Performance Evaluation Model for Buyer-Carts in B2B EC

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Abstract

Even though B2B EC is becoming popular, there have been not so much studies about performance evaluation methodology for B2B systems. In this paper, after analyzing buyer-carts systematically focusing on the buyer's interactional efforts on the typical buying processes of each buyer-cart, we propose a quantitative performance evaluation model. For this, we categorize buyer-carts in B2B EC as s-cart, i-cart, and b-cart depending upon its residing sites : seller, intermediary, and buyer sites. And after proposing the desired features of buyer-carts in B2B EC as identification, collection, trashing, ordering, payment, tracking, recording, purchasing decision support, and transmission of records to e-procurement systems, we derive a performance evaluation model by calculating detail sub-processes from the desired features' viewpoints. By setting variables from interviews of business buyers in 30 listed companies in Korea, we try to evaluate the performance of buyer-carts in B2B EC. In this paper, we suggest a new methodology of performance evaluation for B2B systems, and show that the b-cart platform is more efficient than other buyer-carts especially in B2B EC.

Keywords:
Business-to-Business Electronic Commerce (B2B EC); performance evaluation; electronic shopping cart (e-cart); buyer-cart; b-cart; b2b system

1. Introduction

Owing to the advent of Internet, Electronic Commerce (EC) is increasingly universalizing in all span of our society. Among EC areas, the B2B EC is being spotlighted as an interesting research area considering its size and the potential impact on the whole society. Now various B2B systems are being used in seller-centric e-marketplaces, intermediary-centric e-marketplaces, and buyer-centric e-marketplaces etc. [1]. In the situation that purchasing in e-marketplaces is becoming an important part in a company, this paper tries systematic quantitative analysis for buyer-cart systems in B2B by presenting a performance evaluation model.

Buyer-cart is the conventional shopping cart that handles the two most important information (order, payment) in B2B EC. In comparison with private consumers, business buyers have to precisely keep track of the purchase progress, store records, and integrate them with the buyer's e-procurement system, which might have been implemented as a part of integrated ERP (Enterprise Resource Planning) systems [2,3,4]. From such viewpoint, shopping cart systems to support buyers in B2B EC are classified into ***buyer-cart***, ***an electronic cart (e-cart) that is owned and used by the business buyers*** and ***seller-cart, an electronic cart that is owned and used by business salesmen*** [5]. Buyer-cart, the conventional shopping cart, is classified into ***s-cart***, ***a buyer-cart that resides on the seller's site*** in seller-centric e-marketplace like a) in Figure 1 and ***i-cart***, ***resides on the intermediary's site***, and ***b-cart***, which ***resides on the buyer's site*** like b) in Figure 1 [6]. Figure 2 is an example of b-cart.

Since i-cart is functionally similar to s-cart we will talk about only s-cart comparing to b-cart in this paper. So far, s-cart/i-cart is popular; since the software is thoroughly developed and operated by seller/intermediary, it is easy for users to use and manage it. The concept of b-cart is that a buyer possesses his/her own buyer-cart on his/her PC or server, and carries it to the various e-marketplaces. The b-cart can be implemented by displaying an overlaid window on the buyer's PC. Since the order information is managed in buyer's site, it can be used at a time in an e-marketplace or in several e-marketplaces simultaneously with comparing items from each site. In Figure 2, you can see a b-cart which has received order approvals for two selected items after collecting three items from two different e-marketplaces.

In our previous study, we showed that the b-cart has many advantages than s-cart in B2B EC. Even though there have been some studies on qualitative analysis for buyer-cart, but sufficient quantitative analysis is not yet provided [7]. Generally, it is difficult to measure which EC architecture is more efficient than the others in a certain domain. Therefore, from this paper, we are going to show a methodology to evaluate the performance of an EC system quantitatively.

There have been some studies related to this topic; Andrew and Myers made a performance evaluation for their e-commerce system by measuring processing speed [8], Hahn and Kaufman focused on business value, especially ROI [9], Shahar suggested QoS simulation method focused on real-time access time, response time, and reliability [10], Coarfa, Drushel and Wallach measured CPU time for specific operation [11], Cecchet, Margurite and Zwaenepoel measured CPU, memory, and disk usage for specific architecture on linux kernel [12].

However, these methods cannot fully explain why a certain EC system is more efficient than others are in the changing environment. These methods focus on the computing performance from the system's perspective. However, for EC systems, it needs the user's perspective especially for buyer or seller.

In this paper, we are going to perform the comparison analysis of user interaction for functionally different buyer-carts in B2B EC by quantitative measurement.

We define and analyze purchasing processes of each buyer-cart after defining nine features of buyer-carts for B2B EC in section 2. In section 3, we propose a performance evaluation model and compare buyer's interactional efforts when electronic buyings are processed using each buyer-cart in the same situation. In section 4, we evaluate the performance by setting parameters from practical measurement. In section 5, we try to generalize this methodology and a summary and roads ahead are described in section 6.

