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How Quick Response affects the Supply Chain Performance

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Abstract

Purpose – The goal of this research is to examine the influence of Quick Response on the supply chain performance. Furthermore, this study investigates the potential of Quick Response to be a more advanced form of supply chain collaboration program with extensive information sharing activities.

Research design, data, and methodology – The mathematical model is developed to represent the two stage supply chain system with a single manufacturer and one retailer. In the numerical study with the proposed mathematical models, three supply chain systems including the traditional system, Quick Response, and the fully shared information system are compared in terms of their profits.

Results – The numerical analysis shows both manufacturer and retailer obtain greater profits under Quick Response than in the traditional system. While the fully shared information outperforms Quick Response as well as the traditional system, it results in lower manufacturer's profit compared with Quick Response.

Conclusions – According to the numerical examples, Quick Response is the effective supply chain collaboration program that is beneficial to every supply chain member. The fully shared information system, as a more advanced form of collaboration than Quick Response can bring more benefits to the whole supply chain system, but it is necessary to prepare the proper incentive program that enables every member to share its benefits equally.

Keywords: Supply Chain Collaboration, Quick Response, Optimization Model.

JEL Classifications: M11, M19, M21, M29.

1. Introduction

Quick Response is the collaboration program that enables the seller to respond rapidly to customer's demand at the changing market. It was first employed by U.S. apparel industry in mid-1980's to solve the inherent problems that the apparel industry has had in history (Choi & Sethi, 2010). Under the volatile market situation with short product life cycle, most apparel manufacturers have suffered high stocking cost and sales loss due to the unbalanced inventory level. Quick Response is considered to be the combination of Just-In-time system and advanced information technology, and its three key functions are lead time reduction, real time information application, and flexible manufacturing (Birtwistle, Moore, & Fiorito, 2006; Choi, Zhang, & Cheng, 2018; Giunipero, Fiorito, Pearcy, & Dandeo, 2001; Godinho Filho, Marchesini, Riezebos, Vandaele, & Ganga, 2017b; Godinho Filho & Veloso Saes, 2013; Perry, Sohal, & Rumpf, 1999).

Many business practitioners have recognized that Quick Response brings the supply chain system on the effective inventory management and logistics improvement (Lin & Parlaktürk, 2012), and it has been implemented in various business areas including automobiles, on-line shopping, food, toys, and hospital industries (Birtwistle et al., 2006; Choi, Li, & Yan, 2006; van Wijk, Adan, & van Houtum, 2013; Weir, Browne, Byrne, Roberts, Gafni, Thompson, Walsh, & McColl, 1999). While many researchers have evaluated the performance of Quick Response, only a few of them conducted the investigation on the reason that Quick Response as the collaboration program outperforms the traditional system (Cachon & Swinney, 2011; Chow, Choi, & Cheng, 2012; Yang, Qi, & Li, 2015).

The goal of this study is to examine how Quick Response affects the supply chain performance. This study formulates the mathematical model representing two stage supply chain system where the manufacturer and retailer intend to maximize their own profits. Quick Response and the traditional system are compared in terms of their

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economic performances in the numerical examples of the proposed models. Furthermore, the fully shared information system is developed as a more advanced form of collaboration than Quick Response, and this study tests the potential of the new collaboration program that enables both manufacturer and retailer share the retail market demand information.

The numerical study shows that Quick Response results in greater system profit than the traditional system. Moreover, Quick Response is beneficial to both manufacturer and retailer. Under Quick Response, the delayed pricing and ordering decisions allow the retailer to determine the proper price to increase total throughput in the supply chain system. The fully shared information system outperforms Quick Response as well as the traditional system. Since the manufacturer obtains lower profit under the fully shared information system than in Quick Response, it is necessary to prepare the appropriate incentive program to distribute the benefit from this new system equally to every supply chain member.

The contributions of this study are twofold. First, this study offers the unique managerial implications about how to implement Quick Response, which are different from the suggestions made by most past studies. The numerical analysis in this study discloses the enlarged throughput instead of cost saving is the main reason of Quick Response's superiority over the traditional system. Most past studies focus on retailer's delayed ordering and reception of real demand information, and they examine the cost saving effect due to the right lot sizing decision (Caro & Martínez-de-Albéniz, 2010; Choi, 2017; Iyer & Bergen, 1997). Meanwhile, this study pays attention to the point that the increased throughput caused by the retailer's right pricing decision allows Quick Response to outperform the traditional system. The outcome of the model analysis implies that the pricing decision as well as the ordering decision should be carefully made to obtain the optimal achievement when Quick Response is implemented to the supply chain system.

Second, this study reveals the potential of current Quick Response to be more advanced collaboration program. The fully shared information system has additional features from the original Quick Response, and the manufacturer as well as retailer receives the real demand information. According to the numerical analysis, this new system outperforms the original Quick Response. This result supports the positive effect of information sharing as many past studies hold up (Bourland, Powell, & Pyke, 1996; Gavirneni, Kapuscinski, & Tayur, 1999; Zhao, Xie, & Lau, 2001), and this study provides valuable managerial implication that Quick Response improves further the system performance by letting every member share the real demand information.

