Cost of ownership model for a CRM system

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Abstract

A procurement decision about a CRM system is heavily influenced by the initial purchase cost rather than the effect of the operating cost and utilization over the lifetime. In this paper, we propose a Cost of Ownership (COO) model for a CRM system which takes into account not only the initial cost, but also the operation cost, and the opportunity cost due to customer mismanagement over a life-cycle. In particular, the opportunity cost due to customer mismanagement, which is related to the performance of the CRM system, is used as a key cost factor to reflect the financial impact of the system. We employ an engineering economy model to compare various systems with different life spans. A numerical example is given for comparison of the COO of alternative systems along with sensitivity analysis for an optimal procurement decision.

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1. Introduction

The adoption of CRM (customer relationship management) systems has been enhanced by recent developments in information technology. By using such a CRM system, companies can retain and attract customers who are potentially valuable [15,16,19].

A highly effective CRM system in both implementation and operational use over its life span generally guarantees a better performance, but it may carry the burden of high initial

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purchase cost. Therefore the trade-off between the initial purchase cost and the operating cost needs to be investigated with a Cost of Ownership (COO) model which synthetically evaluates a lifetime expense of a system [11].

Various approaches have been proposed for a cost–benefit analysis for a CRM system. However the contents are not in depth and do not pay much attention to the opportunity cost due to customer mismanagement which could be crucial [1–3,5,7,9,12,13].

In this paper, we propose a COO model for a CRM system which takes into account not only the initial cost, but also the operation, and customer mismanagement cost over a life-cycle. In particular, the opportunity cost due to customer mismanagement is used as a key cost factor to reflect the financial impact of the system. Additionally we will show how to compare CRM systems with different life spans by using the NPV (Net Present Value) of COO over the lifetime.

This paper is organized as follows. In Section 2, the literature on the COO model is briefly reviewed. In Section 3, the proposed COO model for a CRM system is introduced. Numerical examples for implementation are shown in Section 4. Discussion and further study areas are given in Section 5.

2. Literature review

COO models have been used to support acquisition and planning decisions for a wide range of assets such as manufacturing and IT systems which typically have huge burden of initial purchase cost.

In the case of a manufacturing system, semiconductor industries initiated the development of the COO model for wafer fabrication equipment in 1990 as its purchase costs rose. The generic equipment COO per good unit produced developed at SEMATECH is as follows [4,10]:

\[
COO = \frac{CF + CV + CY}{TPT \times Y \times U}
\]

where \( CF \) is the fixed cost, \( CV \) is the variable cost, \( CY \) is the yield loss cost, \( TPT \) is the throughput, \( Y \) is the composite yield, and \( U \) is the utilization.

This kind of COO model has the advantage of considering the trade-off relationship by accommodating not only CF but also CY. The typically expensive initial cost can be offset by a smaller yield loss cost.

Use of COO has been well accepted by the semiconductor industry. Even commercial COO models have been prepared by a joint development between SEMATECH and Wright Williams and Kelly [23]. Later, Dance et al. [4] extended this COO model for assembly and inspection. Recently, Sohn and Moon [17,18] proposed an extended revised COO model for the economic evaluation of the inspection equipment that can accommodate multiple quality characteristics. Additionally they showed how to compare inspection equipments with different life spans by repeatedly using the NPV (Net Present Value) of COO over the lifetime.

In the case of an IT system, a COO model has been developed considering components of an IT system consisting of software and personnel as well as hardware. However, it was not until recently that the COO model was applied to an IT system and it is at the
beginning stage where the total cost is estimated by simple sum or product of all cost components without consideration of the cost–benefit trade-off relationship.

Verhoef [20] estimated the minimal total cost of ownership for an IT project which can be used by the CMM (Capability Maturity Model) level 1 organizations [22]. Typically at level 1, much relevant IT portfolio information is not readily available. However, in most organizations, both project duration and development costs are accessible without too much trouble. Verhoef [20] used three factors for calculating the TCO (total cost of ownership) of an IT project consisting of the tcd (total cost of development) and mco (minimal cost of operation): working days in a year, burdened compensation rate and a project duration function. In order to develop a project duration function, the author benchmarked IT project cost data which were gathered over ten years throughout the world. The formula for TCO for a given duration \( d \) is as follows:

\[
TCO(d) = tcd(d) + mco(y(d))
\]

where,

\[
tcd(d) = r \cdot \frac{w}{1800} \cdot d^{3.564}
\]

\[
y(d) = d^{0.641}
\]

\[
mco(y(d)) = y(d) \cdot nsm(d) \cdot w \cdot r
\]

and

\[
nsm(d) = \frac{d^{2.564}}{750}
\]

where \( d \) is the project duration in calendar months, \( y \) is the number of calendar years the software will be deployed for, \( r \) is a given daily burdened compensation rate, \( w \) is working days in a year. \( nsm(d) \) stands for the number of people needed on a yearly basis to keep a system of \( d \) calendar months development time “up and running” after delivery. The schedule power is derived by benchmarking and varies for different code sizes, and for different industries. The numbers 0.641, 3.564 and 2.564 are estimated from public benchmark data.

META group [8] found how the selection of an infrastructure platform impacts overall cost using a COO model for an ERP platform. For a platform COO, META extracted not only the standard development life-cycle but also the administrative, operational, and infrastructure costs associated with the support life-cycle. Then these cost contributors were used to formulate a COO model. West [21] applied the COO concept for the ERP system in the field of the education industry, according to three life-cycle stages: acquisition and implementation, operation and maintenance, and replacement.