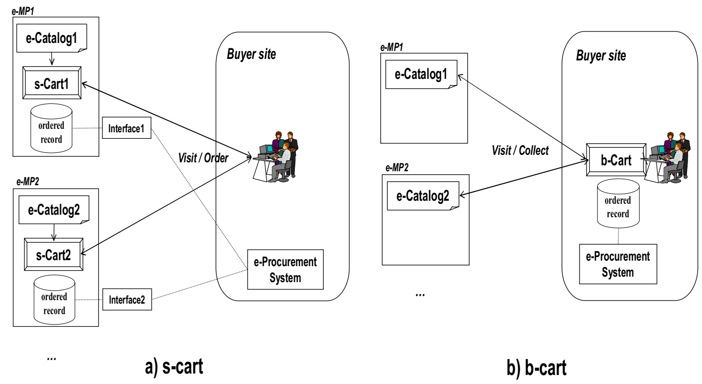

Figure 1. s-cart and b-cart

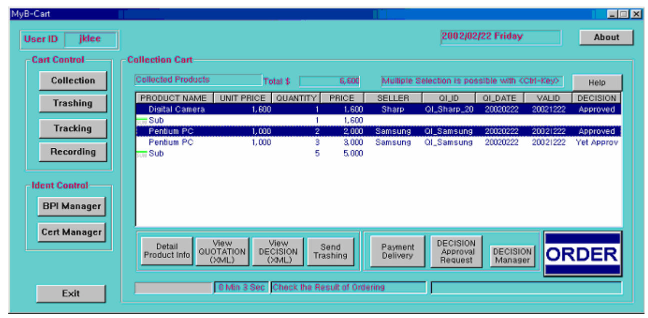

Figure 2. An example of b-Cart (MyB-Cart) on a buyer's PC

2. Features of buyer-cart and purchasing process

At first, we define the essential nine features of buyer-cart. They are ***Collection*** that collects interesting items into buyer-cart possibly from multiple e-marketplaces, and ***Recording*** that records the collected information in a buyer-cart, and ***Trashing*** that trashes items that the buyer is not willing to buy from the current collection, and ***Tracking*** that tracks the progress of current purchase and history of records, and ***Identification*** that identify the owner of a buyer-cart, and that ***Ordering*** that orders the selected items to sellers, and ***Payment*** that pays for the ordered items to sellers[13], and ***Purchase Decision Support*** that supports the buyer organization's purchase decision-making process, and ***Transmission*** that transmits the information in a buyer-cart to the buyer's e-procurement system[1].

In this paper, we analyzed and defined general purchasing processes for buyer-carts in buying following above features as Figure 3 for s-cart and Figure 4 for b-cart to make a performance evaluation model. These purchasing processes assume a general situation that all the desired features of buyer-cart are performed. From these diagrams, we can know that most operations of the purchasing procedure using b-cart are performed on the buyer site. It means that b-cart is more buyer-oriented system than s-cart. In the next section 3, we will compare the buyer's interactional efforts when the buyer purchases electronically using each buyer-cart in the same situation following such buying processes.

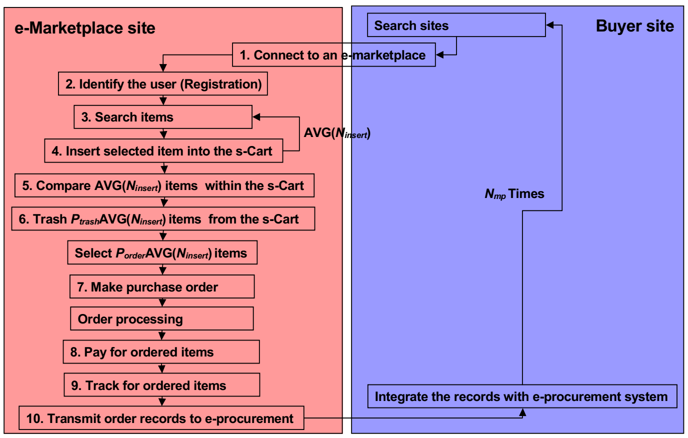

Figure 3. Purchasing operation procedure using the s-cart for a buyer

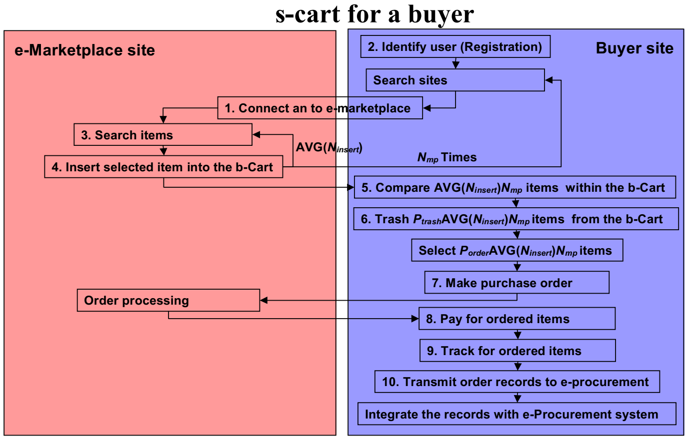

Figure 4. Purchasing operation procedure using the b-cart for a buyer

3. Performance Evaluation Model

3.1. Definitions and Assumptions

For the comparison of the b-cart and the s-cart(i-cart), we tried to make a performance evaluation model as below for buyer's interactionl efforts during the general purchase procedure as Figure 3 and Figure 4. In this case, let's assume that the interactional efforts can be measured by time, and they can be summed each other.

