TUGAS AKHIR – TI 141501

STRATEGI PENETAPAN HARGA *OFFLINE, ONLINE,* DAN *RESELLER* BERDASARKAN STRUKTUR *DUAL-CHANNEL SUPPLY CHAIN*

RIZKY ASTARI RAHMANIA
NRP. 2511 100 060

Pembimbing
Dr. Eng. Erwin Widodo

JURUSAN TEKNIK INDUSTRI
Fakultas Teknologi Industri
Institut Teknologi Sepuluh Nopember
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RIZKY ASTARI RAHMANIA
NRP. 2511 100 060

Supervisor
Dr. Eng. Erwin Widodo

DEPARTMENT OF INDUSTRIAL ENGINEERING
Faculty of Industrial Technology
Institut Teknologi Sepuluh Nopember
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Author:

Rizky Astari Rahmania

NRP. 2511 100 060

Approved by Final Project Supervisor:

Dr. Eng. Erwin Widodo..(Supervisor)

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Nama : Rizky Astari Rahmania

NRP : 2511100060

Pembimbing : Dr. Eng. Erwin Widodo

ABSTRAK

Pertumbuhan *e-commerce* yang menjanjikan menjadi pertimbangan bagi perusahaan untuk melakukan ekspansi terhadap bisnisnya. Pada pemenuhan permintaan, perusahaan tidak hanya melakukannya melalui transaksi langsung *(offline channel)*, namun juga melalui *website (online channel),* yang kemudian disebut seagai konsep *Dual-channel Supply Chain* (DCSC). Implementasi DCSC dapat mengarah ke dua kemungkinan, yaitu kenaikan profit yang karena segmen pasar yang terakomodasi lebih luas, dan penurunan profit karena konflik antar *channel.* Solusi dari permasalahan tersebut adalah kooperasi antar *channel*. Konsep DCSC juga mempertimbangkan preferensi *customer* terhadap *channel* yang ditunjukkan dengan adanya perbedaan harga antar *channel*. Penelitian ini merancang stratregi penetapan harga sesuai dengan konsep DCSC melalui perancangan skenario harga. Terdapat tiga skenario harga yang masing-masing dikembangkan berdasarkan karakteristik yang merepresentasikan struktur DCSC. Model matematis dikembangkan berdasarkan skenario yang telah dirancang, kemudian dilakukan proses optimasi dengan menggunakan MATLAB. Tujuan penelitian ini adalah untuk melihat skenario penetapan harga mana yang menghasilkan performansi finansial terbaik yang ditunjukkan dengan total profit. Hasil dari percobaan numerik menunjukkan bahwa kooperasi antar *channel offline* dan *online* menghasilkan performansi finansial terbaik bagi perusahaan.

Kata kunci: ***dual-channel supply chain, kooperasi antar channel, strategi penetapan harga, quadratic programming.***

OFFLINE, ONLINE, AND RESELLER PRICING STRATEGIES UNDER DUAL-CHANNEL SUPPLY CHAIN STRUCTURE

Name	**: Rizky Astari Rahmania**
NRP	**: 2511100060**
Supervisor	**: Dr. Eng. Erwin Widodo**

ABSTRACT

The promising growth of e-commerce become the consideration of companies to expand their business channels. In the demand fulfillment, the company is not only doing it through face-to-face transaction (offline channel), but also through their website (online channel), which is called Dual-channel Supply Chain (DCSC). Implementing DCSC can lead to two different possible outcome, which are increased profit caused by bigger market segments covered and decreased profit caused by channel conflict. The answer of this problem is channel cooperation that may bring each channel an addition to their profits. DCSC also considers customer's channel preference, shown in price difference between channels. This research proposed pricing strategies based on DCSC concept through several pricing scenarios. Three pricing scenarios are developed, each with its own characteristic representing the DCSC structure. Mathematical model are developed based on the scenarios proposed, then optimization process is done using MATLAB. The aim of this research is to see which pricing scenario generates the best financial performance shown in total gain. The result of numerical experiments shows that cooperating the offline and online channel generates the best financial performance.

Keyword: ***dual-channel supply chain, channel cooperation, pricing strategy, quadratic programming.***

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Surabaya, May 2015

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

This chapter consists of the background of the research, problem formulation, objectives and benefits of the research, scope of the research, and research outline.

1.1 Research Background

Internet today has become a necessity for most people in Indonesia. Based on a research done by Indonesia Internet Service Provider Association (APJII) in 2012, the number of internet users in Indonesia in 2013 has reached 71,19 millions or 15,8% of the total of Indonesian population, increased by 13% from 2012. APJII also predicted that this number will continuously increase for the following years to accomplish Millenium Development Goals by International Telecom Union (ITU) that targeted number of internet users in Indonesia to increase by 50% in 2015 (Indonesia Internet Service Provider Association, 2014). The projection of internet users in Indonesia by APJII is shown below in Figure 1.1.

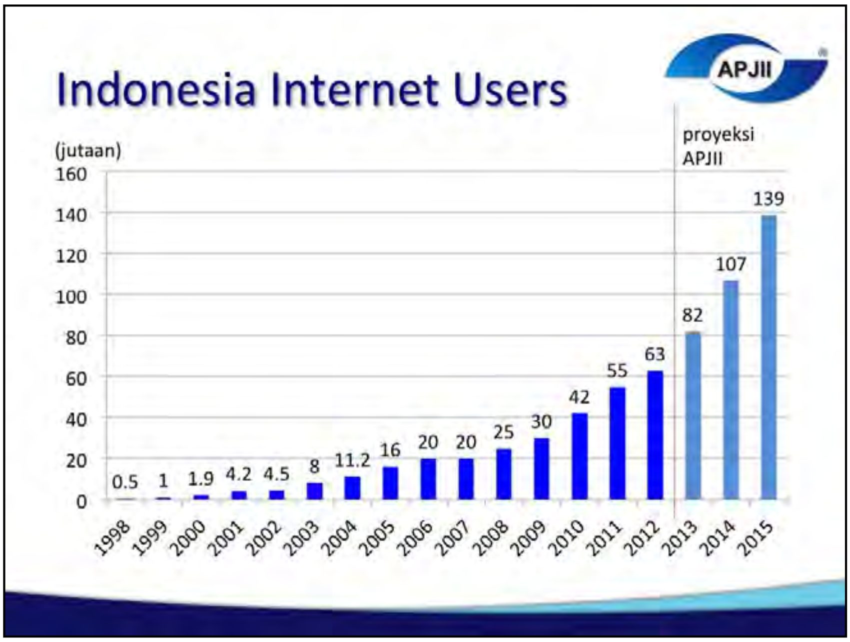


Figure 1.1 Growth of Indonesia Internet Users (Indonesia Internet Service Provider Association, 2012)

The use of internet in daily activities occurs in many aspects, one of them is needs fulfillment (buying and selling transaction). The rapid growth of internet usage in Indonesia is one of the underlying factor of the growth of online shopping (e-commerce) trends. Until now, 22.8% of the total of internet users in Indonesia have done e-commerce transaction (Indonesia Internet Service Provider Association, 2012). Based on a research done by eMarketer, Indonesia has the fastest growth of e-commerce compared to other countries in 2013, increased by 71.3% ($1,8 billions) from 2012. This number is also predicted to be increased for the following years as shown as Figure 1.2 below.

B2C Ecommerce Sales Worldwide, by Region and Country, 2011-2016
billions

	2011	2012	2013	2014	2015	2016
North America	**$327.77**	**$373.03**	**$419.53**	**$469.49**	**$523.09**	**$580.24**
—US*	$308.64	$351.80	$395.28	$441.95	$492.07	$545.81
—Canada	$18.58	$21.23	$24.25	$27.55	$31.02	$34.43
Asia-Pacific	**$237.86**	**$315.91**	**$388.75**	**$501.68**	**$606.54**	**$707.60**
—China**	$56.69	$110.04	$181.62	$274.57	$358.59	$439.72
—Japan	$112.90	$127.82	$118.59	$127.06	$135.54	$143.13
—Australia	$22.86	$25.26	$26.77	$28.31	$29.76	$31.24
—South Korea	$16.34	$17.32	$18.52	$20.24	$21.92	$23.71
—India***	$8.68	$12.12	$16.32	$20.74	$25.65	$30.31
—Indonesia	$0.56	$1.04	$1.79	$2.60	$3.56	$4.49
—Other	$19.84	$22.30	$25.14	$28.16	$31.53	$34.99
Western Europe	**$218.27**	**$255.59**	**$291.47**	**$326.13**	**$358.31**	**$387.94**
—UK	$76.75	$87.25	$99.19	$111.30	$122.68	$132.79
—Germany	$38.08	$47.00	$53.00	$58.00	$62.00	$66.00
—France	$29.68	$33.33	$36.99	$40.35	$43.57	$46.88
—Spain	$15.64	$18.57	$21.57	$24.54	$27.46	$30.21
—Italy	$12.88	$16.16	$19.80	$23.81	$27.80	$31.25
—Netherlands	$7.01	$7.99	$8.98	$9.89	$10.78	$11.50
—Sweden	$5.32	$6.30	$7.32	$8.29	$9.14	$9.96
—Norway	$4.97	$5.82	$6.71	$7.60	$8.40	$9.02
—Denmark	$5.16	$5.90	$6.63	$7.33	$7.98	$8.50
—Finland	$3.29	$3.82	$4.38	$4.87	$5.31	$5.69
—Other	$19.50	$23.45	$26.89	$30.14	$33.19	$36.15
Central & Eastern Europe	**$30.89**	**$40.17**	**$48.56**	**$57.96**	**$64.35**	**$68.88**
—Russia	$11.14	$14.48	$17.54	$20.92	$23.17	$24.78
—Other	$19.75	$25.69	$31.02	$37.04	$41.18	$44.10
Latin America	**$28.33**	**$37.66**	**$45.98**	**$55.95**	**$63.03**	**$69.60**
—Brazil	$13.92	$16.95	$19.74	$23.51	$25.52	$27.28
—Mexico	$4.18	$6.16	$7.98	$9.68	$11.40	$12.92
—Argentina	$2.57	$3.36	$3.86	$4.79	$5.65	$6.33
—Other	$7.66	$11.19	$14.40	$17.77	$20.46	$23.07
Middle East & Africa	**$14.41**	**$20.61**	**$27.00**	**$33.75**	**$39.56**	**$45.49**
Worldwide	**$856.97**	**$1,042.98**	**$1,221.29**	**$1,444.97**	**$1,654.88**	**$1,859.75**

*Note: includes travel, digital downloads and event tickets purchased via any digital channel (including online, mobile and tablet); excludes gambling; numbers may not add up to total due to rounding; *excludes event tickets; **includes sales from businesses that occur over C2C platforms; excludes Hong Kong; ***digital travel sales represent roughly 80% of B2C ecommerce sales*
Source: eMarketer, June 2013
158176 www.eMarketer.com

Figure 1.2 Worlwide E-Commerce Growth for 2011-2016 (eMarketer, 2013)

The promising growth of e-commerce become the consideration of companies to expand their business channels. In the demand fulfillment, the company is not only doing it through face-to-face transaction (offline channel), but also through their website (online channel). Other than the promising growth of e-commerce, the company's wish to increase their competitiveness become the underlying reason to expand their business to a wider scope (Asnawi, 2013). In order to do that, some companies use reseller channel to help them sell their product to meet customer demand. Examples of Indonesian companies that have offline, online, and reseller channel in their business are Rabbani, Elzatta, Dannis, etc.

Demand fulfillment system through several channels, is called Dual-channel Supply Chain (DCSC) (Moriarty & Moran, 1990). Since customers differ in the channel preferences (Kacen, et al., 2002), multiple channel may cover potential market segments that could not be covered by single channel and may thus help increasing market coverage (Chiang & Monahan, 2005). Channels in this supply chain are complementary to meet customer demand (Widodo, et al., 2011). Bin et al. (2008) stated that collaboration between channels may bring each channel an addition to their profits. But in practice, channels in a business are independently managed and compete with each other in meeting customer demand, therefore this will lead to what is called channel conflicts (Tsay & Agrawal, 2004). In dual-channel supply chain concepts, the price of a product should differ in each channel based on customers's preference of the channel that is affected by extra value received by customers when shopping offline (Chen, et al., 2011). There are several things that become customers's consideration in doing online shopping based on the survey done by APJII in 2012 as shown as Figure 1.3 below.

Figure 1.3 Reasons for Not Making Online Shopping
(Indonesia Internet Service Provider Association, 2012)

Figure 1.3 above shows some considerations made by customers to not do online shopping. Those are some of the reasons that affect customers's channel preference.

Attaqi is a moslemwears manufacturers located in Surabaya that has offline, online, and reseller channel in their business process. They own 1 store located in Surabaya, 1 website as online channel, and work with 21 resellers. Like most companies that implement dual-channel supply chain system, each channel in Attaqi is independently managed. They do not do data sharing between each channel in making decisions, including in price determination. They currently apply the same price for products in offline, online, and reseller channel. The price is set in each channel without considering customers's preference of each channel.

Both of the situation stated above are not in accordance with DCSC concept, and can be defined as problems that should be solved by Attaqi in order to gain more profit and achieve their goal, based on the business opportunity available for them today. Therefore, it is necessary to evaluate the existing pricing scenario of Attaqi and also to develop alternative views as consideration for Attaqi in decision making. This research is conducted with a focus on evaluating, developing, and experimenting alternative pricing scenarios based on dual-channel supply chain theories. The output of this research will be a recommendation for Attaqi on the best pricing scenario based on its financial performance.

1.2 Problem Formulation

Based on the research background, the idea of this research is to develop dual-channel pricing model and determine best pricing scenario for offline, online, and reseller that generates optimum profit for Attaqi.

1.3 Research Objectives

The objectives of this research are:

1. Evaluate the existing pricing scenario of Attaqi.
2. Develop alternative pricing scenario for offline, online, and reseller channel for Attaqi based on dual channel supply chain concept.

3. Propose a recommendation of the best pricing scenario for Attaqi based on corresponding financial performance of each scenario.

1.4 Research Benefits

The benefit of this research is giving an alternative view of pricing strategy in order to generate optimum profit for Attaqi by considering customers's preference of offline, online, and reseller channel.

1.5 Research Scope

Research scope states the limitations and the assumptions used in this research.

1.5.1 Limitations

The limitations used in this research are:

1. The company observed is Attaqi.
2. Pricing scenario and model is developed for one variant of product.
3. The type of reseller used in this research is primary agent.
4. Online price used in this research is based on the price listed on Attaqi's official website.
5. Further limitations used in this research will be discussed in Chapter 4.

1.5.2 Assumptions

The assumptions used in this research are:

1. Product is always available in each channel.
2. The demand of the products is deterministic.
3. There is no significant change in demand trend for each channel.
4. Resellers's online and offline channel is negligible.
5. Other variables that affect customers's preference (lead time, competitors) are negligible.
6. Further assumptions used in this research will be discussed in Chapter 4.

1.6 Research Outline

Below is the systematical writing order of this research:

CHAPTER 1 Introduction

This chapter contains the background of the research, problem formulation, objectives and benefits of the research, scope of the research, and research outline.

CHAPTER 2 Literature Review

This chapter contains the theories used in this research as the fundamental of idea development based on journals, books sections, articles, and previous research.

CHAPTER 3 Research Methodology

This chapter shows the reader about the research framework and steps of doing the research.

CHAPTER 4 Model Development

This chapter explains the system description, model development of each pricing scenarios, further limitations and assumptions used in the system, parameters, objective function and constraint formulation, and also data collection for the model development.

CHAPTER 5 Numerical Experiment and Analysis

This chapter explains the numerical experiment of each pricing scenario and shows the best pricing scenario that generates optimum profit.

CHAPTER 6 Conlusions and Suggestions

This chapter contains the conclusions based on the research and provides the recommendations for further research.

CHAPTER 2
LITERATURE REVIEW

This chapter contains the theories used in this research as the fundamental of idea development based on journals, books sections, articles, and previous research.

2.1 Dual-channel Supply Chain

Chopra & Meindl (2001) defined supply chain as a network of firms, whether it is directly or indirectly, in meeting customer demand. It includes the manufacturers, suppliers, transporters, warehouses, retailers, and customers. Supply chain occurs in every business, regardless the size of the business.

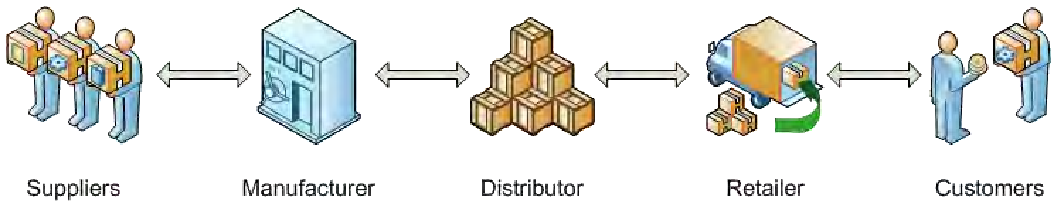


Figure 2.1 Supply Chain Model

Figure 2.1 shows the supply chain model. In supply chain, there are three flows that are carried in the arrow, they are financial flow, material or physical flow, and information flow (Sabrina, 2014).

