarios. Hence, validation will be performed by testing the objective function of total earning for all combined scenarios by checking the objective against cost of manufacture change.

- Validation for Objective Function in Scenario 1

In validation for objective function which are total earning for each scenario, it would be done separately for both when condition of demand makes the consinment product is remain, and when there are no consignment product left. Thus, both validation of objective function for scenario 1 would be provided as follows:

Table 5.5 Input Data for Objective Function in Scenario 1 with consignment against Cost of Manufacture Change

ρ	a_1,β_1	$\beta_1, a_{1,}$	$D_{s_{t+1}}$	d_s^{max}	LC_i	Po	Ps
0.72134	0.32	0.34	253	4325	1	5000	5000

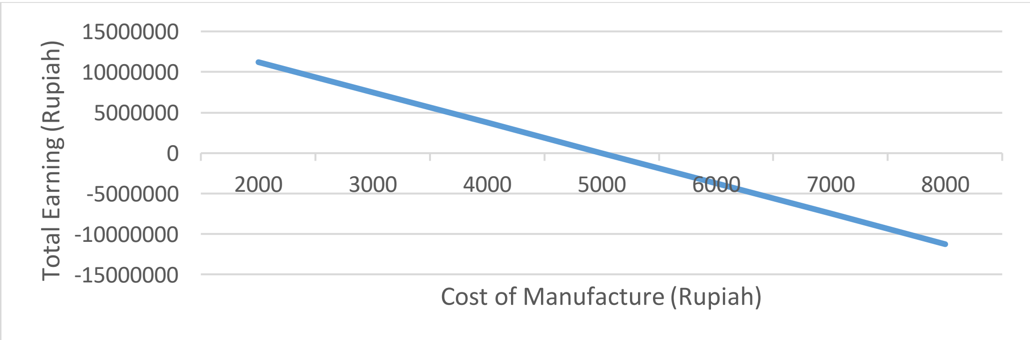

Figure 5.5 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 1 with Consignment

Based on Figure 5.5 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 1 total earning (with consignment) is considered as valid. Note that, the input data is provided in Table 5.5.

Table 5.6 Input Data for Objective Function in Scenario 1 without consignment against Cost of Manufacture Change

ρ	a_1, β_3	a_2, β_1	$D_{s_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

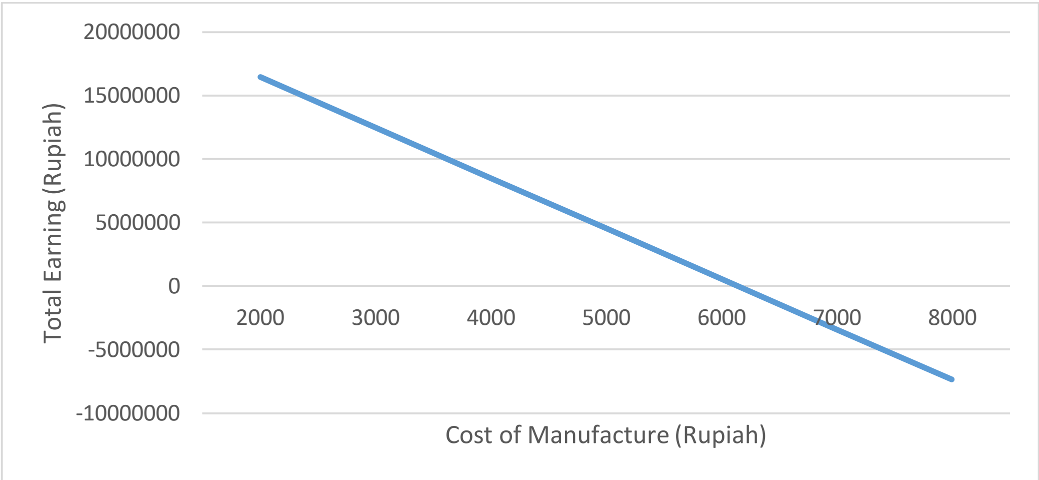

Figure 5.6 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 1 without Consignment

Based on Figure 5.6 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 1 total earning (without consignment) is considered as valid. Note that, the input data is provided in Table 5.6.

- Validation for Objective Function in Scenario 2

In validation for objective function which are total earning for each scenario, it would be done separately for both when condition of demand makes the consinment product is remain, and when there are no consignment product left. Thus, both validation of objective function in scenario would be provided as follows:

Table 5.7 Input Data for Objective Function in Scenario 2 with consignment against Cost of Manufacture Change

ρ	$a_{1,}\beta_1$	$\beta_1, a_{1,}$	$D_{s_{t+1}}$	d_s^{max}	LC_2	Po	Ps
0.72134	0.32	0.34	253	4325	0.6	6142.1	6142.1

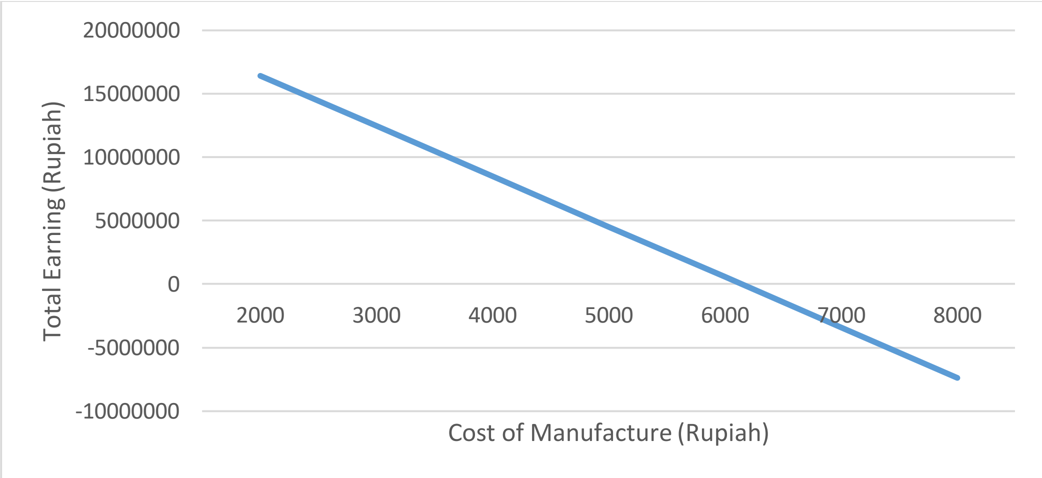

Figure 5.7 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 2 with Consignment

Based on Figure 5.7 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 2 total earning (with consignment) is considered as valid. Note that, the input data is provided in Table 5.7.

Table 5.8 Input Data for Objective Function in Scenario 2 without consignment against Cost of Manufacture Change

ρ	a_1, β_3	a_2, β_1	$D_{s_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

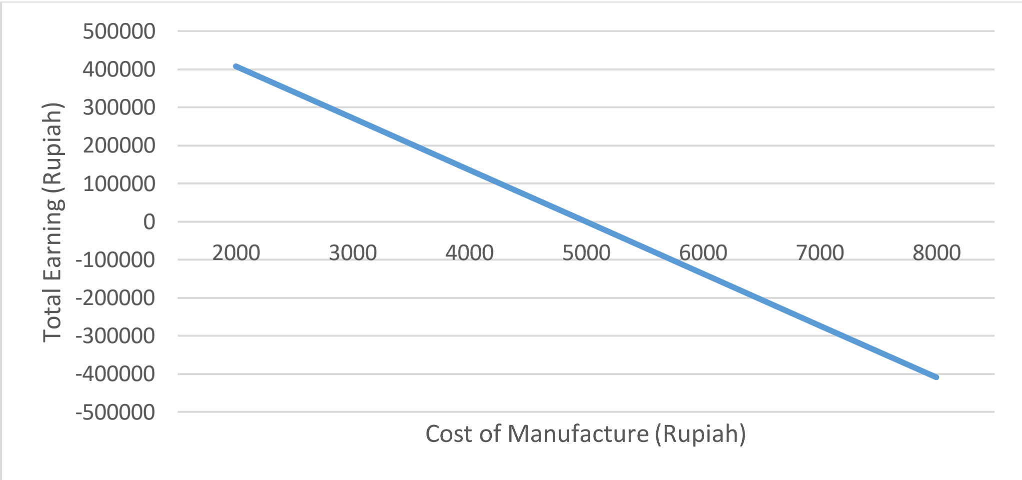

Figure 5.8 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 2 (without consignment)

Based on Figure 5.8 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 2 total earning (without consignment) is considered as valid. Note that, the input data is provided in Table 5.8.

- Validation for Objective Function in Scenario 3

In validation for objective function which are total earning for each scenario, it would be done separately for both when condition of demand makes the consinment product is remain, and when there are no consignment product left. Thus, both validation of objective function in scenario 3 would be provided as follows:

Table 5.9 Input Data for Objective Function in Scenario 3 with consignment against Cost of Manufacture Change

ρ	$a_{1,}\beta_1$	$\beta_1, a_{1,}$	$D_{s_{t+1}}$	d_s^{max}	LC_3	Po	Ps
0.72134	0.32	0.34	253	4325	0.2	8189.5	8189.5

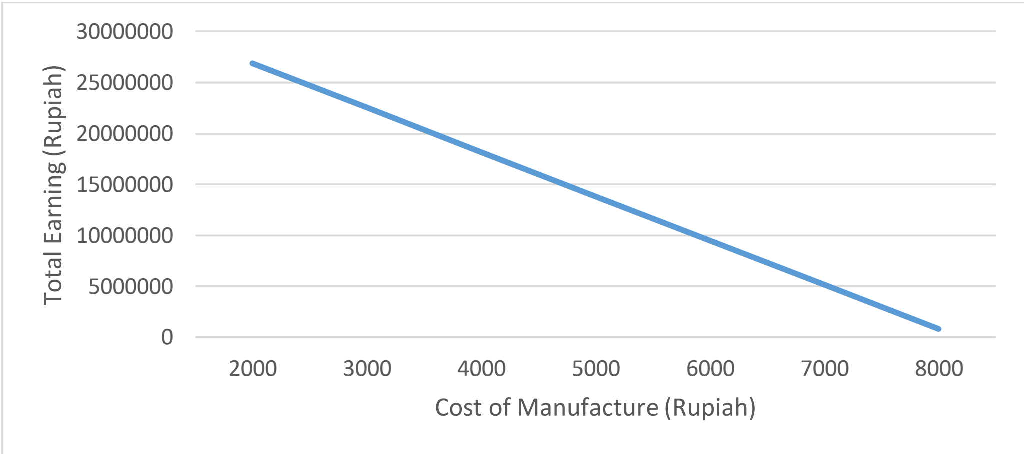

Figure 5.9 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 3 with Consignment

Based on Figure 5.9 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 3 total earning (with consignment) is considered as valid. Note that, the input data is provided in Table 5.9.

Table 5.10 Input Data for Objective Function in Scenario 3 without consignment against Cost of Manufacture Change

ρ	a_1, β_3	a_2, β_1	$D_{S_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

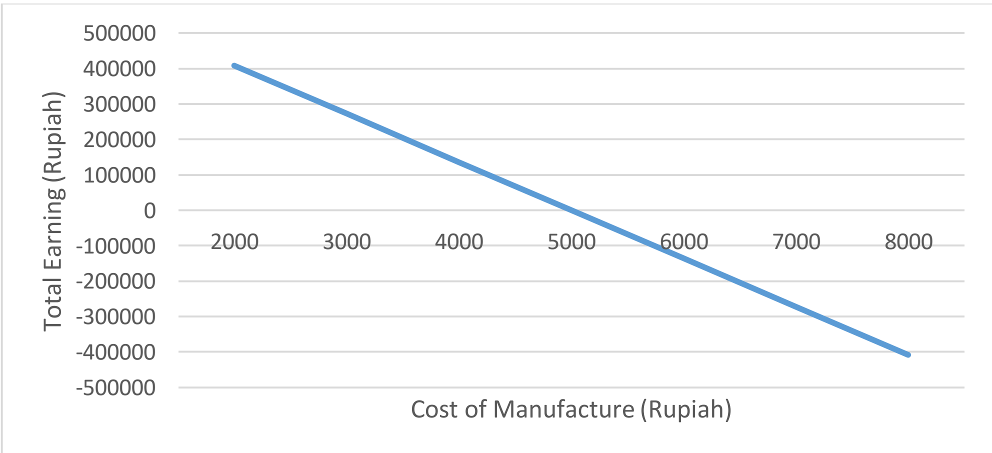

Figure 5.10 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 3 without Consignment

Based on Figure 5.10 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 3 total earning (without consignment) is considered as valid. Note that, the input data is provided in Table 5.10.

- Validation for Objective Function in Scenario 4

In validation for objective function which are total earning for each scenario, it would be done separately for both when condition of demand makes the consinment product is remain, and when there are no consignment product left. Thus, both validation of objective function for scenario 4 would be provided as follows:

Table 5.11 Input Data for Objective Function in Scenario 4 with consignment against Cost of Manufacture Change

ρ	$a_{1,}\beta_1$	$\beta_1, a_{1,}$	$D_{s_{t+1}}$	d_s^{max}	LC_1	Po	Ps
0.72134	0.32	0.34	253	4325	1	5000	6931.5

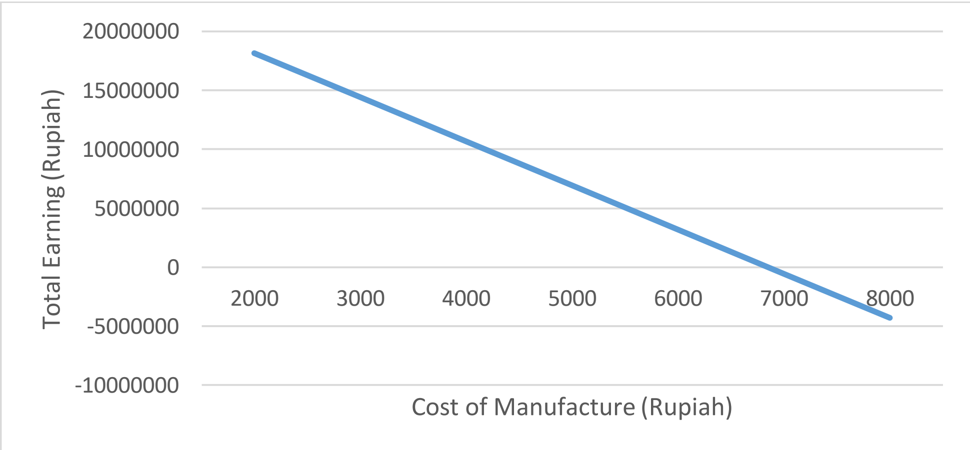

Figure 5.11 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 4 with Consignment

Based on Figure 5.11 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 4 total earning (with consignment) is considered as valid. Note that, the input data is provided in Table 5.11.

Table 5.12 Input Data for Objective Function in Scenario 4 without consignment against Cost of Manufacture Change

ρ	a_1, β_3	a_2, β_1	$D_{s_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

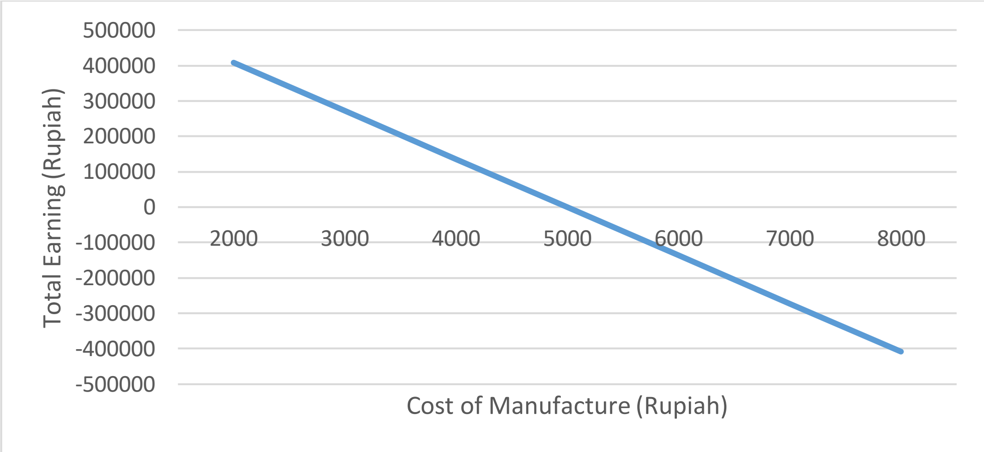

Figure 5.12 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 4 without Consignment

Based on Figure 5.12 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 4 total earning (without consignment) is considered as valid. Note that, the input data is provided in Table 5.12.

- Validation for Objective Function in Scenario 5

In validation for objective function which are total earning for each scenario, it would be done separately for both when condition of demand makes the consinment product is remain, and when there are no consignment product left. Thus, both validation of objective function for scenario 5 would be provided as follows:

Table 5.13 Input Data for Objective Function in Scenario 5 with consignment against Cost of Manufacture Change

ρ	$a_{1,}\beta_1$	$\beta_1, a_{1,}$	$D_{s_{t+1}}$	d_s^{max}	LC_2	Po	Ps
0.72134	0.32	0.34	253	4325	0.6	5000	6931.5

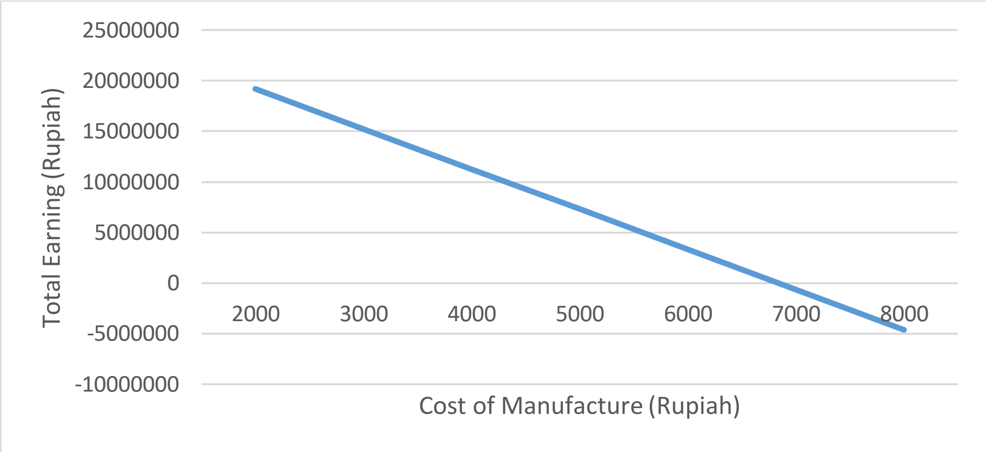

Figure 5.13 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 5 with Consignment

Based on Figure 5.13 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 5 total earning (with consignment) is considered as valid. Note that, the input data is provided in Table 5.13.

Table 5.14 Input Data for Objective Function in Scenario 5 without consignment against Cost of Manufacture Change

ρ	a_1, β_3	a_2, β_1	$D_{s_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

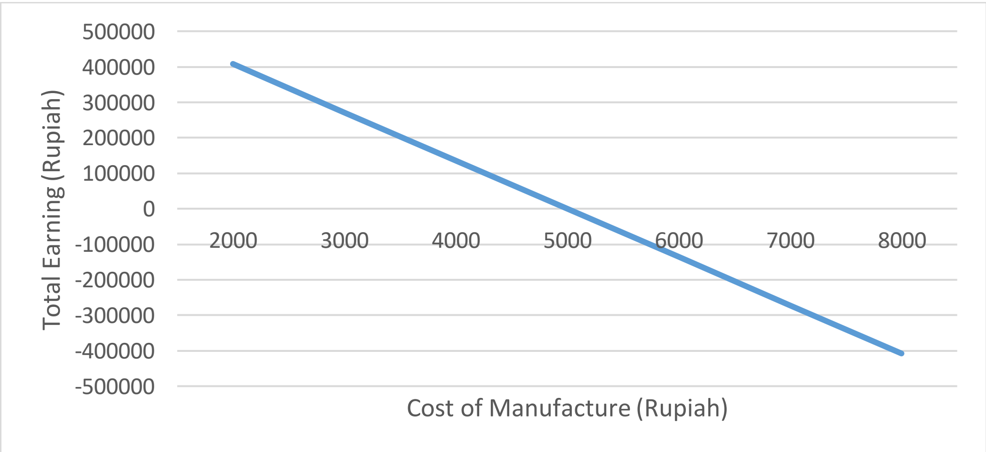

Figure 5.14 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 5 without Consignment

Based on Figure 5.14 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 5 total earning (without consignment) is considered as valid. Note that, the input data is provided in Table 5.14.

- Validation for Objective Function in Scenario 6

In validation for objective function which are total earning for each scenario, it would be done separately for both when condition of demand makes the consinment product is remain, and when there are no consignment product left. Thus, both validation of objective function for scenario 6 would be provided as follows:

Table 5.15 Input Data for Objective Function in Scenario 6 with consignment against Cost of Manufacture Change

ρ	a_1, β_1	$\beta_1, a_1,$	$D_{s_{t+1}}$	d_s^{max}	LC_3	Po	Ps
0.72134	0.32	0.34	253	4325	0.2	5000	6931.5

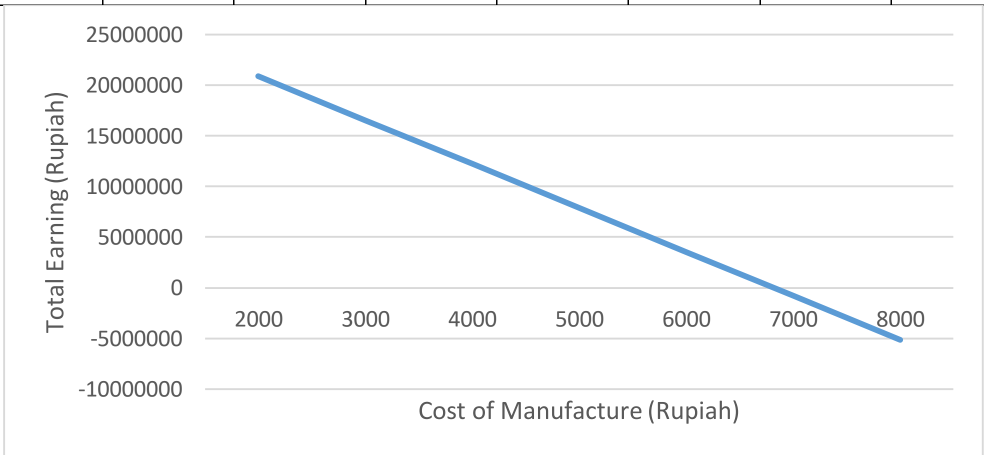

Figure 5.15 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 6 with Consignment

Based on Figure 5.15 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 6 total earning (with consignment) is considered as valid. Note that, the input data is provided in Table 5.15.

Table 5.16 Input Data for Objective Function in Scenario 3 without consignment against Cost of Manufacture Change

ρ	a_1, β_3	a_2, β_1	$D_{s_{t+1}}$	d_s^{max}	Po
0.72134	0.32	0.34	653	796	15000

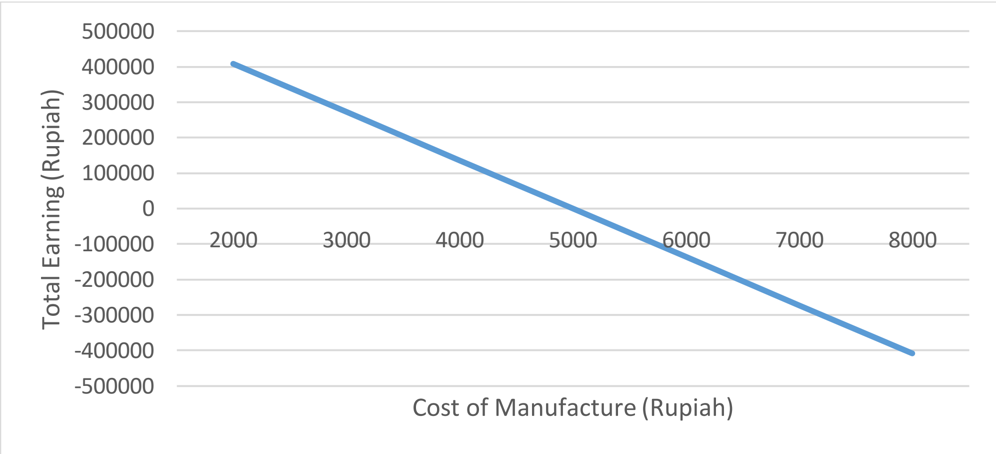

Figure 5.16 Validation for Change in Parameter Cost of Manufacture against Total Earning in Scenario 6 without Consignment

Based on Figure 5.16 above, the result of validation indicate that when the cost of manufacture is reduce, the total earning generated from it is higher. Thus, to conclude the scenario 6 total earning (without consignment) is considered as valid. Note that, the input data is provided in Table 5.16.

5.1.2 Verification

In this research, verification is done to make sure that the model is represented in the software-built model. Hence, the verification would be done by generating MATLAB software, where the profit maximization process is done to obtain optimal price on each channel for each scenario that is processed.

The verification is done by checking all m-file that represent the objective function in each scenario. Thus, the verification would describe in several figures from Figure 5.17 to 5.34. Noted that, for scenario 1 to 3 the model would be form in four combination because there are step-by step optimization process and two types of demand fucntion, while for scenario 4 to 6 the model would be form in two combination only, since the optimization is done in simultaneous way.

- Scenario 1 Verification Process

For scenario 1, the verification process is done by checking m-file represented four figures. First, Figure 5.17 for total earning in offline-channel if there are consignment product exist. Next, Figure 5.18 will represent total earning in online-channel if consignment product exist. After that, total earning for online channel if consignment product is not exist would be represented in Figure 5.19. Lastly, the Figure 5.20 will represent total earning for offline channel if consignment product is not exist.

Editor - D:\reiza TA\Final Project\Matlab Experiment baru\Scenario 1\eo_scenario1a.m

eo_scenario1a.m

```
function [Eo1a]=eo_scenario1a (Po)

%Known parameter%
dsmax=4325.75;
rho=0.72134;
alpha2=0.34;
beta2=0.32;
Dst1=253.273;
Lc1=1;
Ps=15000;
Cm=5000;

%Objective Function%
Eo1a=(((rho*dsmax*Lc1)+(dsmax)-(alpha2*Po*Lc1)+(beta2*Ps*Lc1)-(Dst1*Lc1))/.
    (1+Lc1))*(Po-Cm);
```

Figure 5.17 Verification for Eo Scenario 1 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.17 above, the model could be considered as verified.