<Notations>

N_{mp} : Average number of e-marketplaces that a buyer visits for each purchase.

N_{buy} : Number of buying companies in a market.

n : Average number of buying individuals in each buying company.

$N_{mp}, N_{buy}, n >= 1$.

$AVG(N_{insert})$ **:** The average number of inserting items from an e-marketplace into the buyer-cart per requisition.

P_{trash} **:** The probability of trashing an item inserted in the buyer-cart. ($P_{order} = 1 - P_{trash}$).

Connect(s)/Connect(b) : The connecting effort to an e-marketplace per requisition using the s-cart/b-cart.

Identify(s)/Identify(b) : The effort of identifying a buyer to enter an e-marketplace per requisition using the s-cart/b-cart.

Search(s)/Search(b) : The effort of searching items within an e-marketplace before inserting items into the s-cart/b-cart per requisition.

Insert(s)/Insert(b) : The effort of inserting an item from an e-marketplace into the s-cart/b-cart.

Compare(s)/Compare(b): The effort of comparing collected items within the s-cart/b-cart.

Trash(s)/Trash(b) : The effort of trashing an item from the s-cart/b-cart.

Order(s)/Order(b) : The effort of making a purchase order using the s-cart/b-cart.

Pay(s)/Pay(b) : The effort of making a payment for the ordered items using the s-cart/b-cart.

Track(s)/Track(b) : The effort of tracking the ordered items within the s-cart/b-cart.

Transmit(s)/Transmit(b) : The effort of transmitting ordered records into the buyer's e-procurement system for integration from the s-cart per requisition.

α : Variable interactional effort that is proportional to the number of e-marketplaces.

β : Fixed interactional effort regardless of the number of e-marketplaces.

$\alpha_s, \beta_s, \alpha_b, \beta_b$ **:** The subscripts ***s***, ***b*** imply the situations that use s-cart and b-cart respectively.

e(s) : Individual buyer's interactional effort per purchase using the s-cart, $\mathbf{e(s)} = \alpha_s N_{mp} + \beta_s$.

e(b) : Individual buyer's interactional effort per purchase using the b-cart, $\mathbf{e(b)} = \alpha_b N_{mp} + \beta_b$.

Using above notations, if we calculate the difference between the individual buyers' interactional efforts using s-cart and the case of using b-cart, we can derive **Δe;**

$\mathbf{\Delta e = e(s) - e(b)} = (\alpha_s - \alpha_b)N_{mp} + (\beta_s - \beta_b) = \Delta\alpha N_{mp} + \Delta\beta$, $(\Delta\alpha = \alpha_s - \alpha_b$, $\Delta\beta = \beta_s - \beta_b)$

In this paper, we will compare and evaluate the efficiency by analyzing this difference of interactional efforts.

3.2. Individual Buyers' Interactional Efforts

If we assume that each buyer has one buyer-cart for a specific purchase without redundancy, we can assume that there are N_{mp} buyer-carts in the entire market for a buyer when he/she uses the s-cart. And there is only one buyer-cart in the entire market for a buyer when he/she uses the b-cart because it is enough for a buyer to have only one b-cart in his/her own PC. With these assumptions and the processes of Figure 3 and Figure 4, we can estimate the numbers of each step's interactions as Table 1**.** e(s) and e(b) can be calculated from the summation of the multiplications of the each step's interactional efforts in purchasing process and the number of corresponding interactions.
Then, the total interactional efforts for a buyer using the s-cart per purchase are;

e(s) = Σ (*Coefficient* (s,i)* *Number of Interactions* (s,i)), i = 1, 2,…,10

$= (Connect(s) + Identify(s) + Search(s) + Compare(s) + Order(s) + Pay(s) + Track(s) + Transmit(s) + AVG(N_{insert})(Insert(s) + P_{trash}Trash(s)))N_{mp}$

When **e(s)** $= \alpha_s N_{mp} + \beta_s$, we can know;

$\alpha_s = Connect(s) + Identify(s) + Search(s) + Compare(s) + Order(s) + Pay(s) + Track(s) + Transmit(s) + AVG(N_{insert})(Insert(s) + P_{trash}Trash(s))$ (equation 1)

$\beta_s = 0$ (equation 2)

And the total interactional efforts for a buyer using the b-cart per purchase are;

e(b) = Σ (*Coefficient* (b,i)* *Number of Interactions* (b,i)), i= 1, 2,…,10

$= (Connect(b) + Search(b) + AVG(N_{insert})(Insert(b) + P_{trash}Trash(b)))N_{mp} + (Identify(b) + Compare(b) + Order(b) + Pay(b) + Track(b) + Transmit(b))$

When **e(b)** $= \alpha_b N_{mp} + \beta_b$, we can know;

$\alpha_b = Connect(b) + Search(b) + AVG(Ninsert)(Insert(b) + PtrashTrash(b)))$ (equation 3)

$\beta_b = (Identify(b) + Compare(b) + Order(b) + Pay(b) + Track(b) + Transmit(b))$ (equation 4)

To compare two alternatives, we have to calculate

$\mathbf{\Delta e = e(s) - e(b)} = (\alpha_s - \alpha_b)N_{mp} + (\beta_s - \beta_b) = \Delta\alpha N_{mp} + \Delta\beta$

To simplify the equation to find any meaningful implication, we have to investigate the coefficients. To evaluate Δe, let us analyze the detail operation procedures of each step.