As stated in the previous chapter, the growth of internet technology and e-commerce initiates the emergence of the new supply chain concept. A lot of businesses nowadays expand their business channel by adding online channel or direct channel where they sell their products directly to the customers. A supply chain system like that is called Dual-channel Supply Chain (DCSC). The idea of this supply channel, as stated by Widodo et al. (2011), is to integrate a previously established traditional channel (offline) with a direct internet-based channel (online) demand fulfillment facility. Both these channels works complementary in meeting customer demand. The model of DCSC is shown below:

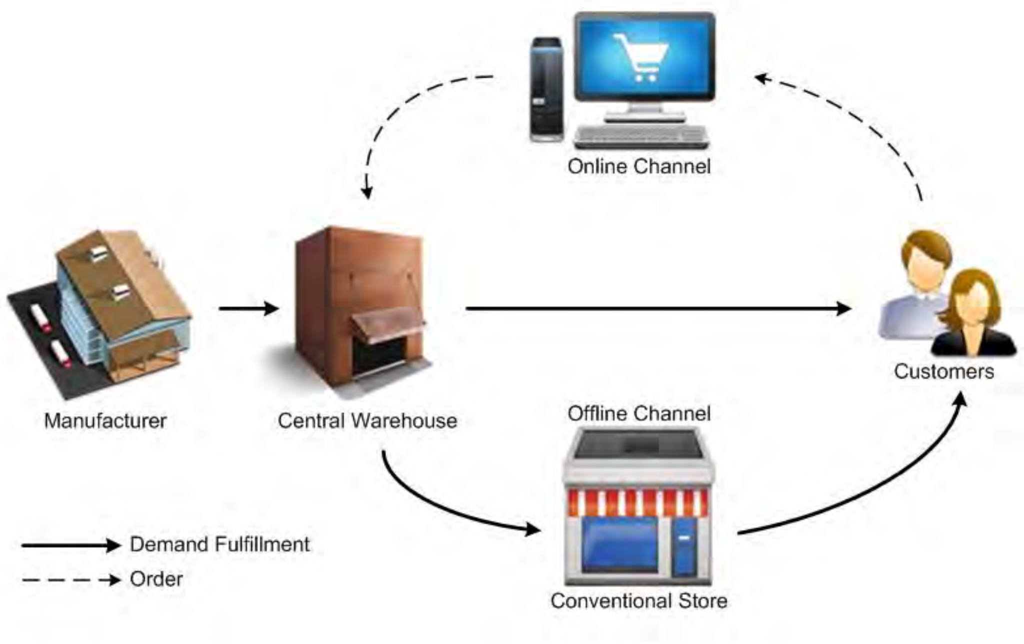


Figure 2.2 Dual-channel Supply Chain Model

Figure 2.2 shows DCSC model that explains how DCSC works. Customers can purchase the product in traditional way through conventional store that is called the offline channel. Customer can also order the product via the website and the product will be sent directly to the customers from the warehouse without intermediaries, which is why the online channel can also be called direct channel.

The emergence of the new channel (online), may lead to a competition between the online channel and the retailers in terms of gaining profit, potentially leading to tension referred as channel conflict (Tsay & Agrawal, 2004), so that eliminating intermediaries (retailer, wholesaler, etc) which can increase the supply chain efficiency, may seem to be a promising strategy to the manufacturer. However, using just one channel can cause profit loss, less market coverage, decreasing of product or brand awareness, and degradation of service level (Ghosh, 1998). Retaining both channel, as stated by Chiang & Monahan (2005), is the best alternative which may bring better market penetration and profit. That makes the channel conflict a serious problem and critical to be solved. This statement is supported by Bin et al. (2008), who in their research showed that collaboration between channels may bring each channel an addition to their profits.

Widodo et al. (2011) stated that, in DCSC concept, in order to achieve an optimum financial performance, there are some variables to be considered, such as central warehouse price, online price, and offline price. These variable are included in the demand functions conducted by Huang et al. (2012) as shown below.

- Offline Demand Function

$$D_s = (1-\rho)d_s^{max} - \alpha_1 P_s + \beta_1 P_o \tag{2.1}$$

- Online Demand Function

$$D_o = \rho d_s^{max} - \alpha_2 P_o + \beta_2 P_s \tag{2.2}$$

- Total Demand Function

$$D_T = d_s^{max} - (\alpha_1 - \beta)P_s - (\alpha_2 - \beta)P_o \tag{2.3}$$

Where:

D_s	= offline demand
D_o	= online demand
d_s^{max}	= forecasted potential demand if the products are free
P_s	= offline price
P_o	= online price
ρ	= customer acceptance ratio of online product compared to the offline product
α	= coefficient of self-price elasticity of D_s and D_o
β	= coefficient of cross-price sensitivity of D_s and D_o

2.2 Pricing Strategy

Pricing strategy is activities intended to find the optimum price of a product with some considerations such as business objectives, demand, competitor's pricing strategy, and economic trend (Pindyck & Rubinfeld, 2001). The price, basically, has to be high enough to gain profit, yet low enough to keep the customers on buying (Gregson, 2009). The objective of a pricing strategy is profitability, however, achieving high profitability requires more than just setting a price level. It includes ensuring that the products are worth the value that is received by the customers. There are three types of pricing strategy, which are value-based, proactive, and profit-driven (Nagle, et al., 2011). In this research, the pricing strategy used is value-based pricing strategy. According to Nagle et al. (2011), value-based pricing strategy means that the price changes in the value to the customers. Below is the model of value-based pricing strategy.

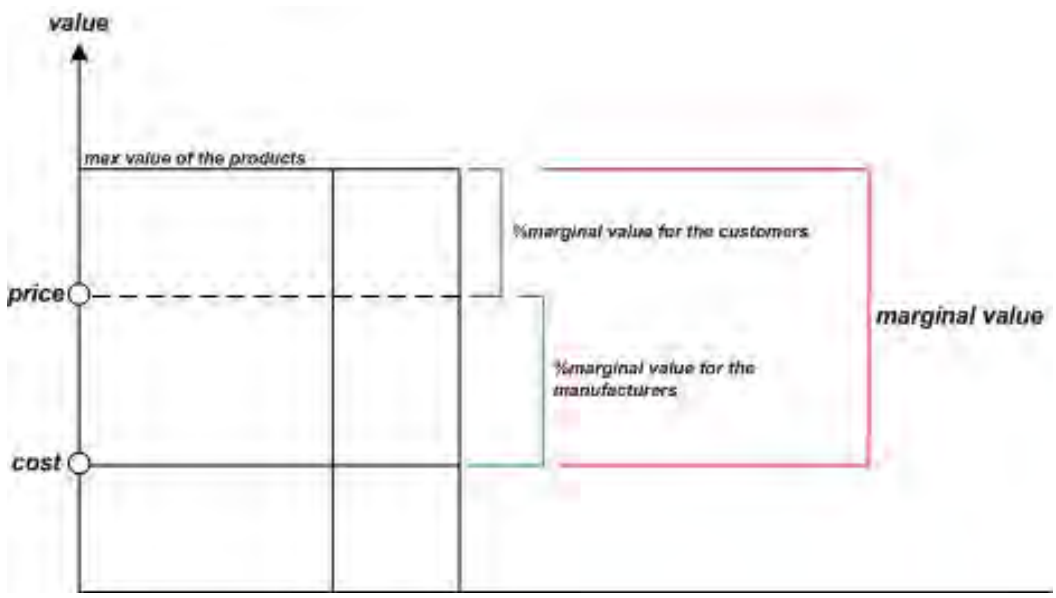


Figure 2.3 Model of Value-based Pricing Strategy

Figure 2.3 shows the model of value-based pricing strategy. Marginal value can be defined as the value of a product that changes in how both customers and the manufacturers value the product. The manufacturers set the product price by dividing the percentage of the marginal value for the customers and themselves. The portion of the marginal value that is received by the manufacturers is their profit. And the other portion is given to customers to increase customers's willingness to buy the product, because according to the theory of customer behaviour, people tend to buy something that valued more than its price (Pindyck & Rubinfeld, 2001).

In DCSC concepts, the price of a product should differ in each channel based on customers's preference of the channel that is affected by extra value received by customers when shopping offline (Chen, et al., 2011). According to the statement, the model of value-based pricing strategy is modified as shown below.

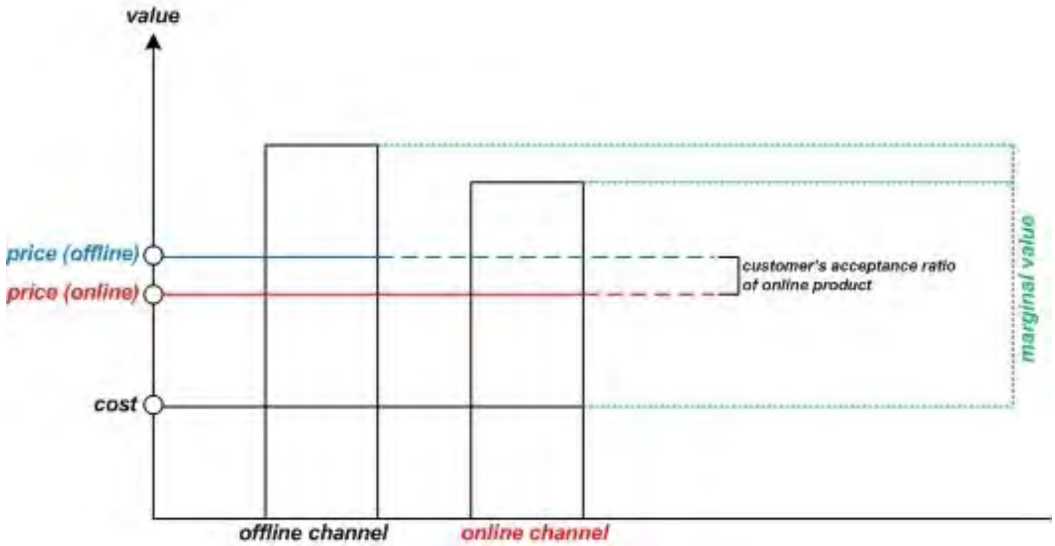


Figure 2.4 Modified Model of Value-based Pricing Strategy Based on DCSC Concept

Figure 2.4 shows the difference of price between offline and online channel. The different price is caused by customer's acceptance of online product compared to the offline product.

2.3 Quadratic Programming

The main objective of most businesses is to earn maximum profit with minimum cost (Cloud, 2012). The profit is the goal, whereas the cost is the constraint. To find the optimum solution for constrained problem like that, optimization is used as a tool. One of the method to solve optimization problem is Non Linear Programming (NLP). NLP is similar to linear programming as it is formed of an objective function, constraints, and variable bounds. The difference is that a NLP has at least one nonlinear function whether it is the objective function or the constraints (Chinneck, 2012). When the objective function is quadratic and the constraints are linear, the problem is called Quadratic Programming (Hoppe, 2006). The general form of Quadratic Programming according to MathWorks is:

Objective function:

$$minimize\ x \left\{\frac{1}{2}x^T Hx + f^T x\right\}$$

Subject to:

$Ax \leq b$	(inequality constraint)
$A_{eq}x = b_{eq}$	(equality constraint)
$lb \leq x \leq ub$	(bound constraint)

(2.4)

In this research, MATLAB software will be used to solve the optimization problem in Quadratic Programming approach. According to MathWorks, the syntax used in MATLAB in solving quadratic programming is *fmincon* or Find Minimum of Constrained Nonlinear Multivariable Function as shown below:

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, options)
x = fmincon (problem)
[x, fval] = fmincon (...)
[x, fval, exitflag] = fmincon (...)
[x, fval, exitflag, output] = fmincon (...)
[x, fval, exitflag, output, lambda] = fmincon (...)
[x, fval, exitflag, output, lambda, grad] = fmincon (...)
[x, fval, exitflag, output, lambda, hessian] = fmincon (...)

Where:

fun	:	function to be minimized
A, b, Aeq, beq	:	linear constraint matrices A (inequality) and Aeq (equality), and their corresponding vectors b (inequality) and beq (equality)
nonlcon	:	function that computes the nonlinear inequality constraint c(x)≤0 and the nonlinear equality constraint ceq(x)≤0
problem	:	objective function

x0	:	initial point of x
lb	:	vector of lower bound
ub	:	vector of upper bound
exitflag	:	exit or stopping condition of fmincon

Table 2.1 exitflag Value Description

exitflag Value	Description
1	First-order optimality measure is less than options.
0	Number of iterations exceeds options.
-1	Stopped by an output function or plot function.
-2	No feasible point is found.
2	Change in x is less than options.
3	Change in the objective function value is less than options.
4	Magnitude of the search direction is less than 2*options.
5	Magnitude of directional derivative in search direction is less than 2* options
-3	Objective function at current iteration goes below options.

grad	:	gradient at x
hessian	:	hessian value at x
lambda	:	structure containing lagrange multiplier at the solution x
output	:	structure containing information of the optimization

CHAPTER 3
RESEARCH METHODOLOGY

This chapter consists of the research flowchart and systematical steps of the research. The flowchart of this research is shown below.

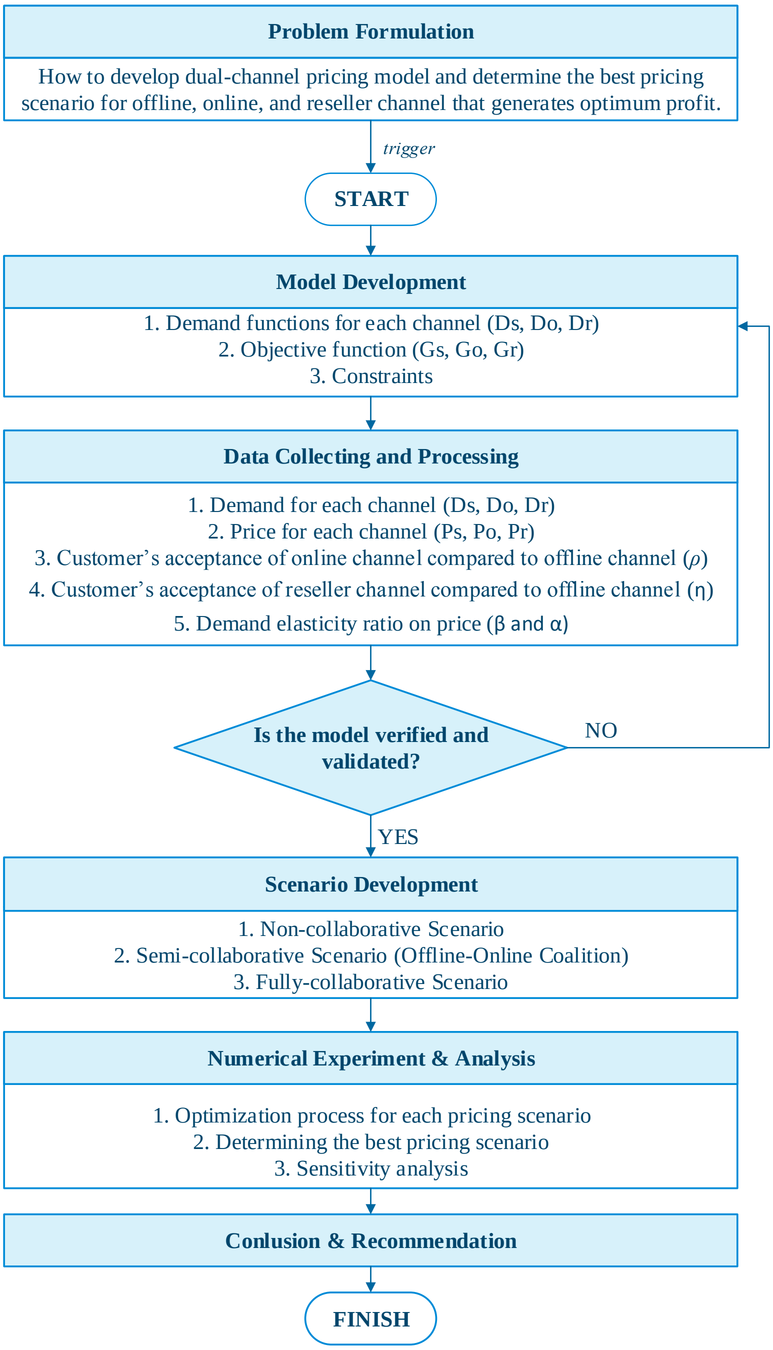


Figure 3.1 Research Methodology Flowchart

Figure 3.1 shows the research methodology flowchart. Based on the flowchart above, below is the explanations of the research methodology.

3.1 Model Development

The problem, which is the trigger of this research, is how to develop dual-channel pricing model and determine best pricing scenario for offline, online, and reseller that generates optimum profit for Attaqi. To solve that problem, the first step of this research is developing models. The models needed in this research are demand function and objective function. There are three demand functions, which are offline demand function (D_s), online demand function (D_o), and reseller demand function (D_r). The demand function refers to previous research by Widodo et al., (2011). The objective function for this research is maximum gain (profit). In addition, the formulation of the constraints is also conducted in this step.

3.2 Parameter Collecting and Processing

Parameter required in this research are demand and price of each channel in Attaqi, cross-price and self-price elasticity (α and β), and customer's acceptance of online and reseller channel compared to the offline channel. The demand and price are based on the Attaqi's historical data. Customer's acceptance of online (ρ) and reseller (η) channel is acquired from questionnares which is given to the customers.

3.3 Verification and Validation

Verification is an evaluation whether or not a model or a system complies with specification or imposed condition, whilst validation is the assurance that a model or a system meets the needs of the system stakeholder (Project Management Institute, 2004). In this research, verification will be done by checking whether or not the model in MATLAB software contains an error, whereas validation will be done by comparing the model with the real condition, whether it is logical or not. If the model is not verified or validated, it is necessary to re-do the model development.

3.4 Scenario Development

After verification and validation is one, the next step of this research is developing scenario. The scenario is developed based on the theories on the literature study about DCSC, specifically about channel conflict. The scenarios are:

1. Existing condition (Scenario 0)
2. Non-cooperative (Scenario A)
3. Semi-cooperative (Offline and Online) (Scenario B)
4. Fully-coooperative (Scenario C)

3.5 Numerical Experiment and Analysis

There are three sub-steps in numerical experiment and analysis step. The first step is performing optimization process for each scenario using MATLAB with *fmincon* syntax. Then, based on the optimization results, it can be concluded which scenario provides the best financial performance. The last step is performing sensitivity analysis on the best scenario to see which parameter in the model is critical and sensitive to the objective function.

3.6 Conclusion and Recommendation

The last step of this research is to conduct conclusions based on the result of the research. The conclusions are built to answer the research objectives. Besides conclusions, recommendations are also made, whether it is addressed to the observed company or to the further researcher.

CHAPTER 4
MODEL DEVELOPMENT

This chapter explains the system description, model development of each pricing scenarios, further limitations and assumptions used in the system, parameters, objective function and constraint formulation, and also data collection for the model development.

4.1 System Description

This research is based on the supply chain system that belongs to Attaqi. Below is the conceptual model of the system.

