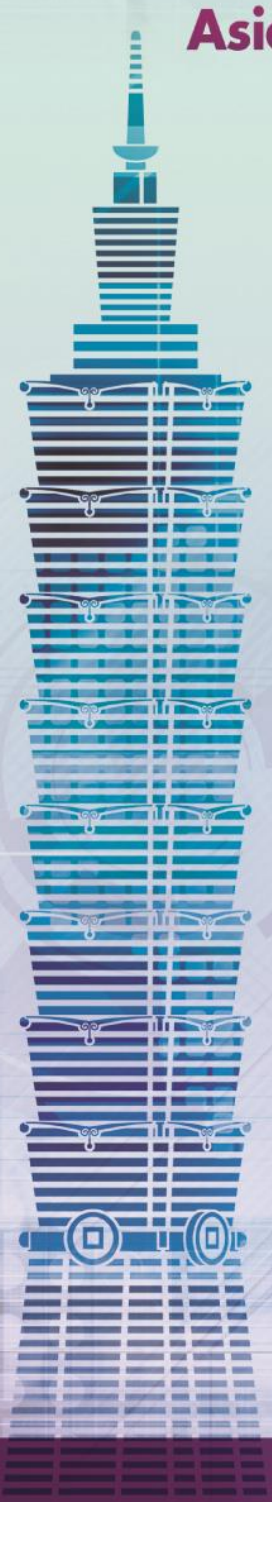
APIEMS
New Era & New Challenge

The 17th (APIEMS 2016)

Asia Pacific Industrial Engineering and Management Systems Conference

Joint with The 3rd East Asia Workshop on Industrial Engineering (EAWIE 2016)
2016 Chinese Institute of Industrial Engineers Annual Conference

December 7-10, 2016
Howard Hotel, Taipei, Taiwan



Organizer :

National Taiwan University of Science and Technology (Taiwan Tech)

Co-Organizer :

Ministry of Science and Technology, Taiwan
Asia Pacific Industrial Engineering and Management Society (APIEMS)
Chinese Institute of Industrial Engineers
National Taipei University of Technology (Taipei Tech)

Abstracting and non-profit use of the material are permitted with credit to the source. Instructors are permitted to photocopy isolated articles for non-commercial use without fee. The authors have the right to republish, in whole or in part, in any publication of which they are authors or editors, and to make other personal use of the work. Any republication or personal use of the work must explicitly identify prior publication in Proceeding of Abstracts and Papers (on USB disk) of the 17th Asia Pacific Industrial Engineering and Management System Conference 2016

Proceeding of Abstracts and Papers (on USB disk) of the 17th Asia Pacific Industrial Engineering and Management System Conference 2016

Copyright ©2016
By the Asia Pacific Industrial Engineering and Management Society

All rights served.

All papers in the proceedings have been peer reviewed by panels from the respective fields.

Responsibility for the contents of these papers rests upon the authors, not the Asia Pacific Industrial Engineering and Management Society and the publisher.

ISBN: 978-986-93997-0-8

APIEMS 2016

Program Book

Table of Contents

Committee

- **Conference Chair**
    - Ching-Jong Liao (Taiwan Tech, Taiwan)

- **Conference Co-Chair**
    - Bernard Jiang (Taiwan Tech, Taiwan)

- **Program Chair**
    - Morris S.K. Fan (Taipei Tech, Taiwan)