2. Research Background

Quick Response has been defined with various terms in different studies (Birtwistle et al., 2006; Perry et al., 1999; Serel, 2009), and they still share the common idea that it equips the specially designed functions that lead to the proper balance between supply and demand (Krishnan, Kapuscinski, & Butz, 2010). A certain group of past studies delineate Quick Response as a mere inventory management strategy run by the retailer to respond to customer's demand efficiently (Choi & Chow, 2008; Choi et al., 2006). Meanwhile, Quick Reponses is commonly considered to be one of supply chain collaboration programs in many studies (Chow et al., 2012; Derrouiche, Neubert & Bouras, 2008; Krishnan et al., 2010; Serel, 2012; Sullivan & Jikyeong, 1999), because this program requires that supply chain members collaborate on timing placing orders and sharing demand information based on POS system (Giunipero et al., 2001; Palmer & Markus, 2000; Serel, 2009).

Past studies take distinct ways to formulate Quick Response in their analytical models to evaluate its performance. A group of studies assumes that the retailer can receive the real demand information under Quick Response (Krishnan et al., 2010; Yang et al., 2015). In other studies, Quick Response enables the retailer to place orders after knowing demand (Cachon & Swinney, 2009, 2011; Caro & Martínez-de-Albéniz, 2010; Lin & Parlaktürk, 2012; Wang, Zhang, Cheng, & Hua, 2018). Many analytical studies apply the Bayesian approach to their models and they describes that the retailer can use the market information observed at the first period to update the demand information at the second stage when the inventory decision is made (Chan, Shen, & Cai, 2018; Choi, 2017; Choi & Chow, 2008; Choi et al., 2006; Choi et al., 2018; Chow et al., 2012; Iyer & Bergen, 1997; Serel, 2009, 2012).

Other than the issue of inventory management, a number of past studies focus on Quick Response Manufacturing, which is the lean production or make-to-order system that is designed to reduce the leadtime of every production operation in the entire supply chain system (Fernandes & do Carmo-Silva, 2006; Gómez & Filho, 2017; Godinho Filho, Marchesini, Ganga, Riezebos, & Vandaele, 2017a; Godinho Filho et al., 2017b; Kuroda & Takeda, 1998; Warburton & Stratton, 2005; Yang & Wee, 2001).

There has been a series of studies that evaluate the performance of Quick Response. In the two stage supply chain with a manufacturer and a retailer, Choi et al. (2018) examine the impact of retailer's preference on the performance of Quick Response. According to their model analysis, Quick Response increases the profits of both supply chain and retailer, but it results in less profit of the manufacturer than non-Quick Response. In particular, their study shows that the value of Quick Response depends on the retailer's risk preference regarding lot sizing.

Iyer and Bergen (1997) develop the Quick Response model by applying Bayesian demand information updating theory and evaluates the influence of Quick Response on the supply chain party's performance. Their model analysis indicates that Quick Response increases the retailer's profit but it is not beneficial for the manufacturer. Furthermore, their study tests that the application of service level, wholesale price, and volume commitments may enable both manufacturer and retailer to increase their profits under Quick Response.

In Wang et al.'s study (2018), Quick Response represents that the retailer determines the price and the initial lot size, and then he can place another order to fill the shortage after knowing the demand. Their study reveals that Quick Response increases the retailer's profit only when the price is higher than unit purchasing cost of following ordering. They also found that the benefit due to Quick Response becomes small when the consumers are risk-seeking in choosing time to purchase the product and product valuation is decreasing fast.

Yang et al. (2015) assess the performance of Quick Response under different decision making structures of the supply chain system. The outcomes from their model analysis indicate that Quick Response increases the supply chain profit in both centralized and decentralized systems. Meanwhile, the benefit from Quick Response is greater in the decentralized system than the centralized system, if it is expensive to implement Quick Response. According to their study, the revenue sharing contract made between the manufacturer and retailer is the useful tool to distribute the profit fairly to supply chain members and it realizes the optimal profit in the decentralized system.

Among many past studies that evaluate the value of Quick Response, only a few of them search for the specific reason that Quick Response outperforms the traditional supply chain system (Cachon & Swinney, 2011). This study investigates how Quick Response improves the supply chain performance by directly comparing Quick Response with the traditional supply chain system. While most past studies focus on the benefit due to the leadtime reduction or demand information updating (Chow et al., 2012; Fernandes & do Carmo-Silva, 2006), this study found that the enlarged throughput caused by retailer's proper pricing decision is the main reason of Quick Response's superior to the conventional supply chain system. Furthermore, by testing the fully shared information system, where every supply chain member shares real demand information, this study even look for the opportunity to develop a more advanced form of collaboration programs than the original Quick Response. Table 1 shows the selected past studies that evaluate the performance of Quick Response by using the analytical models.