3.3. Analyze Detail Operation Procedures

Figure 5 shows the operation procedure of connecting to an e-marketplace. As we see in the figure, we now know that *Connect(s)* = *Connect(b)* because it is identical through the web browser.

Proposition 1] Connect(s) = Connect(b)

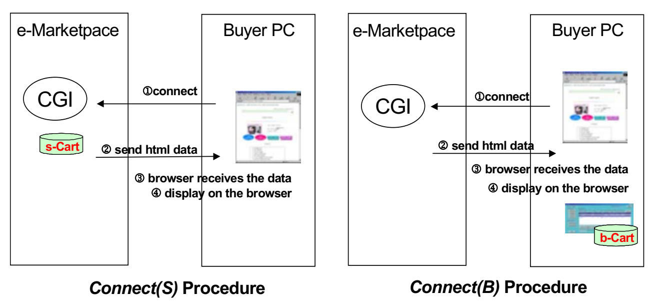

Figure 5. The operation procedure of connecting to an e-marketplace

Table 1. Interactional Efforts Estimation

Step(i)	Operation Procedure	Individual Buyers' Interactional Efforts			
		Using s-Cart		Using b-Cart	
		Coefficient	*Number of Interactions*	*Coefficient*	*Number of Interactions*
1	Connecting to an e-marketplace	***Connect(s)***	N_{mp}	***Connect(b)***	N_{mp}
2	Identifying the buyer (Registration)	***Identify(s)***	N_{mp}	***Identify(b)***	*1*
3	Searching items within an e-marketplace	***Search(s)***	N_{mp}	***Search(b)***	N_{mp}
4	Inserting selected items into the buyer-cart	***Insert(s)***	$AVG(N_{insert})\ N_{mp}$	***Insert(b)***	$AVG(N_{insert})\ N_{mp}$
5	Comparing items within the buyer-cart	***Compare(s)***	N_{mp}	***Compare(b)***	*1*
6	Trashing items from the buyer-cart	***Trash(s)***	$P_{trash}AVG(N_{insert})N_{mp}$	***Trash(b)***	$P_{trash}AVG(N_{insert})N_{mp}$
7	Making purchase orders	***Order(s)***	N_{mp}	***Order(b)***	*1*
8	Making payments for ordered items	***Pay(s)***	N_{mp}	***Pay(b)***	*1*
9	Tracking for ordered items	***Track(s)***	N_{mp}	***Track(b)***	*1*
10	Transmitting the ordered records to the buyer's e-procurement system for integration	***Transmit(s)***	N_{mp}	***Transmit(b)***	*1*
	Total Interaction Efforts	**e(s) = Σ (*Coefficient* (s,i)* *Number of Interactions* (s,i))**		**e(b) = Σ (*Coefficient* (b,i)* *Number of Interactions* (b,i))**	

The identification of the s-cart is needed for every visit to new e-marketplace but of the b-cart is needed only once at in the first execution time within the buyer's PC as we assumed. Figure 6 shows the operation procedure of identifying the buyer for the buyer-cart. As we see in the figure, *Identify(s)* transaction needs more traffic between e-marketplaces and the buyer than *Identify(b)* because *Identify(b)* operation is done within the buyer's PC. Therefore, we now know that *Identify(s) Identify(b)*.

Proposition 2] Identify(s) > Identify(b)

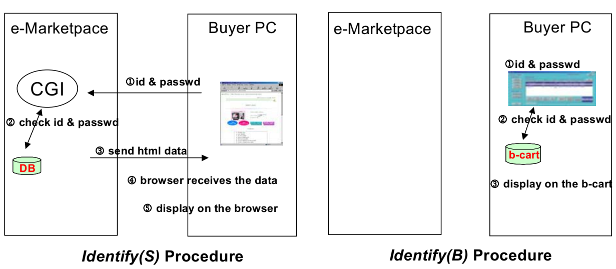

Figure 6. The operation procedure of identifying the buyer for the buyer-cart

Searching an e-marketplace to find items is done through the web browser and it is identical to both the s-cart and the b-cart as in Figure 7. Therefore, we now know that *Search(s) = Search(b).*

Proposition 3] Search(s) = Search(b)