- **International Advisory Board**
    - Bagus Arthaya (Universitas Katolik Parahyangan, Indonesia)
    - Andi Cakravastia (Bandung Institute of Technology, Indonesia)
    - Hing Kai Chan (Nottingham University Business School China, China)
    - Chen-Fu Chien (National Tsing Hua University, Taiwan)
    - Anthony Shun Fung Chiu (De La Salle University, Philippines)
    - Richard Y.K. Fung (City University of Hong Kong, Hong Kong)
    - JinWu Gao (Renmin University of China, China)
    - Mitsuo Gen (Waseda University, Japan)
    - Aldy Gunawan (Singapore Management University, Singapore)
    - Chin-Yin Huang (Tunghai University, Taiwan)
    - Guo Quan (George) Huang (University of Hong Kong, Hong Kong)
    - Hark Hwang (KAIST, Korea)
    - Takashi Irohara (Sophia University, Japan)
    - Kazuyoshi Ishii (Kanazawa Institute of Technology, Japan)
    - Chi-Hyuck Jun (POSTECH, Korea)
    - Mooyoung Jung (UNIST, Korea)
    - Voratas Kachitvichyanukul (AIT, Thailand)
    - Byung-In Kim (POSTECH, Korea)
    - Kap Hwan Kim (Pusan National University, Korea)
    - Kwang-Jae Kim (POSTECH, Korea)
    - Hirokazu Kono (Keio University, Japan)
    - Erhan Kozan (Queensland University of Technology, Australia)
    - Kin Keung Lai (City University of Hong Kong, Hong Kong)
    - Jaewook Lee (Seoul National University, Korea)
    - Young Hae Lee (Hanyang University, Korea)
    - Baoding Liu (Tsinghua University, China)
    - Huynh Trung Luong (AIT, Thailand)
    - Kai Ling Mak (The University of Hong Kong, Hong Kong)
    - Ilkyeong Moon (Seoul National University, Korea)
    - Kenichi Nakashima (Kanagawa University, Japan)
    - Hidetaka Nambo (Kanazawa University, Japan)
    - Takashi Oyabu (Kokusai Business Gakuin College, Japan)

  - Jin Peng (Tsinghua University, China)
  - Ho Thanh Phong (International University, Vietnam)
  - Nyoman Pujawan (Institut Teknologi Sepuluh Nopember, Indonesia)
  - Kanchana Sethanan (Khon Kaen University, Thailand)
  - Zahari Taha (Universiti Malaysia Pahang, Malaysia)
  - Kim Hua Tan (Nottingham University, Malaysia)
  - Katsuhiko Takahashi (Hiroshima University, Japan)
  - Kinya Tamaki (Aoyama Gakuin University, Japan)
  - Du-Ming Tsai (Yuan Ze University, Taiwan)
  - Kuo-Ming Wang (Yuan Ze University, Taiwan)
  - Mao Jiun Wang (National Tsing Hua University, Taiwan)
  - Yiming Wei (Beijing Institute of Technology, China)
  - David M.C. Wu (National Chiao Tung University, Taiwan)
  - Shanlin Yang (Hefei University of Technology, China)
  - Sha'ri bin Mohd Yusof (Universiti Teknologi Malaysia, Malaysia)
  - Yon-Chun Chou (National Taiwan University, Taiwan)
  - Min K. Chung (POSTECH, Korea)
  - Abdul Hakim Halim (Bandung Institute of Technology, Indonesia)
  - Tsong-Ming Lin (Nanhua University, Taiwan)
  - Anna Bella Siriban-Manalang (De La Salla University, Philippines)
  - Min Lang Tseng (Lunghwa University of Science and Technology, Taiwan)

- **Organizing Committee**
  - **Chair**
    - Yu-Chung Tsao (Taiwan Tech, Taiwan)
  - **Members**
    - Chia-Fen Chi; Shuo-Yan Chou; Po-Hsun Kuo; Ren-Jieh Kuo; Chiang-Sheng Lee; Cheng-Jhe Lin; Chiuhsiang Joe Lin; Shi-Woei Lin; Shu-Chiang Lin; Yi-Kuei Lin; Shih-Che Lo; Eiji Mizutani; Chao Ou-Yang; Fu-Kwun Wang; Kung-Jeng Wang; Chao-Lung Yang; Ruey-Huei Yeh; Vincent F. Yu; Kuei-Hsiang Ma; Cian-Ci Shyu; Wan-Han Yu (Taiwan Tech, Taiwan)
    - Wen-Hua Chang; Zhen-Hua Che; Hsieh-Ching Chen; Kai-Ying Chen; Chen-Yang Cheng; Chui-Yu Chiu; Chien-Yi Huang; Ying-Yin Huang; Sheau-Farn Liang; Chih-Ping Lin; I-Chen Lin; Rong-Ho Lin; Jiann-Haw Liou; Chung-Cheng Lu; Fang-Chih Tien; Pei-Fang Tsai; Her-Shing Wang; Gwo-Donq Wu; Kuo-Ching Ying (Taipei Tech, Taiwan)
    - Yon-Chun Chou (National Taiwan University, Taiwan)
    - Ching-Jung Ting (Yuan Ze University, Taiwan)
    - Chien-Chih Wang (Ming Chi University, Taiwan)
    - Kuo-Ping Lin; Chih-Hung Jen (Lunghwa University of Science and Technology, Taiwan)
    - Cheng-Fu Huang (Feng Chia University, Taiwan)
    - Ping-Chen Chang (National Quemoy University, Taiwan)