Table 1: Selected analytical studies on the performance of Quick Response

Authors (Year)	Focused operations/functions	Supply chain structure (Supply chain members)	Inventory system	Decision variables
Choi et al. (2018)	Retailer's risk preference and stocking	Two stage supply chain with single product (a manufacturer and a retailer)	Two period newsvendor model (Bayesian information updating)	Ordering
Wang et al. (2018)	Retailer's optimal decisions on lot size and price for consumers with different risk preferences and decreasing valuation	Two stage supply chain with single product (a retailer and multiple consumers)	Two period newsvendor model	Pricing and ordering
Choi (2017)	Retailer's stocking with imperfectly rational decision making	Two stage supply chain with single product (a manufacturer and a retailer)	Two period newsvendor model (Bayesian information updating)	Ordering
Yang et al. (2015)	Comparing Quick Response(QR) and non-QR under centralized and decentralized supply chains	Two stage supply chain with single product (a manufacturer and a retailer)	Two period newsvendor model	Ordering and pricing
Chow et al. (2012)	Retailer's ordering with minimum order requirement	Two stage supply chain with single product (a manufacturer and a retailer)	Two period newsvendor model (Bayesian information updating)	Ordering
Cachon and Swinney (2011)	Retailer's stocking and pricing	Two stage supply chain with single product (a retailer and multiple consumers)	Two period newsvendor model	Ordering and pricing
Caro and Martínez-de-Albéniz (2010)	Retailers' stocking	Two stage supply chain with single product (two retailers and multiple consumers)	Two period newsvendor model (Bayesian information updating)	Ordering
Cachon and Swinney (2009)	Retailer's stocking and pricing	Two stage supply chain with single product (a retailer and multiple consumers)	Two period newsvendor model	Ordering and pricing
Choi and Chow (2008)	Retailer's ordering under price commitment, service level commitment, and buyback policies	Two stage supply chain with single product (a manufacturer and two retailers)	Two period newsvendor model (Bayesian information updating)	Ordering
Johnson and Scudder (1999)	Manufacturing scheduling to reduce inventories and improving customer service	Make-to-Stock manufacturing system with multiple products	Economic lot sizing/ scheduling model	Production schedule (production quantity)
Iyer and Bergen (1997)	Retailer's stocking decisions under service level requirement	Two stage supply chain with single product (a manufacturer and a retailer)	Two period newsvendor model (Bayesian information updating)	Ordering

3. Three Supply Chain Models

By using the mathematical models, this study examines the influence of Quick Response on the supply chain performance and compares it with two other supply chain systems. The proposed optimization model represents the supply chain system where each supply chain member maximizes his own profit. This study assumes two-stage supply chain system where one manufacturer and one retailer trade a single product item. The manufacturer produces the products and stores them at his warehouse. Once the retailer places orders to the manufacturer, he sells the ordered products to the retailers. The retailer receives the products from the manufacturer, and then stores them at his warehouse until they are sold at the retail market.

The manufacturer's profit is composed of his revenue from sales to the retailer and total cost. His total cost contains the setup cost, inventory holding cost, production cost, and transportation cost. The joint economic lot size model is used to formulate manufacturer's inventory control system (Banerjee, 1986). Equation (1) indicate the manufacturer's profit. The retailer's profit contains the revenue from sales to the retail market, ordering cost, inventory holding cost, and purchasing cost, as shown in Equation (2).

$$\pi_M = T\cdot(M_A - k_A\cdot P) - \frac{S_M\cdot(M_A - k_A\cdot P)}{Q} - \frac{\alpha_M\cdot T\cdot Q\cdot(M_A - k_A\cdot P)}{2\cdot X} - v\cdot X - \beta\cdot T\cdot(M_A - k_A\cdot P) \quad (1)$$

$$\pi_R = P\cdot(M_A - k_A\cdot P) - \frac{S_R\cdot(M_A - k_A\cdot P)}{Q} - \frac{\alpha_R\cdot T\cdot Q}{2} - T\cdot(M_A - k_A\cdot P) \quad (2)$$

In the proposed mathematical models, the demand at the retail market is the linear function of the retail price (P), which is $M - k\cdot P$, where M is the potential maximum demand and k represents the price sensitivity. The unit inventory holding cost ($\alpha\cdot P$) and the unit transportation ($\beta\cdot P$) are proportional to the inventory value. During the entire period of the operation, the manufacturer is supposed to provide the sufficient amount of products to the retailer so that the retailer can fulfil the demand from the retail market. The retailer can controls his inventory level by determining how much to order to the manufacturer each time (Q). Table 2 shows the notations used in the proposed mathematical models.

3.1. Traditional System

The traditional supply chain system represents the base case without any specific collaboration program such as Quick Response. In this system, both retailer and manufacturer do not access the real demand of the retail market. Instead, they make decisions on their own operations based on the estimated demand obtained from their own demand forecasting. The procedure occurs in the traditional system as follows:

Step 1. The retailer determines the retail price (P) and order quantity (Q) with profit margin (ω) based on the estimated demand in a way to maximize his profit.

$$\underset{P,Q}{Maximize}\ \pi_R = P\cdot(M_R - k_R\cdot P) - \frac{S_R\cdot(M_R - k_R\cdot P)}{Q} - \frac{\alpha_R\cdot\frac{P}{\omega}\cdot Q}{2} - \frac{P}{\omega}\cdot(M_R - k_R\cdot P) \quad (3)$$

$$subject\ to\ P,Q \ge 0 \quad (4)$$

Step 2. The manufacturer decides the optimal transfer price (T) and production quantity (X) based on the estimated retail demand.

$$\underset{T,X}{Maximize}\ \pi_M = T\cdot(M_M - k_M\cdot\omega\cdot T) - \frac{S_M\cdot(M_M - k_M\cdot\omega\cdot T)}{Q} - \frac{\alpha_M\cdot T\cdot Q\cdot(M_M - k_M\cdot\omega\cdot T)}{2\cdot X} - v\cdot X - \beta\cdot T\cdot(M_M - k_M\cdot\omega\cdot T) \quad (5)$$