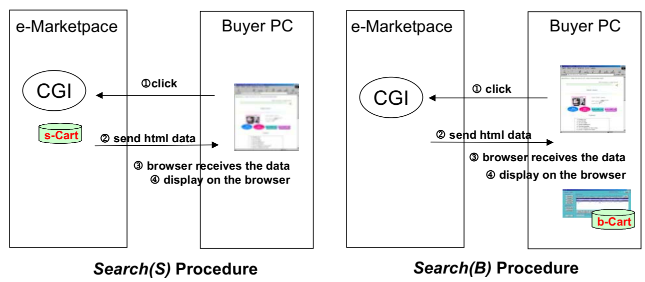

Figure 7. The operation procedure of searching items in an e-marketplace

Figure 8 shows the operation procedure of inserting an item into the buyer-cart. As we see in the diagram, we now know that *Step1(s) = Step1(b)*, *Step2(s) = Step2(b)*, *Step3(s)* ≈ *Step5(b)*, *Step4(s)* ≈ *Step3(b)*, *Step5(s)* ≈ *Step4(b)*, *Step6(s)* ≈ *Step6(b).* Therefore, *Insert(s)* ≈ *Insert(b).*

Proposition 4] Insert(s) ≈ Insert(b)

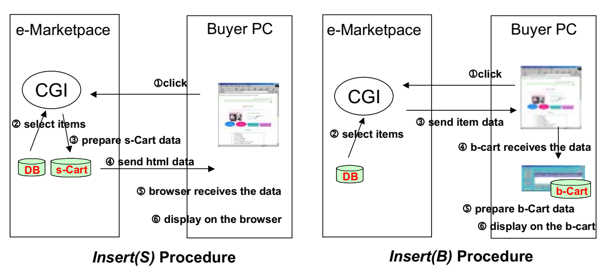

Figure 8. The operation procedure of inserting an item into the buyer-cart

Comparing same number items within a buyer-cart is same for both s-cart and b-cart because it is done within a buyer-cart as in Figure 9. However, with s-cart, the comparison between different s-carts in different e-marketplaces is an overhead comparing to b-cart. Therefore, we can say that *Compare(s) >= Compare(b).*

Proposition 5] Compare(s) >= Compare(b)

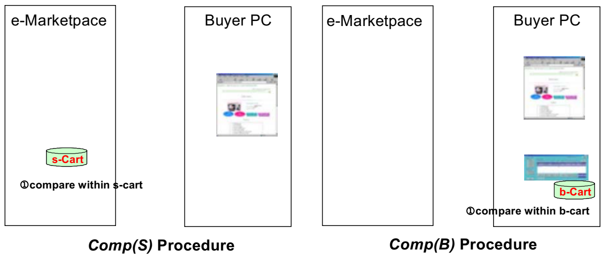

Figure 9. The operation procedure of comparing items within the buyer-cart

Figure 10 shows the operation procedure of trashing an item inserted into the buyer-cart. When a buyer trashes an item from the s-cart, the almost current e-catalog homepage should be refreshed interacting with the e-marketplace's server. As we see in the diagram, *Trash(s)* transaction needs more traffic between e-marketplace and the buyer than *Trash(b)* because *Trash (b)* operation is done within the b-cart in the buyer's PC. Therefore, we now know that *Trash(s) > Trash(b).*

Proposition 6] Trash(s) > Trash(b)

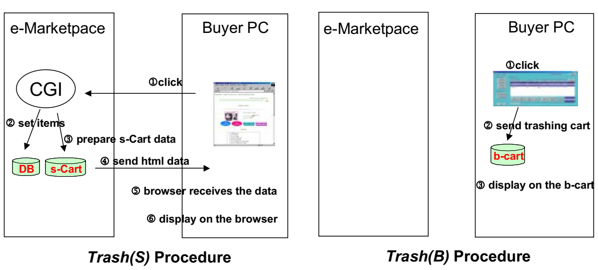

Figure 10. The operation procedure of trashing an item from the buyer-cart

Figure 11 shows the operation procedure of making a purchase order for the remaining items in the buyer-cart. As we see in the diagram, we now know that *Step1(s) = Step1(b)*, *Step3(s) = Step3(b)*, *Step4(s) = Step4(b)*, *Step2(s) ≈ Step2(b)*. Therefore, we can say that *Order(s) ≈ Order(b).*

Proposition 7] Order(s) ≈ Order(b)

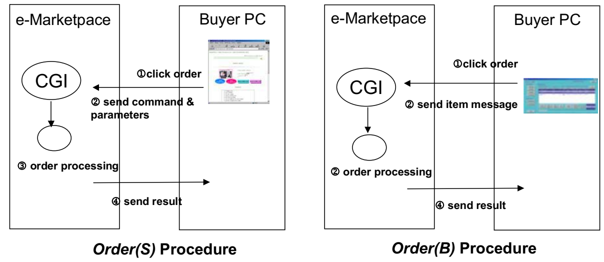

Figure 11. The operation procedure of making a purchase order in the buyer-cart

Figure 12 shows the operation procedure of making a payment for the ordered items. As we see in the diagram, we now know that *Step1(s) = Step1(b)*, *Step3(s) = Step3(b)*, *Step4(s) = Step4(b)*, *Step2(s) ≈ Step2(b).* Therefore, we can say that *Pay(S) ≈ Pay(B).*