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eo_scenario1b.m

```
function [Eo1b]=eo_scenario1b (Po)

%Known parameter%
dsmax=796;
rho=0.72134;
alpha2=0.34;
beta2=0.32;
Ps=15000;
Cm=5000;

%Objective Function%
Eo1b=((rho*dsmax)-(alpha2*Po)+(beta2*Ps))*(Po-Cm);
```

Figure 5.18 Verification for Eo Scenario 1 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.18 above, the model could be considered as verified.

Editor - D:\reiza TA\Final Project\Matlab Experiment baru\Scenario 1\es_scenario1a.m

es_scenario1a.m

```
function [Es1a]=es_scenario1a (Ps)

%Known parameter%
dsmax=4325.75;
rho=0.72134;
alpha1=0.32;
beta1=0.34;
Dst1=253.273;
Lc1=1;
Cm=5000;
Po=6000;

%Objective Function%
Es1a=((((1-rho)*dsmax)-(alpha1*Ps)+(beta1*Po)+Dst1)/(1+Lc1))*(Ps-Cm);
```

Figure 5.19 Verification for Es Scenario 1 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.19 above, the model could be considered as verified.

Editor - D:\reiza TA\Final Project\Matlab Experiment baru\Scenario 1\es_scenario1b.m

es_scenario1b.m

```
function [Es1b]=es_scenario1b (Ps)

%Known parameter%
dsmax=796;
rho=0.72134;
alpha1=0.32;
beta1=0.34;
Cm=5000;
Po=5.00E+03;

%Objective function%
Es1b=(((1-rho)*dsmax)-(alpha1*Ps)+(beta1*Po))*(Ps-Cm);
```

Figure 5.20 Verification for Es Scenario 1 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.20 above, the model could be considered as verified.

- Scenario 2 Verification Process

For scenario 2, the verification process is pretty similar with scenario 1 verification process which is done by checking m-file represented four figures. First, Figure 5.21 for total earning in offline-channel if there are consignment product exist. Next, Figure 5.22 will represent total earning in online-channel if consignment product exist. After that, total earning for online channel if consignment product is not exist would be represented in Figure 5.23. Lastly, the Figure 5.24 will represent total earning for offline channel if consignment product is not exist.

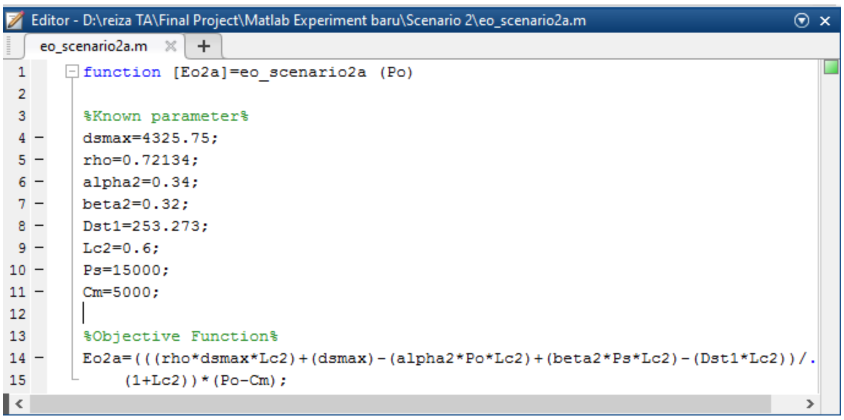


Figure 5.21 Verification for Eo Scenario 2 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.21 above, the model could be considered as verified.

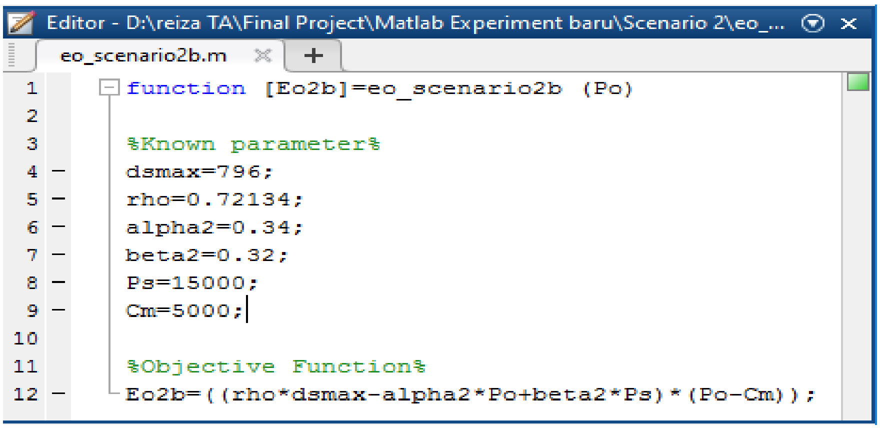


Figure 5.22 Verification for Eo Scenario 2 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.22 above, the model could be considered as verified.

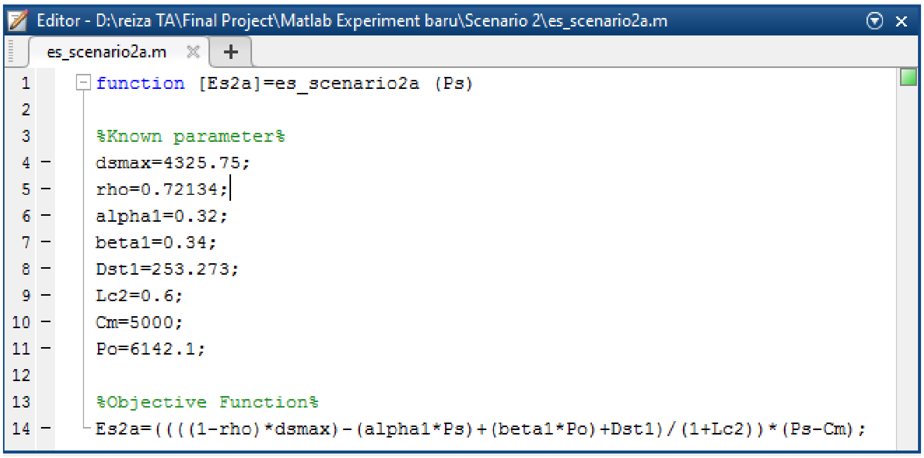


Figure 5.23 Verification for Es Scenario 2 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.23 above, the model could be considered as verified.

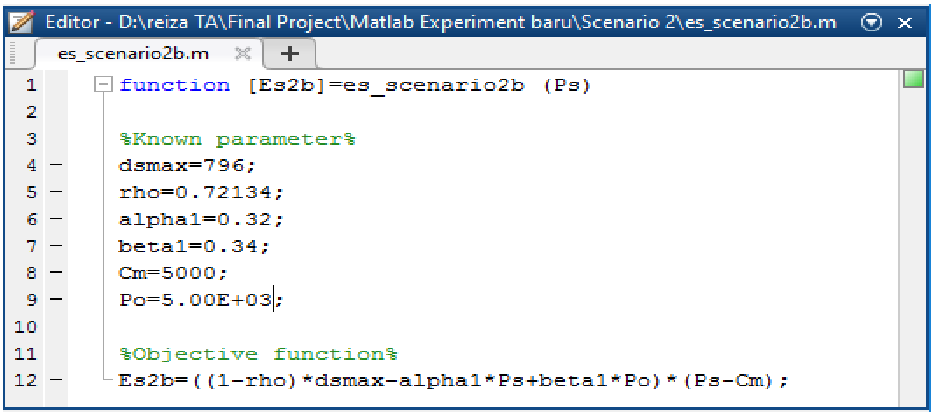
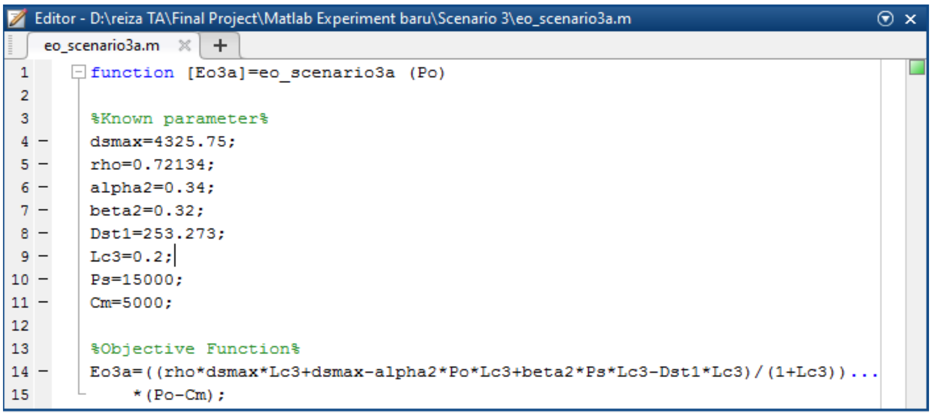


Figure 5.24 Verification for Es Scenario 2 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.24 above, the model could be considered as verified.

- Scenario 3 Verification Process

For scenario 3, the verification process is also pretty similar with scenario 1 and 2. Verification process is done by checking m-file represented four figures. First, Figure 5.25 for total earning in offline-channel if there are consignment product exist. Next, Figure 5.26 will represent total earning in online-channel if consignment product exist. After that, total earning for online channel if consignment product is not exist would be represented in Figure 5.27. Lastly, the Figure 5.28 will represent total earning for offline channel if consignment product is not exist.



Editor - D:\reiza TA\Final Project\Matlab Experiment baru\Scenario 3\eo_scenario3a.m

eo_scenario3a.m

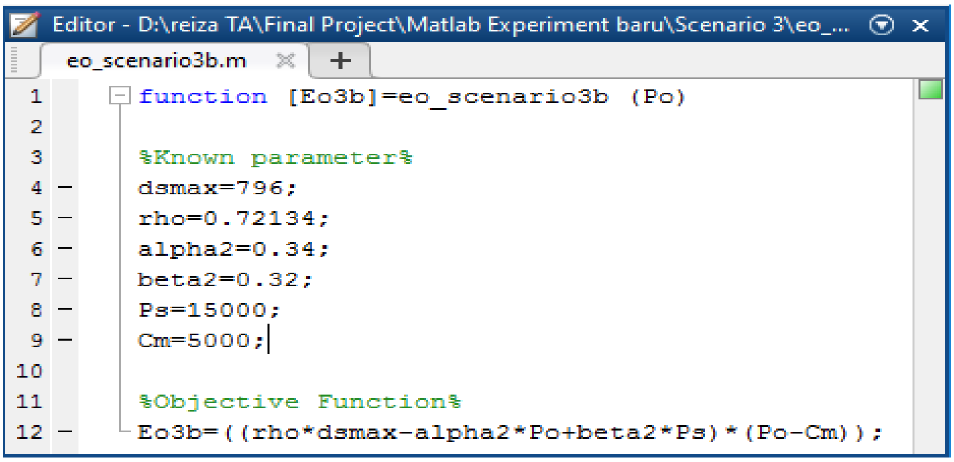
```
function [Eo3a]=eo_scenario3a (Po)

%Known parameter%
dsmax=4325.75;
rho=0.72134;
alpha2=0.34;
beta2=0.32;
Dst1=253.273;
Lc3=0.2;
Ps=15000;
Cm=5000;

%Objective Function%
Eo3a=((rho*dsmax*Lc3+dsmax-alpha2*Po*Lc3+beta2*Ps*Lc3-Dst1*Lc3)/(1+Lc3))...
    *(Po-Cm);
```

Figure 5.25 Verification for Eo Scenario 3 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.25 above, the model could be considered as verified.



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eo_scenario3b.m

```
function [Eo3b]=eo_scenario3b (Po)

%Known parameter%
dsmax=796;
rho=0.72134;
alpha2=0.34;
beta2=0.32;
Ps=15000;
Cm=5000;

%Objective Function%
Eo3b=((rho*dsmax-alpha2*Po+beta2*Ps)*(Po-Cm));
```

Figure 5.26 Verification for Eo Scenario 3 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.26 above, the model could be considered as verified.

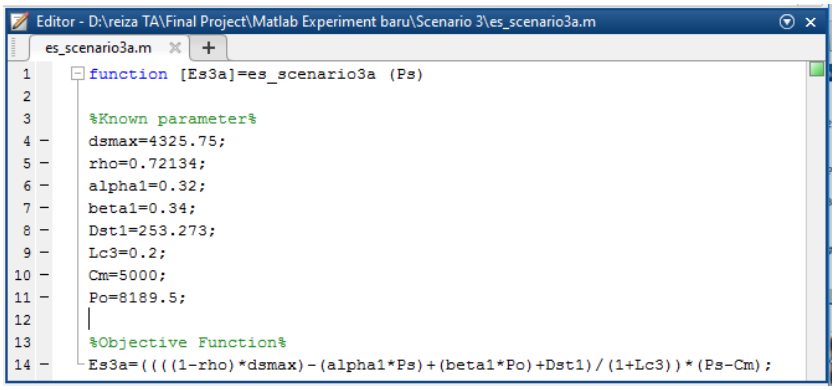


Figure 5.27 Verification for Es Scenario 3 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.27 above, the model could be considered as verified.

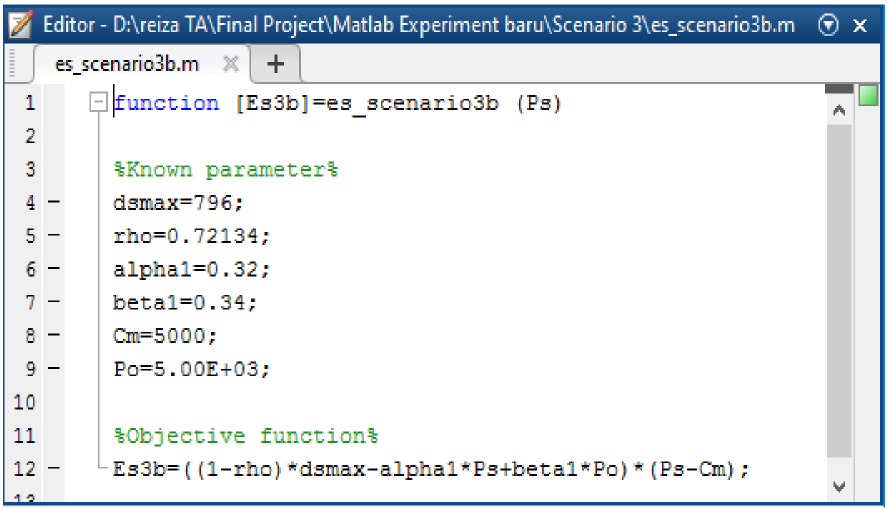
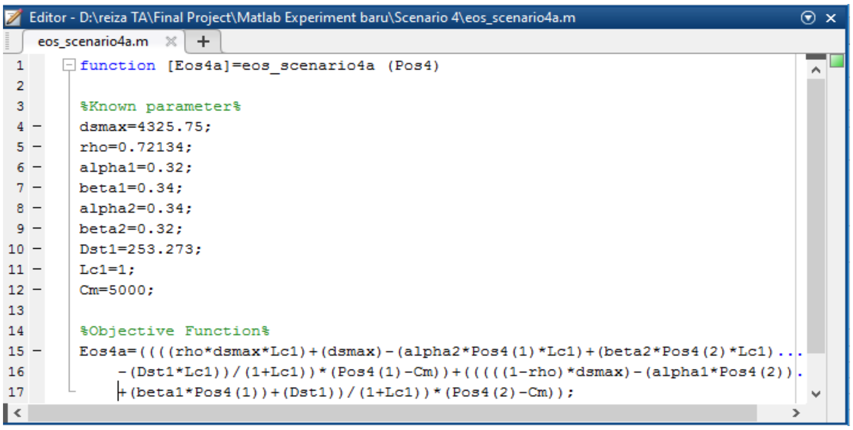


Figure 5.28 Verification for Es Scenario 3 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.28 above, the model could be considered as verified.

- Scenario 4 Verification Process

For scenario 4, the verification process is done by checking m-file represented by two figures. First, Figure 5.29 for total earning in both channel simultaneously if there are consignment product exist. While the Figure 5.30 will represent total earning for both channel simultaneously if consignment product is not exist.



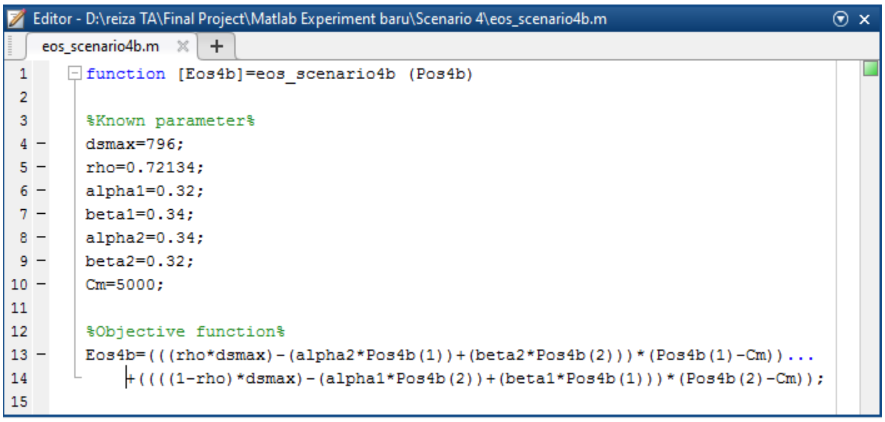

```
function [Eos4a]=eos_scenario4a (Pos4)

%Known parameter%
dsmax=4325.75;
rho=0.72134;
alpha1=0.32;
beta1=0.34;
alpha2=0.34;
beta2=0.32;
Dst1=253.273;
Lc1=1;
Cm=5000;

%Objective Function%
Eos4a=((((rho*dsmax*Lc1)+(dsmax)-(alpha2*Pos4(1)*Lc1)+(beta2*Pos4(2)*Lc1)...
    -(Dst1*Lc1))/(1+Lc1))*(Pos4(1)-Cm))+(((((1-rho)*dsmax)-(alpha1*Pos4(2)).
    +(beta1*Pos4(1))+(Dst1))/(1+Lc1))*(Pos4(2)-Cm));
```

Figure 5.29 Verification for Eos Scenario 4 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.29 above, the model could be considered as verified.




```
function [Eos4b]=eos_scenario4b (Pos4b)

%Known parameter%
dsmax=796;
rho=0.72134;
alpha1=0.32;
beta1=0.34;
alpha2=0.34;
beta2=0.32;
Cm=5000;

%Objective function%
Eos4b=(((rho*dsmax)-(alpha2*Pos4b(1))+(beta2*Pos4b(2)))*(Pos4b(1)-Cm))...
    +((((1-rho)*dsmax)-(alpha1*Pos4b(2))+(beta1*Pos4b(1)))*(Pos4b(2)-Cm));
```

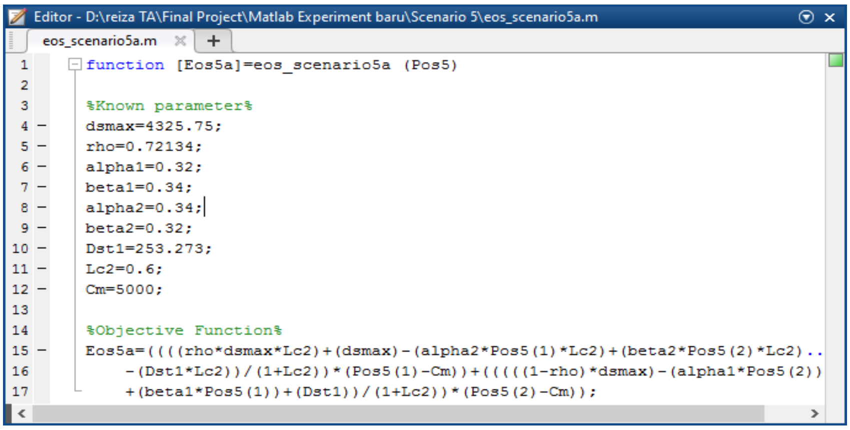
Figure 5.30 Verification for Eos Scenario 4 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.30 above, the model could be considered as verified.

- Scenario 5 Verification Process

For scenario 5, the verification process is done by checking m-file is pretty similar with scenario 4 process will be represented by two figures. First, Figure 5.31

for total earning in both channel simultaneously if there are consignment product exist. While the Figure 5.32 will represent total earning for both channel simultaneously if consignment product is not exist.



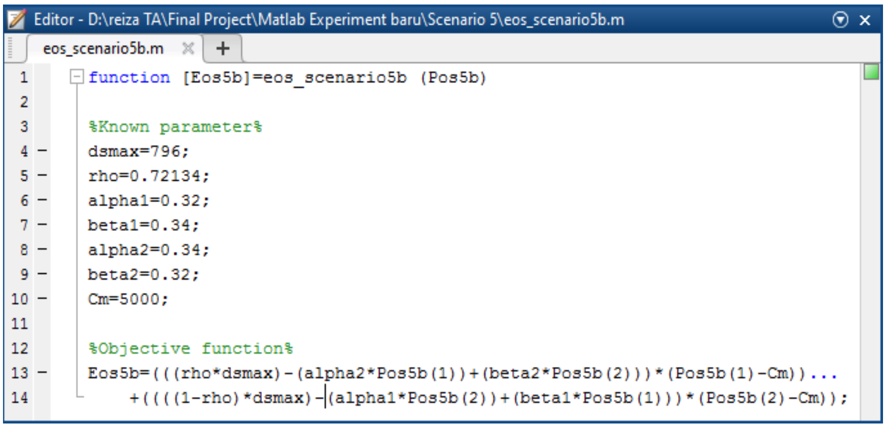

```
function [Eos5a]=eos_scenario5a (Pos5)

%Known parameter%
dsmax=4325.75;
rho=0.72134;
alpha1=0.32;
beta1=0.34;
alpha2=0.34;
beta2=0.32;
Dst1=253.273;
Lc2=0.6;
Cm=5000;

%Objective Function%
Eos5a=(((rho*dsmax*Lc2)+(dsmax)-(alpha2*Pos5(1)*Lc2)+(beta2*Pos5(2)*Lc2)..
    -(Dst1*Lc2))/(1+Lc2))*(Pos5(1)-Cm))+(((((1-rho)*dsmax)-(alpha1*Pos5(2))
    +(beta1*Pos5(1))+(Dst1))/(1+Lc2))*(Pos5(2)-Cm));
```

Figure 5.31 Verification for Eos Scenario 5 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.31 above, the model could be considered as verified




```
function [Eos5b]=eos_scenario5b (Pos5b)

%Known parameter%
dsmax=796;
rho=0.72134;
alpha1=0.32;
beta1=0.34;
alpha2=0.34;
beta2=0.32;
Cm=5000;

%Objective function%
Eos5b=(((rho*dsmax)-(alpha2*Pos5b(1))+(beta2*Pos5b(2)))*(Pos5b(1)-Cm))...
    +((((1-rho)*dsmax)-(alpha1*Pos5b(2))+(beta1*Pos5b(1)))*(Pos5b(2)-Cm));
```

Figure 5.32 Verification for Eos Scenario 5 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.32 above, the model could be considered as verified.

- Scenario 6 Verification Process

For scenario 6, the verification process is done by checking m-file is pretty similar with scenario 4 and 5, which will be represented by two figures. First, Figure

5.33 for total earning in both channel simultaneously if there are consignment product exist. While the Figure 5.34 will represent total earning for both channel simultaneously if consignment product is not exist.

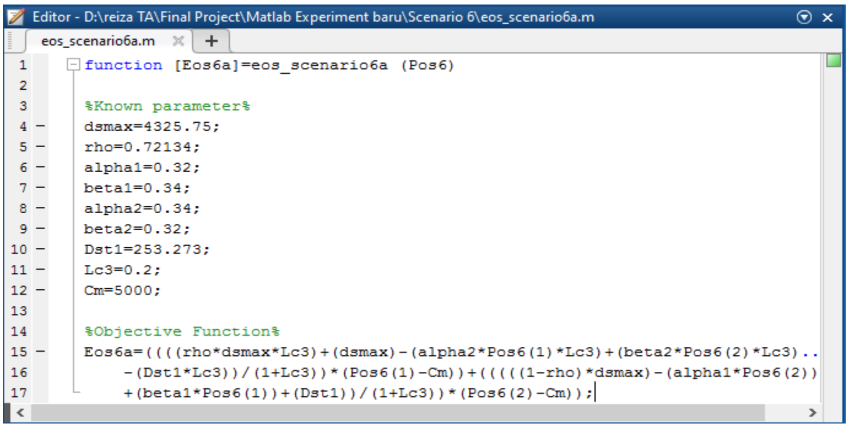


Figure 5.33 Verification for Eos Scenario 6 with consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.33 above, the model could be considered as verified.

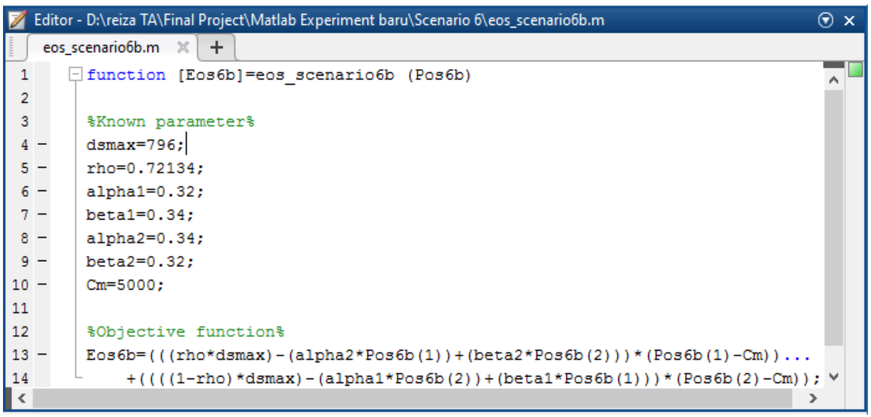


Figure 5.34 Verification for Eos Scenario 6 without consignment condition

Hence, by the result of model building in MATLAB software, the model could be determined as verified if there are green sign in top-right of the MATLAB m-file. Thus, by checking the Figure 5.34 above, the model could be considered as verified.

5.2 Price Optimization Numerical Experiment

In this subchapter, the explanation of numerical experiment to find optimal price for offline-channel and online-channel will be performed in several subsubchapter divided by each numerical experiment scenario. The numerical experiment would be done by using fmincon solver in MATLAB software. Then, each scenarios would also possess constrains unique to each other according to characteristics of each scenario itself.

5.2.1 Numerical Experiment for Scenario 1

For scenario 1, the numerical experiment would be done separate way in each channel, with step-by step numerical experiment process. The order of numerical experiment is online-channel would be done first. Then, the result of online-channel price that has been determined would be treated as the input for offline-channel experiment input by assuming all channels has constant price at Rp 15,000/package. Noted that, there are two types of demand that resulted in two types of numerical experiment process. First, the numerical experiment when consignment product is existed, and when the consignment product is not existed.