Table 2: Notations used in the mathematical models

Manufacturer		Retailer	
π_M	Profit	π_R	Profit
T	Unit price	P	Unit price
X	Production rate	Q	Order quantity
M_M	Estimated potential demand size	M_R	Estimated potential demand size
k_M	Estimated price sensitivity parameter	k_R	Estimated price sensitivity parameter
S_M	Setup cost	S_R	Ordering cost
α_M	Unit inventory holding cost per price	α_R	Unit inventory holding cost per price
v	Unit production cost	ω	Profit margin
β	Unit transportation cost per price	M_A	Real potential demand size
		k_A	Real price sensitivity parameter

$$subject\ to\quad X \geq M_M - k_M \cdot \omega \cdot T \qquad (6)$$

$$T, X \geq 0 \qquad (7)$$

3.2. Quick Response

Under Quick Response, the manufacturer and retailer have authorities to make their own operations to maximize their own profits just like the traditional system. Meanwhile, Quick Response allows the retailer to determine the order quantity and retail price after the manufacturer sets the transfer price and production quantity. Since the retailer postpones his decisions on ordering and pricing up to the point of sales, he can use the real demands from the retail market to decide the order quantity and retail price rather than relying on the estimated demand from forecasting. The detailed operations made by the manufacturer and retailer in Quick Response are following:

Step 1. The manufacturer determines the transfer price (T), estimated order quantity (O) and production quantity (X) based on the estimated retail demand.

$$\underset{T,O,X}{Maximize}\ \pi_M = T \cdot (M_M - k_M \cdot \omega \cdot T) - \frac{S_M \cdot (M_M - k_M \cdot \omega \cdot T)}{O} - \frac{\alpha_M \cdot T \cdot O \cdot (M_M - k_M \cdot \omega \cdot T)}{2 \cdot X} - v \cdot X - \beta \cdot T \cdot (M_M - k_M \cdot \omega \cdot T) \qquad (8)$$

$$subject\ to\quad X \geq M_M - k_M \cdot \omega \cdot T \qquad (9)$$

$$T, O, X \geq 0 \qquad (10)$$

Step 2. The retailer decides the retail price (P) and order quantity (Q) based on the real retail demand.

$$\underset{P,Q}{Maximize}\ \pi_R = P \cdot (M_A - k_A \cdot P) - \frac{S_R \cdot (M_A - k_A \cdot P)}{Q} - \frac{\alpha_R \cdot T \cdot Q}{2} - T \cdot (M_A - k_A \cdot P) \qquad (11)$$

$$subject\ to\quad P, Q \geq 0 \qquad (12)$$

3.3. Fully shared Information System

The last supply chain system represents the extended version of Quick Response, and it is developed to apprehend sharing the demand information through the whole system. Under this system, the retailer determines ordering and pricing after manufacturer's decisions on pricing and production. While only the retailer knows real demands of the retail market under Quick Response, both manufacturer and retailer receive the real retail demands in the fully shared information system. The manufacturer and retailer's operations under this system are following:

Step 1. The manufacturer determines the transfer price (T), estimated order quantity (O) and production quantity (X) based on the real retail demand.

$$\underset{T,O,X}{Maximize}\ \pi_M = T \cdot (M_A - k_A \cdot \omega \cdot T) - \frac{S_M \cdot (M_A - k_A \cdot \omega \cdot T)}{O} - \frac{\alpha_M \cdot T \cdot O \cdot (M_A - k_A \cdot \omega \cdot T)}{2 \cdot X} - v \cdot X - \beta \cdot T \cdot (M_A - k_A \cdot \omega \cdot T) \qquad (13)$$

$$subject\ to\quad X \geq M_A - k_A \cdot \omega \cdot T \qquad (14)$$

$$T, O, X \geq 0 \qquad (15)$$

Step 2. The retailer decides the retail price (P) and order quantity (Q) based on the real retail demand.

$$\underset{P,Q}{Maximize}\ \pi_R = P \cdot (M_A - k_A \cdot P) - \frac{S_R \cdot (M_A - k_A \cdot P)}{Q} - \frac{\alpha_R \cdot T \cdot Q}{2} - T \cdot (M_A - k_A \cdot P) \qquad (16)$$

$$subject\ to\quad P, Q \geq 0 \qquad (17)$$

4. Numerical analysis

By using the numerical analysis on the proposed mathematical models, this study evaluates the performance of Quick Response. Table 3 shows the arbitrarily determined parameters employed in the base case of the numerical examples. Four parameters including the potential market demand, ordering cost, unit inventory holding cost, and profit margin are changed in the numerical examples, and each parameter is assigned to be 15 different levels. The number of cases are 50,625 in total ($15^4 = 50{,}625$).

Table 3: Parameters in Base Case

M_M = 1,000	k_M = 3	S_M = 1,000	α_M = 0.17	β = 0.01
M_R= 800	k_R = 2	S_R = 800	α_R = 0.27	ω = 1.1
M_A = 1,200	k_A = 4	v = 5		

4.1. Performances of Three Supply Chain Systems

Table 4 shows the averaged performances of three supply chain systems from the numerical analysis. The numerical analysis shows that Quick Response achieves greater supply chain profit than the traditional system as many past studies do (Choi et al., 2018; Yang et al., 2015). The main reason that Quick Response outperforms the traditional system is the increased sales due to the reduced retail price. Compared with the traditional system where the retailer relies on the estimated demand, the delayed pricing decision with the accurate information of the retail demand under Quick Response enables the retailer to determine the proper retail price and obtain much higher sales revenue. After all, the enlarged throughput results in the increased profit in the whole supply chain system.

Furthermore, both manufacturer and retailer obtain greater profits in Quick Response than in the traditional system. Under Quick Response, the appropriate retail price based on the real demand increases not only the retailer's revenue but also his purchase quantity from the manufacturer. As a result, the manufacturer obtains the increased profit caused by his enlarged sales to the retailer.

The fully shared information system also outperforms Quick Response as well as the traditional system in term of the supply chain profit. The accurate demand information provided to both manufacturer and retailer enables them to determine lower prices and it leads to the further increased throughput in the whole system compared with the case of Quick Response.