Proposition 8] Pay(S) ≈ Pay(B)

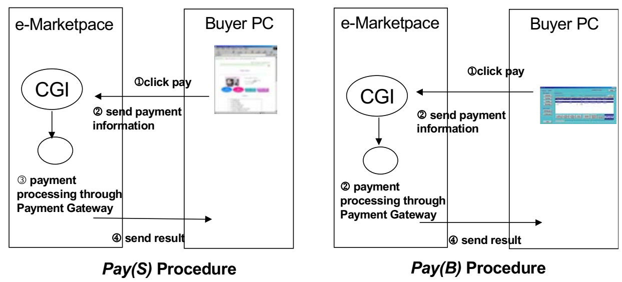

Figure12. The operation procedure of making a payment for ordered items

Figure 13 shows the operation procedure of tracking for the ordered items. As we see in the diagram, we now know that *Step1(s) = Step1(b)*, *Step3(s) = Step3(b)*, *Step4(s) = Step4(b)*, *Step2(s) ≈ Step2(b)*, *Step5(s) ≈ Step5(b).* Therefore, we can say that *Track(s) ≈ Track(b).*

Proposition 9] Track(s) ≈ Track(b)

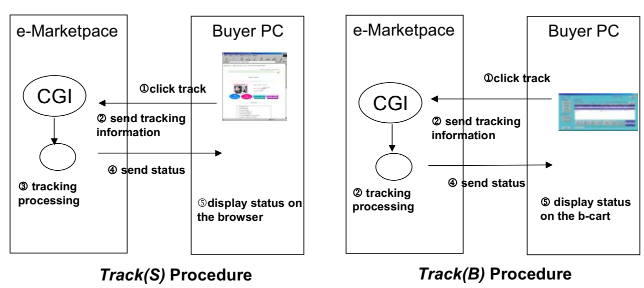

Figure 13. The operation procedure of tracking for ordered items

The interaction efforts of transmitting the ordered records to the buyer's e-procurement system using the s-cart are done with additional interface between the s-cart and the e-procurement system. Therefore, transactions between the e-marketplace and the buyer are needed. However, the transmission using the b-cart needs no transactions between the buyer and the e-marketplace because it is done within the buyer's site. The b-cart can be tightly integrated with the e-procurement system within the buyer's site as Figure 14. Therefore, we now know that *Transmit(s) > Transmit(b).*

Proposition 10] Transmit(s) > Transmit(b)

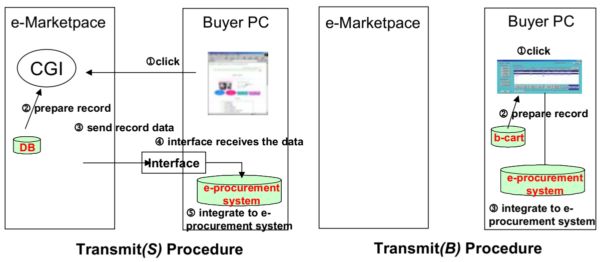

Figure 14. The operation procedure of transmitting ordered records to the buyer's e-procurement system

3.4. Performance Evaluation Model

From the propositions, we know that;

Connect(s) - Connect(b) = 0 (by proposition 1),
Search(s) - Search(b) = 0 (by proposition 3),
Insert(s) - Insert(b) =0 (by proposition 4).

Therefore, if we apply them to the difference between (equation 1) and (equation 3), we now know that;

$\Delta\alpha = \alpha_s - \alpha_b = (Identify(s) + Compare(s) + Order(s) + Pay(s) + Track(s) + Transmit(s) + AVG(N_{insert})(P_{trash}(Trash(s) - Trash(b)))$ (equation 5)

If we apply them to the difference between (equation 4) and (equation 5), we now know that;

$\Delta\beta = \beta_s - \beta_b = -\beta_b = -(Identify(b) + Compare(b) + Order(b) + Pay(b) + Track(b) + Transmit(b))$ (equation 6)

And since

Identify(s) > Identify(b) (by proposition 2),
Compare(s) >= Compare(b) (by proposition 5),
Order(s) ≈ Order(b) (by proposition 7),
Pay(s) ≈ Pay(b) (by proposition 8),
Track(s) ≈ Track(b) (by proposition 9),
Transmit(s) > Transmit(b) (by proposition 10),
Trash(s) > Trash(b) (by proposition 6),
$1 >= P_{trash} >= 0$ (by definition)

If we apply them to (equation 5) and (equation 6),
We can derive below equation;

$|\Delta\alpha| > |\Delta\beta| > 0$ (equation 7)

Therefore, we can get below equation;

$\Delta e = \Delta\alpha N_{mp} + \Delta\beta, \quad |\Delta\alpha| > |\Delta\beta| > 0, \quad \Delta\beta < 0, \quad N_{mp} >= 1$ (equation 8)

The entire market effort can be calculated simply by multiplying the number of buying companies and average number of buyers in a company. Notationally,