- Scenario 1 with Consignment Terms of Payment

The first numerical experiment is done for scenario 1 for consignment condition will be thoroughly explained as follows.

Table 5.17 Online-channel Constraint in Scenario 1 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$\frac{Po}{\rho}$	$\leq$	Ps	Demand Interplay
3	$-\beta_1 Po$	$\leq$	$\frac{(1-\rho)d_s^{max} - a_1 Ps + D_{s_{t+1}}}{1+LC_1}$	Demand can't be in negative value
4	$a_2 PoLC_1$	$\leq$	$\frac{\rho d_s^{max} LC_1 + d_s^{max} + \beta_2 PsLC_1 - D_{s_{t+1}} LC_1}{(1+LC_1)}$	
5	Po	$\leq$	Ps	Offline price the highest price

In Table 5.17 above, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel in scenario 1 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

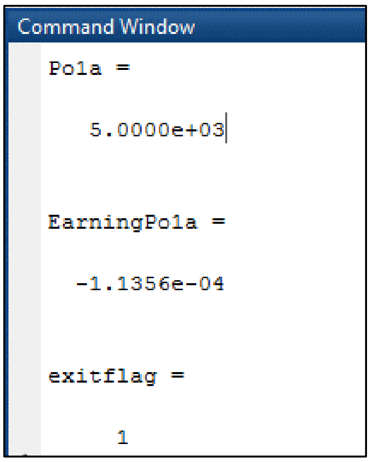


Figure 5.35 Optimum Price Result for Online Channel in Scenario 1 with Consignment

After that, the result of MATLAB software using fmincon solver is indicating feasible solution because the exitflag indicating 1 value as stated in Figure 5.35, which mean all of the constraints are fulfilled. Thus, the price for online-channel with consignment for scenario 1 is Rp 5,000. Next, the second channel that would be evaluated to find optimum price would be offline-channel. In offline-channel numerical experiment, the input for online-channel price is Rp 5,000, as already found before. Then, the constraint for offline-channel with consignment for scenario 1 is provided in Table 5.18.

Table 5.18 Offline-channel Constraint in Scenario 1 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-\frac{Po}{p}$	Demand Interplay
3	$a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + \beta_1 Po + D_{s_{t+1}}}{1+LC_i}$	Demand can't be in negative value
4	$-\beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - a_2 PoLC_i - D_{s_{t+1}} LC_i}{(1+LC_i)}$	
5	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.18 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel in scenario 1 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

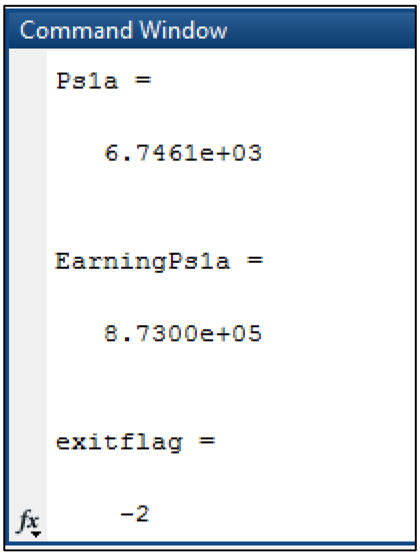


Figure 5.36 Price Result for Offline Channel in Scenario 1 with Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.36 above, which mean it converged to an infeasible point. Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.19 as follows:

Table 5.19 Offline-channel Constraint in Scenario 1 for Consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$a_1 Ps$	$\leq$	$\dfrac{(1-\rho)d_s^{max} + \beta_1 Po + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
3	$-\beta_2 PsLC_i$	$\leq$	$\dfrac{\rho d_s^{max} LC_i + d_s^{max} - a_2 PoLC_i - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	

In Table 5.19 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in offline-channel in scenario 1 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

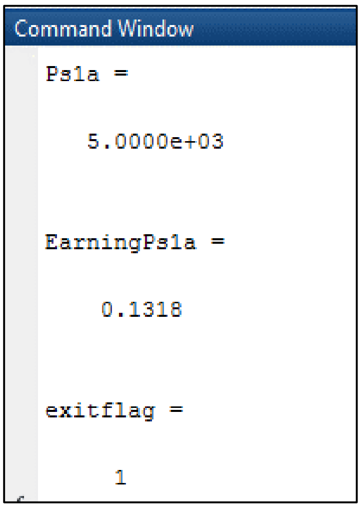


Figure 5.37 Optimum Price Result for Offline Channel in Scenario 1 with Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.37 which mean all of the constraints are fulfilled. Thus, the price for offline-channel with consignment for scenario 1 is Rp 5000.00014.

- Scenario 1 without Consignment Terms of Payment

Next, the numerical experiment is done for scenario 1 for without consignment condition will be thoroughly explained as follows. Hence, in Table 5.20 below, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel in scenario 1 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

Table 5.20 Online-channel Constraint in Scenario 1 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$\frac{Po}{p}$	$\leq$	Ps	Demand Interplay
3	$-\beta_1 Po$	$\leq$	$(1-\rho)d_s^{max} - a_1 Ps$	Demand can't be in negative value
4	$a_2 Po$	$\leq$	$\rho d_s^{max} + \beta_2 ps$	
5	Po	$\leq$	Ps	Offline price the highest price

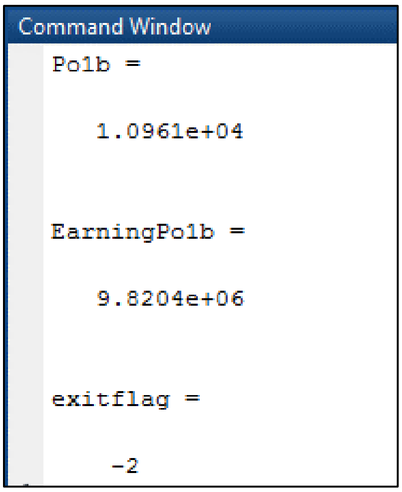


Figure 5.38 Price Result for Online Channel in Scenario 1 without Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.38, which mean it converged to an infeasible point.

Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.21 as follows:

Table 5.21 Online-channel Constraint in Scenario 1 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-\beta_1 Po$	$\leq$	$(1-\rho)d_s^{max} - a_1 Ps$	Demand can't be in negative value
3	$a_2 Po$	$\leq$	$\rho d_s^{max} + \beta_2 ps$	
4	Po	$\leq$	Ps	Offline price the highest price

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.39, which mean all of the constraints are fulfilled. Thus, the price for online-channel without consignment for scenario 1 is Rp 15,000.00

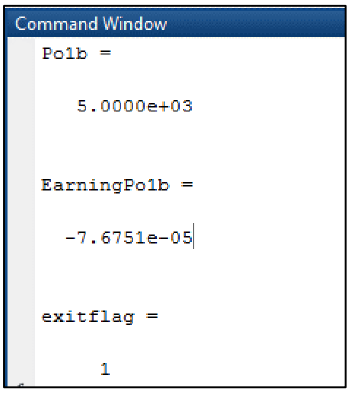


Figure 5.39 Optimum Price Result for Online Channel in Scenario 1 without Consignment (after Constraint Relaxation)

Next, the second channel that would be evaluated to find optimum price would be offline-channel. In offline-channel numerical experiment, the input for online-channel price is Rp 4999.99999997793, as already found before. Then, the constraint for offline-channel without consignment for scenario 1 is provided in Table 5.22.

Table 5.22 Offline-channel Constraint in Scenario 1 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-\frac{Po}{p}$	Demand Interplay
3	$a_1 Ps$	$\leq$	$(1-\rho)d_s^{max} + \beta_1 Po$	Demand can't be in negative value
4	$-\beta_2 Ps$	$\leq$	$\rho d_s^{max} - a_2 Po$	
5	$-Ps$	$\leq$	$-Po$	Offline price the highest price

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.40, which mean it converged to an infeasible point.

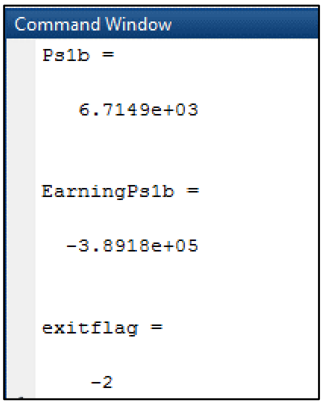


Figure 5.40 Price Result for Offline Channel in Scenario 1 without Consignment (before Constraint Relaxation)

Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.23 as follows:

Table 5.23 Offline-channel Constraint in Scenario 1 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$a_1 Ps$	$\leq$	$(1-\rho)d_s^{max} + \beta_1 Po$	Demand can't be in negative value
3	$-\beta_2 Ps$	$\leq$	$\rho d_s^{max} - a_2 Po$	
4	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.23 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in offline-channel in scenario 1 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

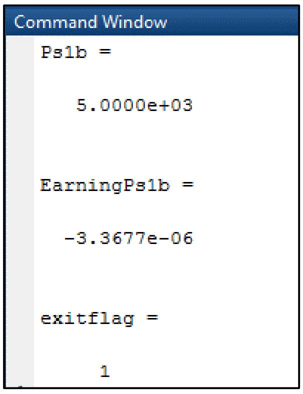


Figure 5.41 Optimum Price Result for Offline Channel in Scenario 1 without Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, which mean all of the constraints are fulfilled. Thus, the price for offline-channel without consignment for scenario 1 is Rp 5000.00014048492. Hence, the optimum price recapitulation for online-channel and offline-channel when consignment product and without consignment product is exist in scenario 1 is provided in Table 5.24.

Table 5.24 Optimum Pricing Recapitulation in Scenario 1 for All Channels

Scenario 1					
Consignment Condition			Non-consignment Condition		
Sequence	Optimal Price		Sequence	Optimal Price	
1	Po	Rp5,000	1	Po	Rp4999.99999997793
2	Ps	Rp5000.00014	2	Ps	Rp5000.000141

5.2.2 Numerical Experiment for Scenario 2

For scenario 2, the numerical experiment would be done separate way in each channel, with step-by step numerical experiment process. The order of numerical experiment is online-channel would be done first. Then, the result of online-channel price that has been determined would be treated as the input for offline-channel experiment input by assuming all channels has constant price at Rp 15,000/package. Noted that, there are two types of demand that resulted in two types of numerical experiment process. First, the numerical experiment when consignment product is existed, and when the consignment product is not existed.

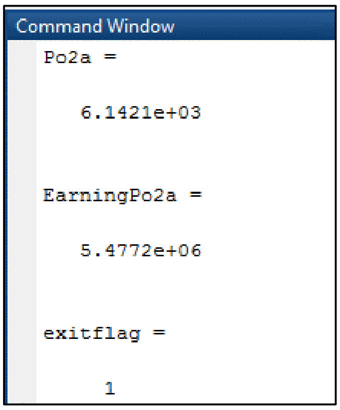
- Scenario 2 with Consignment Terms of Payment

  The first numerical experiment is done for scenario 2 for consignment condition will be thoroughly explained as follows.

Table 5.25 Online-channel Constraint in Scenario 2 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$\frac{Po}{\rho}$	$\leq$	Ps	Demand Interplay
3	$-\beta_1 Po$	$\leq$	$\frac{(1-\rho)d_s^{max} - a_1 Ps + D_{s_{t+1}}}{1+LC_2}$	Demand can't be in negative value
4	$a_2 PoLC_2$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} + \beta_2 PsLC_2 - D_{s_{t+1}} LC_2}{(1+LC_2)}$	Demand can't be in negative value
5	Po	$\leq$	Ps	Offline price the highest price

In Table 5.25 above, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel in scenario 2 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.


```
Command Window
Po2a =

   6.1421e+03


EarningPo2a =

   5.4772e+06


exitflag =

     1
```

Figure 5.42 Optimum Price Result for Online Channel in Scenario 2 with Consignment

After that, the result of MATLAB software using fmincon solver is indicating feasible solution because the exitflag indicating 1 value, which mean all of the constraints are fulfilled, as stated in Figure 5.42. Thus, the price for online-channel with consignment for scenario 2 is Rp 6,142.1.

Next, the second channel that would be evaluated to find optimum price would be offline-channel. In offline-channel numerical experiment, the input for online-channel price is Rp 6,142.1, as already found before. Then, the constraint for online-channel with consignment for scenario 2 is provided in Table 5.26.

Table 5.26 Offline-channel Constraint in Scenario 2 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-\frac{Po}{p}$	Demand Interplay
3	$a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + \beta_1 Po + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
4	$-\beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - a_2 PoLC_i - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	
5	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.26 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel in scenario 2 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

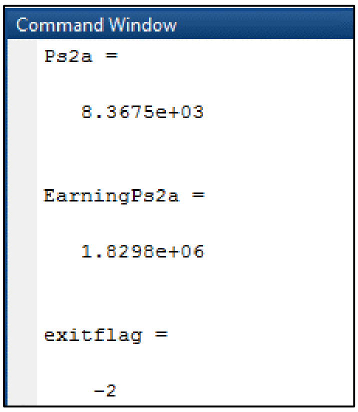


Figure 5.43 Price Result for Offline Channel in Scenario 2 with Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.43, which mean it converged to an infeasible point. Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.27 as follows:

Table 5.27 Offline-channel Constraint in Scenario 2 for Consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + \beta_1 Po + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
3	$-\beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - a_2 PoLC_i - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	
4	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.27 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in offline-channel in scenario 2 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

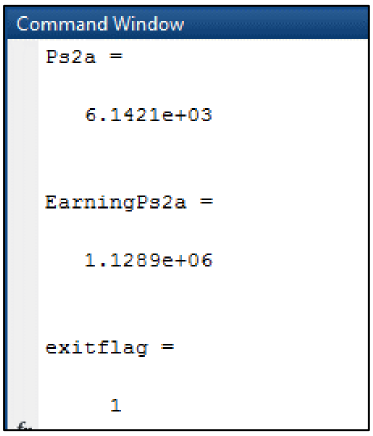


Figure 5.44 Optimum Price Result for Offline Channel in Scenario 2 with Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, which mean all of the constraints are fulfilled. Thus, the price for offline-channel with consignment for scenario 2 is Rp 6142.10000000381.

- Scenario 2 without Consignment Terms of Payment

  Next, the numerical experiment is done for scenario 2 for without consignment condition will be thoroughly explained as follows. Hence, in Table 5.28 below, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel in scenario 2 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

Table 5.28 Online-channel Constraint in Scenario 2 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$\frac{Po}{p}$	$\leq$	Ps	Demand Interplay
3	$-\beta_1 Po$	$\leq$	$(1-\rho)d_s^{max} - a_1 Ps$	Demand can't be in negative value
4	$a_2 Po$	$\leq$	$\rho d_s^{max} + \beta_2 ps$	
5	Po	$\leq$	Ps	Offline price the highest price

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.45, which mean it converged to an infeasible point.

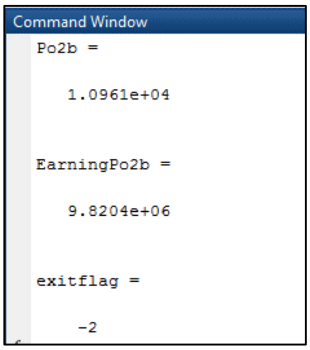


Figure 5.45 Price Result for Online Channel in Scenario 2 without Consignment (before Constraint Relaxation)

Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.29 as follows:

Table 5.29 Online-channel Constraint in Scenario 2 for Consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-\beta_1 Po$	$\leq$	$(1-\rho)d_s^{max} - a_1 Ps$	Demand can't be in negative value
3	$a_2 Po$	$\leq$	$\rho d_s^{max} + \beta_2 ps$	
4	Po	$\leq$	Ps	Offline price the highest price

In Table 5.29 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in offline-channel in scenario 2 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

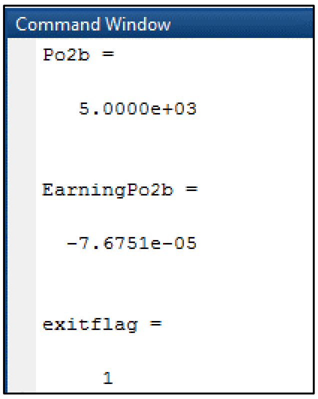


Figure 5.46 Optimum Price Result for Online Channel in Scenario 2 without Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.46, which mean all of the constraints are fulfilled. Thus, the price for online-channel without consignment for scenario 2 is Rp 5,000.00

Next, the second channel that would be evaluated to find optimum price would be offline-channel. In offline-channel numerical experiment, the input for online-channel price is Rp 5,000.00, as already found before. Then, the constraint for offline-channel with consignment for scenario 2 is provided in Table 5.30.

Table 5.30 Offline-channel Constraint in Scenario 2 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-\frac{Po}{p}$	Demand Interplay
3	$a_1 Ps$	$\leq$	$(1-\rho)d_s^{max} + \beta_1 Po$	Demand can't be in negative value
4	$-\beta_2 Ps$	$\leq$	$\rho d_s^{max} - a_2 Po$	
5	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.30 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel in scenario 2 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.47, which mean it converged to an infeasible point.

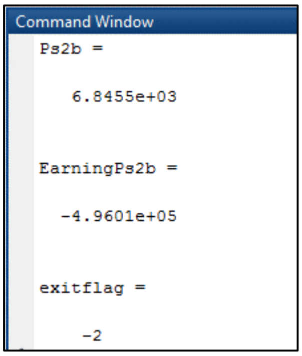


Figure 5.47 Price Result for Offline Channel in Scenario 2 without Consignment (before Constraint Relaxation)

Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.31 as follows:

Table 5.31 Offline-channel Constraint in Scenario 2 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$a_1 Ps$	$\leq$	$(1-\rho)d_s^{max} + \beta_1 Po$	Demand can't be in negative value
3	$-\beta_2 Ps$	$\leq$	$\rho d_s^{max} - a_2 Po$	
4	$-Ps$	$\leq$	$-Po$	Offline price the highest price

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.48, which mean all of the constraints are fulfilled. Thus, the price for online-channel without consignment for scenario 2 is Rp 5,000.00.

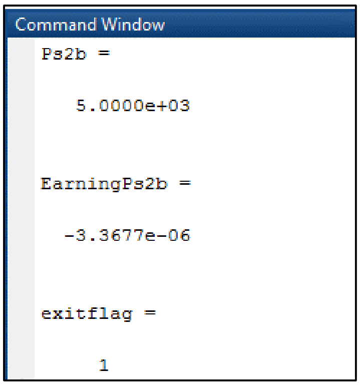


Figure 5.48 Optimum Price Result for Offline Channel in Scenario 2 without Consignment (after Constraint Relaxation)

Hence, the optimum price recapitulation for online-channel and offline-channel when consignment product and without consignment product is exist in scenario 2 is provided in Table 5.32.

Table 5.32 Optimum Pricing Recapitulation in Scenario 2 for All Channels

Scenario 2					
Consignment Condition			Non-consignment Condition		
Sequence	Optimal Price		Sequence	Optimal Price	
1	Po	Rp6,142.1	1	Po	Rp5,000.00
2	Ps	Rp6142.10000000381	2	Ps	Rp5,000.00

5.2.3 Numerical Experiment for Scenario 3

For scenario 3, the numerical experiment would be done separate way in each channel, with step-by step numerical experiment process. The order of numerical experiment is online-channel would be done first. Then, the result of online-channel price that has been determined would be treated as the input for offline-channel experiment input by assuming all channels has constant price at Rp 15,000/package. Noted that, there are two types of demand that resulted in two types of numerical experiment process. First, the numerical experiment when consignment product is existed, and when the consignment product is not existed.

- Scenario 3 with Consignment Terms of Payment

The first numerical experiment is done for scenario 3 for consignment condition will be thoroughly explained as follows.

Table 5.33 Online-channel Constraint in Scenario 3 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$\frac{Po}{\rho}$	$\leq$	Ps	Demand Interplay
3	$-\beta_1 Po$	$\leq$	$\frac{(1-\rho)d_s^{max} - a_1 Ps + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
4	$a_2 PoLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} + \beta_2 PsLC_i - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	
5	Po	$\leq$	Ps	Offline price the highest price

In Table 5.33 above, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel in scenario 3 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

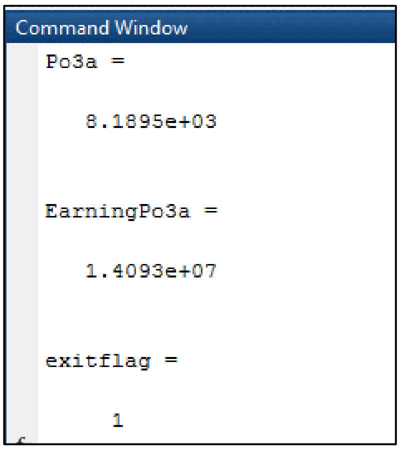


Figure 5.49 Optimum Price Result for Online Channel in Scenario 3 with Consignment

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, which mean all of the constraints are fulfilled as stated in Figure 5.49. Thus, the price for online-channel with consignment for scenario 3 is Rp 8189.5.

Next, the second channel that would be evaluated to find optimum price would be offline-channel. In offline-channel numerical experiment, the input for online-channel price is Rp 8189.5, as already found before. Then, the constraint for offline-channel with consignment for scenario 3 is provided in Table 5.34.

Table 5.34 Offline-channel Constraint in Scenario 3 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-\frac{Po}{p}$	Demand Interplay
3	$a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + \beta_1 Po + D_{s_{t+1}}}{1+LC_i}$	Demand can't be in negative value
4	$-\beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - a_2 PoLC_i - D_{s_{t+1}} LC_i}{(1+LC_i)}$	
5	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.34 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel in scenario 3 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

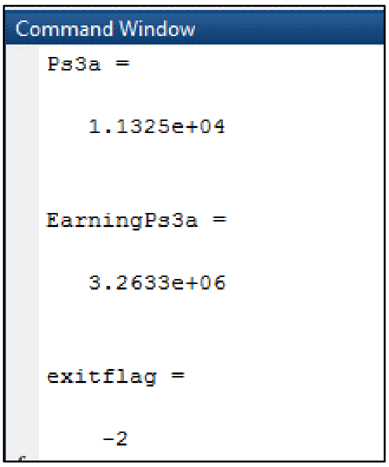


Figure 5.50 Price Result for Offline Channel in Scenario 3 with Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.50, which mean it converged to an infeasible point. Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.35 as follows:

Table 5.35 Offline-channel Constraint in Scenario 3 for Consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	a_1Ps	$\leq$	$\frac{(1-\rho)d_s^{max} + \beta_1 Po + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
3	$-\beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - a_2 PoLC_i - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	
4	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.35 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in offline-channel in scenario 3 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

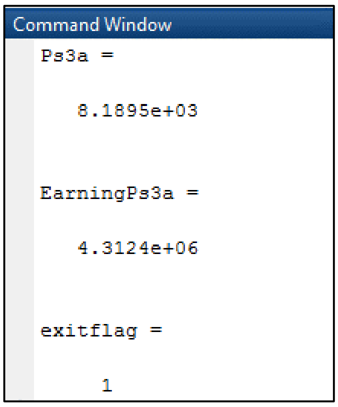


Figure 5.51 Optimum Price Result for Offline Channel in Scenario 3 with Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, which mean all of the constraints are fulfilled as stated in Figure 5.51. Thus, the price for offline-channel with consignment for scenario 3 is Rp 8189.5.

- Scenario 3 without Consignment Terms of Payment

Next, the numerical experiment is done for scenario 3 for without consignment condition will be thoroughly explained as follows. Hence, in Table 5.36 below, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel in scenario 3 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

Table 5.36 Online-channel Constraint in Scenario 3 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$\frac{Po}{p}$	$\leq$	Ps	Demand Interplay
3	$-\beta_1 Po$	$\leq$	$(1-\rho)d_s^{max} - a_1 Ps$	Demand can't be in negative value
4	$a_2 Po$	$\leq$	$\rho d_s^{max} + \beta_2 ps$	
5	Po	$\leq$	Ps	Offline price the highest price

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.52, which mean it converged to an infeasible point.

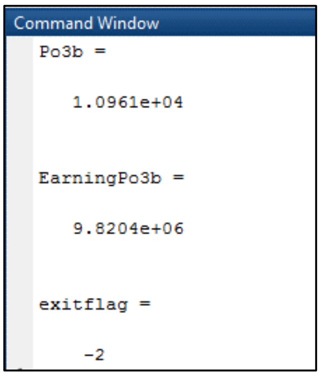


Figure 5.52 Price Result for Online Channel in Scenario 3 without Consignment (before Constraint Relaxation)

Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.37 as follows:

Table 5.37 Online-channel Constraint in Scenario 3 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-\beta_1 Po$	$\leq$	$(1-\rho)d_s^{max} - a_1 Ps$	Demand can't be in negative value
3	$a_2 Po$	$\leq$	$\rho d_s^{max} + \beta_2 ps$	
4	Po	$\leq$	Ps	Offline price the highest price

In Table 5.37 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in online-channel in scenario 3 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

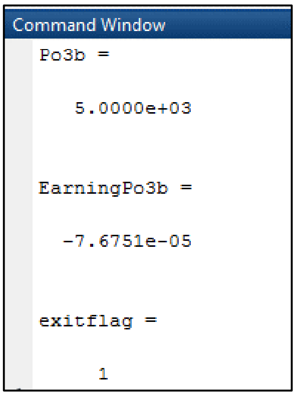


Figure 5.53 Optimum Price Result for Online Channel in Scenario 3 without Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.53, which mean all of the constraints are fulfilled. Thus, the price for online-channel without consignment for scenario 3 is Rp 5,000.00.

Next, the second channel that would be evaluated to find optimum price would be offline-channel. In offline-channel numerical experiment, the input for online-channel price is Rp 5,000.00, as already found before. Then, the constraint for offline-channel without consignment for scenario 3 is provided in Table 5.38.

Table 5.38 Offline-channel Constraint in Scenario 3 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-\frac{Po}{p}$	Demand Interplay
3	$a_1 Ps$	$\leq$	$(1-\rho)d_s^{max} + \beta_1 Po$	Demand can't be in negative value
4	$-\beta_2 Ps$	$\leq$	$\rho d_s^{max} - a_2 Po$	
5	$-Ps$	$\leq$	$-Po$	Offline price the highest price

In Table 5.38 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel in scenario 3 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.54, which mean it converged to an infeasible point.