The retailer achieves greater profit in the fully shared information system than under Quick Response. Meanwhile, the opposite result is observed in term of the manufacturer's profit. The manufacturer obtains less profit mainly because too much decreased transfer price. The manufacturer lowers his price based on the accurate retail demand information. Even though the retailer also decreases the retail price with the consideration with the lowered transfer price, the decrement of the retail price is much lower than the case that Quick Response is used (the retail price drops by 42.3 after Quick Response, but by only 17.68 after the fully shared information). Since the additional impact of the real demand information on the throughput of the whole system is limited after the demand information is fully shared in the entire system, the manufacturer fails to obtain sufficient sales increase to cover his loss due to the lower transfer price.

4.2. Impact of Potential Market Size on Supply Chain Performances

The numerical analysis is further conducted to find how the supply chain performance changes with different market sizes. Figure 1 shows that the supply chain profit increases in all three systems as the potential market size increases. As the retail market demand increases, the enlarged throughput in the supply chain system leads to increased profit. While the profit of the traditional system increases at the relatively constant rate, the profits at both Quick response and the fully shared information system increase at the increasing rate as the market size increases. Since the enlarge throughput is the main cause of the benefit from Quick Response and the fully shared information system as it is seen in the previous analysis, these two collaborated supply chain systems can earn much greater profit from the increased demand than the traditional system.

In all three systems, the manufacturer's profit also increases as the demand size gets larger as Figure 2 shows. While the difference in manufacturer's profit between Quick Response and the fully shared information system is relatively smaller than the difference from the traditional system, the manufacturer gets higher profit under Quick Response than at the fully shared information system.

Figure 3 shows that greater demand leads to higher retailer's profit in all three supply chain system, as it is expected. The retailer earns greater profit under the fully shared information system than at Quick Response and traditional system. Compared with the manufacturer's cases, the impact of the fully shared information on the retailer' profit is significant, and it results in greater retailer's profit than Quick Response as much as Quick Response makes higher profit than the traditional system.

Table 4: Supply Chain Performances

	Traditional	**Quick Response**	**Fully Shared**
Demand	400.00	569.18	639.92
Retail Price	400.00	357.70	340.02
Wholesale Price	209.80	207.19	172.95
Order Quantity	143.29	147.53	170.31
Production Rate	879.59	983.62	1,017.96
Manufacturer			
Revenue	83,920.44	121,695.11	114,545.91
Setup Cost	3,921.30	5,405.21	5,246.59
Inventory Cost	1,676.35	1,813.43	1,903.61
Production Cost	4,397.97	4,918.08	5,089.78
Transportation Cost	839.20	1,216.95	1,145.46
Total Cost	10,834.83	13,353.68	13,385.44
Profit	73,085.61	108,341.43	101,160.46
Retailer			
Revenue	160,000.00	211,812.23	227,195.89
Purchasing Cost	83,920.44	121,695.11	114,545.91
Ordering Cost	3,353.02	4,621.72	4,486.14
Inventory Cost	5,166.29	4,621.72	4,486.14
Total Cost	92,439.75	130,938.56	123,518.18
Profit	67,560.25	80,873.68	103,677.71
Supply Chain System			
Revenue	243,920.44	333,507.34	341,741.80
Cost	103,274.58	144,292.23	136,903.62
Profit	140,645.86	189,215.11	204,838.18