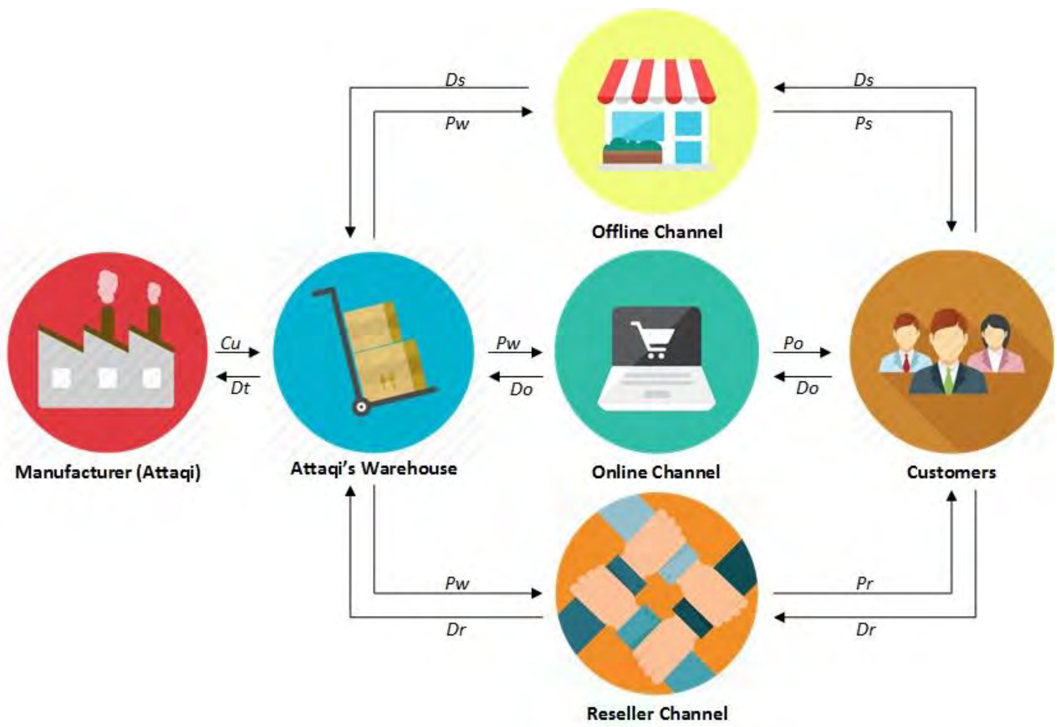


Figure 4.1 Conceptual Model of Attaqi's System

Attaqi is a moslemwears manufacturers located in Surabaya whose demand fulfillment is done through three channels, which are offline, online, and reseller channel in their business process. They own one showroom which is their offline channel, one website as the online channel, and work with 21 resellers. There are two types of reseller, which are primary agent and reguler agent, each with different terms and condition. Their average monthly demand is 1.200 units and almost doubled during Ramadhan, with nett profit approximately 60 million rupiah each month. Each channel in Attaqi is independently managed, since there are no data sharing between each channel in making decisions, including in price determination. Current condition shows that Attaqi apply the same price for products in offline, online, and reseller channel. The price was set in each channel without considering customers's preference of each channel.

In this research, several limitations and assumptions are used to limit the scope of the study.

4.1.1 System Limitations

The limitations used in this system are:

1. Pricing scenario and model is developed for product X.
2. The type of reseller used in this research is primary agent (maximum discount is 40%).
3. Online channel in this supply chain is Attaqi's official website.
4. Offline channel in this supply chain is Attaqi's showroom.

4.1.2 System Assumptions

The assumptions used in this system are:

1. Confidence level is 95%.
2. The price of product X is Rp 100.000,00.
3. $C_u = P_w$
4. Reseller's online and offline channel is negligible.
5. Each reseller follows the same pricing policy.
6. Price elasticity in demand differs based on the characteristic of the scenario.

4.2 Model Reference

This research refers to in-store demand function by Huang, et al., (2012) that modelled as follows:

❖ Offline Demand Function

$$D_s = (1-\rho)d_s^{max} - \alpha_1 P_s + \beta_1 P_o \tag{4.1}$$

❖ Online Demand Function

$$D_o = \rho d_s^{max} - \alpha_2 P_o + \beta_2 P_s \tag{4.2}$$

❖ Total Demand Function

$$D_T = d_s^{max} - (\alpha_1 - \beta)P_s - (\alpha_2 - \beta)P_o \tag{4.3}$$

Where:

D_s = offline demand

D_o = online demand

d_s^{max} = forecasted potential demand if the products are free

P_s = offline price

P_o = online price

ρ = customer acceptance ratio of online product compared to the offline product

α = coefficient of self-price elasticity of D_s and D_o

β = coefficient of cross-price sensitivity of D_s and D_o

4.3 Research Model

This section contains research models developed from the reference model based on the conducted pricing scenario. The scenarios are as follows:

1. Scenario 0

   This is the existing condition of Attaqi. In this scenario, each channel works independently in meeting customer demand without considering customer's channel preference which caused Attaqi to set the same price for each channel.

2. Scenario A

   This is the non-cooperative scenario. In this scenario, each channel works independently in meeting customer demand. Below is the graphical illustration of this scenario.

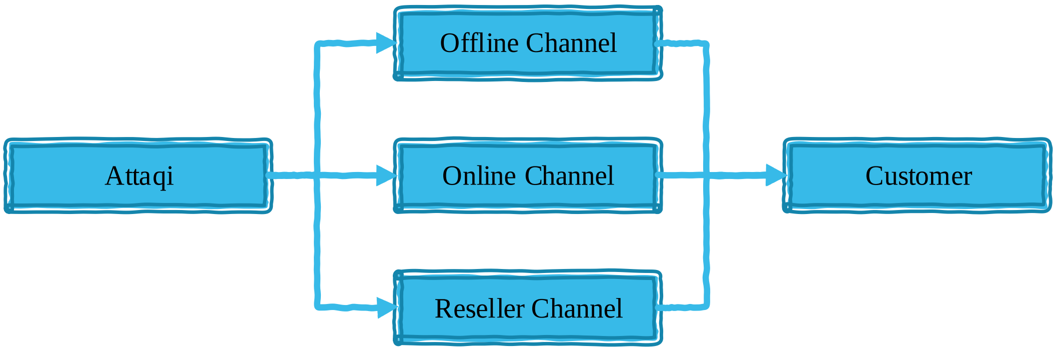


Figure 4.2 Non-cooperative Pricing Scenario

3. Scenario B

   This is the semi-cooperative scenario. In this scenario, the offline and online channel form a coordination and work complementary in meeting customer demand, while the reseller channel works independently. The coordination of the offline and online channel is possible because both channel are owned directly by Attaqi. Below is the graphical illustration of this scenario.

Figure 4.3 Semi-cooperative Pricing Scenario

4. Scenario C

   This is the fully-cooperative scenario. In this scenario, all channels form a coordination and work complementary in meeting customer demand. Below is the graphical illustration of this scenario.

Figure 4.4 Fully-cooperative Pricing Scenario

4.3.1 Notations

The notations used in the research models are:

- Indirect Variables
  - D_s = offline demand
  - D_o = online demand
  - D_r = reseller demand
- Dependent Variables
  - G_s = profit gained by offline channel
  - G_o = profit gained by online channel
  - G_r = profit gained by reseller channel
  - G_{so} = profit gained by offline and online channels
  - G_{sor} = profit gained by offline, online, and reseller channels
  - G_{totA} = profit gained by the whole supply chain system in scenario A
  - G_{totB} = profit gained by the whole supply chain system in scenario B
  - G_{totC} = profit gained by the whole supply chain system in scenario C
- Decision Variables
  - P_s = offline price
  - P_o = online price
  - P_r = reseller price
- Parameters
  - d_s^{max} = maximum amount of D_s when the price is set to be minimum
  - β = cross-price sensitivity
  - α = self-price elasticity
  - ρ = customer acceptance ratio of online product compared to the offline product
  - η = customer acceptance ratio of reseller product compared to the offline product
  - C_u = unit cost for product X

4.3.2 Demand Functions

In this section, demand functions for each channel will be modelled based on the model reference by Huang et al. (2012).

4.3.2.1 Offline Demand Function

The offline or in-store demand function is adopted from (4.1) with α and β is not assumed to be 1 in order to represent the real condition more precisely in the model. P_r and η is also added to capture the interplay between offline, online, and reseller channel. The offline demand function is as follows.

$$D_s = (1 - \rho\eta)d_s^{max} - \alpha_1 P_s + \beta_1 P_o + \beta_2 P_r \tag{4.4}$$

4.3.2.2 Online Demand Function

The online demand function is adopted from (4.2) with α and β is not assumed to be 1 in order to represent the real condition more precisely in the model. The offline demand function is as follows.

$$D_o = \rho d_s^{max} - \alpha_2 P_o + \beta_3 P_s + \beta_4 P_r \tag{4.5}$$

4.3.2.3 Reseller Demand Function

The reseller demand function is adopted from (4.2) with α and β is not assumed to be 1 in order to represent the real condition more precisely in the model. P_o is replaced by P_r and ρ is replaced by η to represent the reseller channel in the model. The reseller demand function is as follows.

$$D_r = \eta d_s^{max} - \alpha_3 P_r + \beta_5 P_s + \beta_6 P_o \tag{4.6}$$

4.3.3 Objective Functions

The objectives of this research is maximizing the profit (gain) of the whole supply chain system. Each scenario has different objectives function depends of the condition of the scenario itself. Generally, profit or gain can be formulated as follows:

$$\boldsymbol{Gain} = \boldsymbol{Demand} \times (\boldsymbol{Price} - \boldsymbol{Cost}) \tag{4.7}$$

Below is the profitability function for each channel of each scenario developed from the general profitability function.

4.3.3.1 Gain for Scenario A

Below is the gain function for scenario A.

$$G_s(P_s) = D_s(P_s - C_u)$$
$$G_s(P_s) = ((1-\rho\eta)d_s^{max} - \alpha_1 P_s + \beta_1 P_o + \beta_2 P_r)(P_s - C_u)$$
(4.8)

$$G_o(P_o) = D_o(P_o - C_u)$$
$$G_o(P_o) = (\rho d_s^{max} - \alpha_2 P_o + \beta_3 P_s + \beta_4 P_r)(P_o - C_u)$$
(4.9)

$$G_r(P_r) = D_r(P_r - C_u)$$
$$G_r(P_r) = (\eta d_s^{max} - \alpha_3 P_r + \beta_5 P_s + \beta_6 P_o)(P_r - C_u)$$
(4.10)

$$G_{totA} = G_s + G_o + G_r$$
(4.11)

In the objective functions above, the first parts are the demand functions to accomodate the number of the products sold and the second parts are the difference between the price and the cost which shows profit per unit. The multiplication of both parts will result in gain for each channel. G_{totA} shows the total gain for the entire supply chain system for Attaqi in Scenario A.

4.3.3.2 Gain for Scenario B

Below is the gain function for scenario B.

$$G_{so}(P_s, P_o) = D_s(P_s - C_u) + D_o(P_o - C_u)$$
$$G_{so}(P_s, P_o) = ((1-\rho\eta)d_s^{max} - \alpha_1 P_s + \beta_1 P_o + \beta_2 P_r)(P_s - C_u) + (\rho d_s^{max} - \alpha_2 P_o + \beta_3 P_s + \beta_4 P_r)(P_o - C_u)$$
(4.12)

$$G_r(P_r) = D_r(P_r - C_u)$$
$$G_r(P_r) = (\eta d_s^{max} - \alpha_3 P_r + \beta_5 P_s + \beta_6 P_o)(P_r - C_u)$$
(4.13)

$$G_{totB} = G_{so} + G_r$$
(4.14)

The objective function above (G_{so}) accomodates the coordination of both offline and online channel which is shown in the sum of the gain for offline channel with the gain for online. The decision variables, which are P_s and P_o will be derived from this objective function. G_r is the objective function to find the optimum P_r for this scenario, while G_{totB} shows the total gain for the entire supply chain system for Attaqi in Scenario B.

4.3.3.3 Gain for Scenario C

Below is the gain function for scenario C.

$$G_{sor}(P_s, P_o, P_r) = D_s(P_s - C_u) + D_o(P_o - C_u) + D_r(P_r - C_u)$$

$$G_{sor}(P_s, P_o, P_r) = ((1-\rho\eta)d_s^{max} - \alpha_1 P_s + \beta_1 P_o + \beta_2 P_r)(P_s - C_u) + (\rho d_s^{max} - \alpha_2 P_o + \beta_3 P_s + \beta_4 P_r)(P_o - C_u) + (\eta d_s^{max} - \alpha_3 P_r + \beta_5 P_s + \beta_6 P_o) \quad (4.15)$$

$$G_{totC} = G_{sor} \quad (4.16)$$

The objective function above (G_{sor}) accomodates the coordination of all offline, online, and reseller channel which is shown in the sum of the gain for each channel. The decision variables, which are P_s, P_o, and P_r will be derived from this objective function. G_{totC} is equal to G_{sor} and shows the total gain for the entire supply chain system for Attaqi in Scenario C.

4.3.4 Constraints

There are several constraints used in this research models, which are:

1. $P_s, P_o, P_r \geq C_u$

   The aim of this constrain is to make sure the price is higher than the cost in order for Attaqi to gain profit.

2. $P_s \geq {P_o}/{\rho}$

   This constraint shows that the opportunity for online sales is available after P_s reaches the threshold value (Widodo, et al., 2011).

3. $P_s \geq {}^{P_r}/_{\eta}$

   This constraint is conducted by modifying and following the form of the second constraint above, and shows that the opportunity for reseller sales is available after P_s reaches the threshold value.

4. $D_s, D_o, D_r \geq 0$

   This constraint is intented to make sure that the demands will not have negative value.

5. $P_r \geq 0{,}6P_s$

   The aim of this constraint is to accomodate Attaqi's reseller regulation which limit the price difference of offline and reseller channel to be maximum of 40%.

6. $P_s \geq P_o, P_r$

   This constraint shows the price leadership in DCSC concept, where P_s is more than or at least equal to P_o and P_r.

4.4 Parameter Data Collection and Processing

This section explains about the parameter needed for this research and how each data is obtained.

4.4.1 Parameter ρ

Parameter ρ symbolizes customer's preference of online channel compared to offline channel which is obtained from the results of the questionnaires (enclosed) filled out by 38 respondents from Attaqi's customers. Assuming that the score for offline channel is 100, the respondents are allowed to score the online channel between 0 to 99 based on their preferences. Below is the score recapitulation of the questionnaires.

Table 4.1 Recapitulation Score of Online Channel to Offline Channel

No.	Score	No.	Score	No.	Score	No.	Score
1.	80	11.	55	21.	50	31.	60
2.	50	12.	40	22.	20	32.	50
3.	50	13.	10	23.	55	33.	30

No.	Score	No.	Score	No.	Score	No.	Score
4.	50	14.	70	24.	30	34.	60
5.	80	15.	50	25.	60	35.	5
6.	85	16.	50	26.	50	36.	50
7.	50	17.	50	27.	50	37.	60
8.	70	18.	50	28.	70	38.	70
9.	10	19.	80	29.	45	**Average**	51.1842
10.	5	20.	65	30.	80	**Std Dev**	20.8739

Table 4.1 shows the recapitulation of the score of customer's preference of online channel compared to offline channel. The average score of the results above can be considered as ρ by dividing it by 100 because the value of ρ is between 0 to 1. Therefore, the value of ρ is 0.51.

Confidence interval without standard deviation population known uses student's t-distribution to find the confidence interval estimation for mean population (Groebner, et al., 2010). Assuming that the confidence level is 98% with degree of freedom is 37, below is the calculation of confidence interval.

$$\bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}} \tag{4.17}$$

$$= 51.1842 \pm 2.4298\frac{20.8739}{\sqrt{38}}$$

$$= 42.9564 \leq \mu \leq 59.4119$$

If the input of this parameter doesn't generate optimum result, the value of ρ can be changed as long as it is still in confidence interval range above.

4.4.2 Parameter η

Parameter η symbolizes customer's preference of reseller channel compared to offline channel. With the same method in the parameter ρ, this parameter is obtained from the results of the questionnaires (enclosed) filled out by 38 respondents from Attaqi's customers. Assuming that the score for offline channel is 100, the respondents are allowed to score the reseller channel between 0 to 99 based on their preferences. Below is the score recapitulation of the questionnaires.

Table 4.2 Recapitulation Score of Reseller Channel to Offline Channel

No.	Score	No.	Score	No.	Score	No.	Score
1.	80	11.	60	21.	50	31.	60
2.	50	12.	70	22.	20	32.	50
3.	25	13.	30	23.	80	33.	50
4.	80	14.	85	24.	70	34.	70
5.	90	15.	60	25.	60	35.	20
6.	80	16.	60	26.	75	36.	50
7.	70	17.	60	27.	80	37.	70
8.	85	18.	50	28.	85	38.	70
9.	50	19.	70	29.	60	**Average**	61.5789
10.	10	20.	75	30.	80	**Std Dev**	19.9697

Table 4.2 shows the recapitulation of the score of customer's preference of reseller channel compared to offline channel. The average score of the results above can be considered as η by dividing it by 100 because the value of η is between 0 to 1. Therefore, the value of ρ is 0.61.

Assuming that the confidence level is 98% with degree of freedom is 37, below is the calculation of confidence interval.

$$\bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}$$

$$= 61.5789 \pm 2{,}4298\frac{19.9697}{\sqrt{38}}$$

$$= 50.7075 \leq \mu \leq 69.4502$$

If the input of this parameter doesn't generate optimum result, the value of η can be changed as long as it is still in confidence interval range above.

4.4.3 Parameter α

According to Huang, et al. (2012), parameter α symbolizes the self-price elasticity of demand. The aim of this parameter is to convert the price into units of demand. The self-price elasticity of demand shows how many demand can be obtained by particular price in the same channel. There are three different α which are α_1 (self-price elasticity of demand in offline channel), α_2 (self-price elasticity in demand of online channel), and α_3 (self-price elasticity of demand in reseller channel). The value of α is obtained from trial in MATLAB that generates optimum solution. From the trial can be obtained that the value of α_1, α_2, and α_3 are 0.0001, 0.0027, and 0.0013 respectively.