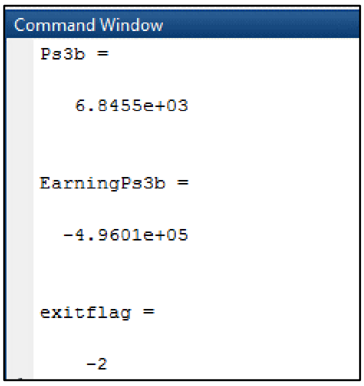


Figure 5.54 Price Result for Offline Channel in Scenario 3 without Consignment (before Constraint Relaxation)

Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.39 as follows:

Table 5.39 Offline-channel Constraint in Scenario 3 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Ps$	$\leq$	$-Cm$	Lower Bound of Price
2	$a_1 Ps$	$\leq$	$(1-\rho)d_s^{max} + \beta_1 Po$	Demand can't be in negative value
3	$-\beta_2 Ps$	$\leq$	$\rho d_s^{max} - a_2 Po$	
4	$-Ps$	$\leq$	$-Po$	Offline price the highest price

After that, the result of MATLAB software using fmincon solver after relaxation of the constraints is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.55, which mean all of the constraints are fulfilled. Thus, the price for offline-channel without consignment for scenario 3 is Rp 5,000.00

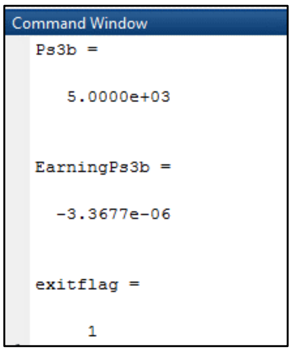


Figure 5.55 Optimum Price Result for Offline Channel in Scenario 3 without Consignment (after Constraint Relaxation)

Hence, the optimum price recapitulation for online-channel and offline-channel when consignment product and without consignment product is exist in scenario 3 is provided in Table 5.40.

Table 5.40 Optimum Pricing Recapitulation in Scenario 3 for All Channels

Scenario 3					
Consignment Condition			Non-consignment Condition		
Sequence	Optimal Price		Sequence	Optimal Price	
1	Po	Rp8,189.5	1	Po	Rp5,000.00
2	Ps	Rp8,189.5	2	Ps	Rp5,000.00

5.2.4 Numerical Experiment for Scenario 4

For scenario 4, the numerical experiment would be done in simultaneous way, because all channels are considered in coordination together to fulfill customer demand, where the optimum price is obtained from one objective function. Noted that, there are two types of demand that resulted in two types of numerical experiment process. First, the numerical experiment when consignment product is existed, and when the consignment product is not existed.

- Scenario 4 with Consignment Terms of Payment

The first numerical experiment is done for scenario 4 with consignment condition will be thoroughly explained as follows:

Table 5.41 Online and Offline-channel Constraint in Scenario 4 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$\frac{Po}{p} - Ps$	$\leq$	0	Demand Interplay
4	$-\beta_1 Po + a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + D_{s_{t+1}}}{1+LC_i}$	Demand can't be in negative value
5	$a_2 PoLC_i - \beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - D_{s_{t+1}} LC_i}{(1+LC_i)}$	
6	$Po - Ps$	$\leq$	0	Offline price the highest price

In Table 5.41 above, all of the constraint that are included are represented the real condition for determining the optimum price in offline-channel and online-channel simultaneously in scenario 4 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

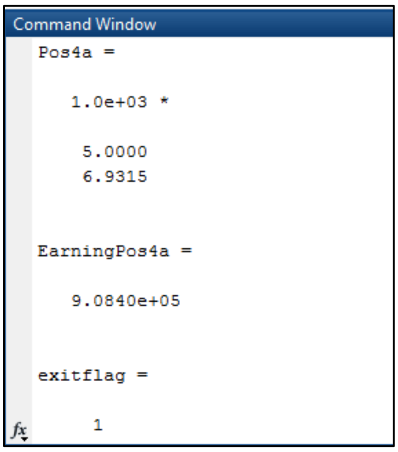


Figure 5.56 Optimum Price Result for Online and Offline Channel in Scenario 4 with Consignment

After that, the result of MATLAB software using fmincon solver is indicating feasible solution because the exitflag indicating 1 value, as stated in Figure 5.56, which mean all of the constraints are fulfilled. Thus, the price for online-channel with consignment for scenario 4 is Rp 5,000 and price for offline-channel with consignment is Rp 6,931.5.

- Scenario 4 without Consignment Terms of Payment

Next, the numerical experiment is done for scenario 4 without consignment condition will be thoroughly explained as follows. Hence, in Table 5.42 below, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel and online-channel simultaneously in scenario 4 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

Table 5.42 Online and Offline-channel Constraint in Scenario 4 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$\dfrac{Po}{p} - Ps$	$\leq$	0	Demand Interplay
4	$-\beta_1 Po + a_1 Ps$	$\leq$	$(1-\rho)d_s^{max}$	Demand can't be in negative value
5	$a_2 Po - \beta_2 Ps$	$\leq$	ρd_s^{max}	
6	$Po - Ps$	$\leq$	0	Offline price the highest price

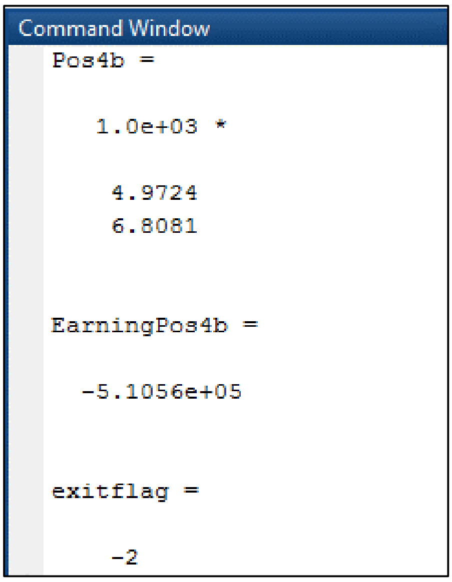


Figure 5.57 Price Result for Online and Offline Channel in Scenario 4 without Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.57, which mean it converged to an infeasible point. Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.43 as follows:

Table 5.43 Online and Offline-channel Constraint in Scenario 4 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$-\beta_1 Po + a_1 Ps$	$\leq$	$(1-\rho)d_s^{max}$	Demand can't be in negative value
4	$a_2 Po - \beta_2 Ps$	$\leq$	ρd_s^{max}	
5	$Po - Ps$	$\leq$	0	Offline price the highest price

In Table 5.43 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in online and offline-channel in scenario 4 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

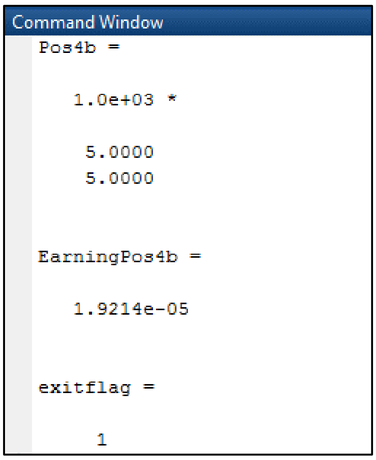


Figure 5.58 Optimum Price Result for Online and Offline Channel in Scenario 4 without Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, as stated in Figure 5.58, which mean all of the constraints are fulfilled. Thus, the price for online and offline-channel without consignment for scenario 4 is Rp 5000.00000000546 and Rp 5000.00000002548. Hence, the optimum price recapitulation for online-channel and offline-channel when consignment product and without consignment product is exist in scenario 4 is provided in Table 5.44.

Table 5.44 Optimum Pricing Recapitulation in Scenario 4 for All Channels

Scenario 4					
Consignment Condition			Non-consignment Condition		
Sequence	Optimal Price		Sequence	Optimal Price	
1	Po	Rp5,000	1	Po	Rp5,000.00000000546
	Ps	Rp6,931.5		Ps	Rp5,000.00000002548

5.2.5 Numerical Experiment for Scenario 5

For scenario 5, the numerical experiment would be done in simultaneous way, because all channels are considered in coordination together to fulfill customer demand, where the optimum price is obtained from one objective function. Noted that, there are two types of demand that resulted in two types of numerical experiment process. First, the numerical experiment when consignment product is existed, and when the consignment product is not existed.

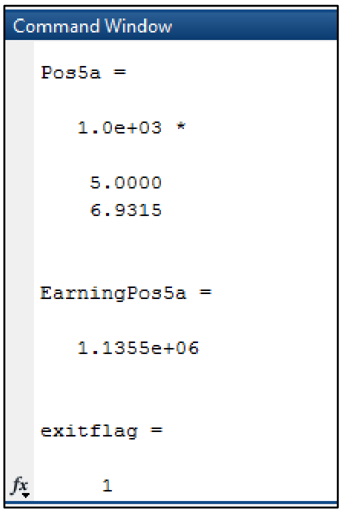
- Scenario 5 with Consignment Terms of Payment

The first numerical experiment is done for scenario 5 with consignment condition will be thoroughly explained as follows:

Table 5.45 Online and Offline-channel Constraint in Scenario 5 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$\frac{Po}{p} - Ps$	$\leq$	0	Demand Interplay
4	$-\beta_1 Po + a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
5	$a_2 PoLC_i - \beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	
6	$Po - Ps$	$\leq$	0	Offline price the highest price

In Table 5.45 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel and online-channel simultaneously in scenario 5 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.



```
Command Window
Pos5a =

   1.0e+03 *

    5.0000
    6.9315


EarningPos5a =

   1.1355e+06


exitflag =

     1
```

Figure 5.59 Optimum Price Result for Online and Offline Channel in Scenario 5 with Consignment

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, as stated in Figure 5.59 which mean all of the constraints are fulfilled. Thus, the price for online-channel with consignment for scenario 5 is Rp 5,000 and price for offline-channel with consignment is Rp 6,931.5.

- Scenario 5 without Consignment Terms of Payment

Next, the numerical experiment is done for scenario 5 without consignment condition will be thoroughly explained as follows. Hence, in Table 5.46 below, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel and online-channel simultaneously in scenario 5 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

Table 5.46 Online and Offline-channel Constraint in Scenario 5 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$\frac{Po}{p} - Ps$	$\leq$	0	Demand Interplay
4	$-\beta_1 Po + a_1 Ps$	$\leq$	$(1-\rho)d_s^{max}$	Demand can't be in negative value
5	$a_2 Po - \beta_2 Ps$	$\leq$	ρd_s^{max}	
6	$Po - Ps$	$\leq$	0	Offline price the highest price

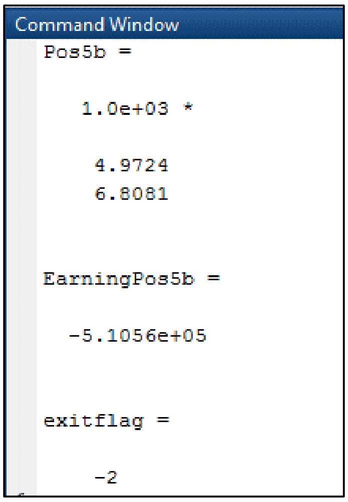


Figure 5.60 Price Result for Online and Offline Channel in Scenario 5 without Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure

5.60, which mean it converged to an infeasible point. Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.47 as follows:

Table 5.47 Online and Offline-channel Constraint in Scenario 5 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$-\beta_1 Po + a_1 Ps$	$\leq$	$(1-\rho)d_s^{max}$	Demand can't be in negative value
4	$a_2 Po - \beta_2 Ps$	$\leq$	ρd_s^{max}	
5	$Po - Ps$	$\leq$	0	Offline price the highest price

In Table 5.47 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in online and offline-channel in scenario 5 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

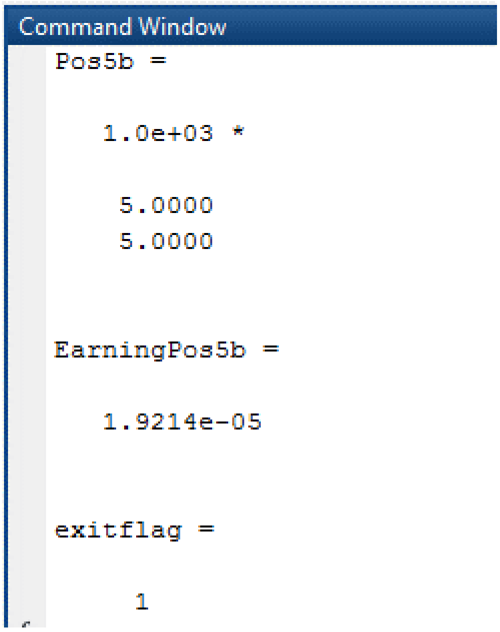


Figure 5.61 Optimum Price Result for Online and Offline Channel in Scenario 5 without Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, which mean all of the constraints are fulfilled as stated in Figure 5.61. Thus, the price for online and offline-channel without consignment for scenario 5 is Rp 5000.00000000546 and Rp 5000.00000002548. Hence, the optimum price recapitulation for online-channel and offline-channel when consignment product and without consignment product is exist in scenario 5 is provided in Table 5.48.

Table 5.48 Optimum Pricing Recapitulation in Scenario 5 for All Channels

Scenario 5					
Consignment Condition			Non-consignment Condition		
Sequence	Optimal Price		Sequence	Optimal Price	
1	Po	Rp5,000	1	Po	Rp5,000.00000000546
	Ps	Rp6,931.5		Ps	Rp5,000.00000002548

5.2.6 Numerical Experiment for Scenario 6

For scenario 6, the numerical experiment would be done in simultaneous way, because all channels are considered in coordination together to fulfill customer demand, where the optimum price is obtained from one objective function. Noted that, there are two types of demand that resulted in two types of numerical experiment process. First, the numerical experiment when consignment product is existed, and when the consignment product is not existed.

- Scenario 6 with Consignment Terms of Payment

The first numerical experiment is done for scenario 6 with consignment condition will be thoroughly explained as follows:

Table 5.49 Online and Offline-channel Constraint in Scenario 6 for Consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$\frac{Po}{p} - Ps$	$\leq$	0	Demand Interplay
4	$-\beta_1 Po + a_1 Ps$	$\leq$	$\frac{(1-\rho)d_s^{max} + D_{s_{t+1}}}{1 + LC_i}$	Demand can't be in negative value
5	$a_2 PoLC_i - \beta_2 PsLC_i$	$\leq$	$\frac{\rho d_s^{max} LC_i + d_s^{max} - D_{s_{t+1}} LC_i}{(1 + LC_i)}$	
6	$Po - Ps$	$\leq$	0	Offline price the highest price

In Table 5.49 above, all of the constraint that is included are represented the real condition for determining the optimum price in offline-channel and online-channel simultaneously in scenario 6 for consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

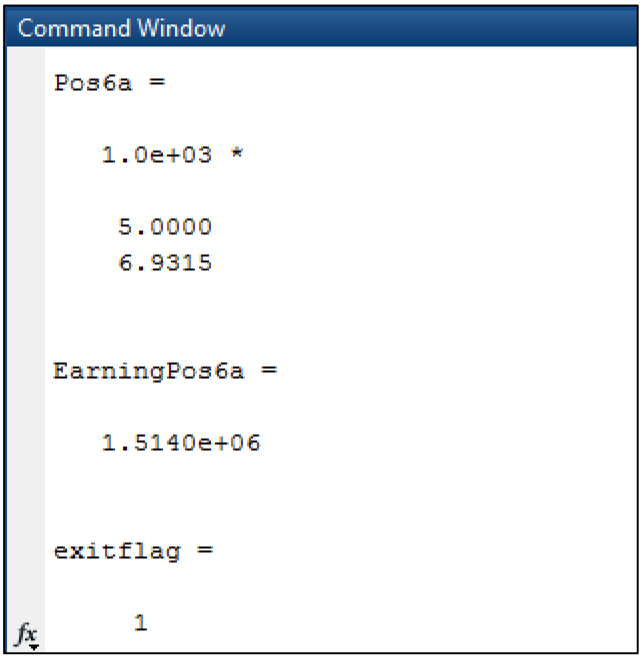


Figure 5.62 Optimum Price Result for Online and Offline Channel in Scenario 6 with Consignment

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, which mean all of the constraints are fulfilled, as stated in Figure 5.62. Thus, the price for online-channel with consignment for scenario 6 is Rp 5,000 and price for offline-channel with consignment is Rp 6,931.5.

- Scenario 6 without Consignment Terms of Payment

Next, the numerical experiment is done for scenario 6 without consignment condition will be thoroughly explained as follows. Hence, in Table 5.50 below, all of the constraint that is included are represented the real condition for determining the optimum price in online-channel and online-channel simultaneously in scenario 6 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

Table 5.50 Online and Offline-channel Constraint in Scenario 6 for Non-consignment Condition

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	

Table 5.50 Online and Offline-channel Constraint in Scenario 6 for Non-consignment Condition (Continue)

No	Linear Constraint		Vector	Information
3	$\frac{Po}{p} - Ps$	$\leq$	0	Demand Interplay
4	$-\beta_1 Po + a_1 Ps$	$\leq$	$(1-\rho)d_s^{max}$	Demand can't be in negative value
5	$a_2 Po - \beta_2 Ps$	$\leq$	ρd_s^{max}	
6	$Po - Ps$	$\leq$	0	Offline price the highest price

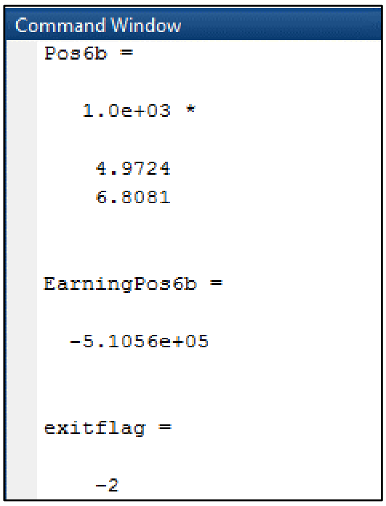


Figure 5.63 Price Result for Online and Offline Channel in Scenario 6 without Consignment (before Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating no feasible solution, indicating by exitflag value of -2, as stated in Figure 5.63, which mean it converged to an infeasible point. Therefore, to solve no feasible solution result, the initial constraints would be relaxed in Table 5.51 as follows:

Table 5.51 Online and Offline-channel Constraint in Scenario 6 for Non-consignment Condition (after Constraint Relaxation)

No	Linear Constraint		Vector	Information
1	$-Po$	$\leq$	$-Cm$	Lower Bound of Price
2	$-Ps$	$\leq$	$-Cm$	
3	$-\beta_1 Po + a_1 Ps$	$\leq$	$(1-\rho)d_s^{max}$	Demand can't be in negative value
4	$a_2 Po - \beta_2 Ps$	$\leq$	ρd_s^{max}	
5	$Po - Ps$	$\leq$	0	Offline price the highest price

In Table 5.51 above, all of the constraint that is already relaxed included are represented the real condition for determining the optimum price in online and offline-channel in scenario 6 for non-consignment condition. Linear constraint is respresenting the left-hand side of the constraints, while the vector column is representing the right-hand side of the constraints.

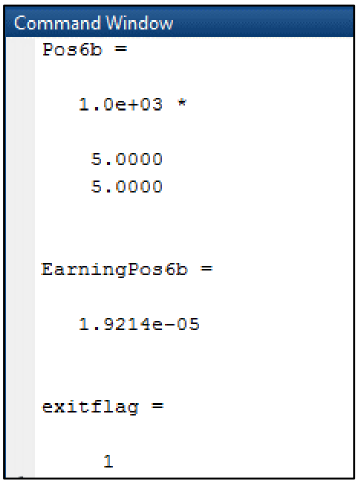


Figure 5.64 Optimum Price Result for Online and Offline Channel in Scenario 6 without Consignment (after Constraint Relaxation)

After that, the result of MATLAB software using fmincon solver is indicating feasible solution, which mean all of the constraints are fulfilled, as stated in Figure 5.64. Thus, the price for online and offline-channel without consignment for scenario 6 is Rp 5000.00000000546 and Rp 5000.00000002548. Hence, the optimum price recapitulation for online-channel and offline-channel when consignment product and without consignment product is exist in scenario 6 is provided in Table 5.52.

Table 5.52 Optimum Pricing Recapitulation in Scenario 6 for All Channels

Scenario 6					
Consignment Condition			Non-consignment Condition		
Sequence	Optimal Price		Sequence	Optimal Price	
1	Po	Rp5,000	1	Po	Rp5,000.00000000546
	Ps	Rp6,931.5		Ps	Rp5,000.00000002548

5.2.7 Comparison of Scenario Results

In this subchapter, after all scenarios numerical experiment is performed, the recapitulation of all scenarios result of numerical experiment would be describe in by disintegrate it into two types, the first one is when consignment products are remain while the second type is when consignment product are not remain. The detail information will be provided in Table 5.53 for consignment condition until Table 5.54 for non-consignment condition.

Table 5.53 Numerical Experiment Result Comparison for Consignment Condition

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	LC1	LC2	LC3	LC1	LC2	LC3
	Without Coordination			With Coordination		
Po	5000	6142.1	8190	5000	5000	5000
Ps	5000.00014	6142.1	8190	6931.5	6931.5	6931.5
Do	5146.40675	4795.6248	4419	3855.446753	3973.022564	4168.982251
Ds	779.343225	988.45531	1352	470.3032475	587.8790594	783.8387458
Eo	-0.0001136	5477083.1	14093010	0	0	0
Es	0.10948597	1128914.8	4312407	0	0	0
Eos	0	0	0	908390.7225	1135488.403	1513984.538
Total Earning	0.10948597	6605997.9	18405417	908390.7225	1135488.403	1513984.538

Table 5.54 Numerical Experiment Result Comparison for Non-consignment Condition

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	Without Coordination			With Coordination		
Po	5000	5000	5000	5,000	5,000	5,000
Ps	5000.00014	5000.00014	5000.00014	5,000	5,000	5,000
Do	5146.406753	5146.406753	5146.406753	4795.625	4795.625	4795.625
Ds	779.343225	779.343225	779.343225	988.4553	988.4553	988.4553
Eo	-7.68E-05	-7.68E-05	-7.68E-05	0	0	0
Es	-3.37E-06	-3.37E-06	-3.37E-06	0	0	0
Eos	0	0	0	1.92E-05	1.92E-05	1.92E-05
Total Earning	-8.01E-05	-8.01E-05	-8.01E-05	1.92E-05	1.92E-05	1.92E-05

Based on table 5.53, when consignment product exist, the result of numerical experiment of all scenarioss shows a different result in earning that could be considered as significant. Consequently, the best scenario which generate highest earning when consignment product is remain is on scenario 3 with Rp 18,405,417. Next, when consignment product is sold out, the best scenarios is to implement either three scenarios of scenario 4,5, or 6.

However, the decision of scenario could be shift into other scenarios in the future due to parameter value change. Hence, this uncertainty would be assessed in subchapter 5.3 of sensitivity analysis as follows:

5.3 Sensitivity Analysis

In this subchapter, the sensitivity analysis will be conducted to assess which parameter is considered as critical towards the total earning of Mr Froniez business system. It is conducted due to parameter characteristics in pricing strategy that is considered as estimation only. These characteristics would lead to total earning result considered as not robust. Thus, the procedure of sensitivity analysis would be done by changing one specific parameter to be analyzed, while leaving the remaining parameter in constant to analyzed whether the parameter value change affect the total earning in the system. Hence, in this research the parameter that would be analyzed are ρ, a, β, C_m, $D_{s_{t+1}}$, and d_s^{max}.

5.3.1 Sensitivity Analysis for ρ Parameter

In this sub-subchapter, the sensitivity analysis would be done towards parameter ρ to determine whether the change of parameter ρ would affect the total earning of the system. Hence, the data recapitulation of parameter ρ sensitivity analysis towards total earning would be provided in several tables, which will be divided into two conditions. First, for consignment product will be explained from Table 5.55 until Table 5.57. Next, for non-consignment condition the data recapitulation will be provided in Table 5.58:. Noted that, for non-consignment condition the scenario 1,2,3 will be consolidated into one calculation process and scenario 4,5,6 also into one calculation process, since those two combinations of scenarios generate same earning results.

Table 5.55 Sensitivity Analysis for ρ Parameter (Scenario 1-3) with Consignment Condition

ρ	Consignment Product		
	Etot1	Etot2	Etot3
0.72134	0.10949	6605997.91	18405416.95
0.7	997550	9774800	17306500
0.6	0.00129	0.00061874	11743700
0.5	0.00073	-5.353E-05	3269600

Table 5.55 Sensitivity Analysis for ρ Parameter (Scenario 1-3) with Consignment Condition (Continue)

ρ	Consignment Product		
	Etot1	Etot2	Etot3
0.4	0.0002	-0.0001178	-0.000124127
0.3	-0.0003	-0.0001171	-0.000126831
0.2	-0.0001	-0.0001164	-0.000129533
0.1	-0.0001	-0.0001157	-0.000132239
0.8	511510	8561300	22167100
0.9	5891280	12569000	25863700
1	9211600	16673000	27353000

Table 5.56 Sensitivity Analysis for ρ Parameter (Scenario 4-6) with Consignment Condition

ρ	Consignment Product		
	Etot4	Etot5	Etot6
0.72134	908391	1135488.4	1513984.538
0.7	1034200	202470	-1406100
0.6	1691900	324400	-2263800
0.5	-0.0001	474880	-3324500
0.4	-1E-04	-0.0001042	-4588300
0.3	-7E-05	-8.372E-05	-0.00011826
0.2	-6E-05	-8.358E-05	-0.00012461
0.1	-7E-05	-0.0001194	-0.00016365
0.8	2404000	522210	696270
0.9	1130200	197630	263510
1	-5E-05	-6.281E-06	-5.9101E-06

Table 5.57 Sensitivity Analysis for ρ Parameter Best Scenario Comparison with Consignment Condition

ρ	Best Scenario
0.72134	Etot3
0.7	Etot3
0.6	Etot3
0.5	Etot3
0.4	Etot1
0.3	Etot4
0.2	Etot4
0.1	Etot4
0.8	Etot3
0.9	Etot3
1	Etot3

In the Table 5.57 above, the sensitivity analysis for ρ parameter with consignment condition shows that, the initial best scenario of scenario 3 will be shift to Scenario 1 if the ρ is 0.4 and shift to scenario 4 if the ρ are 0.3, 0.2 and 0.1.

Table 5.58 Sensitivity Analysis for ρ Parameter without Consignment Condition

Change in Percentage	Dsmax	Non-Consignment Product		Best Scenario
		Etot 1,2,3	Etot 4,5, 6	
0%	4325.75	-8.01E-05	0.000019214	Etot 4,5, 6
-10%	3893.18	-8.18E-05	0.00001698	Etot 4,5, 6
-20%	3460.6	-8.35E-05	0.000015352	Etot 4,5, 6
-30%	3028.03	-8.53E-05	0.000014205	Etot 4,5, 6
-40%	2595.45	-8.70E-05	0.000013522	Etot 4,5, 6
-50%	2162.88	-8.87E-05	0.000013228	Etot 4,5, 6
10%	4758.33	-7.84E-05	0.000022045	Etot 4,5, 6
20%	5190.9	-7.67E-05	0.000027421	Etot 4,5, 6
30%	5623.48	-7.50E-05	0.000027445	Etot 4,5, 6
40%	6056.05	-7.33E-05	2.72876E-05	Etot 4,5, 6
50%	6488.63	-7.16E-05	0.00089029	Etot 4,5, 6

In the Table 5.58 above, the sensitivity analysis for ρ parameter without consignment condition shows that, the initial best scenario of either scenario 4,5, and 6 will not be shift in every value of ρ.