Program at a Glance

Asia Pacific Industrial Engineering and Management Systems Conference (APIEMS 2016)

Day 1: December 7 (Wednesday)	
Registration 17:00 – 20:00 3F, Dragon Hall	Welcome Reception (3F, Dragon Hall) 18:00 – 20:30
Day 2: December 8 (Thursday)	
	Fellow Meeting (3F, Yangtse River) 07:00 – 09:00
Registration 08:00 – 17:00 B2, Lobby	Opening Ceremony 09:00 – 09:30 (B2, Banquet Hall I)
	Keynote Speech I: **Dr. Chi-Ming Chang** 09:30 – 10:30
	Coffee Break
	Keynote Speech II: **Prof. Takashi Oyabu** 11:00 – 12:00
	Lunch (1F, Rainbow Terrace / 4F, Le Louvre) 12:00 – 13:30
	Technical Sessions **A1 – I1**

	Technical Sessions **A1 – J1** 13:30 – 15:00	
	Coffee Break	Board Meeting 14:30 – 17:00 (3F, Yangtse River)
	Technical Sessions **A2 – J2** 15:20 – 16:50	
Day 3: December 9 (Friday)		
Registration 08:30 – 17:00 B2, Lobby	Technical Sessions **A3 – J3** 09:00 – 10:30	
	Coffee Break	
	Technical Sessions **A4 – J4** 10:50 – 12:05	
	Lunch (1F, Rainbow Terrace / 4F, Le Louvre) 12:05 – 13:30	
	Technical Sessions **A5 – J5** 13:30 – 15:00	
	Coffee Break	
	Technical Sessions **A6 – J6** 15:20 – 16:50	
Banquet (B2, Banquet Hall I) 18:00 – 20:30		
Day 4: December 10 (Saturday)		
	Technical Sessions: **A7 – J7** 08:00 – 09:30	
Registration 08:30 – 12:00 B2, Lobby	Keynote Speech III: **Prof. Fugee Tsung** (In Conjunction with CIIE Annual Meeting) 09:30 – 10:30 (B2, Banquet Hall III)	
	Coffee Break	
	Technical Sessions **A8 – J8** 10:50 – 12:05	

Website: http://apiems2016.conf.tw (http://apiems2016.conf.tw)
Email: apiems2016@gmail.com
(mailto:apiems2016@gmail.com)A (mailto:apiems2016@gmail.com)dministrator: Ping-Chen Chang
(mailto:apiems2016@gmail.com)

TAIWAN TECH NATIONAL TAIWAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

G4: Inventory Modeling and Management

ROOM: Meeting Room (CR403) (4F) TIME: Dec. 9 1050-1205

CHAIR: The Jin Ai

G4-1 (PAPER ID: 60)

Optimal sales strategy for seasonal demand with product life cycle considering markdown sales and price sensitivity

Yuta Toki and Etsuko Kusukawa

G4-2 (PAPER ID: 174)

Relationship between fluctuation stock and safety stock

Tomoaki Yamazaki and Keisuke Shida

G4-3 (PAPER ID: 247)

The shortage study of EOQ model with defective and reworked items

Chiang-Sheng Lee, Hsine-Jen Tsai and Christian Bunjamin

G4-4 (PAPER ID: 416)

Forecasting of purchase dependent power demands using vector autoregressive model as basis for inventory policy in a retailer

The Jin Ai, Ririn Diar Astanti, Maria Monika Wardoyo and Huynh Trung Luong

G4-5 (PAPER ID: 454)

Supply chain replenishment for multi-period newsvendor products

Chun-Chin Wei and Liang-Tu Chen

I3: Decision Support System and Expert System

ROOM: Meeting Room (CR406) (4F)

TIME: Dec. 9 0900-1030

CHAIR: Chieh-Yuan Tsai

I3-1 (PAPER ID: 301)

An implicit rating based product recommendation system

Chieh-Yuan Tsai and Sih-Wei Shen

I3-2 (PAPER ID: 374)

Comparison of different sales forecasting techniques for computer servers

I-Fei Chen, Tian-Shyug Lee, Ming Gu and Chi-Jie Lu

I3-3 (PAPER ID: 415)

A buyer vendor coordination model

Ririn Diar Astanti, The Jin Ai, Dah-Chuan Gong and Huynh Trung Luong

I3-4 (PAPER ID: 430)

Implementation of machine learning C4.5 algorithm to forecast regional economic development classification

Hendra M Setiawan and Aditya Wedha

I3-5 (PAPER ID: 308)

The development of behavioral understanding support system for children with developmental disorders

Sakiko Ogoshi, Toru Saitou , Yuuiti Takaku , Yasuhiro Ogoshi , Masahiro Asahara ,Yoshinori Mituhasi, Sinzou Isigami, Seiichiro Miura and Takashi Oyabu.