4.4.4 Parameter β

Parameter β symbolizes the cross-price elasticity of demand (Huang, et al., 2012). The aim of this parameter is to convert the price into units of demand. The cross-price elasticity of demand shows how many demand in one channel can be obtained by particular price in the other channel. There are six different β, which are:

1. β_1 : to convert online price into demand units in offline channel
2. β_2 : to convert reseller price into demand units in offline channel
3. β_3 : to convert offline price into demand units in online channel
4. β_4 : to convert reseller price into demand units in online channel
5. β_5 : to convert offline price into demand units in reseller channel
6. β_6 : to convert online price into demand units in reseller channel

The value of β is obtained from trial in MATLAB that generates optimum solution. From the trial can be obtained that the value of β_1, β_2, β_3 β_4, β_5, and β_6 are 0.0000001, 0.0000001, 0.0009, 0.00001, 0.001, and 0.003 respectively.

4.4.5 Parameter d_s^{max}

Parameter d_s^{max} symbolizes the demand maximum in offline channel when the price is set to be minimum. This parameter is obtained from the historical sales data of Attaqi for the last 12 months which is shown below.

Table 4.3 Historical Sales Data (April 2014-February 2015)

Month	Price	Demand			Total
		Offline	Reseller	Online	
April	Rp100.000	602	501	255	1358
Mei	Rp100.000	613	507	266	1386
Juni	Rp100.000	568	512	267	1347
Juli	Rp100.000	600	520	265	1385
Agustus	Rp100.000	587	515	258	1360
September	Rp100.000	674	503	270	1447
Oktober	Rp100.000	613	515	266	1394

Month	Price	Demand			Total
		Offline	Reseller	Online	
November	Rp100.000	576	497	242	1315
Desember	Rp100.000	590	466	269	1325
Januari	Rp100.000	576	503	259	1338
Februari	Rp100.000	588	478	268	1335
Maret	Rp100.000	594	515	270	1379
Average		599	503	270	

Table 4.3 shows historical sales data of Attaqi during April 2014 – March 2015. Because of there is not any price changes in the data, parameter d_s^{max} can be obtained by calculating the demand from the demand function. Assuming that the average demand in the offline channel represents D_s and the price in offline channel (P_s) is set to be minimum or equal to the unit cost (Rp 50.000), below is the calculation of parameter d_s^{max}.

$$D_s = (1-\rho\eta)d_s^{max} - \alpha_1 P_s + \beta_1 P_o + \beta_2 P_r$$

$$599 = (1-0.51 \times 0.61)d_s^{max} - 0.0000001(50000) + 0.00005(100000) + 0.00001(100000)$$

$$d_s^{max} = 857.75$$

From the calculation above, parameter d_s^{max} can be assumed to be equal to 857.75 ≈ 858 units.

4.4.6 Parameter C_u

The profit in this research is obtained by substracting the cost from the price. The unit cost of product X is Rp 50.000,00 based on the interview with the owner of Attaqi.

Based on the parameter data collecting and processing above, the summary of parameters needed in this research is shown in Table 4.4 below.

Table 4.4 List of Parameters

No.	Parameter	Value
1.	ρ	0.51
2.	η	0.61

No.	Parameter	Value
3.	α_1	0.0001
4.	α_2	0.0027
5.	α_3	0.0013
6.	β_1	0.0000001
7.	β_2	0.0000001
8.	β_3	0.0009
9.	β_4	0.00001
10.	β_5	0.001
11.	β_6	0.0003
12.	d_s^{max}	50000 (rupiah)
13.	C_u	858 (units)

CHAPTER 5
NUMERICAL EXPERIMENT AND ANALYSIS

This chapter explains the numerical experiment of each pricing scenario and shows the best pricing scenario that generates optimum profit.

5.1 Validation and Verification

In this section, validation and verification will be done to check whether the model developed is able to represent the real condition or not.

5.1.1 Validation

In this section, validation process will be done to prove that the model generates result is able to represent the real system.

5.1.1.1 Validation for Demand Functions

Validation process will be done by inputting the real data into the demand function to be compared with the historical data. The comparison will use MAPD (Mean Absolute Percentage Deviation) to see the percentages of errors in the calculation result. Parameter α will be changed until the demand reaches the best result. Validation process will be stopped when MAPD is less than or equal to 5%. According to Hartono (2009), MAPD can be obtained by calculating:

$$MAPD = \frac{\sum |D_t - F_t|}{\sum D_t} \tag{5.1}$$

Where:

D_t : demand on period t (units)

F_t : forecasted demand on period t (units)

Based on the formula above, below is the validation process for offline demand function.

Table 5.1 Validation Process for D_s Function

Iteration	α_1	β_1	β_2	D_s History	P_s	D_s	MAPD
1	0.0001	0. 0000001	0. 0000001	599	100000	578	3.51%

From Table 5.1 above can be concluded that the D_s function is valid. That is shown by the value of MAPD which are less than 5%. Validation for demand function can also be done by checking the behaviour of the function. In demand, the value of price is significant. Theoritically, higher value of price will decrease the amount of demand. Below is the graphical illustration of validation for offline demand function (enclosed).

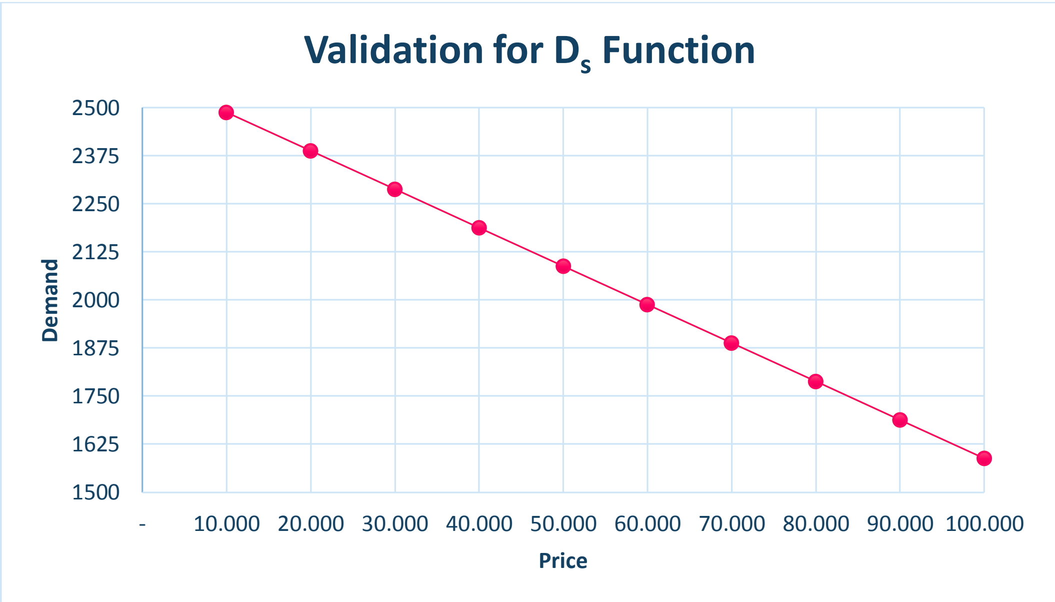


Figure 5.1 Validation for Offline Demand Function

Figure 5.1 shows how the changes in price change the amount of demand. It shows that the offline demand function is able to represent the real system since higher price generates lower amount of demand. Hence it can be concluded that the offline demand function is logically valid.

Below is the validation process for online demand function.

Table 5.2 Validation Process for D_o Function

Iteration	α_2	β_3	β_4	D_o History	P_o	D_o	MAPD
1	0.0027	0.0009	0.00001	270	100000	260	3.7%

Table 5.2 shows that iteration 1 generates MAPD with value of 3.7%. Because the value of MAPD in this iteration is less than 5%, the online demand function can be considered as valid and the iteration is stopped with the value chosen for α_2 is 0.0027. Below is the graphical illustration of validation for online demand function (enclosed).

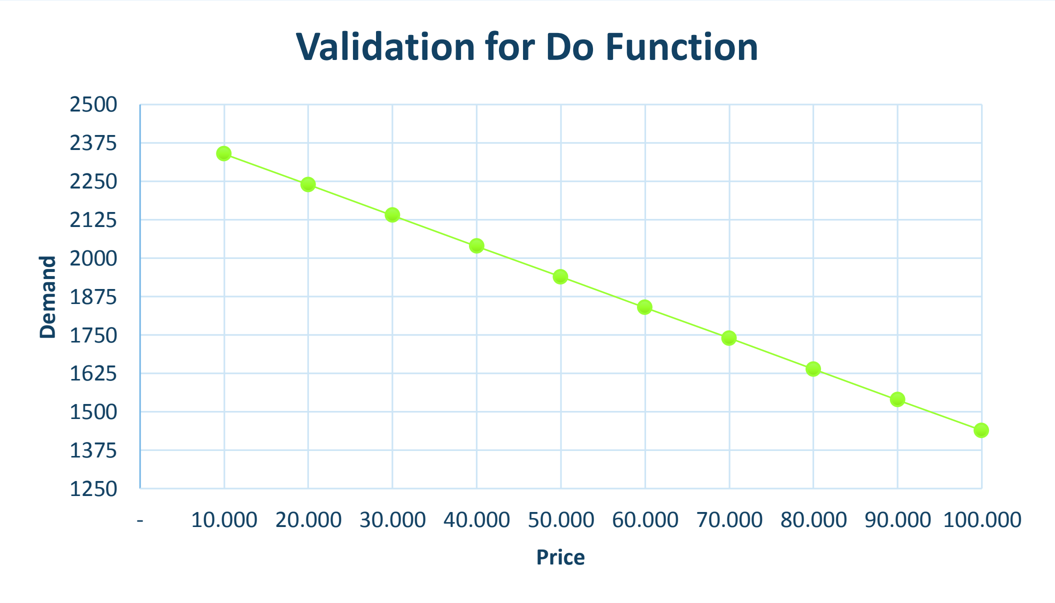


Figure 5.2 Validation for Online Demand Function

Figure 5.2 shows how the changes in price change the amount of demand. It shows that the online demand function is able to represent the real system since higher price generates lower amount of demand. Hence it can be concluded that the online demand function is logically valid.

Below is the validation process for reseller demand function.

Table 5.3 Validation Process for D_r Function

Iteration	α_3	β_5	β_6	D_r History	P_r	D_r	MAPD
1	0.0013	0.001	0.0003	503	100000	528	4.97%

Table 5.3 shows that first iteration generates MAPD to be 4.97% which is less than 5%. Because the value of MAPD in this iteration is less than 5%, the reseller demand function can be considered as valid and the iteration is stopped with the value chosen for α_2 is 0.0013. Below is the graphical illustration of validation for online demand function (enclosed).

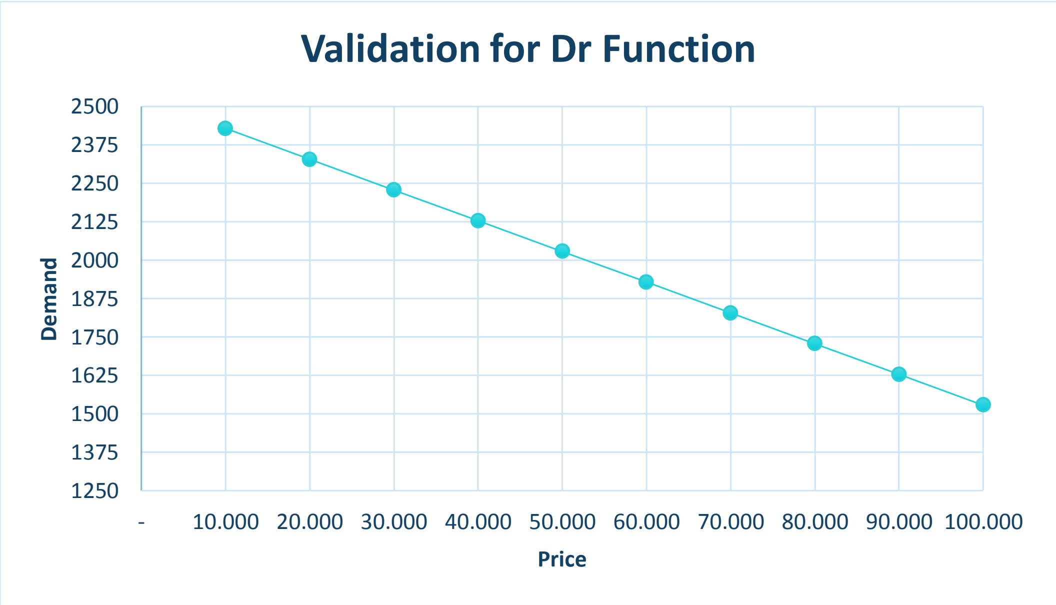


Figure 5.3 Validation for Reseller Demand Function

Figure 5.3 shows how the changes in price change the amount of demand. It shows that the reseller demand function is able to represent the real system since higher price generates lower amount of demand. Hence it can be concluded that the reseller demand function is logically valid.

5.1.1.2 Validation for Gain Function

Validation process for gain function can be done by checking the behaviour of the system by changing its parameter. Parameter C_u will be changed to see its impact to the total gain. Theoritically, assuming that there is not any changes in price, lower unit cost will generate higher gain, whereas higher unit cost will generate lower gain. Below is the validation process for Scenario A (enclosed).

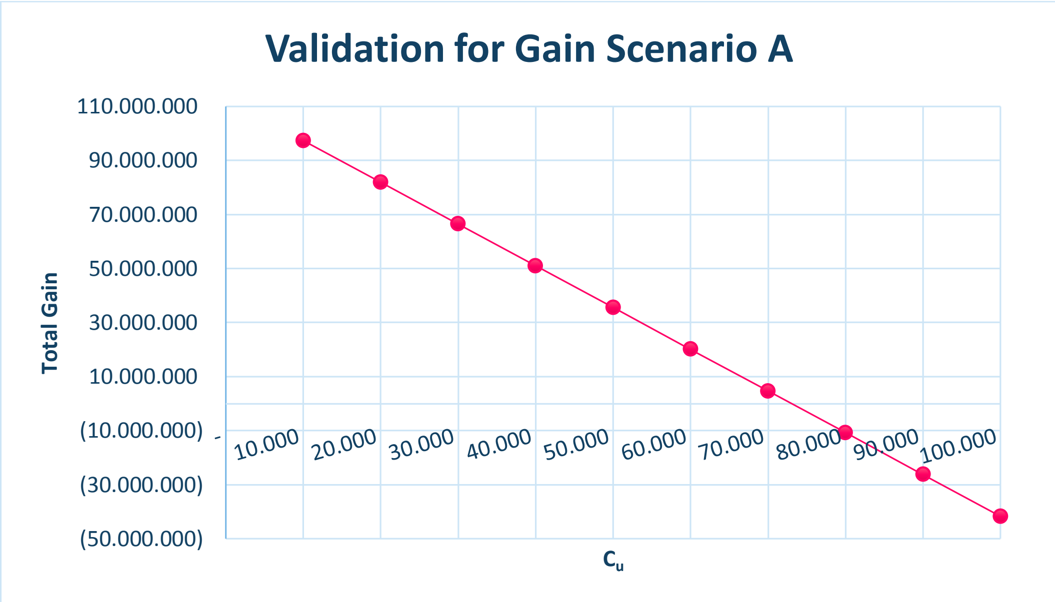


Figure 5.4 Validation for Scenario A

From Figure 5.4 above can be concluded that the model is able represent the real system. It is shown in how the changes of unit cost affect the value of total gain. When Cu is set to be 0, it increases the profit margin to be maximum, whereas when it is set to be maximum, it decreases the profit margin to be minimum. This shows that the model for Scenario A is logically valid. Below is the validation process for Scenario B (enclosed).

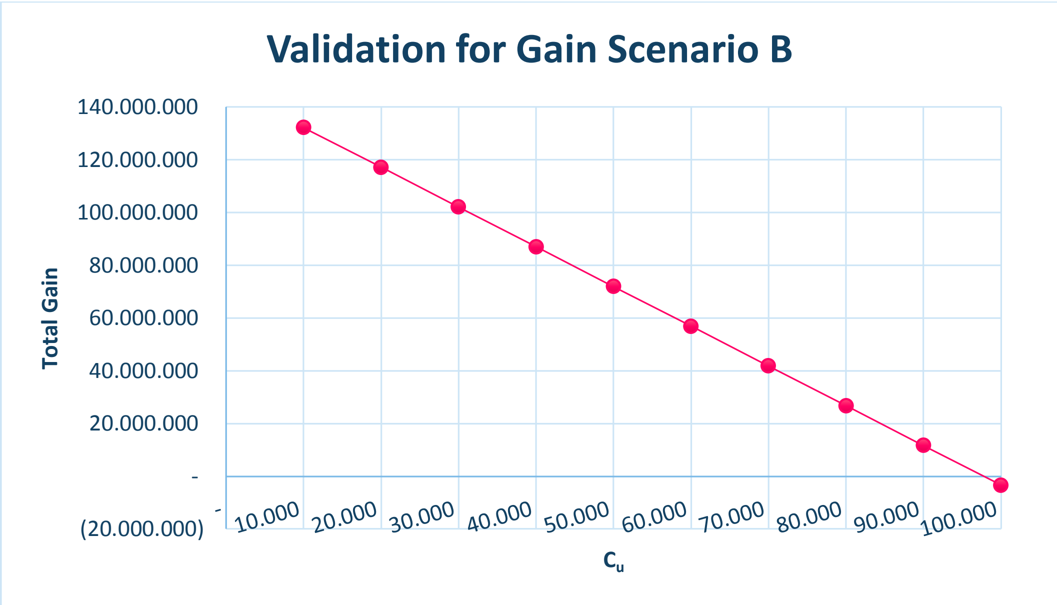


Figure 5.5 Validation for Scenario B

From Figure 5.5 above can be concluded that the model is able represent the real system. It is shown in how the changes of unit cost affect the value of total gain. When Cu is set to be 0, it increases the profit margin to be maximum, whereas higher Cu decreases the profit margin to be reach minimum. This shows that the model for Scenario B is logically valid. Below is the validation process for Scenario C (enclosed).