Next, the graphical illlustration for sensitivity analysis of Parameter ρ, are presented in Figure 5.65 for consignment condition and Figure 5.66 for non-consignment condition as follows:

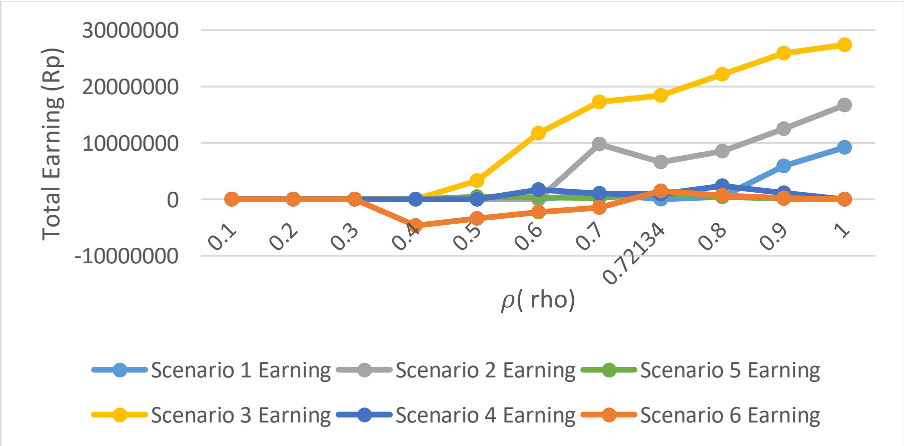


Figure 5.65 Sensitivity Analysis for ρ Parameter with Consignment Condition

Based on the graphical illustration of total earning provided in Figure 5.65 for consignment condition, the overall trend of all scenarios shows that the increase in ρ in consignment condition will generate more earning for every scenarios, which resulted in scenario 3 should be selected if the ρ is greater or equal to 0.5, while for ρ is 0.4 scenario 2 should be chosen and if ρ is less than 0.4 scenario 4 should be selected.

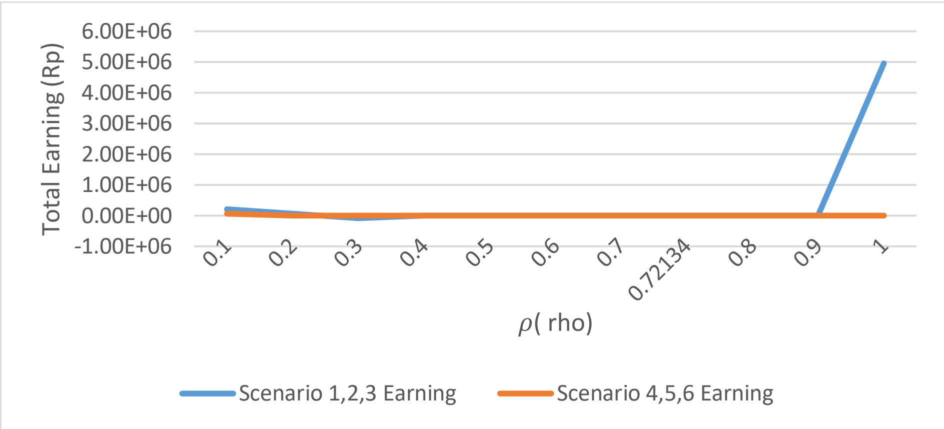


Figure 5.66 Sensitivity Analysis for ρ Parameter without Consignment Condition

For non-consignment condition as explained in Figure 5.66 above, it is recommended to always using scenario 4,5,6, which mean coordination should be implemented. However, there is unique value of total earning if ρ is equal to 1, for scenario 4,5,6 which encourage the business to always implement scenario 4,5,6 and shows that for non-consignment condition in general ρ parameter is insignificant to total earning.

5.3.2 Sensitivity Analysis for α Parameter

In this sub-subchapter, the sensitivity analysis would be done towards parameter α to determine whether the change of parameter α would affect the total earning of the system. Hence, the data recapitulation of parameter α sensitivity analysis towards total earning would be provided in several tables, which will be divided into two conditions. First, for consignment product will be explained from Table 5.59 until Table 5.61. Next, for non-consignment condition the data recapitulation will be provided in Table 5.62:. Noted that, for non-consignment condition the scenario 1,2,3 will be consolidated into one calculation process and scenario 4,5,6 also into one calculation process.

Table 5.59 Sensitivity Analysis for $\boldsymbol{a}$ Parameter (Scenario 1-3) with Consignment Condition

Change in Percentage	a_1	a_2	Consignment Product		
			Etot1	Etot2	Etot3
0%	0.32	0.34	0.10949	6605997.909	18405416.95
-10%	0.288	0.306	-3E+07	4815850	15563200
-20%	0.256	0.272	-3E+07	2654470	13056800
-30%	0.224	0.238	-3E+07	1534400	10697600
-40%	0.192	0.204	-3E+07	1385700	6309600
-50%	0.16	0.17	-3E+07	1448200	1931000
10%	0.352	0.374	574100	8126200	19119600
20%	0.384	0.408	1464900	9441000	22099500
30%	0.416	0.442	2256600	8801200	17899000
40%	0.448	0.476	2317100	8966400	23591600
50%	0.48	0.51	3622200	10451000	23809100

Table 5.60 Sensitivity Analysis for $\boldsymbol{a}$ Parameter (Scenario 4-6) with Consignment Condition

Change in Percentage	a_1	a_2	Consignment Product		
			Etot4	Etot5	Etot6
0%	0.32	0.34	908391	1135488.403	1513984.538
-10%	0.288	0.306	958430	1198000	1597400
-20%	0.256	0.272	1008500	1260600	1680800
-30%	0.224	0.238	1058500	1323100	1764200
-40%	0.192	0.204	1108500	1385700	1847600
-50%	0.16	0.17	1158600	1448200	1931000
10%	0.352	0.374	858360	1073000	1430600
20%	0.384	0.408	808330	1010400	1347200
30%	0.416	0.442	753310	941640	655300
40%	0.448	0.476	-0.0004	-0.000331	613020
50%	0.48	0.51	-0.0004	756180	576370

Table 5.61 Sensitivity Analysis for $\boldsymbol{a}$ Parameter Best Scenario with Consignment Condition

Change in Percentage	a_1	a_2	Best Scenario
0%	0.32	0.34	Etot3
-10%	0.288	0.306	Etot3
-20%	0.256	0.272	Etot3
-30%	0.224	0.238	Etot3
-40%	0.192	0.204	Etot3
-50%	0.16	0.17	Etot6
10%	0.352	0.374	Etot3
20%	0.384	0.408	Etot3
30%	0.416	0.442	Etot3
40%	0.448	0.476	Etot3
50%	0.48	0.51	Etot3

In the Table 5.61 above, the sensitivity analysis for a parameter with consignment condition shows that, the initial best scenario of scenario 3 will be shift to Scenario 6 if the a is decreased 50% from the initial value.

Table 5.62 Sensitivity Analysis for a Parameter without Consignment Condition

Change in Percentage	a_1	a_2	Non-Consignment Product		Best Scenario
			Etot 1,2,3	Etot 4,5, 6	
0%	0.32	0.34	-8.01E-05	0.000019214	Etot 4,5, 6
-10%	0.288	0.306	-7.22E-05	0.0000182	Etot 4,5, 6
-20%	0.256	0.272	-6.44E-05	0.000017365	Etot 4,5, 6
-30%	0.224	0.238	-5.65E-05	1.67917E-05	Etot 4,5, 6
-40%	0.192	0.204	-2.39E-05	0.000016569	Etot 4,5, 6
-50%	0.16	0.17	-1.67E-05	0.000016794	Etot 4,5, 6
10%	0.352	0.374	-8.80E-05	0.000020329	Etot 4,5, 6
20%	0.384	0.408	-9.59E-05	0.000024605	Etot 4,5, 6
30%	0.416	0.442	-1.04E-04	0.000023338	Etot 4,5, 6
40%	0.448	0.476	-1.12E-04	0.00002231	Etot 4,5, 6
50%	0.48	0.51	1.28E+07	0.000021502	Etot 1,2,3

In the Table 5.62 above, the sensitivity analysis for a parameter without consignment condition shows that, the initial best scenario of either scenario 4,5, and 6 will be shift into scenario 1,2,3 if the combination of a is increased with 50% from the initial value.

Next, the graphical illlustrasion for sensitivity analysis of Parameter a, are presented in Figure 5.67 for consignment condition and Figure 5.68 for non-consignment condition as follows:

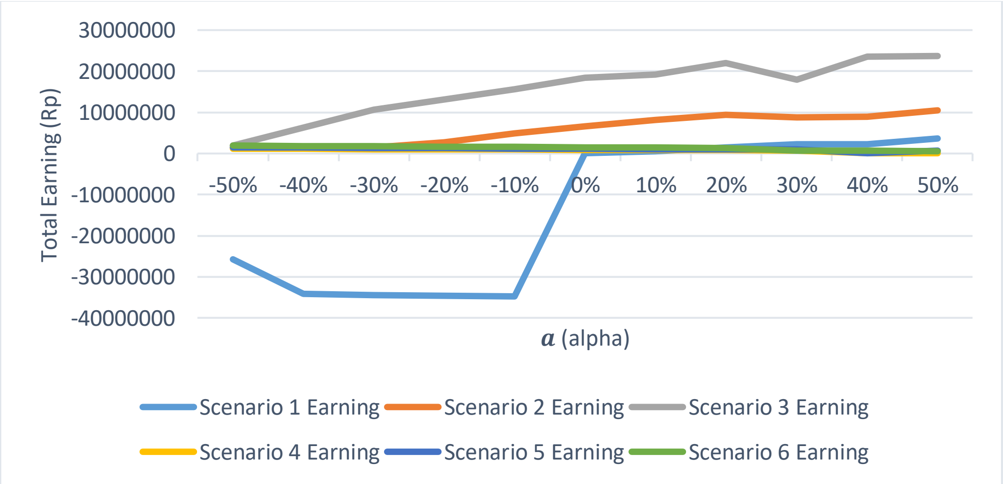


Figure 5.67 Sensitivity Analysis for $\boldsymbol{a}$ Parameter with Consignment Condition

Based on the graphical illustration of total earning provided in Figure 5.67 for consignment condition, the overall trend of all scenarios shows that the increase in α parameter in consignment condition will generate more earning for every scenarios, which resulted in scenario 3 should be selected if the α parameter is not decreased more or the same as 50%, while for below 50% of the initial α parameter scenario 6 should be selected. However, for scenario 1 if the α is increased more or the same than 10% from the initial value the model is not feasible.

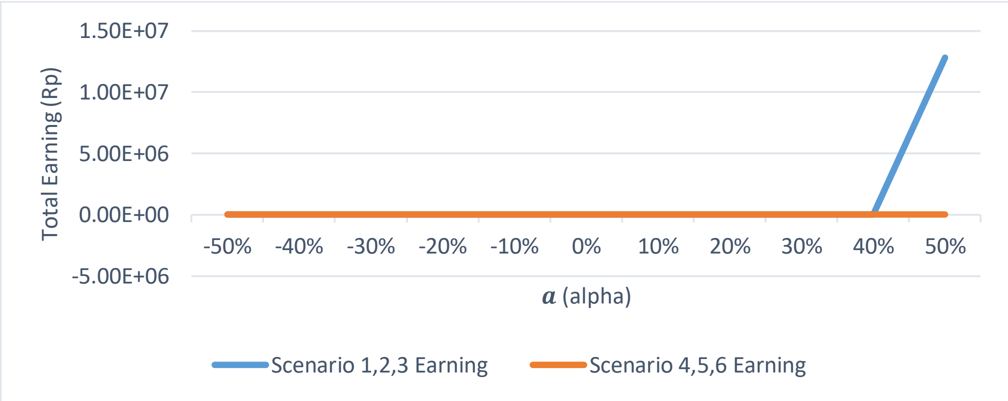


Figure 5.68 Sensitivity Analysis for α Parameter without Consignment Condition

For non-consignment condition as explained in Figure 5.68 above, it is recommended to always using scenario 4,5,6, which mean coordination should be implemented. However, there is unique value of total earning if α is increased 50% from the initial value of α, for scenario 4,5,6 which encourage the business to always implement scenario 4,5,6 and shows that for non-consignment condition in general α parameter is insignificant to total earning.

5.3.3 Sensitivity Analysis for C_m Parameter

In this sub-subchapter, the sensitivity analysis would be done towards parameter C_m to determine whether the change of parameter C_m would affect the total earning of the system. Hence, the data recapitulation of parameter C_m sensitivity analysis towards total earning would be provided in several tables, which will be divided into two conditions. First, for consignment product will be explained from Table 5.63 until Table 5.65. Next, for non-consignment condition the data recapitulation will be provided in Table 5.66:. Noted that, for non-consignment condition the scenario 1,2,3 will be consolidated into one calculation process and scenario 4,5,6 also into one calculation process.

Table 5.63 Sensitivity Analysis for C_m Parameter (Scenario 1-3) with Consignment Condition

C_m	Consignment Product		
	Etot1	Etot2	Etot3
5000	0.10949	6605998	18405416.95
4000	5266300	1E+07	24177100
3000	1.1E+07	1.5E+07	27675100
2000	1.7E+07	2E+07	32683500
1000	2.3E+07	2.5E+07	37691000
6000	0.10949	714905	12635000
7000	0.10949	0.00071	6864300
8000	0.10949	0.00056	1093520
9000	0.10949	2.4E-06	9.2777E-06
10000	0.10949	2.4E-06	9.7665E-06
11000	0.10949	-497520	1.15835E-05

Table 5.64 Sensitivity Analysis for C_m Parameter (Scenario 4-6) with Consignment Condition

C_m	Consignment Product		
	Etot4	Etot5	Etot6
5000	908391	1135488	1513984.538
4000	791980	989980	1320000
3000	675570	844460	1125900
2000	476510	366310	-406010
1000	320310	128120	-818980
6000	164100	-110060	-1232000
7000	1024800	1281000	1708000
8000	1141200	1426500	1902000
9000	1257600	1572100	2096100
10000	1374100	1717600	2290100
11000	1490500	1863100	2484100

Table 5.65 Sensitivity Analysis for C_m Parameter Best Scenario Comparison with Consignment Condition

C_m	Best Scenario
5000	Etot3
4000	Etot3
3000	Etot3
2000	Etot3
1000	Etot3
6000	Etot3
7000	Etot3
8000	Etot6
9000	Etot6
10000	Etot6
11000	Etot6

In the Table 5.65 above, the sensitivity analysis for C_m parameter with consignment condition shows that, the initial best scenario of scenario 3 will be shift to Scenario 6 if the C_m is change from 5000 to 8000, 9000, 10000 and 11000.

Table 5.66 Sensitivity Analysis for C_m Parameter without Consignment Condition

C_m	Non-Consignment Product		Best Scenario
	Etot 1,2,3	Etot 4,5, 6	
5000	-8.01E-05	1.92E-05	Etot 4,5, 6
4000	4.73E-05	1.88E-05	Etot 1,2,3
3000	1.13E-03	1.86E-04	Etot 1,2,3
2000	9.31E-04	4.05E-01	Etot 4,5, 6
1000	5.02E-03	8.00E-07	Etot 1,2,3
6000	7.82E-04	-2.70E-03	Etot 1,2,3
7000	1.81E-03	6.04E-04	Etot 1,2,3
8000	1.13E-01	8.92E-04	Etot 1,2,3
9000	8.90E-02	1.10E-03	Etot 1,2,3
10000	1.14E-05	1.30E-03	Etot 4,5, 6
11000	0.00E+00	1.40E-03	Etot 4,5, 6

In the table 5.66 above, the sensitivity analysis for C_m parameter without consignment condition shows that, the initial best scenario of either scenario 4,5, and 6 will be shift into scenario 1,2,3 if the combination of C_m change from 5000 into several values of 4000, 3000, 1000, 6000, 7000, 8000, and 9000.

Next, the graphical illlustrasion for sensitivity analysis of Parameter C_m, are presented in Figure 5.69 for consignment condition and Figure 5.70 for non-consignment condition as follows:

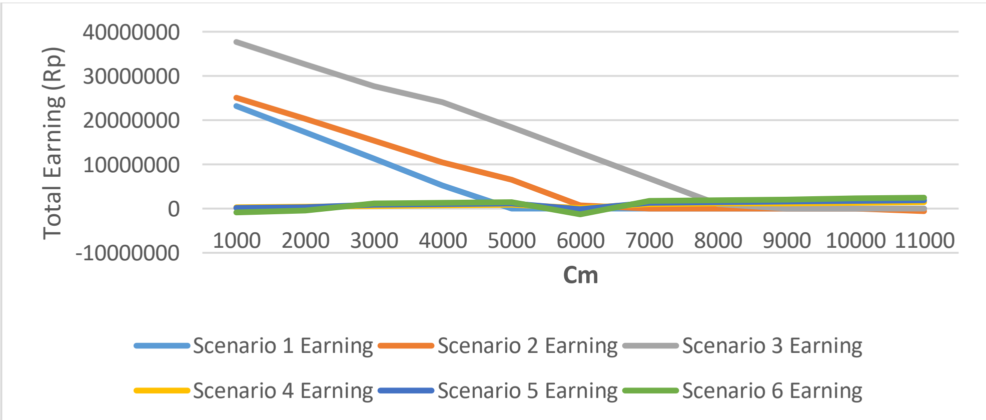


Figure 5.69 Sensitivity Analysis for C_m Parameter with Consignment Condition

Based on the graphical illustration of total earning provided in Figure 5.69 for consignment condition, the overall trend of all scenarios shows that the increase in C_m parameter in consignment condition will generate less earning for every scenarios, which resulted in scenario 3 should be selected if the C_m parameter is not exceed 8000. However, if the C_m parameter is set to above 8000 the scenario 6 should be selected.

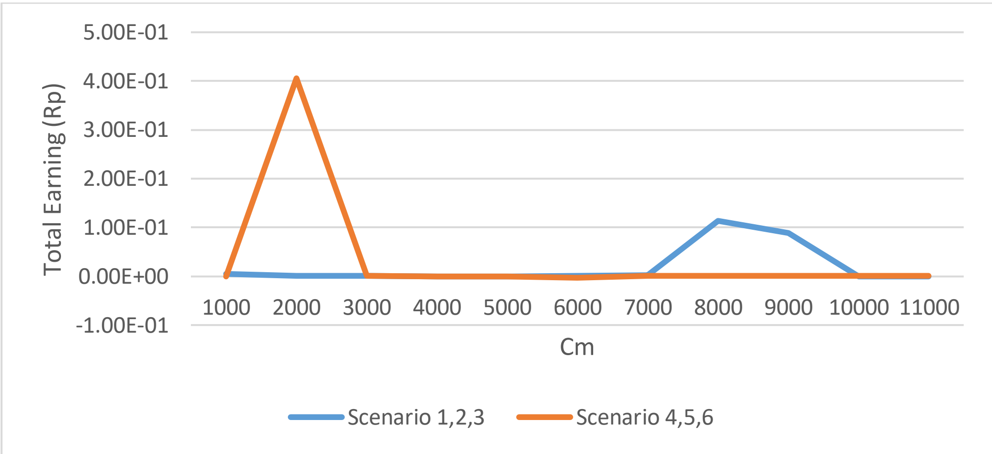


Figure 5.70 Sensitivity Analysis for C_m Parameter without Consignment Condition

For non-consignment condition as explained in Figure 5.70 above, it is recommended to use scenario 4,5,6 if the C_m value is 2000, 5000, 10000, and 11000, which mean coordination should be implemented. However, for other experiment of C_m the scenario 1,2,3 should be selected, which coordination should not be implemented. The unique composition of selection is generated from the constraint relaxation which sometimes generate value that is very low indicated by Figure 5.70 above. Hence, for non-consignment condition the C_m parameter is considered as significant.

5.3.4 Sensitivity Analysis for $D_{s_{t+1}}$ Parameter

In this sub-subchapter, the sensitivity analysis would be done towards parameter $D_{s_{t+1}}$ to determine whether the change of parameter $D_{s_{t+1}}$ would affect the total earning of the system. Hence, the data recapitulation of parameter $D_{s_{t+1}}$ sensitivity analysis towards total earning would be provided in several tables, which will be divided into three tables, from Table 5.67 until Table 5.69. However, in

$D_{s_{t+1}}$ parameter, there is no sensitivity analysis for non-consignment condition since the $D_{s_{t+1}}$ parameter change will not affect the result of calculation process.

Table 5.67 Sensitivity Analysis for $D_{s_{t+1}}$ Parameter (Scenario 1-3) with Consignment Condition

Change in Percentage	$D_{s_{t+1}}$	Consignment Product		
		Etot1	Etot2	Etot3
0%	253.273	0.10949	6605998	1.8E+07
-10%	227.946	-0.0001	5704700	1.9E+07
-20%	202.618	-0.0001	5932500	1.9E+07
-30%	177.291	131750	7368600	1.9E+07
-40%	151.964	325090	7621700	2E+07
-50%	126.637	518890	7870800	2E+07
10%	278.6	-0.0001	6350700	1.8E+07
20%	303.928	0.00189	6092300	1.8E+07

Table 5.68 Sensitivity Analysis for $D_{s_{t+1}}$ Parameter (Scenario 4-6) with Consignment Condition

Change in Percentage	$D_{s_{t+1}}$	Consignment Product		
		Etot4	Etot5	Etot6
0%	253.273	908391	1135488	1513985
-10%	227.946	883940	1104900	1473200
-20%	202.618	859480	1074300	1432500
-30%	177.291	835020	1043800	1391700
-40%	151.964	810560	1013200	1350900
-50%	126.637	786100	982620	1310200
10%	278.6	932860	1166100	1554800
20%	303.928	957320	1196600	1595500

Table 5.69 Sensitivity Analysis for $D_{s_{t+1}}$ Parameter Best Scenario Comparison with Consignment Condition

Change in Percentage	$D_{s_{t+1}}$	Best Scenario
0%	253.273	Etot3
-10%	227.946	Etot3
-20%	202.618	Etot3
-30%	177.291	Etot3
-40%	151.964	Etot3
-50%	126.637	Etot3
10%	278.6	Etot3
20%	303.928	Etot3

In the table 5.70 above, the sensitivity analysis for $D_{s_{t+1}}$ parameter with consignment condition shows that, the initial best scenario of scenario 3 will not shift with all the change in $D_{s_{t+1}}$ parameter.

Next, the graphical illlustrasion for sensitivity analysis of Parameter $\boldsymbol{D_{s_{t+1}}}$, is presented in Figure 5.71 as follows:

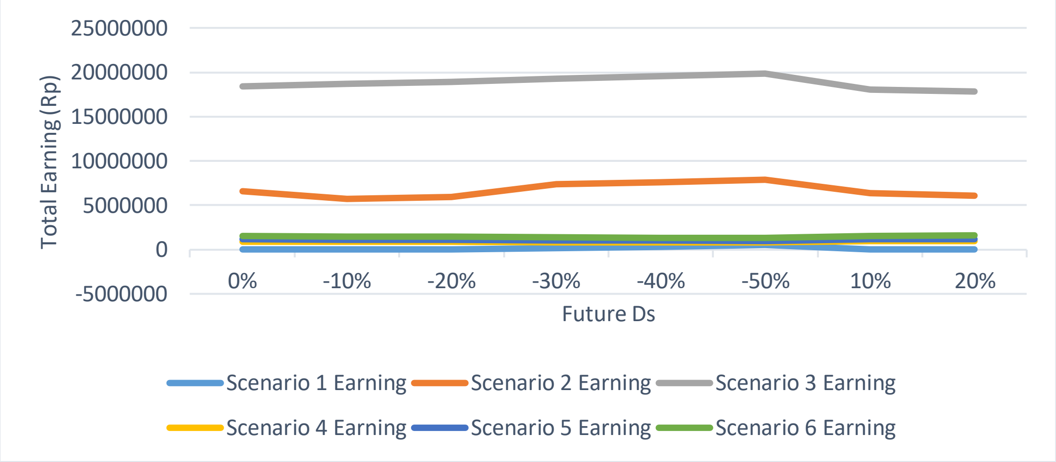


Figure 5.71 Sensitivity Analysis for $D_{s_{t+1}}$ Parameter with Consignment Condition

Based on the graphical illustration of total earning provided in Figure 5.71 for consignment condition, the overall trend of all scenarios shows that the change in $D_{s_{t+1}}$ parameter shows no significant different in total earning for all scenarioss. Thus, the $D_{s_{t+1}}$ parameter change could be considered as insignificant and the scenario 3 is selected for all of the experiment in change of $D_{s_{t+1}}$ parameter. However, for scenario 1 if $D_{s_{t+1}}$ is feasible only if $D_{s_{t+1}}$ value is increased with 20%.

5.3.5 Sensitivity Analysis for d_s^{max} Parameter

In this sub-subchapter, the sensitivity analysis would be done towards parameter d_s^{max} to determine whether the change of parameter d_s^{max} would affect the total earning of the system. Hence, the data recapitulation of parameter d_s^{max} sensitivity analysis towards total earning would be provided in several tables, which will be divided into two conditions. First, for consignment product will be explained from Table 5.70 until Table 5.72. Next, for non-consignment condition the data recapitulation will be provided in Table 5.73:. Noted that, for non-consignment condition the scenario 1,2,3 will be consolidated into one calculation process and scenario 4,5,6 also into one calculation process.