A Buyer Vendor Coordination Model

Ririn Diar Astanti†, The Jin Ai
Department of Industrial Engineering
Universitas Atma Jaya Yogyakarta, Yogyakarta, Indonesia
Tel: (+62) 274-487711, Email: ririn@mail.uajy.ac.id, jinai@mail.uajy.ac.id

Dah-Chuan Gong
Department of Industrial and Business Management
Chang Gung University, Taoyuan, Taiwan
Email: gongdc@mail.cgu.edu.tw

Huynh Trung Luong
Department of Industrial and Manufacturing Engineering
Asian Institute of Technology, Pathumtani, Thailand
Tel: (+66) 2-5245683, Email: luong@ait.ac.th

Abstract. The research in this paper develops the model for buyer vendor coordination. The developed model is motivated by the real situation of an Original Equipment Manufacturers (OEMs) that supply component automotive industry, repair shop, and automotive dealer (Single Vendor Multiple Buyers) in Indonesia. The fact we got from the case study we observed is that the joint economic lot sizing problem is no longer applicable. This is due to the fact that automotive industry as the buyer operates in Just in Time Environment and has higher bargaining power. Therefore, the OEM has to produce as it is required by the automotive industry. In other side in order fulfill the demand for repair shop and automotive dealer, the vendor do demand consolidation before determining when they have to start production and how many product they have to produce. Based on the case study that we observed, in order for the vendor to meet the target profit, they have to decide about the selling price of the product to be sold for automotive industry, repair shop and automotive dealer. Therefore, the model developed in this paper is trying to answer about the selling price of the product to each type of buyer. Numerical example to show the applicability of the model is shown. In term of managerial implication, the research in this paper can be used by the company as a basis for decision purchasing contract with their buyers.

Keywords: Buyer Vendor Coordination, JIT Environment, Purchasing Contract, OEM, Selling Price

1. INTRODUCTION

The research in this paper is motivated by the result on an observation in a spare part manufacturer (vendor) that supply its product to automotive manufacturer (buyer) where the automotive manufacturer operates under Just-in-Time environment. This vendor also performs as an OEM where they supply the product to the dealer and repair shop. Their buyers can be divided in to two: 1) automotive manufacturers (1st) buyer; 2) dealer (2nd) buyer; 3) repair shop (3rd buyer). Based on the information that has been given by the vendor during the observation, it is known that one of their buyers which is 1st buyer operates in Just-in-Time environment. In this situation, the vendor's production lot size is following the requested demand from the buyer. In addition, the vendor has to deliver the product in small quantities to minimize the buyer's holding cost. This result is actually in line with Khan and Sarker (2002) and Wang (2010) have been stated which is "in Just-in-Time (JIT) environment the buyer prefers to have frequent delivery of small quantities of items by the vendor". David and Eben-Chaime (2003) has also stated that in pull production management system such as JIT, the delivery of the product to the buyer has to be as requested. Therefore, according to David and Eben-Chaime (2003), it is un-economical. Especially when the vendor is trying to have more buffer to response the demand quickly, unless the vendor is applying lean manufacturing concept to be more responsive. Kelle and Miller (1998) also stated that in JIT environment, the situation where the buyer prefers to have small lot size and frequent shipment is called as buyer's dominance. Early researches on determining lot size in JIT manufacturing were conducted by Pan Liao (1989) and Ramasesh (1990). However, the coordination between buyer and vendor was not discussed yet in their research.

For the case of spare part manufacturer that has been mentioned above, the make-to-order contract is implemented to the 2nd buyer and 3rd buyer. It is noted that according to the information from the company it is known that the price offered to the 1st buyer is greater than the price offered to the 2nd buyer or the 3rd buyer. The reason is that for the 2nd and the 3rd buyer, the vendor can do demand consolidation of one dealer to other dealer and also from one repair shop to other repair shop until the quantity reach its economic production quantity.