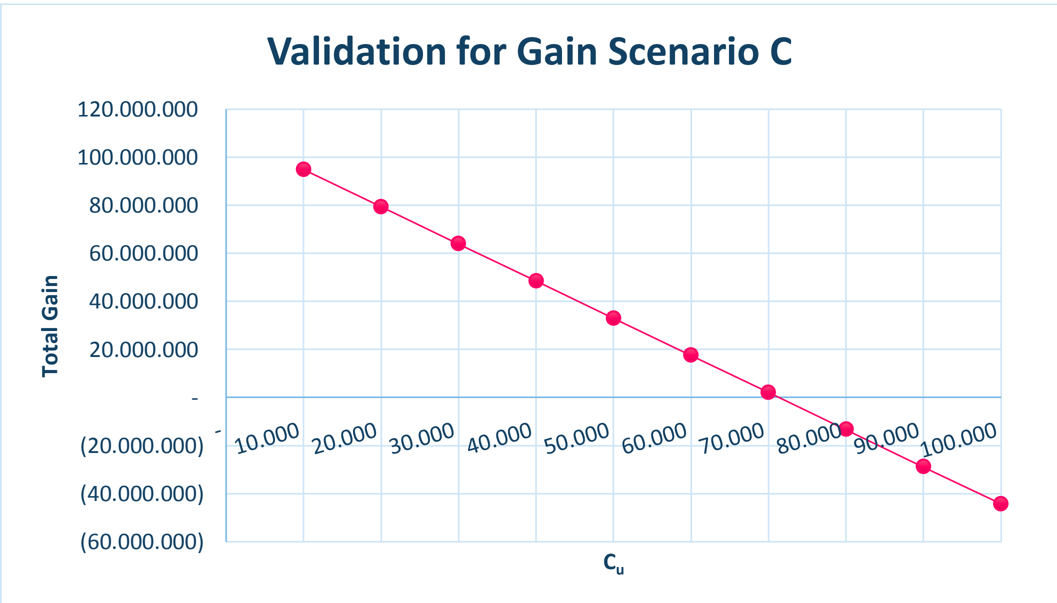


Figure 5.6 Validation for Scenario C

From Figure 5.6 above can be concluded that the model is able represent the real system. It is shown in how the changes of unit cost affect the value of total gain. When Cu is set equal to 0, it increases the profit margin to be maximum, whereas higher Cu decreases the profit margin to be reach minimum. This shows that the model for Scenario C is logically valid.

5.1.2 Verification

In this section, verification process will be done to check if the developed models contain an error. This can be done by observing the m-file script as shown below.

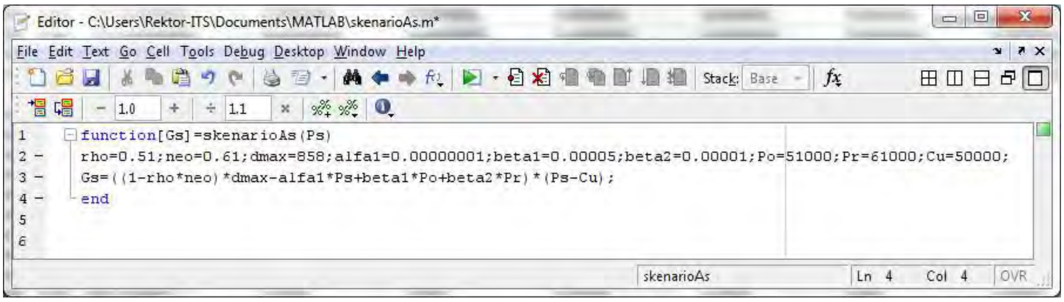


Figure 5.7 Verification for G_s Scenario A

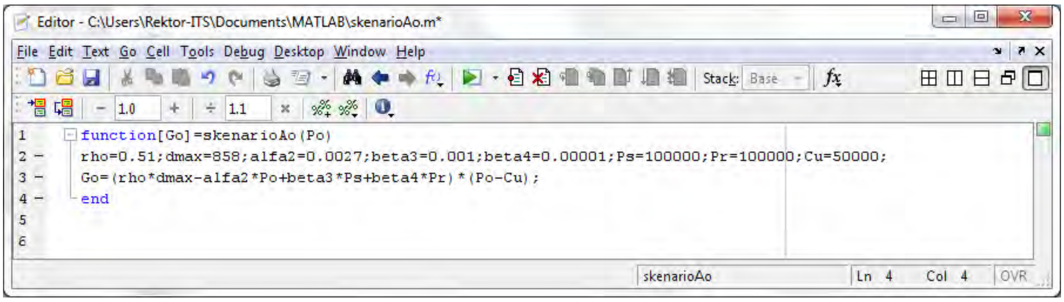


Figure 5.8 Verification for G_o Scenario A

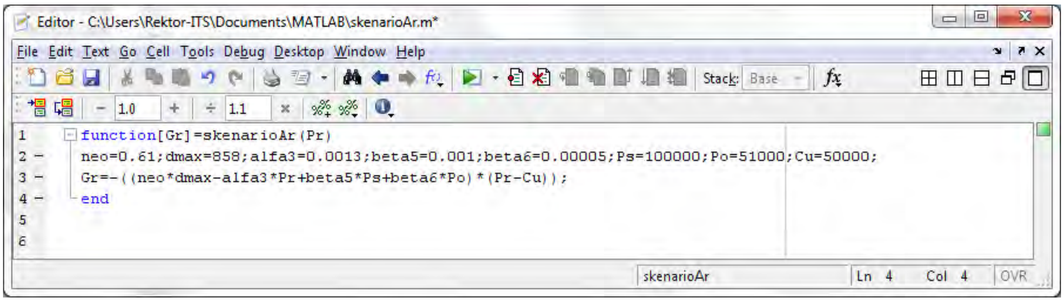


Figure 5.9 Verification for G_r Scenario A

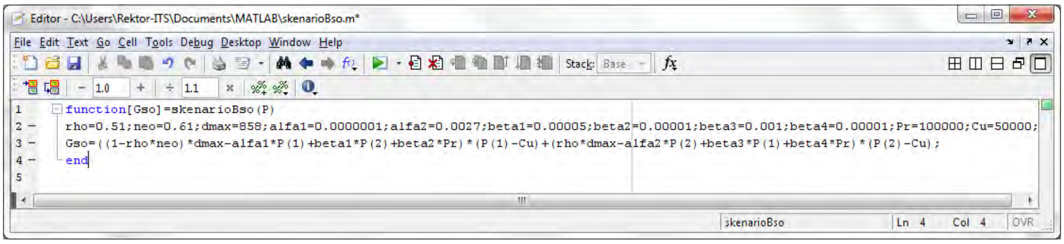


Figure 5.10 Verification for G_{so} Scenario B

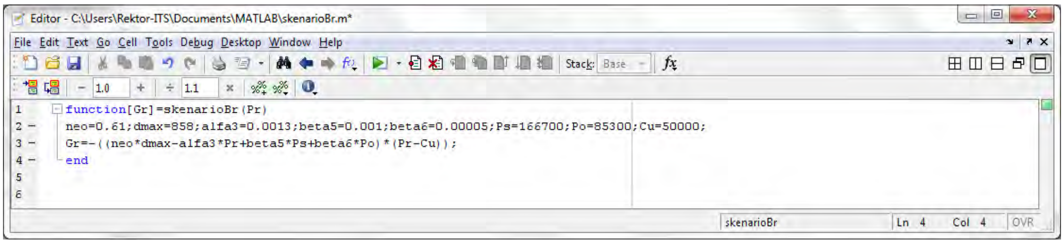


Figure 5.11 Verification for G_r Scenario B

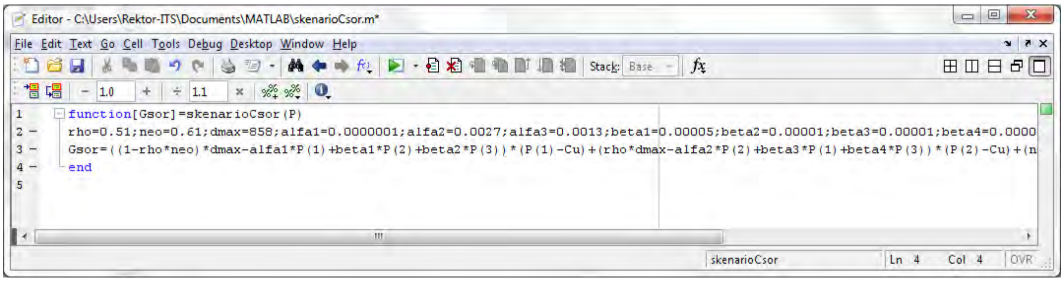


Figure 5.12 Verification for G_{sor} Scenario C

Figure 5.1 to Figure 5.12 show green sign in the upper right side of the m-file. This shows that there are not any errors in the script of the model, therefore the model is verified.

Verification can also be done by checking the exitflag value of the output in MATLAB. Below is the exitflag value of each scenario shown in MATLAB.

Figure 5.13 Exitflag Value of G_s Scenario A

```
Po =

       51180


Go =

 -7.3786e+005


exitflag =

     1
```

Figure 5.14 Exitflag Value of G_o Scenario A

```
Pr =

       60000


Gr =

 -8.2283e+006


exitflag =

     1
```

Figure 5.15 Exitflag Value of G_r Scenario A

```
P =

  1.0e+005 *

    1.2000    0.6142


Gso =

 -4.3762e+007


exitflag =

     1
```

Figure 5.16 Exitflag Value of G_{so} Scenario B

```
Pr =

     100000


Gr =

  2.7413e+007


exitflag =

     1
```

Figure 5.17 Exitflag Value of G_r Scenario B

```
P =

  1.0e+004 *

    9.7694    5.0000    5.8617


Gsor =

  3.7461e+007


exitflag =

     1
```

Figure 5.18 Exitflag Value of G_{sor} Scenario C

Figure 5.13 to 5.18 show the exitflag value of optimization process done by MATLAB. The value of 1 in exitflag means that the optimization process has reached the optimum solution so the iteration can be stopped, therefore it can be concluded that the models conducted are verified.

5.2 Numerical Experiment

In this section, numerical experiment will be performed to see which scenario provides the best financial performance. The output of this experiment is the optimum price that generates highest gain. Numerical experiment is done using MATLAB software with *fmincon* syntax. Each scenario has different script in MATLAB with some adjustment based on the characteristic of the scenario.

The numerical experiment in finding the optimum price follows the theory of Stackelberg Leadership. According to Schoonbeek (1990), Stackelberg Leadership brought the concept of price leader and price follower. A price follower expects that the price of the other party is fixed, therefore it will determines its own optimal price. Whereas a price leader determines its own optimal price by assuming that the other parties behave as follower.

In this research, the channel with lowest market (indicated by the number of sales) is assumed to be the price follower. In this case, it means that the online, reseller, and offline channel have the lowest to highest price leadership tendency respectively.

5.2.1 Numerical Experiment for Scenario A

In scenario A, numerical experiment is done individually for each channel. Based on the theory of Stackelberg Leadership above, online channel is the first channel to be evaluated to find its optimum price, by assuming that P_s and P_r have fixed value of Rp 100.000 which is the existing price. Numerical experiment for online channel is done with some constraints as below.

Table 5.4 Constraints for Scenario A (Online)

No.	A		b	Annotation
1	$-P_o$	$\leq$	$-C_u$	Lower bound of price
2	$\frac{P_o}{\rho}$	$\leq$	P_s	Demand interplay
3	$-\beta_1 P_o$	$\leq$	$(1-\rho\eta)d_s^{max} - \alpha_1 P_s + \beta_2 P_r$	Demand must be positive
4	$\alpha_2 P_o$	$\leq$	$\rho d_s^{max} + \beta_3 P_s + \beta_4 P_r$	
5	$-\beta_6 P_o$	$\leq$	$\eta d_s^{max} - \alpha_3 P_r + \beta_5 P_s$	
6	P_o	$\leq$	P_s	Price leadership

Table 5.4 shows the constraints used in finding optimum online price in order to represent the real system. Column A shows linear constraint matrices for inequality constraints, whereas column b is its corresponding vectors. For this numerical experiment, no constraints are violated, hence there is no need of constraints relaxation. By inputting parameter with the same value as the existing condition, the experiment generates optimum value of P_o to be Rp 51.180.

The second channel to be evaluated in order to find its optimum price is reseller channel. In this experiment, the input for P_o is the optimum P_o from previous experiment, whereas P_s is assumed to have fixed value of Rp 100.000 as the existing condition. Numerical experiment for reseller channel is done with some constraints as below.

Table 5.5 Constraints for Scenario A (Reseller)

No.	A		b	Annotation
1	$-P_r$	$\leq$	$-C_u$	Lower bound of price
2	$\frac{P_r}{\eta}$	$\leq$	P_s	Demand interplay
3	$-\beta_2 P_r$	$\leq$	$(1-\rho\eta)d_s^{max} - \alpha_1 P_s + \beta_1 P_o$	Demand must be positive
4	$-\beta_4 P_r$	$\leq$	$\rho d_s^{max} - \alpha_2 P_o + \beta_3 P_s$	
5	$\alpha_3 P_r$	$\leq$	$\eta d_s^{max} + \beta_5 P_s + \beta_6 P_o$	
6	$-P_r$	$\leq$	$-0.6P_s$	Reseller pricing policy
7	P_r	$\leq$	P_s	Price leadership

Table 5.5 shows the constraints used in finding optimum reseller price in order to represent the real system. For this numerical experiment, no constraints are violated, hence there is no need of constraints relaxation. By inputting parameter with the same value as the existing condition, the experiment generates optimum value of P_r to be Rp 60.000.

The third channel to be evaluated in order to find its optimum price is offline channel. In this experiment, the input for P_o and P_r is the optimum P_o and P_r from previous experiment. Numerical experiment for reseller channel is done with some constraints as below.

Table 5.6 Constraints for Scenario A (Offline)

No.	A		b	Annotation
1	$-P_s$	$\leq$	$-C_u$	Lower bound of price
2	$-P_s$	$\leq$	$-\frac{P_o}{\rho}$	Demand interplay
3	$-P_s$	$\leq$	$-\frac{P_r}{\eta}$	
4	$\alpha_1 P_s$	$\leq$	$(1-\rho\eta)d_s^{max} + \beta_1 P_o + \beta_2 P_r$	Demand must be positive

No.	A		b	Annotation
5	$-\beta_3 P_s$	$\leq$	$\rho d_s^{max} - \alpha_2 P_o + \beta_4 P_r$	
6	$-\beta_5 P_s$	$\leq$	$\eta d_s^{max} - \alpha_3 P_r + \beta_6 P_o$	
7	$0.6 P_s$	$\leq$	P_r	Reseller pricing policy
8	$-P_s$	$\leq$	$-P_o$	Price leadership
9	$-P_s$	$\leq$	$-P_r$	

Table 5.6 shows the constraints used in finding optimum offline price in order to represent the real system. For this numerical experiment, no constraints are violated, hence there is no need of constraints relaxation. By inputting parameter with the same value as the existing condition, the experiment generates optimum value of P_s to be Rp 100.000.

5.2.2 Numerical Experiment for Scenario B

In scenario B, numerical experiment is done for offline-online channel and reseller channel. Reseller channel is the first channel to be evaluated to find its optimum price, by assuming that Ps and Pr have fixed value of Rp 100.000 which is the existing price. Numerical experiment for reseller channel is done with some constraints as below.

Table 5.7 Constraints for Scenario B (Reseller)

No.	A		b	Annotation
1	$-P_r$	$\leq$	$-C_u$	Lower bound of price
2	$-\beta_2 P_r$	$\leq$	$(1-\rho\eta) d_s^{max} - \alpha_1 P_s + \beta_1 P_o$	Demand must be positive
3	$-\beta_4 P_r$	$\leq$	$\rho d_s^{max} - \alpha_2 P_o + \beta_3 P_s$	
4	$\alpha_3 P_r$	$\leq$	$\eta d_s^{max} + \beta_5 P_s + \beta_6 P_o$	
5	$-P_r$	$\leq$	$-0.6 P_s$	Reseller pricing policy
6	P_r	$\leq$	P_s	Price leadership

Table 5.7 shows the constraints used in finding optimum reseller price in order to represent the real system. For this numerical experiment, some constraint relaxation is done and α and β trial is done to find the best result (enclosed) until the experiment generates optimum value of P_r to be Rp 100.000.

The optimum value of P_s and P_o are evaluated simultaneously where both prices are derived from one objctive function. In this experiment, the input for P_r is the optimum P_r from previous experiment with some constraints used as shown below.

Table 5.8 Constraints for Scenario B (Online-Offline)

No.	A		b	Annotation
1	$-P_s$	≤	$-C_u$	Lower bound of price
2	$-P_o$	≤	$-C_u$	
3	$-P_s+\frac{P_o}{\rho}$	≤	0	Demand interplay
4	$-P_s$	≤	$-\frac{P_r}{\eta}$	
5	$\alpha_1 P_s-\beta_1 P_o$	≤	$(1-\rho\eta)d_s^{max}+\beta_2 P_r$	Demand must be positive
6	$\alpha_2 P_o-\beta_3 P_s$	≤	$\rho d_s^{max}+\beta_4 P_r$	
7	$-\beta_5 P_s-\beta_6 P_o$	≤	$\eta d_s^{max}-\alpha_3 P_r$	
8	$0.6P_s$	≤	P_r	Reseller pricing policy
9	$-P_s+P_o$	≤	0	Price leadership
10	$-P_s$	≤	$-P_r$	

Table 5.8 shows the constraints used in finding optimum offline and online price in order to represent the real system. For this numerical experiment, no constraints are violated, hence there is no need of constraints relaxation. α and β trial is done to find the best result (enclosed) until the experiment generates optimum value of P_s and P_o to be Rp 120.000 and Rp 61.416 respectively.

5.2.3 Numerical Experiment for Scenario C

In scenario C, numerical experiment is done for all three channels simultaneously, where all prices are derived from one objective function. Numerical experiment for reseller channel is done with some constraints as below.

Table 5.9 Constraints for Scenario C

No.	A		b	Annotation
1	$-P_s$	≤	$-C_u$	Lower bound of price
2	$-P_o$	≤	$-C_u$	

No.	A		b	Annotation
3	$-P_r$	$\leq$	$-C_u$	
4	$-P_s + \frac{P_o}{\rho}$	$\leq$	0	Demand interplay
5	$-P_s + \frac{P_r}{\eta}$	$\leq$	0	
6	$\alpha_1 P_s - \beta_1 P_o - \beta_2 P_r$	$\leq$	$(1 - \rho\eta) d_s^{max}$	Demand must be positive
7	$\alpha_2 P_o - \beta_3 P_s - \beta_4 P_r$	$\leq$	ρd_s^{max}	
8	$\alpha_3 P_r - \beta_5 P_s - \beta_6 P_o$	$\leq$	ηd_s^{max}	
9	$0.6 P_s - P_r$	$\leq$	0	Reseller pricing policy
10	$-P_s + P_o$	$\leq$	0	Price leadership
11	$-P_s + P_r$	$\leq$	0	

Table 5.9 shows the constraints used in finding optimum offline, online, and reseller price in order to represent the real system. For this numerical experiment, no constraints are violated, hence there is no need of constraints relaxation. α and β trial is done to find the best result (enclosed) until the experiment generates optimum value of P_s, P_o, and P_r to be Rp 97.694, Rp 50.000, and Rp 58.617 respectively.