Table 5.70 Sensitivity Analysis for d_s^{max} Parameter (Scenario 1-3) with Consignment Condition

Change in Percentage	d_s^{max}	Consignment Product		
		Etot1	Etot2	Etot3
0%	4325.75	0.10949	6605998	18405416.95
-10%	3893.18	432860	7218500	18277100
-20%	3460.6	1168500	7623200	17847700
-30%	3028.03	1761400	6412100	16191400
-40%	2595.45	2211600	6355400	15184600
-50%	2162.88	2519200	6114500	13940700
10%	4758.33	0.00178	5773710	17636100
20%	5190.9	0.00157	4725380	17376700
30%	5623.48	0.00146	3460550	16846200
40%	6056.05	0.00125	1979210	16080500
50%	6488.63	0.00114	2137810	15044400

Table 5.71 Sensitivity Analysis for d_s^{max} Parameter (Scenario 4-6) with Consignment Condition

Change in Percentage	d_s^{max}	Consignment Product		
		Etot4	Etot5	Etot6
0%	4325.75	908391	1135488	1513984.538
-10%	3893.18	791980	989980	1320000
-20%	3460.6	675570	844460	1125900
-30%	3028.03	555840	631290	482930
-40%	2595.45	-0.0001	508040	387290
-50%	2162.88	-6E-05	398100	302160
10%	4758.33	1024800	1281000	1708000
20%	5190.9	1141200	1426500	1902000
30%	5623.48	1257600	1572100	2096100
40%	6056.05	1374100	1717600	2290100
50%	6488.63	1490500	1863100	2484100

Table 5.72 Sensitivity Analysis for d_s^{max} Parameter Best Scenario Comparison with Consignment Condition

Change in Percentage	d_s^{max}	Best Scenario
0%	4325.75	Etot3
-10%	3893.18	Etot3
-20%	3460.6	Etot3
-30%	3028.03	Etot3
-40%	2595.45	Etot3
-50%	2162.88	Etot3
10%	4758.33	Etot3
20%	5190.9	Etot3
30%	5623.48	Etot3
40%	6056.05	Etot3
50%	6488.63	Etot3

In the Table 5.72 above, the sensitivity analysis for d_s^{max} parameter with consignment condition shows that, the initial best scenario of scenario 3 will not shift with all the change in d_s^{max} parameter.

Table 5.73 Sensitivity Analysis for d_s^{max} Parameter without Consignment Condition

Change in Percentage	d_s^{max}	Non-Consignment Product		Best Scenario
		Etot 1,2,3	Etot 4,5, 6	
0%	4325.75	-8.01E-05	0.000019214	Etot 4,5, 6
-10%	3893.18	-8.18E-05	0.00001698	Etot 4,5, 6
-20%	3460.6	-8.35E-05	0.000015352	Etot 4,5, 6
-30%	3028.03	-8.53E-05	0.000014205	Etot 4,5, 6
-40%	2595.45	-8.70E-05	0.000013522	Etot 4,5, 6
-50%	2162.88	-8.87E-05	0.000013228	Etot 4,5, 6
10%	4758.33	-7.84E-05	0.000022045	Etot 4,5, 6
20%	5190.9	-7.67E-05	0.000027421	Etot 4,5, 6
30%	5623.48	-7.50E-05	0.000027445	Etot 4,5, 6
40%	6056.05	-7.33E-05	2.72876E-05	Etot 4,5, 6
50%	6488.63	-7.16E-05	0.00089029	Etot 4,5, 6

In the Table 5.73 above, the sensitivity analysis for d_s^{max} parameter without consignment condition shows that, the initial best scenario of either scenario 4,5, and 6 will not shift with all the change in d_s^{max} parameter.

Next, the graphical illlustrasion for sensitivity analysis of Parameter d_s^{max}, are presented in Figure 5.72 for consignment condition and Figure 5.73 for non-consignment condition as follows:

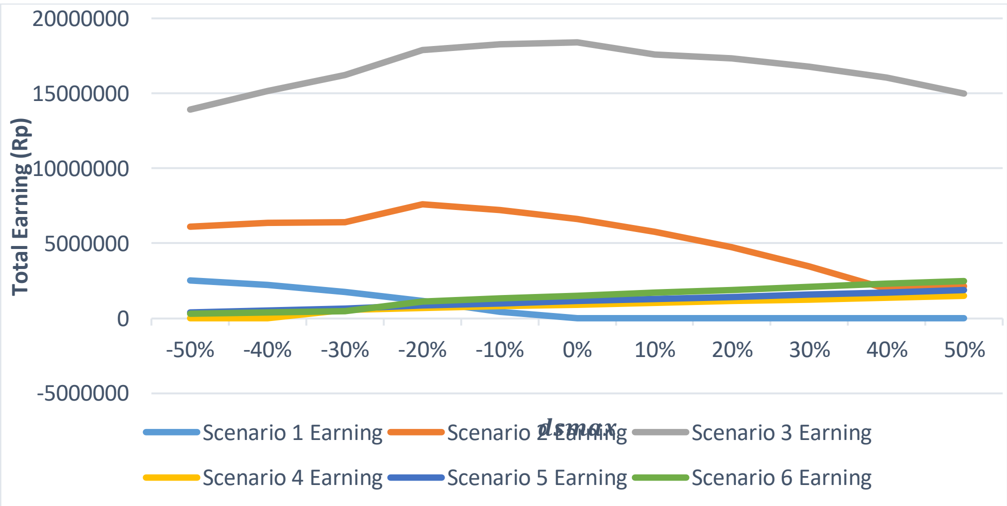


Figure 5.72 Sensitivity Analysis for d_s^{max} Parameter with Consignment Condition

Based on the graphical illustration of total earning provided in Figure 5.72 for consignment condition, the overall trend of all scenarios shows that the increase in d_s^{max} parameter in consignment condition does not affect the selection of scenario 3 which always generate highest total earning compare to other scenarios.

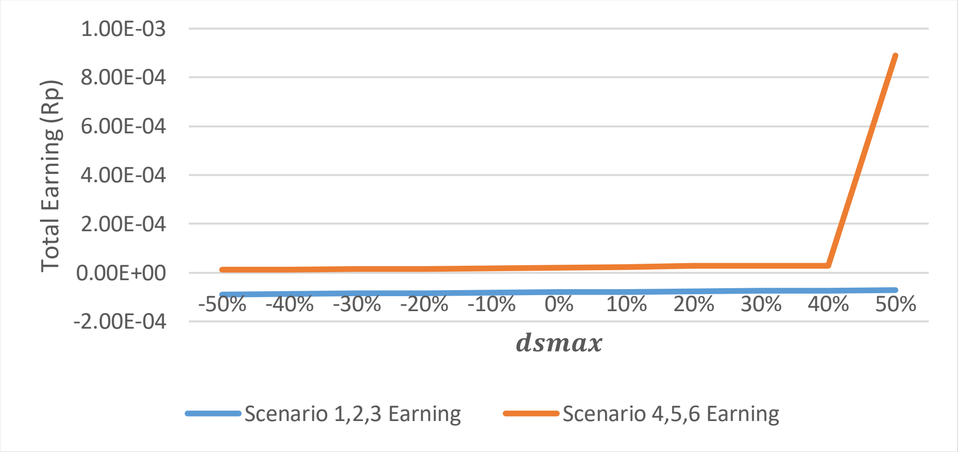


Figure 5.73 Sensitivity Analysis for d_s^{max} Parameter without Consignment Condition

For non-consignment condition as explained in Figure 5.73 above, it is recommended to always using scenario 4,5,6, which mean coordination should be implemented. However, there is unique value of total earning if d_s^{max} is increased 50% from the initial value of d_s^{max}. Hence, for all the proposed scenarios, scenario 4,5,6 is always better than scenario 1,2,3, which encourage the business to always implement scenario 4,5,6 and shows that for non-consignment condition in general d_s^{max} parameter is insignificant to total earning.

5.3.6 Sensitivity Analysis for a and ρ Parameter

In this, sub-subchapter, sensitivity analysis would be done for both parameters a and ρ and in simultaneous way. Hence, the purpose of performing two parameters sensitivity analysis in simultaneous way would be to assess whether critical parameters in total earning change would also being resulted from the interaction of two parameter, which has not been assessed in the other sensitivity analysis in this research. Hence, the 3-D graphical representation of the profit function is provided in Figure 5.74 as follows:

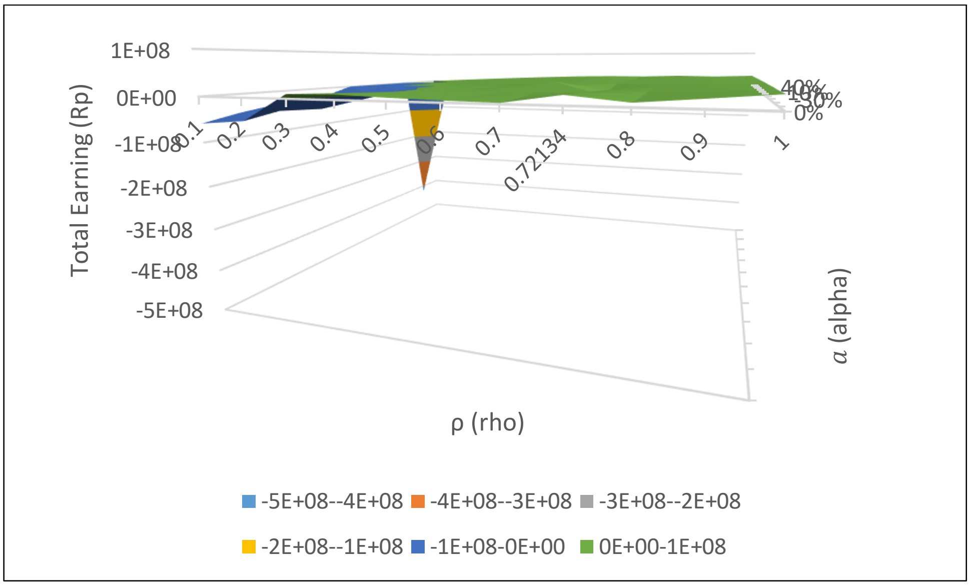


Figure 5.74 Sensitivity Analysis for α and ρ Parameter

Based on Figure 5.74 above, the sensitivity analysis for α and ρ Parameter is done by changing the value of ρ with the initial value of changing that already formulated in separate sensitivity analysis by ρ parameter, combined by the changing in α parameter ranging from -50% until 50% from the initial value. Then, it is implied form the Figure 5.74 that the highest earning is obtained from the combination when α is decreased by 30% and ρ is equal to 0.7. Therefore, the result would be useful for the observation object as one of the aspect to select scenario with specific set of parameter compare to others.

5.4 Managerial Implication for Mr Froniez Business

In this subchapter, the implication from the result of the research for the managerial decision in observation object which are Mr Froniez would be explained in each point as follows:

1. Based on the existing parameter condition of Mr Froniez, scenario 3 (low consignment level without coordination) would generated highest earning for Mr Froniez business compared to other pricing and consignment level combination of scenarios.
2. The result of the best pricing scenario is not a rigid decision, due to condition change in the system, including the change of parameter value in the future.

3. Hence, the order of parameter from the most significant until the least signiicant for total earning are Cost of manufacture of product (C_m), preference of customer in purchasing product in online channel compare to offline channel (ρ), self-price elasticity compare to demand (a),and d_s^{max} and $D_{s_{t+1}}$ parameters are the least significant in the same position.

5.5 Model Weakness Analysis for Further Improvement in the Following Research

In this subchapter, several aspects that is not covered in the research would be listed in the following list. However, the analysis is conducted for the determination of several aspects which are important for the following research.

1. Apart from conventional selling, there are price discount rate and promotional sales which also should be optimized and incurred in the system model.
2. All of the rejected product from the retail shop should be separated from the remain returned product to be included as a separate parameter.
3. Customer behaviors and characteristics in observational object should also be incurred.

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CHAPTER 6
CONCLUSION AND SUGGESTION

In this chapter, the concluison of the research and suggestion regarding the whole research process will be explained in further subchapter.

6.1 Conclusion

Here is several conclusion which are emerge from the result of the research process:

1. In the Mr Froniez business, especially for Bronchips product. The initial pricing decision is determined in the same price with Rp 15000/pack in every selling channel existed. Hence, this aspect of pricing decision is implying that in general Mr Froniez business not yet consider the customer preference into its pricing decision determination. Then, since the retail channel of Bronchips consist of big market retail such as Giant and Indomaret they are imposing 100% consignment terms of payment in order for Mr Froniez to put their product in their channel. Thus, based on result of the research implied that the existing condition is not generating best financial performance for Mr Froniez.
2. In the construction of demand model for both channel, the consideration could be divided into two (2) major groups, Dual-channel Supply-Chain and Consignment terms of payment conditions. First, for Dual-channel supply chain condition several parameters such as preference of customer in purchasing product in online channel compare to offline channel, self-price and cross-price elasticity compare to demand is considered. Next, for Consignment terms of payment several parameters such as future purchasing demand in offline channel parameter and three consignment level as the basic of the scenarios construction. Thus, there are 6 combination of scenarios that is constructed resulting from the condition of the business. Scenario 1 which possess high-consignment level and non-cooperative condition, Scenario 2 which possess medium-consignment level and non-cooperative condition, Scenario 3 which possess low-

consignment level and non-cooperative condition, Scenario 4 which possess high-consignment level and cooperative condition, Scenario 5 which possess high-consignment level and non-cooperative condition, and Scenario 6 which possess high-consignment level and non-cooperative condition. Note that, for non-cooperative condition offline and online channel pricing optimization is done in sequential way, while for cooperative condition offline and online channel pricing optimization is done in simultaneous way. Hence, the different condition of all scenarios resulting in difference in objective function thus resulting in different optimum price especially when consignment product is remained in the following period.

3. Based on the result of all scenarios optimization process. Scenario 3 which possess low-consignment level and non-cooperative condition, shows the best financial performance if consignment product is remain and either scenario 4,5, and 6 if consignment product is all being purchased in the following period, which generate most total earning compared to other scenarios. However, the best pricing scenario is not a rigid decision, due to condition change in the system, including the change of parameter value in the future. Hence, the order of parameter from the most significant until the least signiicant for total earning are cost of manufacture of product (C_m), preference of customer in purchasing product in online channel compare to offline channel (ρ), self-price elasticity compare to demand (a),and d_s^{max} and $D_{s_{t+1}}$ parameters are the least significant in the same position.
4. Scenario 3 which possess low-consignment level and non-cooperative condition, shows the best financial performance if consignment product is remain and either scenario 4,5, and 6 if consignment product is all being purchased in the following period, which generate most total earning compared to other scenarios. However, there are several occasions based on the result of sensitivity analysis that the initial best strategy would shift. First, when consignment condition product remains initial best scenario of scenario 3 will be shift to Scenario 1 if the ρ is 0.4 and shift to scenario 4 if

the ρ are 0.3, 0.2 and 0.1, or the initial best scenario of scenario 3 will be shift to Scenario 6 if the a is decreased 50% or the initial best scenario of scenario 3 will be shift to Scenario 6 if the C_m is change from 5000 to 8000, 9000, 10000 and 11000. Next, when the consignment product are all being purchased initial best scenario of either scenario 4,5, and 6 will be shift into scenario 1,2,3 if the combination of a is increased with 50% from the initial value or the initial best scenario of either scenario 4,5, and 6 will be shift into scenario 1,2,3 if the parameter of C_m change from 5000 into several values of 4000, 3000, 1000, 6000, 7000, 8000, and 9000.

6.2 Suggestion

Here is several suggestion or recommendation which are emerge from the result of the research process:

1. The pricing policy should be evaluate every period to accomodate change of parameter value that possibly happened, especially for the following period since the following period demand is crucial in selecting the possible scenarios
2. In the following research, Apart from conventional selling, there are price discount rate and promotional sales which also should be optimized and incurred in the system model.
3. In the following research, all of the rejected product from the retail shop should be separated from the remain returned product to be included as a separate parameter to increase the broader business aspect of Mr Froniez
4. In the following research, all of the cost that is neglected in this research such as inventory cost, and all other operational cost should be incurred in the system model.

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APPENDIX

Appendix 1 Customer Preference and Price Elasticity Questionnaire

Kuisioner Preferensi Pelanggan

A. IDENTITAS RESPONDEN

Nama	:	Usia	:………Tahun
Jenis Kelamin	: P/L	Pekerjaan	:
Nomor Telepon/HP	:		

Saya Reiza Pradipta Makruf mahasiswa jurusan Teknik Industri, Fakultas Teknik Industri (FTI), Institut Teknologi Sepuluh Nopember Surabaya. Kuisioner ini disusun untuk mengetahui preferensi konsumen berbelanja ditoko konvensional dan online dalam bisnis UKM Mr. Froniez, khususnya produk Bronchips
Kriteria responden untuk mengisi kuesioner penelitian TA saya adalah konsumen Bronchips yang merupakan Produk dari Mr Froniez.
Identitas serta data responden akan dijaga kerahasiaannya dan digunakan untuk kepentingan penelitian TA saja.
Hormat saya,
Reiza Pradipta Makruf
083854911861.

Produk Bronchips

Nama Produk : Bronchips

Tipe Produk : Beverage/ Snack

Harga : Rp 15.000,00/60 gr package

B. PERTANYAAN KUALITATIF

1. Apakah anda pernah membeli produk bronchips atau produk sejenisnya sebelumnya?

a. Ya b. Tidak

2. Apakah anda pernah melakukan berbelanja online untuk produk ini?

a. Ya b. Tidak

☐ Resiko penipuan

☐ Waktu tunggu

☐ Kehilangan Pengalaman mencoba produk

☐ Lainnya:………………………..

C. PERTANYAAN PREFERENSI KONSUMEN

3. Jika nilai preferensi Anda membeli produk melalui *offline-channel*/ di toko konvensional adalah 100, maka berapakah nilai untuk preferensi Anda membeli produk yang sama melalui *online-channel*/ situs resmi?

☐ (Isilah nilai antara 0-100)

D. PERTANYAAN ELASTISITAS HARGA

4. Semisal, keputusan Anda berbelanja di channel **offline/ toko konvensional** dipengaruhi oleh harga Bronchips di channel tersebut. Pada penurunan harga berapakah Anda akan memutuskan untuk belanja satu package lebih banyak lagi?

☐ (Isi dengan harga antara Rp 0 – Rp 10.000)

5. Semisal, keputusan Anda berbelanja di channel **online/website** dipengaruhi oleh harga produk Bronchips di channel tersebut. Pada penurunan harga berapakah Anda akan memutuskan untuk belanja satu package lebih banyak lagi?

☐ (Isi dengan harga antara Rp 0 – Rp 10.000)

TERIMA KASIH ATAS WAKTU DAN PARTISIPASINYA

Appendix 2 Questionnaire Data Recapitulation

Name	Gender	Age	Occupation	Telephone Number	1	2	3	4	5
Alifah Andini	Perempuan	21	Mahasiswa	082310146007	Tidak	Tidak	80	5000	7000
Deiazalfa	Perempuan	20	Mahasiswa	082231344610	Ya	Ya	80	5000	5000
Ghea	Perempuan	19	Mahasiswa	081393046656	Ya	Tidak	40	5000	7000
Rifqi Azis	Laki-laki	20	Mahasiswa	081255248399	Ya	Tidak	80	6000	5500
Moh Fadhlan Rosyidi	Laki-laki	19 tahun	Mahasiswa	085655558104	Tidak	Tidak	50	7000	7000
Saskia Putri Kamala	Perempuan	20 tahun	Mahasiswa	08568385358	Ya	Tidak	40	5000	6000
Ica	Perempuan	22	Mahasiswa	085231923349	Tidak	Tidak	50	5000	5000
Egar	Laki-laki	22	Swasta	08563545635	Tidak	Tidak	75	5000	5000
Calvin	Laki-laki	22	Mahasiswa	085748426202	Tidak	Tidak	80	2000	2500
Michael Joshua Wijaya	Laki-laki	21	Mahasisa	08561111167	Tidak	Tidak	100	3000	3000
Arnold Hasian	Laki-laki	21	Mahasiswa	08777307201	Ya	Tidak	35	5000	3500
Reine	Perempuan	21	Mahasiswa	087871248110	Ya	Tidak	65	5000	5000
Dafa	Laki-laki	20	Mahasiswa	085817589393	Ya	Ya	70	5000	5000
Rachmad Irvan S	Laki-laki	19	Mahasiswa	081216014156	Tidak	Tidak	75	4000	4000
Nisrina	Perempuan	19	Mahasiswi	08111221198	Ya	Tidak	90	1000	1000
Daffa	Laki-laki	18	Mahasiswa	085253545657	Tidak	Tidak	100	2000	5000
Citra Wulandari	Perempuan	20	Mahasiswa	081249690239	Tidak	Tidak	50	4000	5000
Nabilah Putri Khansa	Perempuan	20	Mahasiswi	081335845544	Tidak	Tidak	85	5000	7000
Ridwan Aziz	Laki-laki	21	Drafter	089602854743	Ya	Ya	75	6000	6000
Zulfapermata	Perempuan	20	Mahasiswi	0352485275	Tidak	Tidak	100	7000	7000

Name	Gender	Age	Occupation	Telephone Number	1	2	3	4	5
Farida	Perempuan	22	Mahasiswa	085736867755	Ya	Tidak	50	7000	7000
Meng	Perempuan	23	Joobseeker	081934697034	Ya	Tidak	30	9000	9000
Nur Fitria Ningsih	Perempuan	21	Mahasiswi	082310944279	Tidak	Tidak	85	3000	5000
Winahyu Tyas Wicaksaba	Laki-laki	21	Mahasiswa	081231397697	Ya	Ya	75	6000	7000
Komarudin	Laki-laki	21	Karyawan Swasta	089653175255	Ya	Tidak	80	5000	5000
Ardiyan Abi Winata	Laki-laki	21	mahasiswa	080678641355	Tidak	Tidak	90	8000	5000
Widi	Perempuan	21	Mahasiswi	081284638789	Ya	Tidak	80	6000	6000
Nur Ilman	Laki-laki	21	Mahasiswa	087829837549	Tidak	Tidak	85	3500	5000
Evy	Perempuan	17 tahun	Mahasiswi	089656579046	Ya	Tidak	70	4000	5000
Fawwaz	Laki-laki	20	Mahasiswa	081288047975	Tidak	Tidak	70	5000	7000
Tiara	Perempuan	22	Swasta	081230808931	Ya	Ya	80	7000	5000
Ammar	Laki-laki	21	Mahasiswa	081217070492	Tidak	Tidak	50	7000	0
Nadya	Perempuan	20	Mahasiswa	085706370627	Ya	Tidak	80	6000	5500
Peny Switika Erniyati	Perempuan	21	mahasiswa	085781333380	Tidak	Tidak	85	6000	5000
Hidro	Laki-laki	22	Mahasiswa	082226788965	Ya	Tidak	50	5000	5000
Muhammad Irfan Barmisto	Laki-laki	22 tahun	Mahasiswa	082231508406	Ya	Ya	90	5000	7000
Fika Juliani	Perempuan	21	Mahasiswa	082213494112	Tidak	Tidak	70	6000	6000
Niar	Perempuan	22	Mahasiswa	087853131970	Ya	Tidak	75	5000	7000
Sari	Perempuan	20	Mahasiswi	082245618473	Tidak	Tidak	80	5000	7000
Akhbar Buddy Al Afghan	Laki-laki	21 Tahun	Pengangguran	081216462460	Ya	Tidak	79	3000	2000
Sanrego	Laki-laki	22	Mahasiswa	089696891134	Ya	Ya	75	2500	2500
Nuansa Apsari	Perempuan	21	Mahasiswa	081225330464	Ya	Tidak	80	6000	6000

Name	Gender	Age	Occupation	Telephone Number	1	2	3	4	5
Muchamad Iqbal	Laki-laki	22	Mahasiswa	087877861774	Tidak	Tidak	100	5000	5000
Faizal Imam	Laki-laki	21	Karyawan Swasta	081222405393	Ya	Ya	90	3000	3000
Wisnun DH	Laki-laki	48	Swasta	082217721250	Tidak	Tidak	40	5000	5000
Khairul Fadli	Laki-laki	21	Mahasiswa	082261939900	Tidak	Tidak	75	5000	5000
Denty Astamiar	Perempuan	20	Mahasiswa	085852191088	Ya	Tidak	80	5000	5000
Ella	Perempuan	20	Mahasiswa	082136175685	Ya	Tidak	50	4000	5000
Farah Tsani	Perempuan	17	Pelajar	081230704282	Ya	Tidak	50	3000	4000
Habieb	Laki-laki	22	Mahasiswa	081295217046	Tidak	Ya	75	5000	4000
Lazuardi Zaki	Laki-laki	21	Mahasiswa	081252957166	Tidak	Tidak	90	2000	3000

Appendix 3 Offline Demand Function Validation Process

- Offline Demand Function Validation for Consignment Condition

No	rho	alpha1	beta1	dsmax	Dst1	Ps	Po	Ds
1	0.72134	0.34	0.32	4325	253	16000	15000	156.102
2	0.72134	0.32	0.32	4325	253	15000	15000	326.102
3	0.72134	0.32	0.32	4325	253	14000	15000	496.102
4	0.72134	0.32	0.32	4325	253	13000	15000	666.102
5	0.72134	0.32	0.32	4325	253	12000	15000	836.102
6	0.72134	0.32	0.32	4325	253	11000	15000	1006.1
7	0.72134	0.32	0.32	4325	253	10000	15000	1176.1

- Offline Demand Function Validation for Non-consignment Condition

No	rho	alpha1	beta1	dsmax	Ps	Po	Ds
1	0.72134	0.34	0.32	796	16000	15000	-418.19
2	0.72134	0.32	0.32	796	15000	15000	-78.187
3	0.72134	0.32	0.32	796	14000	15000	261.813
4	0.72134	0.32	0.32	796	13000	15000	601.813
5	0.72134	0.32	0.32	796	12000	15000	941.813
6	0.72134	0.32	0.32	796	11000	15000	1281.81
7	0.72134	0.32	0.32	796	10000	15000	1621.81

Appendix 4 Online Demand Function Validation Process

- Online Demand Function Validation for Consignment Condition

No	rho	alpha2	beta2	Dst1	dsmax	Ps	Po	Do
1	0.72134	0.32	0.34	253	4325	15000	16000	3585.9
2	0.72134	0.32	0.34	253	4325	15000	15000	3745.9
3	0.72134	0.32	0.34	253	4325	15000	14000	3905.9
4	0.72134	0.32	0.34	253	4325	15000	13000	4065.9
5	0.72134	0.32	0.34	253	4325	15000	12000	4225.9
6	0.72134	0.32	0.34	253	4325	15000	11000	4385.9
7	0.72134	0.32	0.34	253	4325	15000	10000	4545.9

- Online Demand Function Validation for Non-consignment Condition

No	rho	alpha2	beta2	Dst1	dsmax	Ps	Po	Do
1	0.72134	0.32	0.34	653	796	15000	16000	554.187
2	0.72134	0.32	0.34	653	796	15000	15000	874.187
3	0.72134	0.32	0.34	653	796	15000	14000	1194.19
4	0.72134	0.32	0.34	653	796	15000	13000	1514.19
5	0.72134	0.32	0.34	653	796	15000	12000	1834.19
6	0.72134	0.32	0.34	653	796	15000	11000	2154.19
7	0.72134	0.32	0.34	653	796	15000	10000	2474.19