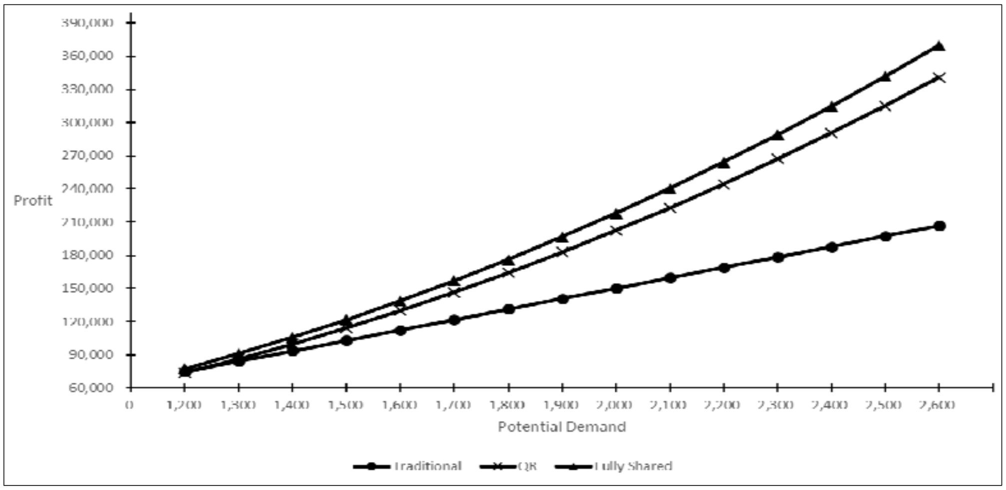

Figure 1: Impact of Potential Demand Size on Supply Chain Profit

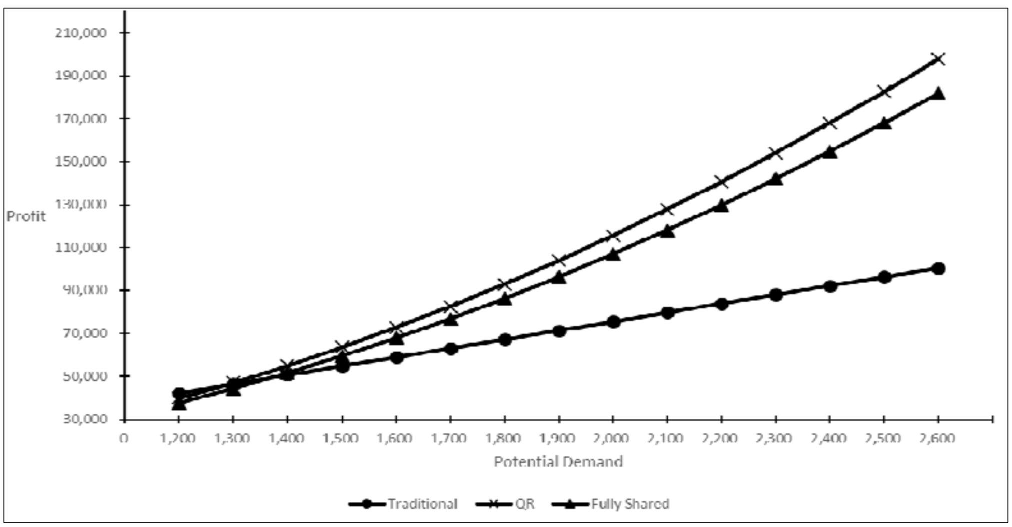

Figure 2: Impact of Potential Demand Size on Manufacturer's Profit

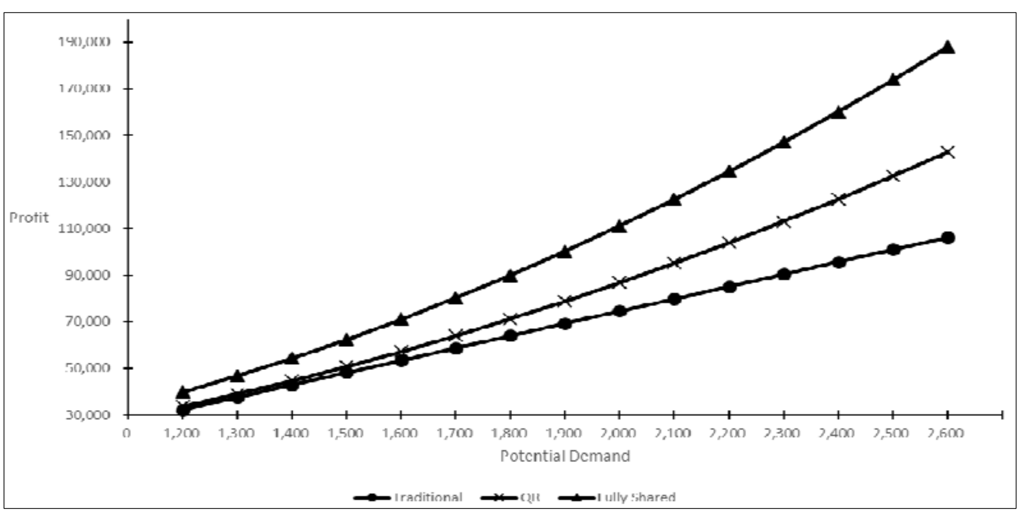

Figure 3: Impact of Potential Demand Size on Retailer's Profit

4.3. Impact of Profit Margin on Supply Chain Performances

The additional analysis on the numerical examples focuses on how the supply chain performance changes with different profit margins. The profit margin represents the retailer's price over the price paid to the manufacturer in the proposed models. Figure 4 shows how the profit margin affects the supply chain profit. While all three systems earn greater profit as the profit margin increases, the amount of profit increase due to the increased profit margin is different depending on the system. In particular, the supply chain system earns significantly greater profit with higher profit margin under Quick Response compared with the other two systems.

As the retailer's profit margin increases, the manufacturer loses more profit as Figure 5 shows. In the traditional system, the manufacturer's profit decreases significantly as the profit margin increases. Meanwhile, the amount of profit decrease due to the increased profit margin is relatively small in Quick Response and the fully shared information system.

Figure 6 shows that the retailer earns greater profit with higher profit margin in all three systems as it is expected. Meanwhile, the amount of profit increase is different depending on the supply chain system. Compared with the traditional system where the profit increase caused by higher profit margin is relatively small, the retailer gets much greater profit with the increased profit margin in Quick Response and the fully shared information system.