5.2.4 Comparison of Scenarios

After evaluting each scenario, the results of the numerical experiments are summarized below.

Table 5.10 Comparison of Numerical Experiment Results

	Scenario 0 (Existing)	**Scenario A** (Non Cooperative)	**Scenario B** (Offline-Online Cooperation)	**Scenario C** (Fully Cooperative)
P_s	Rp 100.000	Rp 100.000	Rp 120.000	Rp 97.694
P_o	Rp 100.000	Rp 51.180	Rp 61.416	Rp 50.000
P_r	Rp 100.000	Rp 60.000	Rp 100.000	Rp 58.617
D_s	578 units	573 units	528 units	628 units
D_o	260 units	585 units	593 units	627 units
D_r	528 units	823 units	533 units	853 units
G_s	Rp 28.887.055	Rp 27.137.000		
G_o	Rp 13.006.220	Rp 737.860		
G_r	Rp 26.413.530	Rp 8.228.300	Rp 43.762.000	

	Scenario 0 (Existing)	**Scenario A** (Non Cooperative)	**Scenario B** (Offline-Online Cooperation)	**Scenario C** (Fully Cooperative)
G_{so}			Rp 27.413.000	
G_{sor}				Rp 37.461.000
G_{tot}	Rp 68.306.805	Rp 36.103.160	Rp 71.175.000	Rp 37.461.000

Table 5.10 shows the results of the numerical experiments in each scenario. The result of numerical experiments shows that there is a huge gap in total gain between scenarios. It is caused by the price difference in each scenario generated from optimization process done with MATLAB. Based on the result above, it can be concluded that Scenario B generates the best financial performance for Attaqi. However, this decision can be changed in the future due to the changes in parameters that will be explained in sensitivity analysis.

5.3 Sensitivity Analysis

Sensitivity analysis is done to see which parameter is critical to the total gain. The aim of sensitivity analysis is to see how the changes of a parameter affect the total gain that will cause Attaqi to change the decision regarding the choice of scenario. Sensitivity analysis is done by changing one parameter while other parameter remains the same. In this research, the parameters evaluated are d_s^{max}, Cu, ρ, and η.

5.3.2 Sensitivity Analysis of Parameter d_s^{max}

In this section, parameter d_s^{max} is evaluated to see how the changes on its value affects the total gain. Below is the summary of sensitivity analysis of parameter d_s^{max}.

Table 5.11 Sensitivity Analysis of Parameter d_s^{max}

d_s^{max}	Gtot0	GtotA	GtotB	GtotC	Best Scenario
50	2.301.412	2.252.406	2.905.761	3.069.973	B
150	8.804.336	6.049.450	12.112.156	6.049.440	B
250	15.307.259	10.610.429	20.569.120	9.846.478	B
350	22.316.683	14.710.945	29.026.085	13.643.516	B
450	31.378.607	18.811.461	37.483.049	17.440.554	B

550	40.440.530	22.911.977	45.940.013	21.237.592	B
650	49.502.454	27.012.493	54.396.977	25.034.630	B
750	58.564.378	37.100.060	62.853.941	28.831.668	B
858	68.306.805	36.103.160	71.175.000	37.461.000	B
950	76.688.225	39.314.041	79.767.869	36.425.744	B
1050	85.750.149	43.414.558	88.224.833	40.222.782	B
1150	94.812.073	47.515.074	96.681.797	44.019.820	B
1250	103.873.996	51.615.590	105.138.761	47.816.858	B
1350	112.935.920	55.716.106	113.595.725	51.613.896	B

Table 5.11 shows the summary of sensitivity analysis done towards parameter d_s^{max} (enclosed). Based on the data above, below is the graphical illustration for sensitivity analysis of parameter d_s^{max}.

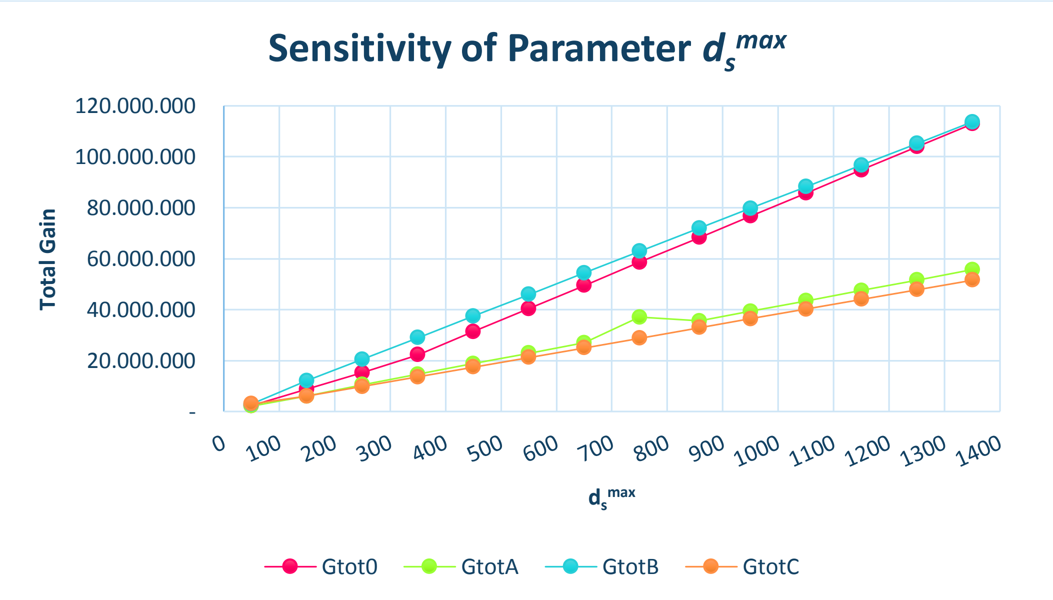


Figure 5.19 Sensitivity of Parameter d_s^{max}

Figure 5.19 is the graphical illustration of sensitivity analysis of parameter d_s^{max}. The result of the sensitivity analysis shows that increasing d_s^{max} increases the total gain. It also shows that no changes of d_s^{max} makes other scenarios provide a better financial performance, hence Scenario B remains the best pricing scenario for Attaqi.

5.3.3 Sensitivity Analysis of Parameter C_u

Sensitivity analysis is done to parameter C_u to see how the changes on its value affects the total gain. Below is the summary of sensitivity analysis of parameter C_u.

Table 5.12 Sensitivity Analysis of Parameter C_u

C_u	Gtot0	GtotA	GtotB	GtotC	Best Scenario
10.000	123.032.260	97.347.851	132.281.194	6.529.778	B
20.000	109.362.009	81.896.280	117.207.761	13.088.399	B
30.000	95.691.757	66.444.709	102.134.328	19.674.799	B
40.000	82.021.506	50.993.138	87.060.895	26.504.425	B
50.000	68.306.805	36.103.160	71.175.000	37.461.000	B
60.000	54.681.004	33.838.037	56.914.029	39.601.993	B
70.000	41.010.753	39.517.760	55.694.075	46.303.710	B
80.000	27.340.502	45.208.926	56.395.821	53.031.768	B
90.000	13.670.251	50.911.535	56.706.325	59.788.137	C
100.000	-	56.625.587	56.625.587	66.572.817	C

Table 5.12 shows the summary of sensitivity analysis done towards parameter C_u (enclosed). Based on the data above, below is the graphical illustration for sensitivity analysis of parameter C_u.

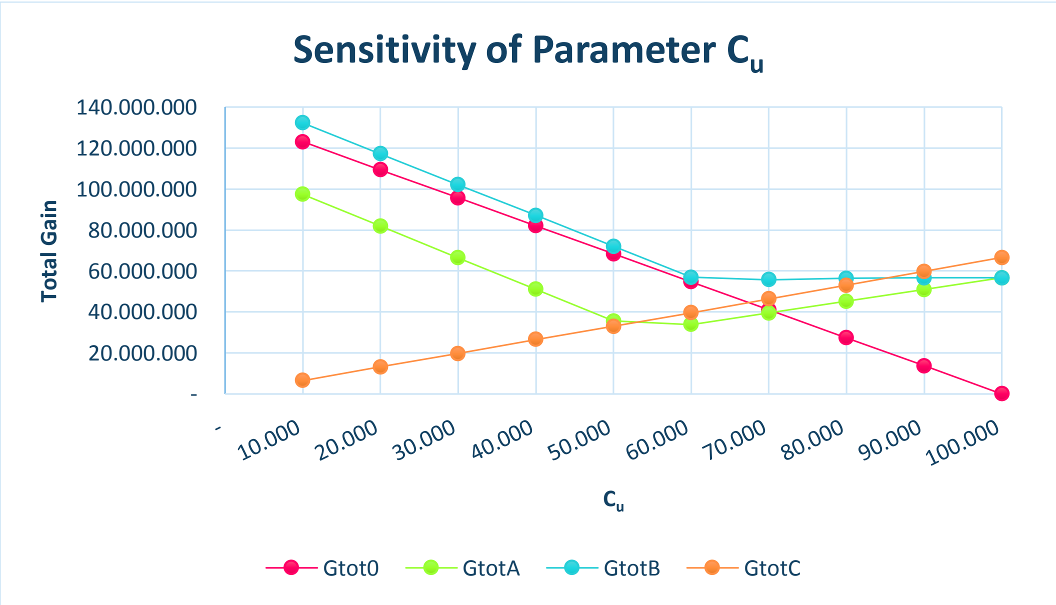


Figure 5.20 Sensitivity of Parameter C_u

Figure 5.20 is the graphical illustration of sensitivity analysis of parameter C_u. The result of the sensitivity analysis shows that when the value of C_u is less than Rp 90.000, Scenario B remains the best pricing scenario for Attaqi. However, when the value of C_u reaches Rp 90.000 and above, the maximum total gain occurs in Scenario C.

5.3.4 Sensitivity Analysis of Parameter ρ

In this section, parameter ρ is evaluated to see how the changes on its value affects the total gain. Below is the summary of sensitivity analysis of parameter ρ.

Table 5.13 Sensitivity Analysis of Parameter ρ

ρ	Gtot0	GtotA	GtotB	GtotC	Best Scenario
0,10	61.562.127	43.308.055	408.939.103	527.427.238	C
0,20	63.210.774	40.788.499	183.707.206	211.622.458	C
0,30	64.859.421	38.268.944	110.393.041	110.393.041	B or C
0,40	66.508.068	35.749.388	75.052.818	62.702.303	B
0,51	68.306.805	36.103.160	71.175.000	37.461.000	B
0,60	69.805.362	37.298.538	73.998.881	18.134.379	B
0,70	71.454.009	48.577.470	77.485.387	15.329.674	B
0,80	73.102.656	59.192.779	82.253.492	13.681.048	B
0,90	74.751.303	70.298.770	88.303.198	12.032.421	B
1,00	76.399.950	82.010.354	95.634.504	10.383.794	B

Table 5.13 shows the summary of sensitivity analysis done towards parameter ρ (enclosed). Based on the data above, below is the graphical illustration for sensitivity analysis of parameter ρ.

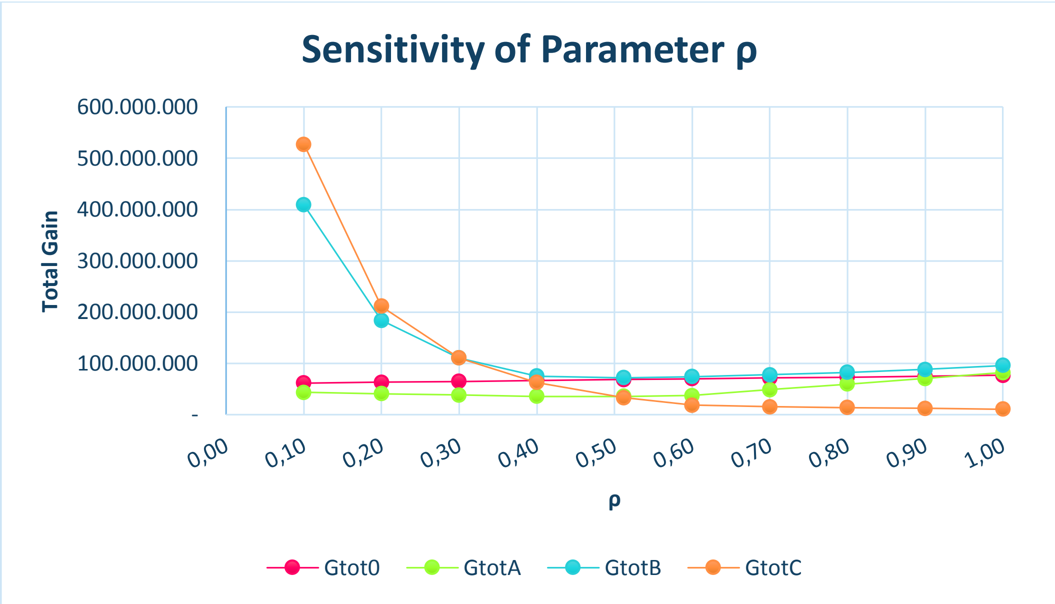


Figure 5.21 Sensitivity of Parameter ρ

Figure 5.21 is the graphical illustration of sensitivity analysis of parameter ρ. The result of the sensitivity analysis shows that when the value of ρ is equal to 0.4 or above, Scenario B remains the best pricing scenario for Attaqi. Then, when the value of ρ reaches 0.3, the maximum total gain occurs in both Scenario B and Scenario C, hence either of the scenario will provide Attaqi the best financial performance. However, when the value of ρ is less than 0.3, the maximum total gain occurs in Scenario C.

5.3.5 Sensitivity Analysis of Parameter η

Sensitivity analysis is done to parameter η to see how the changes on its value affects the total gain. Below is the summary of sensitivity analysis of parameter η.

Table 5.14 Sensitivity Analysis of Parameter η

η	Gtot0	GtotA	GtotB	GtotC	Best Scenario
0,10	57.550.548	27.692.222	645.758.069	367.687.152	B
0,20	59.644.926	26.228.474	303.083.646	154.634.524	B
0,30	61.739.304	24.764.726	183.399.049	85.080.452	B
0,40	63.833.682	23.300.978	124.965.529	51.401.174	B
0,50	65.928.060	21.837.230	91.912.532	32.071.840	B

0,62	68.306.805	36.103.160	71.175.000	37.461.000	B
0,70	70.116.816	49.996.747	59.145.467	31.790.186	0
0,80	72.211.194	64.566.820	58.454.974	30.435.165	0
0,90	74.305.572	79.468.083	60.549.352	29.080.144	A
1,00	76.399.950	94.699.658	62.643.730	27.725.122	A

Table 5.14 shows the summary of sensitivity analysis done towards parameter η (enclosed). Based on the data above, below is the graphical illustration for sensitivity analysis of parameter η.

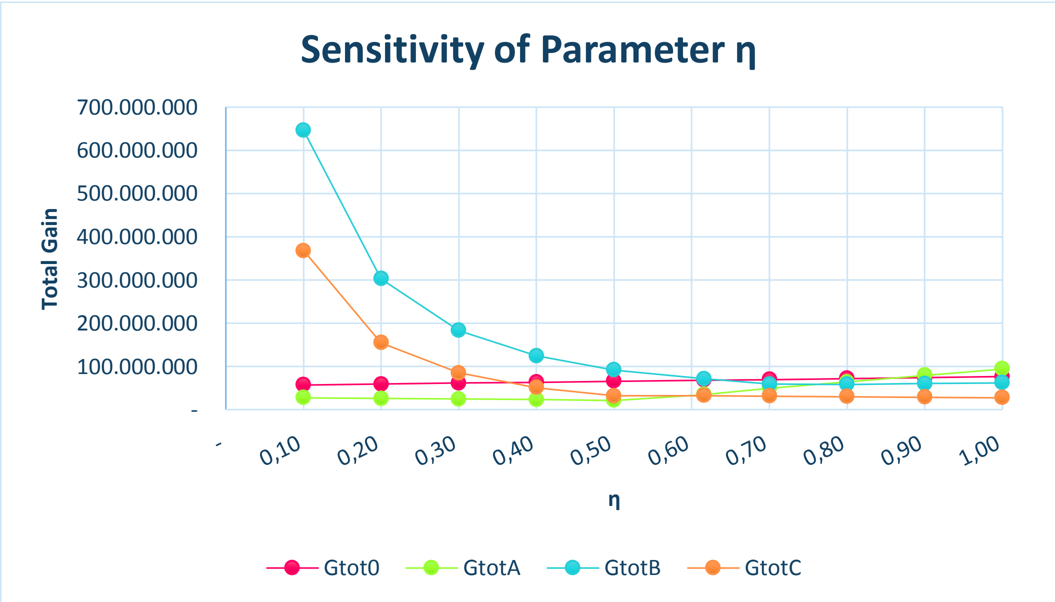


Figure 5.22 Sensitivity of Parameter η

Figure 5.22 is the graphical illustration of sensitivity analysis of parameter η. The result of the sensitivity analysis shows that when the value of η is less than or equal to 0.62, Scenario B remains the best pricing scenario for Attaqi. Moreover, when the value of η is between 0.62 and 0.8, the maximum total gain occurs in Scenario 0, hence it is not neccessary for Attaqi to change its pricing scenario. However, when the value of η is more than 0.9, the maximum total gain occurs in Scenario A.

5.3.6 Sensitivity Analysis of Parameter ρ and η

In this section, sensitivity analysis is done towards parameter ρ and η simultaneously. The aim of this sensitivity analysis is to see how the interaction between ρ and η affects the total gain. This sensitivity analysis is done by MATLAB using *meshgrid* syntax. The scenario to be evaluated in this sensitivity analysis is Secnario 0 and B, since both scenario generate almost equal value in the total gain. Assuming that the other parameters and variables are fixed, and both ρ and η are matrix, below are the 3-D plotting of each gain function.