Appendix 5 Scenario 1 Validation Process

- Scenario 1 Validation for Consignment Condition

No	Parameter								Scenario 1a				Total Earning
	rho	dsmax	Dst1	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	253	2000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	11226000.5
2	0.72134	4325	253	3000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	7484000.504
3	0.72134	4325	253	4000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	3742000.504
4	0.72134	4325	253	5000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	0.503761113
5	0.72134	4325	253	6000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	-3741999.496
6	0.72134	4325	253	7000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	-7483999.496
7	0.72134	4325	253	8000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	5000	-11225999.5

- Scenario 1 Validation for Non-consignment Condition

No	Parameter							Scenario 1b				Total Earning
	rho	dsmax	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	2000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	408000.0779
2	0.72134	4325	3000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	272000.0779
3	0.72134	4325	4000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	136000.0779
4	0.72134	4325	5000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	0.077864095
5	0.72134	4325	6000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-135999.9221
6	0.72134	4325	7000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-271999.9221
7	0.72134	4325	8000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-407999.9221

Appendix 6 Scenario 2 Validation Process

- Scenario 2 Validation for Consignment Condition

No	Parameter								Scenario 2a				Total Earning
	rho	dsmax	Dst1	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	253	2000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	16426745
2	0.72134	4325	253	3000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	12460944
3	0.72134	4325	253	4000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	8495143
4	0.72134	4325	253	5000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	4529341
5	0.72134	4325	253	6000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	563540
6	0.72134	4325	253	7000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	-3402261
7	0.72134	4325	253	8000	0.34	0.32	0.32	0.34	195.128	3770.67	6142.1	6142.1	-7368062

- Scenario 2 Validation for Non-consignment Condition

No	Parameter							Scenario 2b				Total Earning
	rho	dsmax	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	2000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	408000.0779
2	0.72134	4325	3000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	272000.0779
3	0.72134	4325	4000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	136000.0779
4	0.72134	4325	5000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	0.077864095
5	0.72134	4325	6000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-135999.9221
6	0.72134	4325	7000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-271999.9221
7	0.72134	4325	8000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-407999.9221

Appendix 7 Scenario 3 Validation Process

- Scenario 3 Validation for Consignment Condition

No	Parameter								Scenario 3a				Total Earning
	rho	dsmax	Dst1	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	253	2000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	26855021
2	0.72134	4325	253	3000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	22516218
3	0.72134	4325	253	4000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	18177415
4	0.72134	4325	253	5000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	13838612
5	0.72134	4325	253	6000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	9499809
6	0.72134	4325	253	7000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	5161006
7	0.72134	4325	253	8000	0.34	0.32	0.32	0.34	260.17	4078.63	8189.5	8189.5	822203

- Scenario 3 Validation for Non-consignment Condition

No	Parameter							Scenario 3b				Total Earning
	rho	dsmax	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	2000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	408000
2	0.72134	4325	3000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	272000
3	0.72134	4325	4000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	136000
4	0.72134	4325	5000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	0.07786
5	0.72134	4325	6000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-136000
6	0.72134	4325	7000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-272000
7	0.72134	4325	8000	0.34	0.32	0.32	0.34	-418.19	554.187	5000	5000	-408000

Appendix 8 Scenario 4 Validation Process

- Scenario 4 Validation for Consignment Condition

No	Parameter								Scenario 4a				Total Earning
	rho	dsmax	Dst1	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	253	2000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	18152161.5
2	0.72134	4325	253	3000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	14410161.5
3	0.72134	4325	253	4000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	10668161.5
4	0.72134	4325	253	5000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	6926161.504
5	0.72134	4325	253	6000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	3184161.504
6	0.72134	4325	253	7000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	-557838.4959
7	0.72134	4325	253	8000	0.34	0.32	0.32	0.34	156.102	3585.9	5000	6931.5	-4299838.496

- Scenario 4 Validation for Non-consignment Condition

No	Parameter							Scenario 4b				Total Earning
	rho	dsmax	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	2000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	408000
2	0.72134	4325	3000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	272000
3	0.72134	4325	4000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	136000
4	0.72134	4325	5000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	0.00031
5	0.72134	4325	6000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-136000
6	0.72134	4325	7000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-272000
7	0.72134	4325	8000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-408000

Appendix 9 Scenario 5 Validation Process

- Scenario 5 Validation for Consignment Condition

No	Parameter								Scenario 5a				Total Earning
	rho	dsmax	Dst1	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	253	2000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	19180459
2	0.72134	4325	253	3000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	15214658
3	0.72134	4325	253	4000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	11248857
4	0.72134	4325	253	5000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	7283056
5	0.72134	4325	253	6000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	3317254
6	0.72134	4325	253	7000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	-648547
7	0.72134	4325	253	8000	0.34	0.32	0.32	0.34	195.128	3770.67	5000	6931.5	-4614348

- Scenario 5 Validation for Non-consignment Condition

No	Parameter							Scenario 5b				Total Earning
	rho	dsmax	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	2000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	408000
2	0.72134	4325	3000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	272000
3	0.72134	4325	4000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	136000
4	0.72134	4325	5000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	0.00031
5	0.72134	4325	6000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-136000
6	0.72134	4325	7000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-272000
7	0.72134	4325	8000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-408000

Appendix 10 Scenario 6 Validation Process

- Scenario 6 Validation for Consignment Condition

No	Parameter								Scenario 6a				Total Earning
	rho	dsmax	Dst1	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	253	2000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	20894288
2	0.72134	4325	253	3000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	16555485
3	0.72134	4325	253	4000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	12216682
4	0.72134	4325	253	5000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	7877879
5	0.72134	4325	253	6000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	3539076
6	0.72134	4325	253	7000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	-799727
7	0.72134	4325	253	8000	0.34	0.32	0.32	0.34	260.17	4078.63	5000	6931.5	-5138530

- Scenario 6 Validation for Non-consignment Condition

No	Parameter							Scenario 6b				Total Earning
	rho	dsmax	Cm	alpha1	beta1	alpha2	beta2	Ds	Do	Ps	Po	
1	0.72134	4325	2000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	408000.0003
2	0.72134	4325	3000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	272000.0003
3	0.72134	4325	4000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	136000.0003
4	0.72134	4325	5000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	0.000312045
5	0.72134	4325	6000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-135999.9997
6	0.72134	4325	7000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-271999.9997
7	0.72134	4325	8000	0.34	0.32	0.32	0.34	-418.19	554.187	5,000	5,000	-407999.9997

Appendix 11 Sensitivity Analysis for ρ Parameter

- Consignment Condition
    - Scenario 1 ρ Parameter Sensitivity Analysis

Cm	Scenario 1							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	5000	5146.407	779.3432	-0.00011	0.109486		0.109486
4000	4.91E+03	4.00E+03	5.76E+03	3.21E+02	5.27E+06	1.77E-04		5.27E+06
3000	4.91E+03	4.89E+03	5.76E+03	1.67E+02	1.10E+07	3.14E+05		11360042
2000	4.91E+03	4.89E+03	5.76E+03	1.66E+02	1.68E+07	4.81E+05		17274650
1000	4.91E+03	4.89E+03	5.76E+03	1.66E+02	2.26E+07	6.47E+05		23204980
6000	6.00E+03		5.58E+03	0.00E+00	2.18E-05			0.00E+00
7000	7.00E+03		6.06E+03	0.00E+00	3.64E-07			0.00E+00
8000	8.00E+03		5.29E+03	0.00E+00	3.02E-06			0.00E+00
9000	9.00E+03		5.11E+03	0.00E+00	3.27E-06			0.00E+00
10000	1.00E+04		4.91E+03	0.00E+00	3.44E-06			0.00E+00
11000	1.09E+04		4.75E+03	0.00E+00	-5.71E+05			0.00E+00

- Scenario 2 ρ Parameter Sensitivity Analysis

Cm	Scenario 2							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	6142.1	6142.1	4795.625	988.4553	5477083	1128915		6605998
4000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	1.03E+07	2.27E+05		10499890
3000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	1.51E+07	3.04E+05		15372380
2000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	1.99E+07	3.82E+05		20245880
1000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	2.47E+07	4.59E+05		25119380
6000	6.14E+03	6.14E+03	4.80E+03	2.35E+02	6.82E+05	3.33E+04		714905
7000	7.00E+03	7.00E+03	4.69E+03	2.46E+02	1.12E-04	5.97E-04		0.000709
8000	8.00E+03	8.00E+03	4.65E+03	2.58E+02	2.00E-06	5.59E-04		0.000561
9000	9.00E+03		4.45E+03	0.00E+00	2.44E-06			2.44E-06
10000	1.00E+04		4.80E+03	0.00E+00	2.40E-06			2.4E-06
11000	1.09E+04		4.19E+03	0.00E+00	-4.98E+05			-497520

- Scenario 3 ρ Parameter Sensitivity Analysis

Cm	Scenario 3							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	8189.5	8189.5	4418.564	1352.064	14093010	4312407		18405417
4000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	1.85E+07	5.67E+06		24177100
3000	8.19E+03	1.10E+04	4.42E+03	5.89E+02	2.29E+07	4.75E+06		27675100
2000	8.19E+03	1.10E+04	4.42E+03	5.89E+02	2.73E+07	5.33E+06		32683500
1000	8.19E+03	1.10E+04	4.42E+03	5.89E+02	3.18E+07	5.92E+06		37691000
6000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	9.67E+06	2.96E+06		12635000
7000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	5.26E+06	1.61E+06		6864300
8000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	8.37E+05	2.56E+05		1093520
9000	9.00E+03	9.00E+03	4.48E+03	1.37E+03	1.03E-06	8.25E-06		9.28E-06
10000	1.00E+04	1.00E+04	5.26E+03	1.38E+03	1.05E-06	8.71E-06		9.77E-06
11000	1.10E+04	1.10E+04	4.93E+03	1.40E+03	2.46E-06	9.12E-06		1.16E-05

- Scenario 4 ρ Parameter Sensitivity Analysis

Cm	Scenario 4							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	6931.5	3855.447	470.3032			908390.7	908390.7
4000	5,000	6,932	3855.447	470.3032			7.92E+05	7.92E+05
3000	5,000	6,932	3855.447	470.3032			6.76E+05	6.76E+05
2000	5,000	7,592	3855.447	470.3032			4.77E+05	4.77E+05
1000	5,000	7,592	3855.447	470.3032			3.20E+05	3.20E+05
6000	5,000	7,592	3855.447	470.3032			1.64E+05	1.64E+05
7000	5,000	6,932	3855.447	470.3032			1.02E+06	1.02E+06
8000	5,000	6,932	3855.447	470.3032			1.14E+06	1.14E+06
9000	5,000	6,932	3855.447	470.3032			1.26E+06	1.26E+06
10000	5,000	6,932	3855.447	470.3032			1.37E+06	1.37E+06
11000	5,000	6,932	3855.447	470.3032			1.49E+06	1.49E+06

- Scenario 5 ρ Parameter Sensitivity Analysis

Cm	Scenario 5							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	6931.5	3973.023	587.8791			1135488	1135488
4000	5,000	6,932	3973.023	587.8791			9.90E+05	9.90E+05
3000	5,000	6,932	3973.023	587.8791			8.44E+05	8.44E+05
2000	5,000	8,161	3973.023	587.8791			3.66E+05	3.66E+05
1000	5,000	8,161	3973.023	587.8791			1.28E+05	1.28E+05
6000	5,000	8,161	3973.023	587.8791			-1.10E+05	-1.10E+05
7000	5,000	6,932	3973.023	587.8791			1.28E+06	1.28E+06
8000	5,000	6,932	3973.023	587.8791			1.43E+06	1.43E+06
9000	5,000	6,932	3973.023	587.8791			1.57E+06	1.57E+06
10000	5,000	6,932	3973.023	587.8791			1.72E+06	1.72E+06
11000	5,000	6,932	3973.023	587.8791			1.86E+06	1.86E+06

- Scenario 6 ρ Parameter Sensitivity Analysis

Cm	Scenario 6							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	6931.5	4168.982	783.8387			1513985	1513985
4000	5,000	6,932	4168.982	783.8387			1.32E+06	1.32E+06
3000	5,000	6,932	4168.982	783.8387			1.13E+06	1.13E+06
2000	5,000	9,111	4168.982	783.8387			-4.06E+05	-4.06E+05
1000	5,000	9,111	4168.982	783.8387			-8.19E+05	-8.19E+05
6000	5,000	9,111	4168.982	783.8387			-1.23E+06	-1.23E+06
7000	5,000	6,932	4168.982	783.8387			1.71E+06	1.71E+06
8000	5,000	6,932	4168.982	783.8387			1.90E+06	1.90E+06
9000	5,000	6,932	4168.982	783.8387			2.10E+06	2.10E+06
10000	5,000	6,932	4168.982	783.8387			2.29E+06	2.29E+06
11000	5,000	6,932	4168.982	783.8387			2.48E+06	2.48E+06

- Non-consignment Condition
    - Scenario 1,2,3 ρ Parameter Sensitivity Analysis

Cm	Scenario 1, 2, and 3							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	5000	5146.407	779.3432	-7.68E-05	-3.37E-06		-8.01E-05
4000	4.00E+03	4.94E+03	4.02E+03	3.69E-08	1.25E-05	3.48E-05		4.73E-05
3000	3.00E+03	3.88E+03	4.35E+03	1.25E-06	2.72E-05	0.0011		1.13E-03
2000	2.00E+03	2.82E+03	4.62E+03	-8.48E-08	0.001	-6.93E-05		9.31E-04
1000	1.00E+03	1.76E+03	5.03E+03	-3.70E-07	0.0053	-2.79E-04		5.02E-03
6000	6.00E+03	6.00E+03	3.33E+03	3.42E+02	7.67E-07	7.81E-04		7.82E-04
7000	7.00E+03	7.00E+03	2.99E+03	3.62E+02	9.84E-04	8.30E-04		1.81E-03
8000	8.00E+03	8.00E+03	2.66E+03	3.82E+02	6.92E-06	0.1125		1.13E-01
9000	9.00E+03	9.00E+03	2.32E+03	4.02E+02	8.43E-06	0.089		8.90E-02
10000	1.00E+04	1.00E+04	2.00E+03	4.23E+02	9.20E-06	2.24E-06		1.14E-05
11000			0.00E+00	0.00E+00				0.00E+00

- Scenario 4,5,6 ρ Parameter Sensitivity Analysis

Cm	Scenario 4, 5, and 6							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5,000	5,000	4795.625	988.4553			1.92E-05	1.92E-05
4000	4,000	4,000	4795.625	988.4553			1.88E-05	1.88E-05
3000	3,000	3,000	4795.625	988.4553			1.86E-04	0.000186
2000	2,000	2,818	4795.625	988.4553			0.4048	0.4048
1000	1,000	1,756	4795.625	988.4553			8.00E-07	8E-07
6000	6,000	6,000	4795.625	988.4553			-0.0027	-0.0027
7000	7,000	7,000	4795.625	988.4553			6.04E-04	0.000604
8000	8,000	8,000	4795.625	988.4553			8.92E-04	0.000892
9000	9,000	9,000	4795.625	988.4553			0.0011	0.0011
10000	10,000	10,000	4795.625	988.4553			0.0013	0.0013
11000	11,000	11,000	4795.625	988.4553			0.0014	0.0014

Appendix 12 Sensitivity Analysis for α Parameter

- Consignment Condition
  - Scenario 1 α Parameter Sensitivity Analysis

Change in Percentage	alpha 1	alpha 2	Scenario 1							
			Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	0.32	0.34	5000	5000	5146.407	779.3432	-0.00011	0.109486		0.109486
-10%	0.288	0.306	5.00E+03	5.00E+03	4989.591	2.81E+15	-1.10E-04	-3.48E+07		-3.5E+07
-20%	0.256	0.272	5.00E+03	5.00E+03	4835.072	2.79E+15	-1.06E-04	-3.46E+07		-3.5E+07
-30%	0.224	0.238	5.00E+03	5.00E+03	4679.593	2.78E+15	-1.02E-04	-3.44E+07		-3.4E+07
-40%	0.192	0.204	5.00E+03	5.00E+03	4524.675	2.76E+15	-9.80E-05	-3.42E+07		-3.4E+07
-50%	0.16	0.17	5.00E+03	6.93E+03	4370.111	-13374.3	-9.42E-05	-2.58E+07		-2.6E+07
10%	0.352	0.374	5.11E+03		5281.124	0	5.74E+05			574100
20%	0.384	0.408	5.27E+03		5401.199	0	1.46E+06			1464900
30%	0.416	0.442	5.41E+03		5521.062	0	2.26E+06			2256600
40%	0.448	0.476	5.41E+03		5669.083	0	2.32E+06			2317100
50%	0.48	0.51	5.63E+03		5761.058	0	3.62E+06			3622200

  - Scenario 2 α Parameter Sensitivity Analysis

Change in Percentage	alpha 1	alpha 2	Scenario 2							
			Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	0.32	0.34	6142.1	6142.1	4795.625	988.4553	5477083	1128915		6605998
-10%	0.288	0.306	5.84E+03	5.84E+03	4728.104	976.6212	3.99E+06	8.24E+05		4815850
-20%	0.256	0.272	5.47E+03	5.47E+03	4660.552	966.0889	2.20E+06	4.56E+05		2654470
-30%	0.224	0.238	5.00E+03	7.59E+03	4591.556	593.4497	-1.02E-04	1.53E+06		1534400
-40%	0.192	0.204	5.00E+03	6.93E+03	4475.117	717.4053	-9.68E-05	1.39E+06		1385700
-50%	0.16	0.17	5.00E+03	6.93E+03	4358.909	749.7629	-9.39E-05	1.45E+06		1448200
10%	0.352	0.374	6.39E+03	6.39E+03	4863.102	1000.444	6.74E+06	1.39E+06		8126200
20%	0.384	0.408	6.59E+03	6.59E+03	4930.643	1010.748	7.83E+06	1.61E+06		9441000
30%	0.416	0.442	6.76E+03	5.00E+03	4998.106	1478.468	8.80E+06	-2.19E-05		8801200
40%	0.448	0.476	6.76E+03	5.00E+03	5091.921	1522.121	8.97E+06	-2.30E-05		8966400
50%	0.48	0.51	7.04E+03	5.00E+03	5133.297	1630.212	1.05E+07	-2.57E-05		10451000

- Scenario 3 α Parameter Sensitivity Analysis

Change in Percentage	alpha 1	alpha 2	Scenario 3							
			Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	0.32	0.34	8189.5	8189.5	4418.564	1352.064	14093010	4312407		18405417
-10%	0.288	0.306	7.79E+03	1.11E+04	4405.053	533.1919	1.23E+07	3.26E+06		15563200
-20%	0.256	0.272	7.30E+03	1.12E+04	4391.706	479.1839	1.01E+07	2.97E+06		13056800
-30%	0.224	0.238	6.66E+03	9.23E+03	4378.552	813.7113	7.26E+06	3.44E+06		10697600
-40%	0.192	0.204	5.81E+03	8.05E+03	4365.28	915.4342	3.52E+06	2.79E+06		6309600
-50%	0.16	0.17	5.00E+03	6.93E+03	4340.796	999.7183	-9.34E-05	1.93E+06		1931000
10%	0.352	0.374	8.51E+03	6.93E+03	4431.908	1834.594	1.56E+07	3.54E+06		19119600
20%	0.384	0.408	8.79E+03	8.79E+03	4445.281	1392.865	1.68E+07	5.27E+06		22099500
30%	0.416	0.442	9.01E+03	5.00E+03	4458.54	2799.748	1.79E+07	-5.49E-05		17899000
40%	0.448	0.476	9.21E+03	1.09E+04	4471.877	811.1587	1.88E+07	4.76E+06		23591600
50%	0.48	0.51	9.21E+03	1.07E+04	4499.662	854.6238	1.89E+07	4.86E+06		23809100

- Scenario 4 α Parameter Sensitivity Analysis

rho	Scenario 4							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0.72134	5000	6931.5	3855.446753	470.3032475	0	0	908390.7225	908390.7225
0.7	5,000	7,143	3843.108143	516.459	0	0	1.03E+06	1034200
0.6	5,000	8,412	3829.85675	732.7465	0	0	1.69E+06	1691900
0.5	5.00E+03	5,000	3067.676	949.034	0	0	-1.48E-04	-0.00014778
0.4	5,000	5,000	2851.3885	1165.3215	0	0	-9.56E-05	-0.000095601
0.3	5,000	5,000	2635.101	1381.609	0	0	-6.56E-05	-0.000065633
0.2	5,000	5,000	2418.8135	1597.8965	0	0	-5.66E-05	-0.000056611
0.1	5,000	5,000	2202.526	1814.184	0	0	-6.56E-05	-0.000065587
0.8	5,000	6,250	3916.5385	300.1715	0	0	2.40E+06	2404000
0.9	5,000	5,556	4021.714889	83.884	0	0	1.13E+06	1130200
1	5,000	5,000	4149.1135	-132.4035	0	0	-5.48E-05	-0.000054765

- Scenario 5 α Parameter Sensitivity Analysis

Change in Percentage	alpha 1	alpha 2	Scenario 5							
			Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	0.32	0.34	5000	6931.5	3973.023	587.8791			1135488	1135488
-10%	0.288	0.306	5000	6931.54407	3953.595	620.2591			1.20E+06	1198000
-20%	0.256	0.272	5000	6931.54407	3934.167	652.6391			1.26E+06	1260600
-30%	0.224	0.238	5000	6931.54407	3914.739	685.0191			1.32E+06	1323100
-40%	0.192	0.204	5000	6931.54407	3895.311	717.3991			1.39E+06	1385700
-50%	0.16	0.17	5000	6931.54407	3875.883	749.7791			1.45E+06	1448200
10%	0.352	0.374	5000	6931.544071	3992.451	555.4991			1.07E+06	1073000
20%	0.384	0.408	5000	6931.544071	4011.879	523.1191			1.01E+06	1010400
30%	0.416	0.442	5000	7065.728958	4031.307	490.7391			9.42E+05	941640
40%	0.448	0.476	5,000	5,000	4050.735	458.3591			-3.31E-04	-0.00033
50%	0.48	0.51	5,000	7,212	4070.163	425.9791			7.56E+05	756180

- Scenario 6 α Parameter Sensitivity Analysis

rho	Scenario 6							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0.72134	5000	6931.5	4168.982251	783.839	0	0	1513984.538	1513984.538
0.7	5,000	9,352	4153.597	860.765	0	0	-1.41E+06	-1406100
0.6	5,000	10,478	4081.501167	1221.24	0	0	-2.26E+06	-2263800
0.5	5,000	11,605	4009.405333	1581.72	0	0	-3.32E+06	-3324500
0.4	5,000	12,731	3937.3095	1942.2	0	0	-4.59E+06	-4588300
0.3	5,000	5,000	3865.213667	2302.68	0	0	-1.18E-04	-0.00011826
0.2	5,000	5,000	3793.117833	2663.16	0	0	-1.25E-04	-0.00012461
0.1	5,000	5,000	3721.022	3023.64	0	0	-1.64E-04	-0.00016365
0.8	5,000	6,250	4225.692833	500.286	0	0	6.96E+05	696270
0.9	5,000	5,556	4297.788667	139.807	0	0	2.64E+05	263510
1	5,000	5,000	4369.8845	-220.67	0	0	-5.91E-06	-5.9101E-06

- Non-consignment Condition
  - Scenario 1,2,3 α Parameter Sensitivity Analysis

rho	Scenario 1, 2, and 3							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0.72134	5000	5000.00014	5146.41	779.343	-7.68E-05	-3.37E-06	0	-8.01E-05
0.7	5.00E+03	5.00E+03	3657.18	338.623	-7.63E-05	-3.58E-06	0	-7.99E-05
0.6	5.00E+03	5.00E+03	3577.31	418.222	-7.43E-05	-4.57E-06	0	-7.89E-05
0.5	5.00E+03	5.00E+03	3496.79	497.718	-7.23E-05	-5.56E-06	0	-7.79E-05
0.4	5.00E+03	5.00E+03	3417.04	577.318	-7.04E-05	-6.56E-06	0	-7.69E-05
0.3	1.48E+04	1.75E+04	4.4E-07	-6.8	0.0043	-8.49E+04	0	-8.49E+04
0.2	1.46E+04	1.75E+04	4.4E-07	4.8	0.0042	5.99E+04	0	5.99E+04
0.1	1.44E+04	1.75E+04	4.4E-07	16.4004	0.0041	2.05E+05	0	2.05E+05
0.8	5.00E+03	5.00E+03	3736.32	259.207	-7.83E-05	9.98E-06	0	-6.83E-05
0.9	5.00E+03	5.56E+03	3814.92	1.8E-07	-8.03E-05	9.88E-05	0	1.85E-05
1	1.50E+04	1.59E+04	496	1.9E-07	4.96E+06	0.0021	0	4.96E+06

  - Scenario 4,5,6 α Parameter Sensitivity Analysis

rho	Scenario 4, 5, and 6							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0.72134	5,000	5,000	474.18664	321.813			1.92E-05	0.000019214
0.7	5,000	5,000	457.2	338.8			2.50E-05	0.000025028
0.6	5,000	5,000	377.6	418.4			-5.13E-06	-5.1283E-06
0.5	5,000	5,000	298	498			-5.96E-06	-5.9616E-06
0.4	5,000	5,000	218.4	577.6			-6.81E-06	-6.8122E-06
0.3	5,000	5,000	138.8	657.2			-7.70E-06	-7.6955E-06
0.2	5,000	5,000	59.20000001	736.8			-8.62E-06	-8.6237E-06
0.1	5,000	5,064	-20.4	816.4			5.07E+04	50745
0.8	5,000	5,000	536.8	259.2			1.88E-05	0.000018803
0.9	5,000	5,561	616.4	179.6			4.00E-06	4.0003E-06
1	5,000	5,000	696	100			5.53E-07	5.5257E-07

Appendix 13 Sensitivity Analysis for C_m Parameter

- Consignment Condition
  - Scenario 1 C_m Parameter Sensitivity Analysis

Cm	Scenario 1							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	5000	5146.407	779.3432	-0.00011	0.109486		0.109486
4000	4.91E+03	4.00E+03	5.76E+03	3.21E+02	5.27E+06	1.77E-04		5.27E+06
3000	4.91E+03	4.89E+03	5.76E+03	1.67E+02	1.10E+07	3.14E+05		11360042
2000	4.91E+03	4.89E+03	5.76E+03	1.66E+02	1.68E+07	4.81E+05		17274650
1000	4.91E+03	4.89E+03	5.76E+03	1.66E+02	2.26E+07	6.47E+05		23204980
6000	6.00E+03		5.58E+03	0.00E+00	2.18E-05	0		0.00E+00
7000	7.00E+03		6.06E+03	0.00E+00	3.64E-07	0		0.00E+00
8000	8.00E+03		5.29E+03	0.00E+00	3.02E-06	0		0.00E+00
9000	9.00E+03		5.11E+03	0.00E+00	3.27E-06	0		0.00E+00
10000	1.00E+04		4.91E+03	0.00E+00	3.44E-06	0		0.00E+00
11000	1.09E+04		4.75E+03	0.00E+00	-5.71E+05	0		0.00E+00