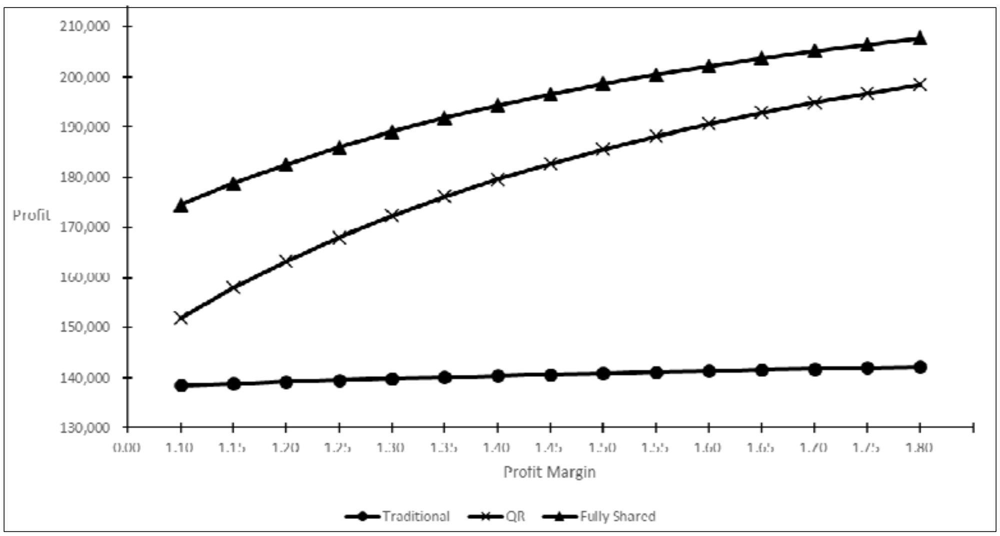

Figure 4: Impact of Profit Margin on Supply Chain Profit

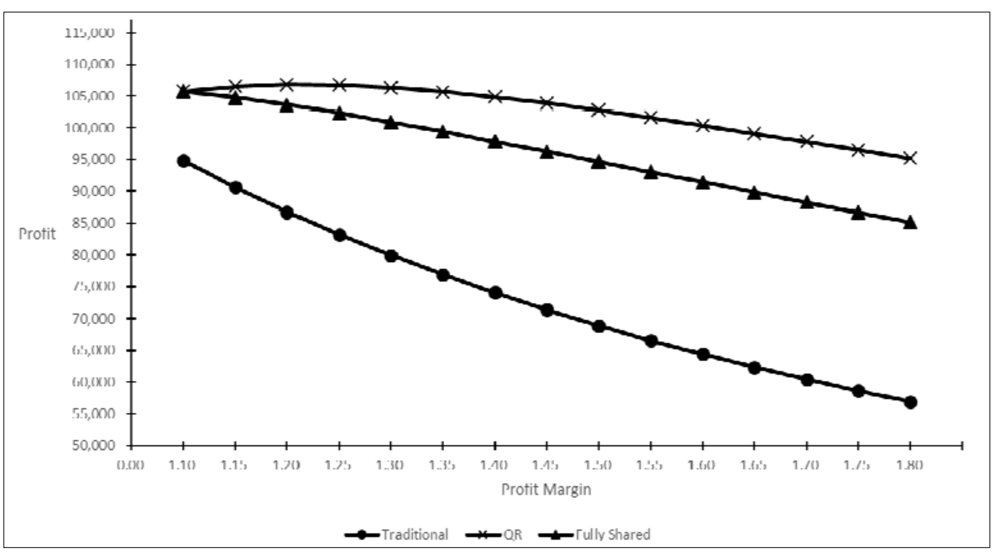

Figure 5: Impact of Profit Margin on Manufacturer's Profit

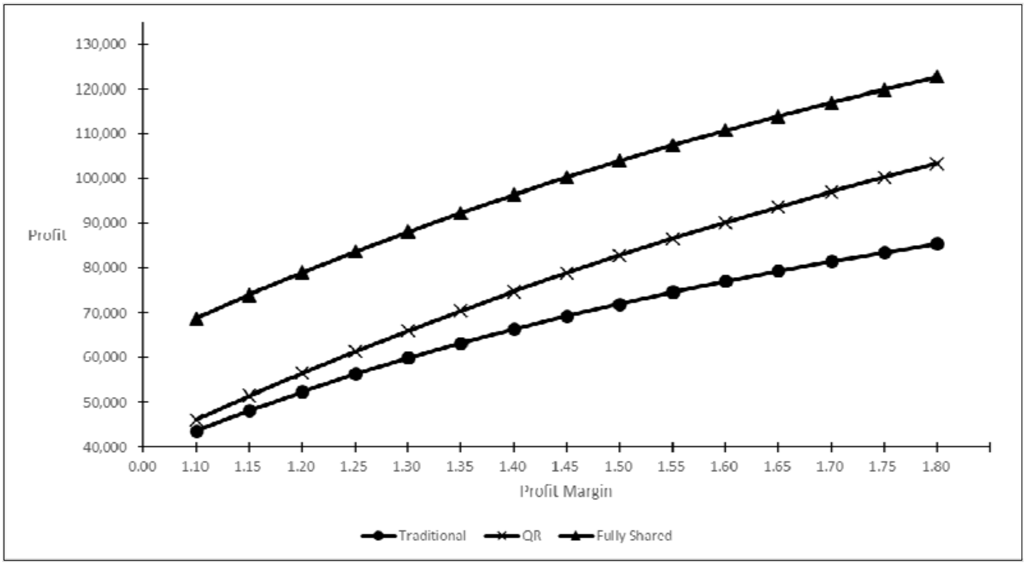

Figure 6: Impact of Profit Margin on Retailer's Profit

5. Discussion

This study examines whether Quick Response plays the role of supply chain collaboration that brings the significant benefit to the entire supply chain system. The mathematical models are proposed to represent the traditional supply chain system and Quick Response, and their economic performances are compared in the numerical examples. The numerical study provides the following critical managerial implications.

First, Quick Response is shown to outperform the traditional supply chain system. With Quick Respond, where the retailer can delay his ordering and pricing decisions until the sales and receive the real demand information, the supply chain system obtains greater profit than without Quick Response. The main reason that Quick Response improves the system performance is the increased demand caused by the retailer's proper pricing decision. By implication, in order to improve the system performance, the supply chain collaboration program should be designed to provide the accurate demand information and proper timing to their members so that they can make right decisions.