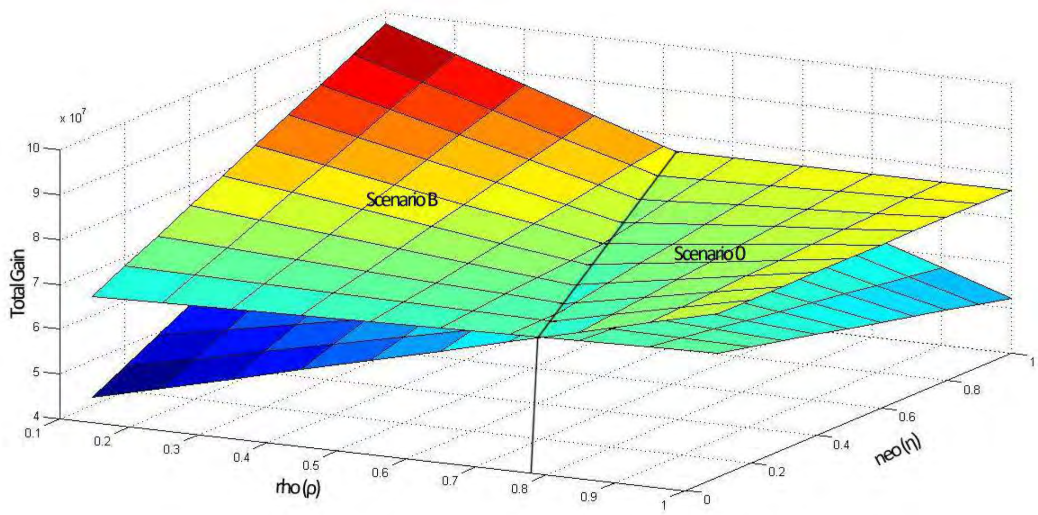


Figure 5.23 3-D Plotting of Total Gain Scenario 0 and B

Figure 5.23 shows the 3D plotting of fain function in each scenario. The x-axis, y-axis, and z-axis are ρ, η, and total gain respectively. From Figure 5.23 can be observed that the interaction between ρ and η caused maximum gain occurs in Scenario 0 when the value of ρ is approximately between 0.8 to 1, however when the value of ρ is between 0.1 to 0.8, the maximum gain occurs in Scenario B. This sensitivity analysis shows how the interaction between parameter ρ and η affects total gain for Scenario 0 and Scenario B. This will be useful for Attaqi to reconsider their pricing scenario when there is change in customer behaviour in the future.

5.4 Managerial Implication

Based on the experiment done on pricing scenario in this research, there are some points for Attaqi to consider, such as:

1. Different scenario provides different financial performance.
2. With the existing condition (parameters), Scenario B (offline and online cooperation) will generate higher profit for Attaqi compared to its existing pricing scenario.
3. Cooperating offline and online channel is the best scenario for Attaqi, not only because it generates highest profit, but also because it is applicable since both offline and online channel are managed directly by Attaqi itself.
4. The decision on the best pricing scenario is not absolute decision, since it can be changed in the future, regarding the changes in system conditions.
5. The parameters that affect the total gain the most are in the following order: customer's channel preference of reseller channel compared to offline channel (η), customer's channel preference of reseller channel compared to offline channel (ρ), unit cost (C_u), and maximum amount of demand (d_s^{max}).

CHAPTER 6
CONCLUSION AND RECOMMENDATION

This chapter contains the conclusions based on the research and provides the recommendations for further research.

6.1 Conclusions

There are several points that can be concluded from this research, which are:

1. The existing pricing scenario of Attaqi sets the same price in all offline, online, and reseller channel. It means that in the price determination, customer’s channel preference is not considered. There is also a tendency for channel conflict in Attaqi since each channel is individually managed. This research shows that the existing pricing scenario does not provide the best financial performance for Attaqi.
2. By considering customer’s channel preference based on the dual channel supply chain concept, three alternative pricing scenarios are developed in order to see which scenario provides the best financial peformance for Attaqi. The first pricing scenario is Non-cooperative scenario, where offline, online, and reseller channel are independently managed. The second scenario is Semi-cooperative scenario, where online and offline channel form a coordination, while reseller channel is independently managed. The third scenario is Fully-cooperative scenario, where all offline, online, and reseller channel form a coordination in meeting customer’s demand. Different profitability (gain) function is developed for each scenario based on the characteristic of the scenario itself, resulting in different optimum price for each channel in all scenarios.
3. Different pricing scenario provides different financial performance. In this research, it is shown that Semi-cooperative scenario, alongside the existing condition (parameters), generates the best financial performance, resulting in the highest profit for Attaqi. This scenario is applicable since both

offline and online channel are managed directly by Attaqi itself. However, the decision about the best pricing scenario is not an absolute decision, since it can be changed in the future regarding the changes in system conditions. Several sensitivity analysis are done to see which parameter is critical to the total gain. The research shows that the parameter that affects the total gain the most are in the following order: customer's channel preference of reseller channel compared to offline channel, customer's channel preference of reseller channel compared to offline channel, unit cost, maximum amount of demand, and demand elasticity in price.

6.2 Recommendations

Below are several recommendations given based on the result of this research.

1. Pricing strategy needs to be evaluated periodically to make sure that the strategy used is still able to generate the best financial performance. Evaluation is also needed to be done when there is change in the system condition (parameters).
2. To what extend the degree of cooperation between channels should be undertaken has not been explored in detail.
3. To capture the reality, the setting of demand function is better off in non-stationary condition.
4. This research can be developed by evaluating a bigger scope of the supply chain system, where in Attaqi and in some other similar business, the reseller channel expands their channel by adding their own online channel.

ENCLOSURE

Enclosure 1 – Questionnaires of Customer's Channel Preference

Dear Sir/Madam,

I am Rizky Astari Rahmania, a student of Industrial Engineering Department of ITS Surabaya who is currently working on a final project which is titled **"OFFLINE, ONLINE, AND RESELLER PRICING STRATEGIES UNDER DUAL-CHANNEL SUPPLY CHAIN STRUCTURE".** Therefore, I expect the willingness of Sir/Madam to fill out the questionnaire about customer's acceptance towards online and reseller channel in an apparel business.

Thank you for your attention and consideration.

DATA OF RESPONDENT

Name : ....
Occupation : ....
Age : .... years old
Sex : Male/Female

A. ILLUSTRATION

Product Name: Hijab
Material: Chiffon Cerutti
Price: Rp 99.000,00

PT X is a moslemwear manufacturer that produce various product both for women and men. One of the product that PT X sells is hijab as seen as the picture above. That hijab is marketed by PT X through variety of ways, which are through PT X's showroom where the customers can see and try the product, through PT X's website where customers buy the product via online and the product will be shipped directly to the customers, and through reseller or third party who works for PT X in marketing their product.

B. CHARACTERISTICS OF RESPONDENTS

1. Have you ever bought hijab or similar products?
    a. YES   b. NO

2. Have you done online shopping before?
    a. YES
    b. NO, because
        - Risk of fraud
        - Inability of trying the product
        - Waiting time
        - Other: ....

3. Have you ever bought product through reseller or third party before?
    a. YES
    b. NO, because
        - Risk of counterfait goods
        - No reseller acquaintance
        - Other: ....

C. CUSTOMER'S CHANNEL PREFERENCE

4. Assuming that the score of your desire of buying the product **in the showroom/store** is **100**, how much would you score your desire to buy the **same product** from **website (online)?**
   (fill the score between 0-100)

5. Assuming that the score of your desire of buying the product **in the showroom/store** is **100**, how much would you score your desire to buy the **same product** from **third party (reseller)?**
   (fill the score score between 0-100)

Enclosure 2 – Recapitulation of Questionnaires

No.	Nama	Pekerjaan	Usia	Gender	1	2	3	4	5
1	Ana Zuqaidah	Housewife	39	FEMALE	YES	YES	80	YES	80
2	Sayeti	Housewife	35	FEMALE	YES	YES	50	YES	50
3	Yuni	Housewife	39	FEMALE	YES	YES	50	YES	25
4	Defin	Housewife	37	FEMALE	YES	NO	50	YES	80
5	Sinta M.	Housewife	47	FEMALE	YES	YES	80	YES	90
6	Elis Z. M.	Housewife	47	FEMALE	YES	YES	85	YES	80
7	Joejoen	Housewife	44	FEMALE	YES	YES	50	YES	70
8	Yayik	Housewife	43	FEMALE	YES	YES	70	YES	85
9	Kasy	Housewife	51	FEMALE	YES	YES	10	YES	50
10	Isni Yuli	Housewife	51	FEMALE	YES	YES	5	YES	10
11	Nurul Hatimah	Housewife	44	FEMALE	YES	YES	55	YES	60
12	Agustini Widowati	Housewife	47	FEMALE	YES	YES	40	YES	70
13	Ratna	Employee	40	FEMALE	YES	YES	10	YES	30
14	Amelia Bouty	Housewife	53	FEMALE	YES	YES	70	YES	85
15	Ntuk	Housewife	48	FEMALE	YES	YES	50	YES	60
16	Machfudotin	Housewife	54	FEMALE	YES	YES	50	YES	60
17	Agung WP Andika	Housewife	53	FEMALE	YES	YES	50	YES	60
18	Endang Handayani	Housewife	60	FEMALE	YES	YES	50	YES	50
19	Rini Thomas	Housewife	59	FEMALE	YES	YES	80	YES	70
20	Ediningtyas	Dentist	52	FEMALE	YES	YES	65	YES	75
21	Sofya	Employee	42	FEMALE	YES	YES	50	YES	50
22	Heni	Wirausaha	38	FEMALE	YES	YES	20	YES	20
23	Yanti	Wirausaha	37	FEMALE	YES	YES	55	YES	80
24	Siska Iskandar	Housewife	45	FEMALE	YES	YES	30	YES	70
25	Ayu	Wirausaha	39	FEMALE	YES	YES	60	YES	60
26	Aditya S. Sari	Co Assistant	22	FEMALE	YES	YES	50	YES	75
27	Anya Azaria	Student	23	FEMALE	YES	YES	50	YES	80
28	Arkanty	Student	23	FEMALE	YES	YES	70	YES	85
29	Binar Larasanti	Co Assistant	22	FEMALE	YES	YES	45	YES	60
30	Diandra	Student	22	FEMALE	YES	YES	80	YES	80
31	Diah Ariesa	Student	22	FEMALE	YES	YES	60	YES	60
32	Hesty R. F.	Co Assistant	22	FEMALE	YES	YES	50	YES	50
33	Jeco	Co Assistant	22	FEMALE	YES	YES	30	YES	50
34	Pury Pratiwi	Co Assistant	22	FEMALE	YES	YES	60	YES	70
35	Putri Fary	Student	23	FEMALE	YES	YES	5	YES	20
36	Fatmah	Student	21	FEMALE	YES	YES	50	YES	50
37	Safana D.	Student	22	FEMALE	YES	YES	60	YES	70
38	Evita Karina	Student	22	FEMALE	YES	YES	70	YES	70

Enclosure 3 – MATLAB m-file Script of Gain Function

❖ Scenario A (Offline)

```
function[Gs]=skenarioAs(Ps)
rho=0.51;neo=0.61;dmax=858;alfa1=0.00000001;beta1=0.00005;beta2=0.
00001;Po=51180;Pr=50000;Cu=50000;
Gs=((1-rho*neo)*dmax-alfa1*Ps+beta1*Po+beta2*Pr)*(Ps-Cu);
end
```

❖ Scenario A (Online)

```
function[Go]=skenarioAo(Po)
rho=0.51;dmax=858;alfa2=0.0027;beta3=0.001;beta4=0.00001;Ps=100000
;Pr=100000;Cu=50000;
Go=(rho*dmax-alfa2*Po+beta3*Ps+beta4*Pr)*(Po-Cu);
end
```

❖ Scenario A (Reseller)

```
function[Gr]=skenarioAr(Pr)
neo=0.61;dmax=858;alfa3=0.0013;beta5=0.00001;beta6=0.00005;Ps=1000
00;Po=51180;Cu=50000;
Gr=(neo*dmax-alfa3*Pr+beta5*Ps+beta6*Po)*(Pr-Cu);
end
```

❖ Scenario B (Online-Offline)

```
function[Gso]=skenarioBso(P)
rho=0.51;neo=0.61;dmax=858;alfa1=0.00000001;alfa2=0.0027;beta1=0.0
0005;beta2=0.00001;beta3=0.001;beta4=0.00001;Pr=100000;Cu=50000;
Gso=((1-rho*neo)*dmax-alfa1*P(1)+beta1*P(2)+beta2*Pr)*(P(1)-
Cu)+(rho*dmax-alfa2*P(2)+beta3*P(1)+beta4*Pr)*(P(2)-Cu);
end
```

❖ Scenario B (Reseller)

```
function[Gr]=skenarioBr(Pr)
neo=0.61;dmax=858;alfa3=0.0013;beta5=0.001;beta6=0.00005;Ps=100000
;Po=100000;Cu=50000;
Gr=-((neo*dmax-alfa3*Pr+beta5*Ps+beta6*Po)*(Pr-Cu));
end
```

❖ Scenario C

```
function[Gsor]=skenarioCsor(P)
rho=0.51;neo=0.61;dmax=858;alfa1=0.00000001;alfa2=0.0027;alfa3=0.0
013;beta1=0.00005;beta2=0.00001;beta3=0.001;beta4=0.00001;beta5=0.
001;beta6=0.00005;Cu=50000;
Gsor=-(((1-rho*neo)*dmax-alfa1*P(1)+beta1*P(2)+beta2*P(3))*(P(1)-
Cu)+(rho*dmax-alfa2*P(2)+beta3*P(1)+beta4*P(3))*(P(2)-
Cu)+(neo*dmax-alfa3*P(3)+beta5*P(1)+beta6*P(3))*(P(3)-Cu));
end
```

Enclosure 4 – Validation for Offline Demand Function

dsmax	Cu	rho	neo	alfa1	alfa2	alfa3	beta1	beta2	beta3	beta4	beta5	beta6	Ps	Po	Pr	Ds	Do	Dr
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	100.000	1588	1439	1528
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	90.000	100.000	100.000	1688	1339	1428
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	80.000	100.000	100.000	1788	1239	1328
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	70.000	100.000	100.000	1888	1139	1228
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	60.000	100.000	100.000	1988	1039	1128
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	50.000	100.000	100.000	2088	939	1028
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	40.000	100.000	100.000	2188	839	928
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	30.000	100.000	100.000	2288	739	828
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	20.000	100.000	100.000	2388	639	728
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	10.000	100.000	100.000	2488	539	628

Enclosure 5 – Validation for Online Demand Function

dsmax	Cu	rho	neo	alfa1	alfa2	alfa3	beta1	beta2	beta3	beta4	beta5	beta6	Ps	Po	Pr	Ds	Do	Dr
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	100.000	1588	1439	1528
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	90.000	100.000	1488	1539	1428
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	80.000	100.000	1388	1639	1328
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	70.000	100.000	1288	1739	1228
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	60.000	100.000	1188	1839	1128
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	50.000	100.000	1088	1939	1028
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	40.000	100.000	988	2039	928
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	30.000	100.000	888	2139	828
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	20.000	100.000	788	2239	728
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	10.000	100.000	688	2339	628

Enclosure 6 – Validation for Reseller Demand Function

dsmax	Cu	rho	neo	alfa1	alfa2	alfa3	beta1	beta2	beta3	beta4	beta5	beta6	Ps	Po	Pr	Ds	Do	Dr
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	100.000	1588	1439	1528
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	90.000	1488	1339	1628
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	80.000	1388	1239	1728
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	70.000	1288	1139	1828
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	60.000	1188	1039	1928
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	50.000	1088	939	2028
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	40.000	988	839	2128
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	30.000	888	739	2228
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	20.000	788	639	2328
858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	100.000	10.000	688	539	2428

Enclosure 7 – Validation for Total Gain of Scenario A

No	Parameter													Scenario A						GAIN TOTAL
	dmax	Cu	rho	neo	a1	a2	a3	b1	b2	b3	b4	b5	b6	Ps	Po	Pr	Ds	Do	Dr	
1	858	10.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	97.347.851
2	858	20.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	81.896.280
3	858	30.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	66.444.709
4	858	40.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	50.993.138
5	858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	35.541.567
6	858	60.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	20.089.996
7	858	70.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	4.638.425
8	858	80.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	(10.813.147)
9	858	90.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	(26.264.718)
10	858	100.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	100.000	51.180	60.000	591	402	553	(41.716.289)

Enclosure 8 – Validation for Total Gain of Scenario B

No	Parameter													Scenario B						GAIN TOTAL
	dmax	Cu	rho	neo	a1	a2	a3	b1	b2	b3	b4	b5	b6	Ps	Po	Pr	Ds	Do	Dr	
1	858	10.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	132.281.194
2	858	20.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	117.207.761
3	858	30.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	102.134.328
4	858	40.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	87.060.895
5	858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	71.987.462
6	858	60.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	56.914.029
7	858	70.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	41.840.596
8	858	80.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	26.767.163
9	858	90.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	11.693.730
10	858	100.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	120.000	61.416	100.000	592	394	521	(3.379.703)

Enclosure 9 – Validation for Total Gain of Scenario C

No	Parameter													Scenario C						GAIN TOTAL
	dmax	Cu	rho	neo	a1	a2	a3	b1	b2	b3	b4	b5	b6	Ps	Po	Pr	Ds	Do	Dr	
1	858	10.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	94.747.804
2	858	20.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	79.293.970
3	858	30.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	63.840.137
4	858	40.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	48.386.303
5	858	50.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	32.932.469
6	858	60.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	17.478.635
7	858	70.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	2.024.802
8	858	80.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	(13.429.032)
9	858	90.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	(28.882.866)
10	858	100.000	0,51	0,62	0,00000001	0,0027	0,0013	0,00005	0,00001	0,001	0,00001	0,001	0,00005	97.694	50.000	58.617	591	402	552	(44.336.699)