  - Scenario 2 C_m Parameter Sensitivity Analysis

Cm	Scenario 2							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	6142.1	6142.1	4795.625	988.4553	5477083	1128915		6605998
4000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	1.03E+07	2.27E+05		10499890
3000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	1.51E+07	3.04E+05		15372380
2000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	1.99E+07	3.82E+05		20245880
1000	6.14E+03	6.93E+03	4.80E+03	7.75E+01	2.47E+07	4.59E+05		25119380
6000	6.14E+03	6.14E+03	4.80E+03	2.35E+02	6.82E+05	3.33E+04		714905
7000	7.00E+03	7.00E+03	4.69E+03	2.46E+02	1.12E-04	5.97E-04		0.000709
8000	8.00E+03	8.00E+03	4.65E+03	2.58E+02	2.00E-06	5.59E-04		0.000561
9000	9.00E+03		4.45E+03	0.00E+00	2.44E-06			2.44E-06
10000	1.00E+04		4.80E+03	0.00E+00	2.40E-06			2.4E-06
11000	1.09E+04		4.19E+03	0.00E+00	-4.98E+05			-497520

  - Scenario 3 C_m Parameter Sensitivity Analysis

Cm	Scenario 3							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	8189.5	8189.5	4418.564	1352.064	14093010	4312407	0	18405417
4000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	1.85E+07	5.67E+06		24177100
3000	8.19E+03	1.10E+04	4.42E+03	5.89E+02	2.29E+07	4.75E+06		27675100
2000	8.19E+03	1.10E+04	4.42E+03	5.89E+02	2.73E+07	5.33E+06		32683500
1000	8.19E+03	1.10E+04	4.42E+03	5.89E+02	3.18E+07	5.92E+06		37691000
6000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	9.67E+06	2.96E+06		12635000
7000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	5.26E+06	1.61E+06		6864300
8000	8.19E+03	8.19E+03	4.42E+03	1.35E+03	8.37E+05	2.56E+05		1093520
9000	9.00E+03	9.00E+03	4.48E+03	1.37E+03	1.03E-06	8.25E-06		9.28E-06
10000	1.00E+04	1.00E+04	5.26E+03	1.38E+03	1.05E-06	8.71E-06		9.77E-06
11000	1.10E+04	1.10E+04	4.93E+03	1.40E+03	2.46E-06	9.12E-06		1.16E-05

- Scenario 4 C_m Parameter Sensitivity Analysis

Cm	Scenario 4							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	6931.5	3855.447	470.3032			908390.7	908390.7
4000	5,000	6,932	3855.447	470.3032			7.92E+05	7.92E+05
3000	5,000	6,932	3855.447	470.3032			6.76E+05	6.76E+05
2000	5,000	7,592	3855.447	470.3032			4.77E+05	4.77E+05
1000	5,000	7,592	3855.447	470.3032			3.20E+05	3.20E+05
6000	5,000	7,592	3855.447	470.3032			1.64E+05	1.64E+05
7000	5,000	6,932	3855.447	470.3032			1.02E+06	1.02E+06
8000	5,000	6,932	3855.447	470.3032			1.14E+06	1.14E+06
9000	5,000	6,932	3855.447	470.3032			1.26E+06	1.26E+06
10000	5,000	6,932	3855.447	470.3032			1.37E+06	1.37E+06
11000	5,000	6,932	3855.447	470.3032			1.49E+06	1.49E+06

○ Scenario 5 C_m Parameter Sensitivity Analysis

Cm	Scenario 5							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	6931.5	3973.023	587.8791			1135488	1135488
4000	5,000	6,932	3973.023	587.8791			9.90E+05	9.90E+05
3000	5,000	6,932	3973.023	587.8791			8.44E+05	8.44E+05
2000	5,000	8,161	3973.023	587.8791			3.66E+05	3.66E+05
1000	5,000	8,161	3973.023	587.8791			1.28E+05	1.28E+05
6000	5,000	8,161	3973.023	587.8791			-1.10E+05	-1.10E+05
7000	5,000	6,932	3973.023	587.8791			1.28E+06	1.28E+06
8000	5,000	6,932	3973.023	587.8791			1.43E+06	1.43E+06
9000	5,000	6,932	3973.023	587.8791			1.57E+06	1.57E+06
10000	5,000	6,932	3973.023	587.8791			1.72E+06	1.72E+06
11000	5,000	6,932	3973.023	587.8791			1.86E+06	1.86E+06

○ Scenario 6 C_m Parameter Sensitivity Analysis

Cm	Scenario 6							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	6931.5	4168.982	783.8387			1513985	1513985
4000	5,000	6,932	4168.982	783.8387			1.32E+06	1.32E+06
3000	5,000	6,932	4168.982	783.8387			1.13E+06	1.13E+06
2000	5,000	9,111	4168.982	783.8387			-4.06E+05	-4.06E+05
1000	5,000	9,111	4168.982	783.8387			-8.19E+05	-8.19E+05
6000	5,000	9,111	4168.982	783.8387			-1.23E+06	-1.23E+06
7000	5,000	6,932	4168.982	783.8387			1.71E+06	1.71E+06
8000	5,000	6,932	4168.982	783.8387			1.90E+06	1.90E+06
9000	5,000	6,932	4168.982	783.8387			2.10E+06	2.10E+06
10000	5,000	6,932	4168.982	783.8387			2.29E+06	2.29E+06
11000	5,000	6,932	4168.982	783.8387			2.48E+06	2.48E+06

- Non-consignment Condition
  - Scenario 1,2,3 C_m Parameter Sensitivity Analysis

Cm	Scenario 1, 2, and 3							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5000	5000	5146.407	779.3432	-7.68E-05	-3.37E-06		-8.01E-05
4000	4.00E+03	4.94E+03	4.02E+03	3.69E-08	1.25E-05	3.48E-05		4.73E-05
3000	3.00E+03	3.88E+03	4.35E+03	1.25E-06	2.72E-05	0.0011		1.13E-03
2000	2.00E+03	2.82E+03	4.62E+03	-8.48E-08	0.001	-6.93E-05		9.31E-04
1000	1.00E+03	1.76E+03	5.03E+03	-3.70E-07	0.0053	-2.79E-04		5.02E-03
6000	6.00E+03	6.00E+03	3.33E+03	3.42E+02	7.67E-07	7.81E-04		7.82E-04
7000	7.00E+03	7.00E+03	2.99E+03	3.62E+02	9.84E-04	8.30E-04		1.81E-03
8000	8.00E+03	8.00E+03	2.66E+03	3.82E+02	6.92E-06	0.1125		1.13E-01
9000	9.00E+03	9.00E+03	2.32E+03	4.02E+02	8.43E-06	0.089		8.90E-02
10000	1.00E+04	1.00E+04	2.00E+03	4.23E+02	9.20E-06	2.24E-06		1.14E-05
11000			0.00E+00	0.00E+00				0.00E+00

  - Scenario 4,5,6 C_m Parameter Sensitivity Analysis

Cm	Scenario 4, 5, and 6							
	Po	Ps	Do	Ds	Eo	Es	Eos	Etot
5000	5,000	5,000	4795.625	988.4553			1.92E-05	1.92E-05
4000	4,000	4,000	4795.625	988.4553			1.88E-05	1.88E-05
3000	3,000	3,000	4795.625	988.4553			1.86E-04	0.000186
2000	2,000	2,818	4795.625	988.4553			0.4048	0.4048
1000	1,000	1,756	4795.625	988.4553			8.00E-07	8E-07
6000	6,000	6,000	4795.625	988.4553			-0.0027	-0.0027
7000	7,000	7,000	4795.625	988.4553			6.04E-04	0.000604
8000	8,000	8,000	4795.625	988.4553			8.92E-04	0.000892
9000	9,000	9,000	4795.625	988.4553			0.0011	0.0011
10000	10,000	10,000	4795.625	988.4553			0.0013	0.0013
11000	11,000	11,000	4795.625	988.4553			0.0014	0.0014

Appendix 14 Sensitivity Analysis for $D_{s_{t+1}}$ Parameter

- Scenario 1 $D_{s_{t+1}}$ Parameter Sensitivity Analysis

Change in Percentage	Dst1	Scenario 1							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	253.273	5000	5000.0001	5146.4068	779.34323	-0.00011358	0.109485971		0.10948597
-10%	227.946	5.00E+03		5.16E+03	0.00E+00	-1.14E-04			-0.0001139
-20%	202.618	5.00E+03		5.17E+03	0.00E+00	-1.15E-04			-0.0001151
-30%	177.291	5.03E+03		5.18E+03	0.00E+00	1.32E+05			131750
-40%	151.964	5.06E+03		5.19E+03	0.00E+00	3.25E+05			325090
-50%	126.637	5.10E+03		5.19E+03	0.00E+00	5.19E+05			518890
10%	278.6	5.00E+03		5.13E+03	0.00E+00	-1.13E-04			-0.0001132
20%	303.928	5.00E+03	5.00E+03	5.12E+03	7.96E+02	-1.13E-04	0.002		0.00188709

- Scenario 2 $D_{s_{t+1}}$ Parameter Sensitivity Analysis

Change in Percentage	Dst1	Scenario 2							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	253.273	6142.1	6142.1	4795.6248	988.45531	5477083.1	1128914.809		6605998
-10%	227.946	6.19E+03	5.00E+03	4.80E+03	9.70E+02	5.70E+06	8.35E-06		5704700
-20%	202.618	6.24E+03	5.00E+03	4.80E+03	9.65E+02	5.93E+06	8.40E-06		5932500
-30%	177.291	6.28E+03	6.28E+03	4.81E+03	9.42E+02	6.16E+06	1.21E+06		7368600
-40%	151.964	6.33E+03	6.33E+03	4.81E+03	9.28E+02	6.39E+06	1.23E+06		7621700
-50%	126.637	6.37E+03	6.37E+03	4.81E+03	9.11E+02	6.62E+06	1.25E+06		7870800
10%	278.6	6.10E+03	6.10E+03	4.79E+03	1.00E+03	5.25E+06	1.10E+06		6350700
20%	303.928	6.05E+03	6.05E+03	4.79E+03	1.02E+03	5.02E+06	1.07E+06		6092300

- Scenario 3 $D_{s_{t+1}}$ Parameter Sensitivity Analysis

Change in Percentage	Dst1	Scenario 3							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	253.273	8189.5	8189.5	4418.5639	1352.0637	14093009.61	4312407.338		18405417
-10%	227.946	8.25E+03	8.25E+03	4.42E+03	1.33E+03	1.44E+07	4.33E+06		18699600
-20%	202.618	8.31E+03	8.31E+03	4.42E+03	1.31E+03	1.46E+07	4.34E+06		18989800
-30%	177.291	8.38E+03	8.38E+03	4.42E+03	1.29E+03	1.49E+07	4.37E+06		19288000
-40%	151.964	8.44E+03	8.44E+03	4.42E+03	1.28E+03	1.52E+07	4.39E+06		19588400
-50%	126.637	8.50E+03	8.50E+03	4.42E+03	1.25E+03	1.55E+07	4.38E+06		19857900
10%	278.6	8.13E+03	8.13E+03	4.42E+03	1.37E+03	1.38E+07	4.29E+06		18109500
20%	303.928	8.07E+03	8.07E+03	4.42E+03	1.41E+03	1.35E+07	4.32E+06		17863700

- Scenario 4 $D_{s_{t+1}}$ Parameter Sensitivity Analysis

Change in Percentage	Dst1	Scenario 4							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	253.273	5000	6931.5	3855.446753	470.3032475			908390.7225	908391
-10%	227.9457	5,000	6,932	3868.110403	457.6395975			8.84E+05	883940
-20%	202.6184	5,000	6,932	3880.774053	444.9759475			8.59E+05	859480
-30%	177.2911	5,000	6,932	3893.437703	432.3122975			8.35E+05	835020
-40%	151.9638	5,000	6,932	3906.101353	419.6486475			8.11E+05	810560
-50%	126.6365	5,000	6,932	3918.765003	406.9849975			7.86E+05	786100
10%	278.6003	5,000	6,932	3842.783103	482.9668975			9.33E+05	932860
20%	303.9276	5,000	6,932	3830.119453	495.6305475			9.57E+05	957320

- Scenario 5 $D_{s_{t+1}}$ Parameter Sensitivity Analysis

Change in Percentage	Dst1	Scenario 5							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	253.273	5000	6931.5	3973.022564	587.879			1135488.403	1135488
-10%	227.9457	5,000	6,932	3982.520302	572.049			1.10E+06	1104900
-20%	202.6184	5,000	6,932	3992.018039	556.22			1.07E+06	1074300
-30%	177.2911	5,000	6,932	4001.515777	540.39			1.04E+06	1043800
-40%	151.9638	5,000	6,932	4011.013514	524.561			1.01E+06	1013200
-50%	126.6365	5,000	6,932	4020.511252	508.731			9.83E+05	982620
10%	278.6003	5,000	6,932	3963.524827	603.709			1.17E+06	1166100
20%	303.9276	5,000	6,932	3954.027089	619.538			1.20E+06	1196600

- Scenario 6 $D_{s_{t+1}}$ Parameter Sensitivity Analysis

Change in Percentage	Dst1	Scenario 6							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	253.273	5000	6931.5	4168.98	783.839			1513984.538	1513985
-10%	227.9457	5,000	6,932	4173.2	762.733			1.47E+06	1473200
-20%	202.6184	5,000	6,932	4177.42	741.627			1.43E+06	1432500
-30%	177.2911	5,000	6,932	4181.65	720.52			1.39E+06	1391700
-40%	151.9638	5,000	6,932	4185.87	699.414			1.35E+06	1350900
-50%	126.6365	5,000	6,932	4190.09	678.308			1.31E+06	1310200
10%	278.6003	5,000	6,932	4164.76	804.945			1.55E+06	1554800
20%	303.9276	5,000	6,932	4160.54	826.051			1.60E+06	1595500

Appendix 15 Sensitivity Analysis for d_s^{max} Parameter

- Consignment Condition d_s^{max}
  - Scenario 1 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 1							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	4325.75	5000	5000.0001	5146.41	779.343	-0.00011358	0.109485971		0.109485971
-10%	3893.18	5.09E+03		4758.64	0	4.33E+05			432860
-20%	3460.6	5.27E+03		4356.34	0	1.17E+06			1168500
-30%	3028.03	5.45E+03		3953.79	0	1.76E+06			1761400
-40%	2595.45	5.62E+03		3551.27	0	2.21E+06			2211600
-50%	2162.88	5.80E+03		3148.88	0	2.52E+06			2519200
10%	4758.33	5.00E+03	5.00E+03	5516.42	848.389	-1.23E-04	0.0019		0.00177715
20%	5190.9	5.00E+03	5.00E+03	5889.05	884.597	-1.32E-04	0.0017		0.00156785
30%	5623.48	5.00E+03	5.00E+03	6261.61	973.266	-1.41E-04	0.0016		0.00145855
40%	6056.05	5.00E+03	5.00E+03	6635.54	1000.74	-1.51E-04	0.0014		0.00124924
50%	6488.63	5.00E+03	5.00E+03	7005.21	1100.45	-1.60E-04	0.0013		0.00113993

  - Scenario 2 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 2							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	4325.75	6142.1	6142.1	4795.62	988.455	5477083.1	1128914.809		6605998
-10%	3893.18	6.36E+03	6.36E+03	4379.98	915.809	5.97E+06	1.25E+06		7218500
-20%	3460.6	6.59E+03	6.59E+03	3964.39	844.327	6.28E+06	1.34E+06		7623200
-30%	3028.03	6.81E+03	5.00E+03	3548.73	1132.14	6.41E+06	-1.33E-05		6412100
-40%	2595.45	7.03E+03	5.00E+03	3133.13	1103.46	6.36E+06	-1.26E-05		6355400
-50%	2162.88	7.25E+03	5.00E+03	2717.51	1074.87	6.11E+06	-1.19E-05		6114500
10%	4758.33	5.92E+03	5.92E+03	5211.2	1060.91	4.80E+06	9.77E+05		5773710
20%	5190.9	5.70E+03	5.70E+03	5626.84	1133.81	3.93E+06	7.92E+05		4725380
30%	5623.48	5.48E+03	5.48E+03	6042.48	1206.72	2.88E+06	5.76E+05		3460550
40%	6056.05	5.26E+03	5.26E+03	6458.11	1279.62	1.65E+06	3.27E+05		1979210
50%	6488.63	5.03E+03	6.98E+03	6873.84	961.464	2.35E+05	1.90E+06		2137810

○ Scenario 3 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 3							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	4325.75	8189.5	8189.5	4418.56	1352.06	14093009.61	4312407.338		18405416.95
-10%	3893.18	8.48E+03	8.48E+03	3989.45	1255.14	1.39E+07	4.37E+06		18277100
-20%	3460.6	8.78E+03	8.78E+03	3560.22	1160.91	1.35E+07	4.39E+06		17847700
-30%	3028.03	9.08E+03	1.09E+04	3130.9	582.132	1.28E+07	3.43E+06		16191400
-40%	2595.45	9.37E+03	1.08E+04	2701.73	577.793	1.18E+07	3.37E+06		15184600
-50%	2162.88	9.67E+03	1.08E+04	2272.48	576.295	1.06E+07	3.34E+06		13940700
10%	4758.33	7.89E+03	1.11E+04	4847.88	590.961	1.40E+07	3.61E+06		17636100
20%	5190.9	7.60E+03	1.12E+04	5277.06	595.296	1.37E+07	3.66E+06		17376700
30%	5623.48	7.30E+03	1.12E+04	5706.07	596.804	1.31E+07	3.70E+06		16846200
40%	6056.05	7.01E+03	1.13E+04	6135.33	601.13	1.23E+07	3.76E+06		16080500
50%	6488.63	6.71E+03	1.13E+04	6564.96	602.627	1.12E+07	3.80E+06		15044400

○ Scenario 4 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 4							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	4325.75	5000	6931.5	3855.446753	470.3032475			908390.7225	908391
-10%	3893.175	5,000	6,932	3483.142427	410.0325728			7.92E+05	791980
-20%	3460.6	5,000	6,932	3110.838102	349.761898			6.76E+05	675570
-30%	3028.025	5,000	7,027	2738.533777	289.4912233			5.56E+05	555840
-40%	2595.45	5,000	5,000	2366.229452	229.2205485			-1.16E-04	-0.0001
-50%	2162.875	5,000	5,000	1993.925126	168.9498738			-5.99E-05	-6E-05
10%	4758.325	5,000	6,932	4227.751078	530.5739223			1.02E+06	1024800
20%	5190.9	5,000	6,932	4600.055403	590.844597			1.14E+06	1141200
30%	5623.475	5,000	6,932	4972.359728	651.1152718			1.26E+06	1257600
40%	6056.05	5,000	6,932	5344.664054	711.3859465			1.37E+06	1374100
50%	6488.625	5,000	6,932	5716.968379	771.6566213			1.49E+06	1490500

- Scenario 5 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 5							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	4325.75	5000	6931.5	3973.022564	587.879			1135488.403	1135488
-10%	3893.175	5,000	6,932	3585.65057	512.541			9.90E+05	989980
-20%	3460.6	5,000	6,932	3198.278577	437.202			8.44E+05	844460
-30%	3028.025	5,000	7,455	2810.906583	361.864			6.31E+05	631290
-40%	2595.45	5,000	7,220	2423.534589	286.526			5.08E+05	508040
-50%	2162.875	5,000	6,984	2036.162595	211.187			3.98E+05	398100
10%	4758.325	5,000	6,932	4360.394558	663.217			1.28E+06	1281000
20%	5190.9	5,000	6,932	4747.766552	738.556			1.43E+06	1426500
30%	5623.475	5,000	6,932	5135.138546	813.894			1.57E+06	1572100
40%	6056.05	5,000	6,932	5522.51054	889.232			1.72E+06	1717600
50%	6488.625	5,000	6,932	5909.882534	964.571			1.86E+06	1863100

- Scenario 6 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 6							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	4325.75	5000	6931.5	4168.98	783.839			1513984.538	1513985
-10%	3893.175	5,000	6,932	3756.5	683.388			1.32E+06	1320000
-20%	3460.6	5,000	6,932	3344.01	582.936			1.13E+06	1125900
-30%	3028.025	5,000	8,169	2931.53	482.485			4.83E+05	482930
-40%	2595.45	5,000	7,856	2519.04	382.034			3.87E+05	387290
-50%	2162.875	5,000	7,542	2106.56	281.583			3.02E+05	302160
10%	4758.325	5,000	6,932	4581.47	884.29			1.71E+06	1708000
20%	5190.9	5,000	6,932	4993.95	984.741			1.90E+06	1902000
30%	5623.475	5,000	6,932	5406.44	1085.19			2.10E+06	2096100
40%	6056.05	5,000	6,932	5818.92	1185.64			2.29E+06	2290100
50%	6488.625	5,000	6,932	6231.41	1286.09			2.48E+06	2484100

- Non-consignment Condition
  - Scenario 1,2,3 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 1, 2, and 3							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	796	5000	5000.0001	5146.41	779.343	-7.68E-05	-3.37E-06		-8.01E-05
10%	876	5.00E+03	5.00E+03	3730.45	343.9	-7.82E-05	-3.65E-06	0	-8.18E-05
20%	955	5.00E+03	5.00E+03	3787.59	365.969	-7.96E-05	-3.92E-06	0	-8.35E-05
30%	1035	5.00E+03	5.00E+03	3845.25	388.279	-8.11E-05	-4.20E-06	0	-8.53E-05
40%	1114	5.00E+03	5.00E+03	3903.59	410.255	-8.25E-05	-4.47E-06	0	-8.70E-05
50%	1194	5.00E+03	5.00E+03	3960.44	432.61	-8.39E-05	-4.75E-06	0	-8.87E-05
-10%	716	5.00E+03	5.00E+03	3615.38	299.418	-7.53E-05	-3.09E-06	0	-7.84E-05
-20%	637	5.00E+03	5.00E+03	3558.89	277.459	-7.39E-05	-2.82E-06	0	-7.67E-05
-30%	557	5.00E+03	5.00E+03	3501.34	255.189	-7.24E-05	-2.54E-06	0	-7.50E-05
-40%	478	5.00E+03	5.00E+03	3444.17	233.092	-7.10E-05	-2.27E-06	0	-7.33E-05
-50%	398	5.00E+03	5.00E+03	3385.74	210.728	-6.96E-05	-1.99E-06	0	-7.16E-05

  - Scenario 4,5,6 d_s^{max} Parameter Sensitivity Analysis

Change in Percentage	Ds Max	Scenario 4, 5, and 6							
		Po	Ps	Do	Ds	Eo	Es	Eos	Etot
0%	796	5,000	5,000	474.187	321.813			1.92E-05	0.000019214
10%	876	5,000	5,000	531.605	343.995			1.70E-05	0.00001698
20%	955	5,000	5,000	589.024	366.176			1.54E-05	0.000015352
30%	1035	5,000	5,000	646.443	388.357			1.42E-05	0.000014205
40%	1114	5,000	5,000	703.861	410.539			1.35E-05	0.000013522
50%	1194	5,000	5,000	761.28	432.72			1.32E-05	0.000013228
-10%	716	5,000	5,000	416.768	299.632			2.20E-05	0.000022045
-20%	637	5,000	5,000	359.349	277.451			2.74E-05	0.000027421
-30%	557	5,000	5,000	301.931	255.269			2.74E-05	0.000027445
-40%	478	5,000	5,000	244.512	233.088			2.73E-05	2.72876E-05
-50%	398	5,000	5,000	187.093	210.907			8.90E-04	0.00089029

Appendix 16 Sensitivity Analysis for ρ and α Parameter Simultaneously

		rho										
alpha		0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,72134	0,8	0,9	1
	0%	-58004000	-49071000	9477400	10617000	6942300	4167300	2246700	18405417	7803100	16646500	25819700
	-10%	-43650000	-36169000	-28646000	9179500	6317300	3898800	4557200	15563200	9518937	19449800	25205000
	-20%	-33371000	-26927000	-20447000	5623400	5692300	3630300	9318300	13056800	14934900	21563600	25934000
	-30%	-25640000	-19973000	-12930600	5085700	3824500	6197200	30698600	10697600	17527500	23246700	26502000
	-40%	-19606000	-9550900	-4170800	4664500	4468190	9462900	14489300	6309600	19550200	24641900	26965000
	-50%	-0,000132	-0,000130	-0,000127	-0,000124	3269600	11743700	17306500	18405417	22167100	25863700	27353000
	10%	-0,000134	-0,000131	-0,000128	2865336	9026658	14550527	19436544	19119600	22707994	26886300	27687000
	20%	-0,000135	-0,000132	453375	6812705	12019221	16925236	22327183	22099500	23989973	27825500	27980000
	30%	-0,000136	-0,000134	4199795	9662453	14585523	18968815	22812740	17899000	25135030	28680400	28242000
	40%	-420178129	2004482	7442968	12380435	16817108	20752505	22896715	23591600	26172298	25001000	28480000
	50%	-0,000140	5333518	10283511	14765850	18780831	22327942	24061920	23809100	27123388	25436000	28698000

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BIOGRAPHY

The author, Reiza Pradipta, was born on November 8th 1996, in Semarang, Indonesia. The author had completed his formal studies at SDN Sawah Lama 01 Bandar Lampung (2002-2003) and SDN Setia Asih 03 Bekasi (2003-2008) for the elementary school, SMPN 193 Jakarta (2008-2009) and SMPN 1 Nganjuk (2009-2011) for the junior high school, and SMAN 1 Sumber, Cirebon (2011-2014) for the senior high school. In 2014, the author obtains an opportunity to continue his study in Industrial Engineering Department of Sepuluh Nopember Institute of Technology.

During the study, the author involved at several organization and event such as a staff of ITS Expo 2015 as the Staff of Dance Competition Event in the first year. Next, the author involved in Staff of Internal Affairs Department of *Himpunan Mahasiswa Teknik Industri* ITS, Staff of Internal Affairs of Student Executive Board of ITS (BEM ITS), and Steering Committee of SISTEM 2015 in the second year. After that, the author take part as the General Director of Student Executive Board of ITS (BEM ITS) in the third year. Beside university activities, the author also got an opportunity to participated in the internship program of PT. Petronas Carigali LTD in Supply Chain Management Department. For further discussion and suggestion regarding to this research, the author can be reached through email at reizmakruf@gmail.com.