E(s) : A market's total interactional effort using the s-cart
E(b) : A market's total interactional effort using the b-cart
$\mathbf{E(s) = e(s)}nN_{buy}$
$\mathbf{E(b) = e(b)}nN_{buy}$

Then, we can have,

$\Delta E = E(s) - E(b) = (e(s)- e(b))nN_{buy} = \Delta enN_{buy} = (\Delta\alpha N_{mp} + \Delta\beta)\, nN_{buy}$ (equation 9)

The relationship between the N_{mp} and **ΔE** is graphically depicted in Figure 15. In this example, we can know $0 < |\Delta\beta/\Delta\alpha| < 1$, $\Delta\alpha > 0$, $\Delta\beta < 0$ because (equation 8), so the horizontal intersection lies between 0 and 1. This means that **ΔE** is positive as far as at least one e-marketplace exists. The magnitude of **ΔE** increases as either N_{buy} or n increases. This shows that using the b-cart is more efficient than using others.

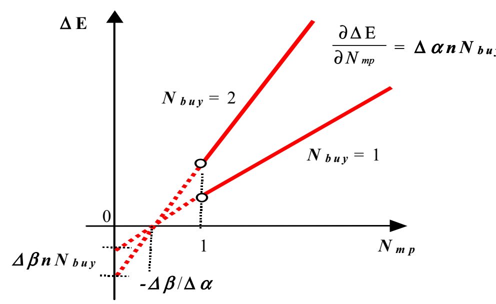

Figure 15. $\Delta E = (\Delta\alpha N_{mp} + \Delta\beta)\, nN_{buy}$

4. Measuring Performance Evaluation

Among the about 1,500 listed companies on the Korea stock exchange market (KOSPI and KOSDAQ), we randomly interviewed 30 different buyers (one buyer per company). From the interview, we come to know that a buyer in a company consults 3.2 marketplaces(N_{mp}) for each purchase and buys 11 items($(1-P_{trash})AVG(N_{insert})$, when $P_{trash} = 0.3$) per purchase on the average. The buyer does such purchase processing 46.5 times per month and a company has 8 business buyers(n) for such purchasing activity on the average. To measure the coefficients of interactional efforts, we estimated interaction times that are measured based on the network environment of Sejong University in Seoul (T3) with Pentium PC Windows as Table 2.

Logically the coefficients of *Coonect* and *Search* for each cart are identical and the main parts of *Identify*, *Insert*, *Order*, *Pay*, and *Track* of each cart are very similar. There would be some variances according to their implementations and operations. Therefore, we took the same measured time for s-cart and b-cart for these coefficients.

Table 2. Measured interaction times (*Coeffients*)

s-cart			b-cart		
Coefficient	**Average Value(s)**	**Standard deviation**	**Coefficient**	**Average Value(s)**	**Standard deviation**
Connect(s)	7.8	1.4	***Connect(b)***	7.8	1.4
Identify(s)	7.2	1.6	***Identify(b)***	2.1	0.4
Search(s)	120	11.5	***Search(b)***	120	11.5
Insert(s)	3.7	0.8	***Insert(b)***	3.7	0.8
Compare(s)	30	4.3	***Compare(b)***	2.8	0.3
Trash(s)	3.6	0.7	***Trash(b)***	1.0	0.3
Order(s)	23.9	2.6	***Order(b)***	23.9	2.6
Pay(s)	35.7	4.3	***Pay(b)***	35.7	4.3
Track(s)	16.4	2.7	***Track(b)***	16.4	2.7

From above results, we can have $\Delta\alpha = \alpha_s - \alpha_b$ = 331.2 – 191.8 = 139.4 seconds, $\Delta\beta = \beta_s - \beta_b$ = 0 – 84.5 = -84.5 seconds, N_{mp} = 3.2. Therefore, we can know $\Delta e = \Delta\alpha N_{mp} + \Delta\beta$ = 139.4*3.2 - 178 = 362 seconds. We can easily convert the time effort to cost by multiplying the unit cost of time, denoted by c. In this study, we assume c = $16/hour. Therefore, the cost saved for an individual purchase is $c\Delta e$ = $16*362/3600 = $1.61. In this study, the average number of buying individuals in a company was 8, and the average number of annual purchase for a buyer was 558. Therefore, the average annual cost saved for each company is $c\Delta E$ = $1.607*8*558= $7,172. When we count 1,500 companies listed in the Korean stock markets, the total saving for the market is $1.61*8*558*1,500 = $10,758,716 per year.

This study implies that with increasing N_{mp}, N_{buyer} and n in B2B EC, the buyer's interactional efforts using the b-cart are more efficient than those of the s-cart are in the purchasing items. When N_{mp}, N_{buyer} and n are small, the difference of interactional efforts between the s-cart and the b-cart (ΔE) is small and relatively insignificant. This means that the s-cart may be the dominant framework of B2B EC in the early stage because of its advantage of early introduction to the e-market. However, when N_{mp}, N_{buyer} and n are large, ΔE is large and significant. Therefore, we can expect that the b-cart will become the dominant framework of B2B EC because of its efficiency.