Enclosure 10 – Sensitivity Analysis of Parameter d_s^{max}

dmax	Scenario 0							Scenario A						
	Ps	Po	Pr	Ds	Do	Dr	Gtot0	Ps	Po	Pr	Ds	Do	Dr	GtotA
858	100.000	100.000	100.000	578	260	528	68.351.255	100.000	51.180	60.000	573	585	823	36.103.160
750	100.000	100.000	100.000	520	215	437	58.564.378	100.000	51.180	60.000	517	346	486	37.100.060
650	100.000	100.000	100.000	451	164	375	49.502.454	100.000	51.180	60.000	448	295	425	27.012.493
550	100.000	100.000	100.000	383	112	314	40.440.530	100.000	51.180	60.000	380	244	363	22.911.977
450	100.000	100.000	100.000	314	61	252	31.378.607	100.000	51.180	60.000	311	193	302	18.811.461
950	100.000	100.000	100.000	657	317	560	76.688.225	100.000	51.180	60.000	654	449	609	39.314.041
1050	100.000	100.000	100.000	725	368	621	85.750.149	100.000	51.180	60.000	722	500	671	43.414.558
1150	100.000	100.000	100.000	794	420	683	94.812.073	100.000	51.180	60.000	791	551	733	47.515.074
1250	100.000	100.000	100.000	862	471	745	103.873.996	100.000	51.180	60.000	859	602	794	51.615.590
1350	100.000	100.000	100.000	931	522	806	112.935.920	100.000	51.180	60.000	928	653	856	55.716.106
350	100.000	100.000	100.000	246	10	190	22.316.683	100.000	51.180	60.000	243	142	240	14.710.945
250	100.000	100.000	100.000	177	0	129	15.307.259	100.000	51.180	60.000	174	90	178	10.610.429
150	100.000	100.000	100.000	109	0	67	8.804.336	97.694	50.000	58.617	106	40	116	6.049.450
50	100.000	100.000	100.000	40	0	6	2.301.412	97.694	50.000	58.617	37	0	55	2.252.406

dmax	Scenario B							Scenario C							Best Scenario
	Ps	Po	Pr	Ds	Do	Dr	GtotB	Ps	Po	Pr	Ds	Do	Dr	GtotC	
858	120.000	61.416	100.000	528	593	533	71.175.000	97.694	50.000	58.617	591	402	552	37.461.000	B
750	120.000	61.416	100.000	518	339	455	62.853.941	97.694	50.000	58.617	517	347	486	28.831.668	B
650	120.000	61.416	100.000	449	288	393	54.396.977	97.694	50.000	58.617	448	296	424	25.034.630	B
550	120.000	61.416	100.000	381	237	332	45.940.013	97.694	50.000	58.617	380	245	363	21.237.592	B
450	120.000	61.416	100.000	312	185	270	37.483.049	97.694	50.000	58.617	311	194	301	17.440.554	B
950	120.000	61.416	100.000	655	441	578	79.767.869	97.694	50.000	58.617	654	449	609	36.425.744	B
1050	120.000	61.416	100.000	723	493	640	88.224.833	97.694	50.000	58.617	722	501	670	40.222.782	B
1150	120.000	61.416	100.000	792	544	701	96.681.797	97.694	50.000	58.617	791	552	732	44.019.820	B
1250	120.000	61.416	100.000	860	595	763	105.138.761	97.694	50.000	58.617	859	603	794	47.816.858	B

dmax	Scenario B							Scenario C							Best Scenario
	Ps	**Po**	**Pr**	**Ds**	**Do**	**Dr**	**GtotB**	**Ps**	**Po**	**Pr**	**Ds**	**Do**	**Dr**	**GtotC**	
1350	120.000	61.416	100.000	929	646	824	113.595.725	97.694	50.000	58.617	928	654	855	51.613.896	B
350	120.000	61.416	100.000	244	134	209	29.026.085	97.694	50.000	58.617	243	142	239	13.643.516	B
250	120.000	61.416	100.000	175	83	147	20.569.120	97.694	50.000	58.617	174	91	178	9.846.478	B
150	120.000	61.416	100.000	107	32	85	12.112.156	97.694	50.000	58.617	106	40	116	6.049.440	B
50	103.146	52.790	85.611	38	0	25	2.905.761	108.760	50.000	65.250	37	0	57	3.069.973	B

Enclosure 11 – Sensitivity Analysis of Parameter C_u

Cu	Scenario 0							Scenario A						
	Ps	Po	Pr	Ds	Do	Dr	Gtot0	Ps	Po	Pr	Ds	Do	Dr	GtotA
50.000	100.000	100.000	100.000	578	260	528	68.306.805	100.000	51.180	60.000	573	585	823	36.103.160
60.000	100.000	100.000	100.000	578	260	528	54.681.004	117.233	60.000	60.000	591	395	571	33.838.037
70.000	100.000	100.000	100.000	578	260	528	41.010.753	136.772	70.000	70.000	592	388	578	39.517.760
80.000	100.000	100.000	100.000	578	260	528	27.340.502	156.311	80.000	80.000	592	380	585	45.208.926
90.000	100.000	100.000	100.000	578	260	528	13.670.251	175.850	90.000	90.000	593	373	592	50.911.535
100.000	100.000	100.000	100.000	578	260	528	-	195.389	100.000	100.000	594	366	599	56.625.587
40.000	100.000	100.000	100.000	578	260	528	82.021.506	100.000	51.180	60.000	591	402	553	50.993.138
30.000	100.000	100.000	100.000	578	260	528	95.691.757	100.000	51.180	60.000	591	402	553	66.444.709
20.000	100.000	100.000	100.000	578	260	528	109.362.009	100.000	51.180	60.000	591	402	553	81.896.280
10.000	100.000	100.000	100.000	578	260	528	123.032.260	100.000	51.180	60.000	591	402	553	97.347.851

Cu	Scenario B							Scenario C							Best Scenario
	Ps	Po	Pr	Ds	Do	Dr	GtotB	Ps	Po	Pr	Ds	Do	Dr	GtotC	
50.000	120.000	61.416	100.000	528	593	533	71.175.000	97.694	50.000	58.617	628	627	853	37.461.000	B
60.000	120.000	61.416	100.000	592	394	521	56.914.029	117.230	60.000	70.340	591	395	557	39.601.993	B
70.000	136.772	70.000	100.000	592	388	539	55.694.075	136.772	70.000	82.063	592	388	562	46.303.710	B
80.000	156.311	80.000	100.000	593	380	559	56.395.821	156.311	80.000	93.787	593	380	567	53.031.768	B
90.000	175.850	90.000	100.000	593	373	579	56.706.325	175.850	90.000	105.510	593	373	571	59.788.137	C
100.000	195.389	100.000	100.000	594	366	599	56.625.587	195.389	100.000	117.233	594	366	576	66.572.817	C
40.000	120.000	61.416	100.000	592	394	521	87.060.895	78.516	40.000	46.893	590	410	548	26.504.425	B
30.000	120.000	61.416	100.000	592	394	521	102.134.328	58.617	30.000	35.170	589	417	543	19.674.799	B
20.000	120.000	61.416	100.000	592	394	521	117.207.761	39.078	20.000	23.447	589	424	538	13.088.399	B
10.000	120.000	61.416	100.000	592	394	521	132.281.194	19.539	10.000	11.723	588	432	533	6.529.778	B

Enclosure 12 – Sensitivity Analysis of Parameter ρ

ρ	Scenario 0							Scenario A						
	Ps	Po	Pr	Ds	Do	Dr	Gtot0	Ps	Po	Pr	Ds	Do	Dr	GtotA
0,51	100.000	100.000	100.000	578	260	528	68.306.805	100.000	51.180	60.000	573	585	823	36.103.160
0,60	100.000	100.000	100.000	547	346	503	69.805.362	100.000	60.000	60.000	545	453	553	37.298.538
0,70	100.000	100.000	100.000	494	432	503	71.454.009	109.640	70.000	65.785	492	522	556	48.577.470
0,80	100.000	100.000	100.000	441	517	503	73.102.656	117.980	80.000	70.785	440	589	558	59.192.779
0,90	100.000	100.000	100.000	389	603	503	74.751.303	126.310	90.000	75.785	388	656	561	70.298.770
1,00	100.000	100.000	100.000	336	689	503	76.399.950	134.790	100.000	80.875	336	724	563	82.010.354
0,40	100.000	100.000	100.000	653	174	503	66.508.068	97.694	50.000	58.617	650	306	552	35.749.388
0,30	100.000	100.000	100.000	706	88	503	64.859.421	97.694	50.000	58.617	703	221	552	38.268.944
0,20	100.000	100.000	100.000	758	3	503	63.210.774	97.694	50.000	58.617	755	135	552	40.788.499
0,10	100.000	100.000	100.000	811	0	503	61.562.127	97.694	50.000	58.617	808	49	552	43.308.055

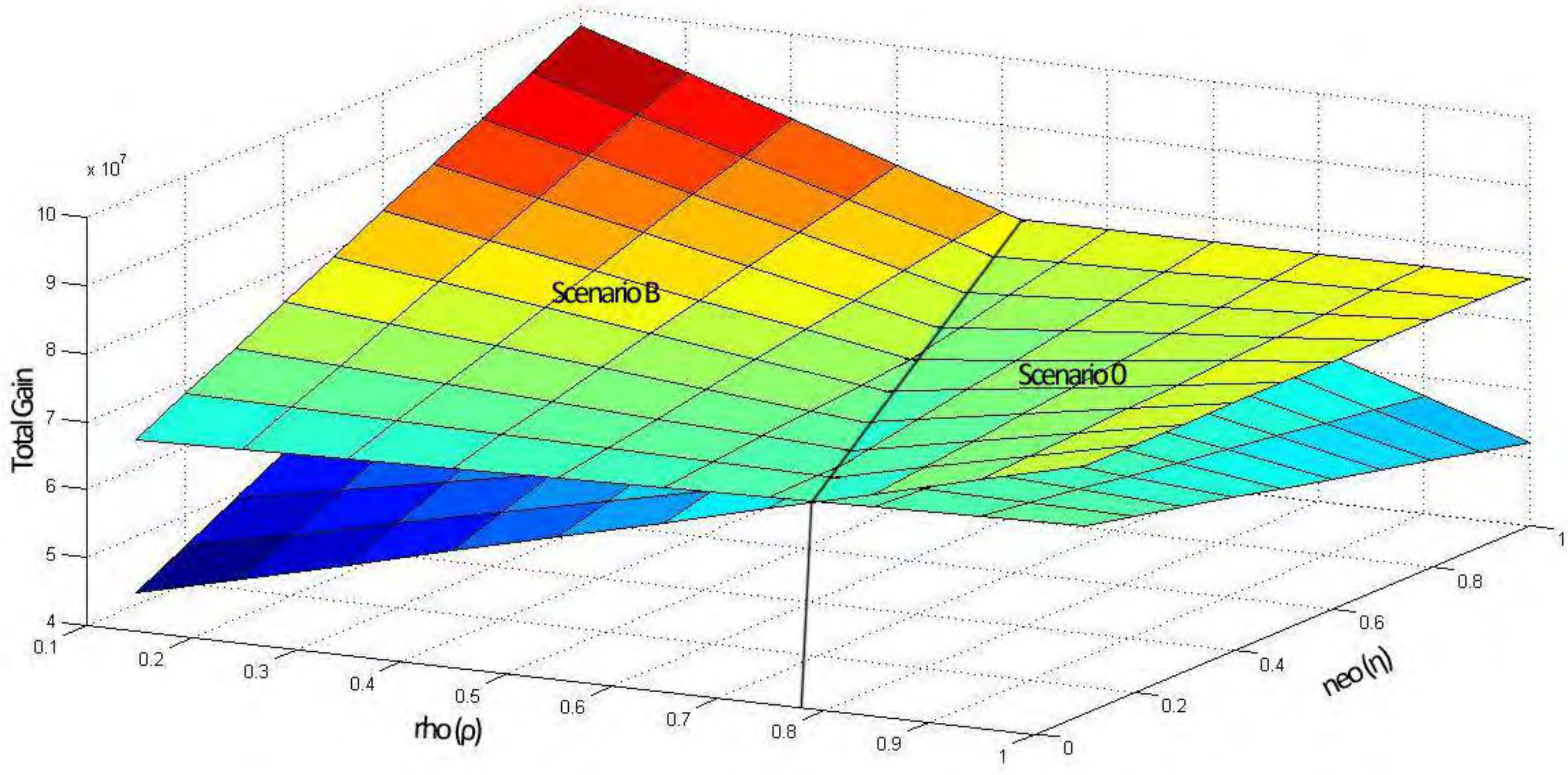
ρ	Scenario B							Scenario C							Best Scenario
	Ps	Po	Pr	Ds	Do	Dr	GtotB	Ps	Po	Pr	Ds	Do	Dr	GtotC	
0,51	120.000	61.416	100.000	528	593	533	71.175.000	97.694	50.000	58.617	628	627	853	37.461.000	B
0,60	120.000	72.000	100.000	546	441	522	73.998.881	83.333	50.000	50.000	544	464	549	18.134.379	B
0,70	120.000	84.000	100.000	493	495	522	77.485.387	81.208	50.000	50.000	491	547	547	15.329.674	B
0,80	120.000	96.000	100.000	441	548	523	82.253.492	81.208	50.000	50.000	438	633	547	13.681.048	B
0,90	120.000	108.000	100.000	389	602	524	88.303.198	81.208	50.000	50.000	386	719	547	12.032.421	B
1,00	120.000	120.000	100.000	337	655	524	95.634.504	81.208	50.000	50.000	333	805	547	10.383.794	B
0,40	125.000	50.000	100.000	650	334	526	75.052.818	125.000	50.000	75.000	650	334	558	62.702.303	B
0,30	166.670	50.000	100.000	703	290	567	110.393.041	166.670	50.000	100.000	703	290	567	110.393.041	B or C
0,20	250.000	50.000	100.000	756	288	651	183.707.206	250.000	50.000	153.925	756	288	581	211.622.458	C
0,10	500.000	50.000	100.000	809	452	901	408.939.103	500.000	50.000	307.850	811	454	631	527.427.238	C

Enclosure 13 – Sensitivity Analysis of Parameter η

η	Scenario 0							Scenario A						
	Ps	Po	Pr	Ds	Do	Dr	Gtot0	Ps	Po	Pr	Ds	Do	Dr	GtotA
0,62	100.000	100.000	100.000	578	260	528	68.306.805	100.000	51.180	60.000	573	585	823	36.103.160
0,70	100.000	100.000	100.000	557	270	576	70.116.816	116.670	51.180	70.000	554	418	629	49.996.747
0,80	100.000	100.000	100.000	513	270	661	72.211.194	133.333	51.180	80.000	510	435	718	64.566.820
0,90	100.000	100.000	100.000	469	270	747	74.305.572	150.000	51.180	90.000	466	452	808	79.468.083
1,00	100.000	100.000	100.000	425	270	833	76.399.950	166.670	51.180	100.000	422	469	897	94.699.658
0,50	100.000	100.000	100.000	644	270	404	65.928.060	83.333	51.180	50.000	641	385	450	21.837.230
0,40	100.000	100.000	100.000	688	270	318	63.833.682	83.333	51.180	50.000	685	385	364	23.300.978
0,30	100.000	100.000	100.000	732	270	232	61.739.304	83.333	51.180	50.000	729	385	278	24.764.726
0,20	100.000	100.000	100.000	776	270	147	59.644.926	83.333	51.180	50.000	773	385	192	26.228.474
0,10	100.000	100.000	100.000	820	270	61	57.550.548	83.333	51.180	50.000	817	385	107	27.692.222

neo	Scenario B							Scenario C							Best Scenario
	Ps	Po	Pr	Ds	Do	Dr	GtotB	Ps	Po	Pr	Ds	Do	Dr	GtotC	
0,62	120.000	61.416	100.000	528	593	533	71.175.000	97.694	50.000	58.617	628	627	853	37.461.000	B
0,70	102.840	52.634	100.000	554	401	576	59.145.467	97.694	50.000	58.617	554	402	625	31.790.186	0
0,80	100.000	50.000	100.000	510	405	659	58.454.974	97.694	50.000	58.617	510	402	710	30.435.165	0
0,90	100.000	50.000	100.000	466	405	745	60.549.352	97.694	50.000	58.617	466	402	796	29.080.144	A
1,00	100.000	50.000	100.000	422	405	831	62.643.730	97.694	50.000	58.617	422	402	882	27.725.122	A
0,50	143.997	73.698	100.000	643	385	447	91.912.532	100.000	50.000	50.000	641	405	467	32.071.840	B
0,40	179.996	92.122	100.000	688	371	398	124.965.529	125.000	50.000	50.000	685	430	406	51.401.174	B
0,30	239.995	122.829	100.000	733	348	374	183.399.049	166.667	50.000	50.000	729	471	362	85.080.452	B
0,20	359.993	184.244	100.000	780	303	411	303.083.646	250.000	50.000	50.000	773	555	359	154.634.524	B
0,10	719.986	368.489	100.000	834	165	694	645.758.069	500.000	50.000	50.000	817	805	523	367.687.152	B

Enclosure 14 – Sensitivity Analysis of Parameter ρ and η



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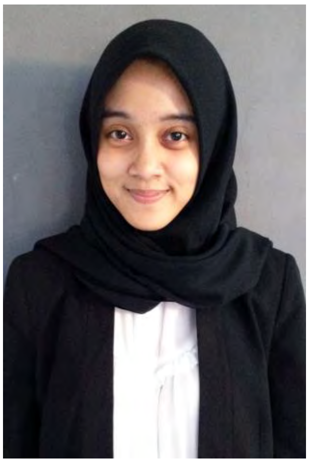
BIOGRAPHY



Rizky Astari Rahmania was born in Grenoble, France, on September 2nd 1992. She received her formal education in KB-TK Yaa Bunayya Surabaya (1995-1999), SD Muhammadiyah 4 Pucang Surabaya (1999-2005), SMP Negeri 1 Surabaya (2005-2008), and SMA Negeri 5 Surabaya (2008-2011). She finished her bachelor degree in 2011, majoring in industrial engineering at Industrial Engineering Department of Institut Teknologi Sepuluh Nopember Surabaya. During college, she was actively participating in various student activities. She was a staff of Student Resource Development Department in Himpunan Mahasiswa Teknik Industri ITS Surabaya during the second year of college. She was also secretary of SRD Department in HMTI ITS Surabaya in 2013-2014. She can be contacted by e-mail: rizky.astari@yahoo.com.