Ideally, the decision related to the delivery quantity has to be discussed between supplier and buyer or it is called as buyer-vendor coordination. Sarmah et al. (2006) categorized the coordination model in to four. One of them which will be the focus on the research in this paper is vendor's perspective coordination model or it called as decentralized model Toptal and Çetinkaya (2008). This model is trying to maximize vendor's profit through either by:

1. Producing with different lot size policy by giving incentive to the buyer such as vendor offering quantity discount (Banerjee, 1986a). Other research was conducted by Lee and Rosenblatt (1986) who conducted the research on integrated inventory model by assuming that in order to maximize the vendor's yearly net profit, the vendor adopted the KQ policy. KQ is the buyer order quantity, where K is the integer number to reach the optimality from the vendor's point of view. Banerjee (2005) conducted the research to determine the lot sizing for make-to-order contract production and selling price concurrently in order to achieve the targeted profit.
2. Producing on lot for lot policy which this policy is usually found where the buyer operates in JIT environment. The pioneer of the researches related to buyer coordination in JIT environment such as Monahan (1984) by assuming that the vendor operates on lot for lot policy. Other research was also be conducted by Banerjee (1986b) who proposed a pricing model for vendor's perspective to increase the profit of the vendor. This situation is motivated by situation that if the vendor has to follow the lot's size given by the buyer, then the vendor has to find pricing strategy so that they can reach their target profit.

The opposite of decentralized model is centralized model where buyer and vendor determined the lot-size together. However, this approach somewhat is not desirable to implement as each member has its own interest (Toptal and Çetinkaya, 2008). The motivation why the research presented in this paper is considering buyer-vendor coordination model from the vendor's perspective (decentralized model) is that from the observation that was conducted in spring manufacturer as a vendor that supply their product to automotive manufacturers (buyer) that operate in Just in Time environment where the decision regarding the lot size is determined by the buyer. This fact confirm of what Toptal and Çetinkaya (2008) has been stated which is "centralized model may not be feasible or desirable in many practical cases due to incentive conflict." In term of supply chain management perspective, the buyer vendor coordination is an enabler for improving the system profit (Li and Wang, 2007; Wo et al., 2001). In the research conducted by Sarmah et al. (2007), it is stated that each member in the supply chain have their own target profit and coordination will be interested if it helps each member to reach their target. Therefore, for decentralized model, especially where the buyer operates in Just in Time environment, as the vendor, they have to find a way in order to make them reach the target profit. Therefore, the decision related how much is the selling price of the product need to be determined.

The research in this paper is then proposed the model to determine the selling price of the vendor so that it can be used as the consideration before they are making document contract agreement between vendor-buyer. The sensitivity analysis will also be conducted in order to give a deep insight on how the effect on the changing of the margin profit to their profit.

This paper is organized as follows. Following the introduction, the mathematical formulation will be explained. After the mathematical formulation is explained the numerical example to illustrate the applicability of the model is given. Finally, conclusions are drawn.

2. MATHEMATICAL MODEL

This paper considers the problem in an OEM manufacturer that supply its products to: 1) an automotive manufacturer; 2) automotive dealers; 3) repair shops as it can be shown in figure 1.

The Original Equipment Manufacturer (OEM) receives order from automotive manufacturer (1^{st} buyer) in the rate of D_1units per time period and the order has to be delivered in the lot of Q_1 units. In addition, OEM also receives orders from dealers (2^{nd} buyer) and repair shop (3^{rd} buyer). The demand from the 2^{nd} buyer and repair shop 3^{rd} buyer can be consolidated with rate of D_2 units per time period.

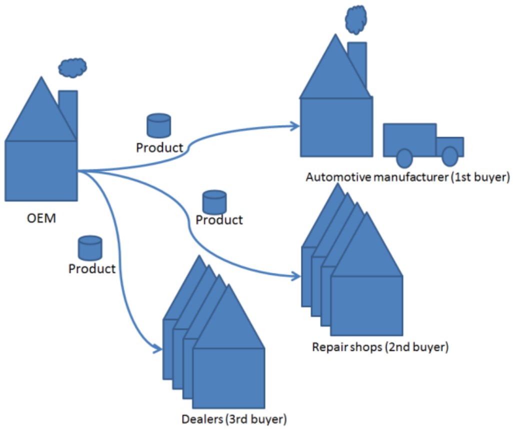


Figure 1. Problem Illustration

The OEM produce with 2 separated production lot as it can be seen in figure 2 by assuming that:

$$T_2 = nT_1 \tag{1}$$

Subject to:

$$\tau_1 + \tau_2 \le T_1 \tag{2}$$

where

n= integer,

τ_1 = production up time for fulfilling demand from 1st buyer,

τ_2 = production up time for fulfilling demand from 2nd buyer and 3rd buyer.