Second, Quick Response can be beneficial to every supply chain member. The numerical examples show that Quick Response brings greater profit to the manufacturer as well as the retailer compared with the traditional system. Under Quick Response, increased retail demand leads to enlarged throughput in the entire system and both retailer and manufacturer obtain greater profits than under the traditional system. Some past studies found that Quick Response does not improve manufacturer's performance (Choi et al., 2018; Iyer & Bergen, 1997; Lin & Parlaktürk, 2012). Those studies may fail to support that Quick Response can be beneficial to every supply chain member, because they consider merely cost saving to be the benefit of Quick Response. By focusing on the revenue increase due to enlarged throughput, this study shows that Quick Response can improve not only the entire supply chain performance but also every member's share. This result implies that it is not necessary to prepare additional incentive program to compensate any member's loss once Quick Response gets on the right track.

Third, the supply chain system can improve its performance by providing the real retail demand to both retailer and manufacturer. In addition to Quick Response where only the retailer knows the retail demand, this study considers the fully shared information system where even the manufacturer receives the real retail demand. This special program enables the manufacturer to make the proper pricing decision based on the real demand information. The numerical study shows that the fully shared information system outperforms Quick Response as well as the traditional system.

Fourth, unlike Quick Response, the fully shared information system fails to benefit every supply chain member. In the numerical examples, the retailer obtains greater profit under the fully shared information system than under Quick Response. The manufacturer, however, should pay much higher production cost to cover the increased demand and eventually achieves lower profit under the fully shared information system than under Quick Response. By implication, in order to ensure every supply chain member's participation in the fully shared information system, it is necessary to prepare the appropriate incentive program to compensate any member's loss.

Fifth, Quick Response results in greater supply chain performance as the market demand and profit margin become higher. Compared with the traditional system, Quick Response results in much higher supply chain profit as the demand size and profit margin increase. Furthermore, both manufacturer and retailer obtains greater profits as the demand size becomes larger. As the profit margin increases, the retailer achieves greater profit, but the manufacturer’s profit decreases. This result indicates that it is more preferable to employ Quick Response when the market demand is larger. Meanwhile, the profit margin should be carefully determined with every supply chain member’s agreement to obtain the best outcome from Quick Response.

Finally, the fully shared information system also obtains superior supply chain performance with large marker demand and high profit margin. The increased profit margin raises retailer’s profit, but it decreases manufacturer’s profit. In particular, compared with Quick Response, the manufacturer’s loss due to the fully shared information system becomes larger as the profit margin becomes higher. By implication, the supply chain system with large demand and high profit margin can improve its performance by employing the fully shared information program. Meanwhile, when the retailer has high profit margin, the fully shared information system needs to equip with the proper incentive program to compensate any supply chain member’s loss.

6. Conclusion

Quick Response has received heavy attentions from both firm managers and academic scholars, because its prominent achievement has been proven in many industries. In particular, Quick Response has been the effective supply chain collaboration program in the apparel industry to cope with the uncertain demands and resolve the chronic problem of unbalanced inventory level. While there have been many studies that conducted research on Quick Response, only a few of them evaluate its performance and investigate the reason of its superiority over the conventional supply chain system.

This study examines how Quick Response affects the supply chain performance. Based on the mathematical model that depicts the supply chain system with a single manufacturer and one retailer, this study compares Quick Response with the traditional system in terms of the economic performance. Furthermore, by testing the fully shared information system, which has the additional collaboration feature, this study examines the potential of Quick Response to be a more advanced collaboration program. The numerical analysis on the proposed supply chain models are used to evaluate the performances of three different supply chain systems.

The results from the numerical examples provide valuable managerial implications regarding how to obtain the best outcome from Quick Response. The numerical study shows that Quick Response outperforms the traditional system in terms of the supply chain profit. Furthermore, unlike other collaboration programs such as consignment and Vendor-Managed Inventory (Ryu, 2016), Quick Response is beneficial for both manufacturer and retailer. Under Quick Response, the retailer’s delayed pricing and ordering decisions with the real demand information result in the increased sales, and ultimately the enlarged throughput in the whole system leads to greater profits for every supply chain member than in the traditional system. The fully shared information system, where even the manufacturer is able to receive the real demand information before any decisions are made, results in higher supply chain profit than Quick Response as well as the traditional system. However, the manufacturer’s profit under this new system is lower than the one in Quick Response. By implication, the proper incentive scheme is required for every supply chain member to share the equal benefit from this new program.

The additional analysis on the numerical examples indicates that both Quick Response and the fully shared information system obtain greater supply chain profits as the market size and retailer’s profit margin increase. This result implies that Quick Response and the fully shared information system are preferable when the market demand is huge and profit margin is high. Meanwhile, with higher market size and profit margin, the retailer’s profit increases but the manufacturer has lower profit under these two systems.

This study still has some limitations. First, this study uses the arbitrarily chosen parameters in the numerical examples and their outcomes may not represent the realistic features of Quick Response when it is applied to the real industry. Future studies would obtain the real data from the case studies and use them to the numerical analysis to provide the practical implications for the business practitioners (Gómez & Filho, 2017; Warburton & Stratton, 2005).

Second, this study may overestimate the value of Quick Response without considering its cost. In general, the extra cost should be paid to implement Quick Response in the supply chain system, and it commonly appears as the increased price paid by the retailer due to the order delay (Choi, 2017; Wang et al., 2018; Yang et al., 2015). Quick Response cost is ignored in this study, because the main objective of this study is to examine the pure impact of Quick Response on the supply chain performance by comparing it with the traditional system under the exactly same conditions. Meanwhile, future researchers would consider various costs due to Quick Response including retailer’s purchasing cost and manufacturer’s production cost in their analysis and they can successfully assess the realistic value of Quick Response (Liu & Nagurney, 2013).

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