The main differences of interactional efforts between the s-cart and the b-cart are because the operation procedure and the degree of the integrated services. The differences of the operation procedures are mainly in identifying, trashing and transmitting to the e-procurement system. The reason is that the interface traffic between the e-marketplace and the buyer is needed in using the s-cart but the b-cart can support integrated services in the buyer's site compared to the s-cart.

In B2C EC, *Transmit(s)* = *Transmit(b)* = 0, but the equation and the evaluation are consistent as the B2B EC. Therefore, we now know that the b-cart is more efficient than the s-cart in B2B EC as well as B2C EC.

5. Generalization of the Methodology

To generalize this methodology for EC systems, we try to formulate this approach as Figure 16. It can be divides into three stages; defining system, making performance evaluation model, and measuring performance evaluation.

At the first defining system stage, the target system and its alternatives must be defined. And after defining basic desired features of the target system, one can derive the operation procedure of each alternatives.

In the making performance evaluation stage, one should define notations and assumptions at first, and define coefficients that are needed for each operation step. One can estimate individual interactional effort by summarizing the multiplications of the each step's interactional efforts and the number of corresponding interactions. By analyzing the detail operation procedures of each coefficients, one can derive some propositions by comparing each detail steps of the process to compare alternatives. A performance model can be derived by comparing alternatives and propositions.

In the measuring performance evaluation stage, one can measure each coefficient value by interviews or experiments. And one can derive implications by sensitivity analysis. Any new EC architecture can be measured by its' interactional efforts following these steps.

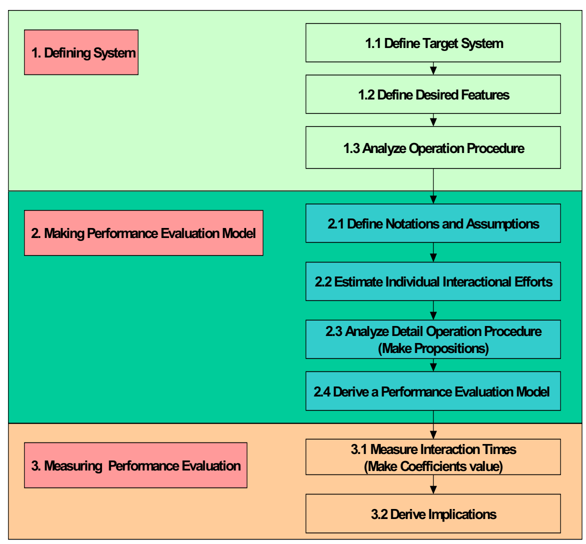

Figure 16. Performance evaluation model

6. Conclusion

Even though B2B EC is becoming popular, there have been not so much studies about performance evaluation methodology for B2B systems. In this paper, after analyzing buyer-carts systematically focusing on the buyer's interactional efforts on the typical buying processes of each buyer-cart, we proposed a quantitative performance evaluation model and tried to evaluate the performance.

For this, we categorize buyer-carts in B2B EC as s-cart, i-cart, and b-cart depending upon its residing sites : seller, intermediary, and buyer sites. And after proposing the desired features of buyer-carts in B2B EC as identification, collection, trashing, ordering, payment, tracking, recording, purchasing decision support, and transmission of records to e-procurement systems, we analyzed the purchasing processes of s-cart and b-cart. When a buyer purchases items using s-cart and b-cart following such processes, after analyzing detail sub-processes, we calculated individual buyer's interactional efforts by time, and derived a quantitative performance evaluation model. From the performance evaluation in this paper, we can know that the b-cart is very much more efficient than other buyer-carts in B2C EC and especially in B2B EC.

From the interviews of business buyers in 30 listed companies in Korea, we could estimate the cost reduction about $10,758,716 per year in entire market when the b-cart is used. Such result is changeable according to the number of e-marketplaces and the cost structure of the market. However, since many parts of a company's purchasing will be done in e-marketplaces, and desktop purchasing will be more popular [14], the number of individual buyers in each company will increase enormously. Therefore, we can expect that the benefit of b-cart will increase.

The b-cart is buyer-oriented shopping cart. With b-cart a buyer can visit multiple e-marketplaces collecting items in his/her own one b-cart and make purchase orders simultaneously over multiple items inserted from different e-marketplaces. Moreover, the b-cart also supports integrated services in personalized comparison on purchasing items, order tracking, financial/payment management and user's account management on the buyer site. This will allow the tight integration of the information in b-cart with the e-procurement system. From this paper, we showed the validity of the using b-cart in B2B EC especially in integrating e-marketplace and e-procurement system by proposing a quantitative performance evaluation model.

The methodology shown in this paper is appropriate to evaluate the efficiency of EC systems by comparing the users' interaction effort. We tried to generalize this methodology by summarizing the sequence of this method. This method is fit in the cases when the interaction is the important part of a system like common EC systems and when it is needed to choose architecture in several alternatives.

Further research topics are the generalization of this methodology to apply other systems and the consideration for agent-based electronic commerce environment [15,16].

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