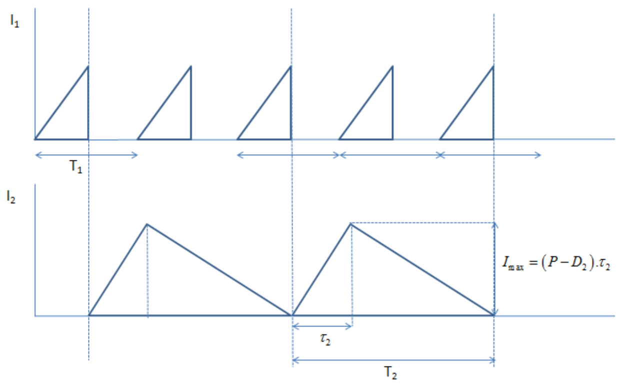


Figure 2. Inventory level of finished product at vendor

In line with JIT principles, i.e. to minimize the buyer's total inventory cost, the value of Q_1 is the economic order quantity (EOQ) from the standpoint of the buyer. To meet the 1st buyer's demand, the vendor produces the part in a batch of Q_1 at a rate of P units per time. Lot-for-lot shipment is applied here, in which a batch of parts is shipped to the buyer once it is finished. However, this situation is not applied for the demand from the 2nd and 3rd buyers, in which not in a JIT environment. Therefore, the vendor is free to decide the value of Q_2.

Total cost for producing the product for the 1st buyer is then expressed by TC_1 while total cost for production the product for the 2nd buyer and the 3rd buyer is expressed as TC_2. It is noted the value of TC_1 and TC_2 affect the cost of goods sold of the product price. Since TC_1 and TC_2 most probably different due to different operational setting, then the company can set different selling price to each buyer.

Notation:

D_1 = demand parts for the 1st buyer, units/time

D_2 = demand parts for the 2nd buyer and 3rd buyer, units/time

Q_1 = production lot size for the 1st buyer, units

Q_2= production lot size for the 2nd and 3rd buyers, units

P= vendor's production rate for fulfilling the demand, units/time

S_1 = 1st buyer's unit setup cost, \$

S_v = vendor's unit setup cost, \$

h_1 = 1st buyer's unit holding cost, \$/unit/time

h_v = vendor's unit holding cost, \$/unit/time

C_1 = vendor's unit selling price for 1st buyer, \$/unit

C_2 = vendor's unit selling price for 2nd buyer and 3rd buyer , \$/unit

C_v = vendor's unit production cost, \$

τ_1 = production up time for fulfilling the demand from the 1st buyer

τ_2 = production up time for fulfilling the demand from the 2nd buyer and 3rd buyer

M_1 = cost of goods sold for the product that has to be sold for 1st buyer

M_2 = cost of goods sold for the product that has to be sold for 2nd buyer

As a buyer, the decision related to how many order that have to be ordered from the vendor is affected by the selling price C_1offered by the vendor. Therefore, the Q_1

where it represents optimal quantity from buyer's perspective can be calculated using their Economic Order Quantity. The cost components that make up the total cost of the buyer includes purchasing cost, ordering cost, and inventory cost. The expression of total cost is the same as the model described by Banerjee (1986) as follows:

$$TC_{1B} = D.C_1 + \frac{D}{Q_1}.S_1 + \frac{Q_1}{2}.h_1.C_1 \quad (3)$$

Therefore to find Economic Order Quantity then we take the first derivative of TC_{1B} with respect to Q_1 as follows:

$$\frac{dTC_{1B}(Q_1)}{dQ_1} = \frac{h_1.C_1}{2} - \frac{D.S_1}{Q_1^2}$$

$$Q_1^* = \sqrt{\frac{2.D.S_1}{h_1.C_1}} \quad (4)$$

Related to Figure 2, the cycle time to production process to fulfill the demand for product 1 can be expressed as:

$$T_1 = \frac{Q_1^*}{D_1} \quad (5)$$

The expression of formula (1) is then can be written as

$$T_2 = n\frac{Q_1^*}{D_1} \quad (6)$$

As $T_2 = \frac{Q_2}{D_2}$, therefore Q_2 can be expressed as

$$Q_2 = n\frac{Q_1^*}{D_1}.D_2 \quad (7)$$

The total cost for producing the product to fulfill the demand from the 2nd buyer and 3rd buyer is then can be expressed as:

$$TC_2 = \frac{D_2}{n.Q_1^*}\frac{1}{D_2/D_1}.K + \frac{1}{2}.T_2.I_{\max}.h \quad (8)$$

$$= \frac{D_1.K}{n.Q_1^*} + \frac{1}{2}.n.\frac{Q_1^*}{D_1}(P - D_2)n.\frac{Q_1 D_2/D_1}{P}.h \quad (9)$$

$$= \frac{D_1K}{nQ_1^*} + \frac{1}{2}n^2.\frac{Q_1^{*2}}{D_1^2}.\frac{D_2}{P}(P - D_2).h \quad (10)$$

Subtituting Eq. (4) to Eq. (10) we have the expression:

$$= \frac{D_1K}{n}\sqrt{\frac{h_1c_1}{2D_1S_1}} + \frac{1}{2}n^2.\frac{2S_1}{h_1C_1}.\frac{1}{D_1}.\frac{D_2}{P}(P - D_2).h \quad (11)$$

Therefore to find the optimal value of *n,* then the minimization problem is solved with the objective function and constraint as follows:

$$\min \quad \mathrm{TC}_2 = \frac{D_1K}{n}\sqrt{\frac{h_1c_1}{2D_1S_1}} + \frac{1}{2}n^2.\frac{2S_1}{h_1C_1}.\frac{1}{D_1}.\frac{D_2}{P}(P - D_2).h$$

s.t

$$\Leftrightarrow \frac{Q_1^*}{P} + \frac{n.Q_1^*.D_2/D_1}{P} \le \frac{Q_1}{D_1}$$

$$\Leftrightarrow \frac{Q_1^* + n.Q_1^*.D_2/D_1}{P} \le \frac{Q_1}{D_1}$$

$$\Leftrightarrow Q_1^* + n.Q_1^*.\frac{D_2}{D_1} \le \frac{Q_1}{D_1}.P$$

$$\Leftrightarrow n \le \frac{D_1}{D_2}\left(\frac{P}{D_1} - 1\right) \quad (12)$$

As according to the case study considered in the research of this paper, the vendor (OEM manufacturer) has to incorporate the different value of lot size to accommodate the different type of buyer, then the vendor has to find the selling price that has to be offered for different type of buyer in such a way that the vendor's target profit can be achieved. This situation is actually different of the idea of joint economic lot size problem, where the idea is how to determine the lot size that can minimize the total system cost (both buyer and vendor).

Given,

$$M_1 = C_v + \frac{TC_1}{D_1} \quad (13)$$

$$M_2 = C_v + \frac{TC_2}{D_2} \quad (14)$$

Therefore vendor's target profit can be expressed as:

$$\pi = \frac{D_1(C_1 - M_1) + D_2(C_2 - M_2)}{D_1M_1 + D_2M_2} \quad (15)$$

This target profit is actually a performance that have to be achieved by the company by determining the selling price.

3. NUMERICAL EXAMPLE

A numerical example represent the real situation when the vendor produce the spare part that has longer end-of-life.

D_1 = 10,000 units/year

D_2 = 1,000 units/year

P= 20,000 units/year

S_1 = 50$

S_v = 500 $

h_1 = 10%$/$ inventory

h_v = 10% $/$ inventory

C_v = 70 $

Suppose, the vendor offer to the first buyer C_1=87 $ in order to obtain target profit 20%. Therefore, following formula (4) and (6) one can obtain: Q_1* = 339.03 units and TC_1 = $ 15341.19/year.

Then, TC_2 as a minimization problem for determining n can be solved using enumerative method, by boundary on formula (12)

$$n \le \frac{D_1}{D_2}\left(\frac{P}{D_1}-1\right)$$

$$n \le \frac{10000}{1000}\left(\frac{20000}{10000}-1\right)$$

$$n \le 10$$

The relationship between n and TC_2 in this case can be presented in the following Table. It is noted that although the smallest TC_2 found is $ 2580.73 at n = 11, the optimal n that satisfying the boundary is n* = 10 with TC_2 = $ 2602.07.

Table 1: Result of TC_2 on various n

n	***TC*₂**	***n***	***TC*₂**
1	14860.61	8	2745.31
2	7599.40	9	2653.21
3	5254.14	10	2602.07
4	4137.88	11	2580.73
5	3513.22	12	2581.73
6	3134.35	13	2599.92
7	2895.94	14	2631.61

Utilizing formula (15), one can obtain that offering the second and third buyers with C_2 = $80/unit the target profit 20% is already achieved, since

$$M_1 = 70 + \frac{15341.19}{10000} = 71.53$$

$$M_2 = 70 + \frac{2602.07}{1000} = 72.60$$

$$\pi = \frac{10000(87-71.53)+1000(80-72.60)}{10000\cdot 71.53+1000\cdot 72.60} = 0.2056$$

4. CONCLUDING REMARK

The research presented here are mainly about the buyer vendor coordination for an OEM manufacturer that support the component to manufacturer. The decision variable in the research presented here is the selling price of the product provided by the vendor to each type of buyer. Using this value, the vendor can used it as the consideration before making a purchasing contract, i.e. during the negotiations phase between supplier and buyer.

ACKNOWLEDGMENT

This work is partially supported by Ministry of Research, Technology, and Higher Education, Republic Indonesia under International Research Collaboration and Scientific Publication Research Grant No. 005/HB-LIT/III/2016.

REFERENCES

L.R.Khan, and R.A. Sarker:"An optimal batch size for a JIT manufacturing system", Computers & Industrial Engineering, Vol.42,pp 127-136, 2002.

I-C, Wang:" The application of third party logistics to implement Just-In-Time system with minimum cost under a global environment", Expert Systems with Application, Vol. 37,pp 2117-2123,2010.

I. David, and M. Eben-Chaime:"How far should JIT vendor-buyer relationship go?", International Journal of Production Economics, Vol. 81-82 ,pp361-368, 2003.

P. Kelle, and P.A. Miller: "Quantitative support for buyer-supplier negotiation in JIT purchasing', International Journal of Purchasing and Materials Management, Vol. 34, pp 25-30, 1998.

A.C. Pan and C. Liao :"An inventory model under just in time purchasing agreements', Production and Inventory Management, Vol. 30(1), pp 49-52, 1989.

R.V. Ramasesh:" Recasting the traditional inventory model to implement just in time purchasing", Production and Inventory Management, Vol. 31 (1), pp. 71-75, 1990.

S.P. Sarmah, D. Acharya, S.K. Goyal:" Buyer vendor coordination models in supply chain management", European Journal of Operational Research, Vol. 175, pp. 1-15, 2006.

A. Toptal and S. Çetinkaya", Quantifying the value of buyer-vendor coordination Analytical and numerical results under different replenishment cost structures", European Journal of Operational Research, Vol. 187, pp. 785-805, 2008.

A. Banerjee:" A quantity discount pricing model to increase vendor profit", Management Science, Vol. 32(8), pp.1513-1517, 1986.

H.L. Lee and M.J. Rosenblatt:" A generalized quantity discount pricing policy", Management Science, Vol. 32(9), pp. 1177-1185, 1986a.

A. Banerjee:" Concurrent pricing and lot sizing for make-to-order contract production", International Journal of Production Economics, Vol. 93-94, pp. 189-195, 2005.

J.P. Monahan:" A quantity discount pricing model to increase vendor profit", Management Science, Vol. 30(6), pp. 720-726, 1984.

A. Banerjee:" A supplier's pricing model under a customer's economic purchasing policy", OMEGA International Journal of Management Science, Vol. 14 (3), pp. 409-414, 1986b.

X. Li and Q. Wang:" Coordination mechanism of supply chain systems", European Journal of Operational Research, Vol 179, pp. 1-16, 2007.

Y.Y. Wo, S.L. Hsu, S.Wu:" An integrated inventory model for a single vendor and multiple buyers with ordering cost reduction", International Journal of Production Economics, Vol 73(3), pp. 203-221, 2001.

S.P. Sarmah, D. Acharya, S.K. Goyal:" Coordination and profit sharing between a manufacturer and a buyer with target profit under credit option", Vol. 182, pp. 1469-1478, 2007.