Above all, the existing COO models applied to an IT system have not paid much attention to the yield loss cost due to the adoption of a poor system which may not require as much as the initial purchase cost for a better system. For that reason, it is noticeable that David et al. [5] used both the control cost occurring from IT hardware management along with the general IT costs related to acquisition and operation. Their control cost can represent the yield loss cost due to a poor system. Using this control cost, the authors conceptually suggested that careful network infrastructure and a comprehensive IT implementation plan can reduce the COO without service-level loss. However, their
application is at the rudimentary level and cannot accommodate the specific situations related to the CRM.

In this paper, we propose a COO model for a general CRM system which covers operational, analytical, and collaborative aspects as well. The opportunity cost due to customer mismanagement is used as a key cost factor to reflect the impact of poor performance of the system. Additionally we will show how to compare CRM systems with different life spans by repeatedly using the NPV of COO over the lifetime.

3. Cost of ownership model for a CRM system

Shahnam [14] defines CRM as the first and foremost business strategy for realizing higher profit and enhanced competitive advantage, which comprises three fundamental aspects: operational CRM, analytical CRM and collaborative CRM. It was mentioned that CRM application architecture must combine operational and analytical and collaborative technologies and it is named the CRM Ecosystem (see Fig. 1).

On the other hand, most of the recent COO for CRM studies have concentrated on the aspect of operational CRM. However, as a comprehensive CRM system is established, which supports the entire business, the CRM Ecosystem should be realized, and COO for CRM also needs to be based on this Ecosystem.

Based on such a CRM Ecosystem, we take the following into consideration.
(a) The CRM system consists of operational, analytical, and collaborative aspects. Data created on the operational CRM is analyzed by the analytical CRM for the purpose of understanding the customer. Collaborative CRM enables consistent collaboration between customers and business organizations.

(b) Customers managed by the CRM system are classified by their behavioral RFM score.

(c) There are both Type I and Type II errors involved in customer classification. Type I error occurs when a profitable customer is classified as unprofitable while Type II error occurs when an unprofitable customer is classified as profitable.

With the above considerations, we present the CRM COO model as follows:

\[
COO = \frac{AC + SC + OCCM}{\sum_{k=1}^{K} (NC_k \times (1 - \pi_k + \lambda_k)) \times U}
\]

where \(COO\) represents the annual cost per customer management, \(AC\) is the acquisition cost per year, \(SC\) is the ongoing support cost per year, \(OCCM\) is the opportunity cost due to customer mismanagement per year, \(NC_k\) is the number of customers of group \(k\), \(\pi_k\) is the customer churn rate of group \(k\), \(\lambda_k\) is the customer acquisition rate of group \(k\), \(K\) is the total number of categories of customer group, and \(U\) is the utilization rate of CRM system.

Typically COO is obtained over the lifetime of the system. Therefore, it is necessary to allocate it per annum for operational comparison purposes and we introduce the concept of the annual COO for fiscal year. Detailed descriptions for each cost are as follows.

3.1. Annual acquisition cost (\(AC_i\))

Total acquisition cost, also referred to as the system building cost, is the expenditure that is required to purchase and build a CRM system.

Total acquisition cost includes the cost incurred due to software licenses and hardware [6].

Software license cost includes the CRM software that will be placed on desktops, laptops and mobile devices, as well as the server license fees associated with the software. All third-party software and server license fees (such as database, application server, security software and integration software) should be included. The license cost for all software types that will be needed to yield a production implementation must be included. Hardware cost includes laptops, handhelds, desktops, servers and other peripheral hardware, plus the associated maintenance costs for the upkeep of these items.

The details of these costs depend upon some decisions such as the following:

(a) whether to do outsourcing or in-house development of the front-office system;
(b) which system to introduce earlier between the front- and back-office systems;
(c) the purpose of the CRM project (for example, marketing-oriented or risk management-oriented CRM projects).

In addition, market circumstances and the internal environment of the company introducing the CRM system must be considered when CRM COO is applied.

\[
Total\ Acquisition\ Cost = \text{software licenses} + \text{hardware}.
\]
Annual Acquisition cost at year $i$ ($AC_i$) is then derived as follows:

$$AC_i = \text{Total Acquisition Cost}_i \times (1 + r)^{i-1}$$

$i = (1, 2, \ldots, \text{Life of System}), \ r = \text{interest rate}$  \hspace{1cm} (5)

3.2. Annual support cost ($SC_i$)

Many enterprises have neglected ongoing support costs in the later system building period and leave several cost components out of the calculation [6]. However, according to Gartner’s research [6], $SC$ is in the region of 44% of TCO. $AC$ occurs at the system purchase stage while $SC$ occurs at the system maintenance stage.

Total support cost includes the cost incurred due to software maintenance, telecommunications, internal resources, External Service Providers and software vendor’s consultants and others [6].

Software maintenance costs are yearly payments made to vendors, above and beyond the initial software cost. Generally, maintenance entitles an enterprise to bug fixes, upgrades and access to the software vendor support desk. Telecommunications costs are associated with data and voice connections that result from the project. Internal staffing cost consists of the cost of the business, technical, financial and help desk personnel assigned to the CRM project. Another cost category involves TCO costs that fall outside the above categories to cover errors and omissions made during the project estimation process and as the assumptions and business conditions change during project execution. The External Service Providers (ESPs) cost includes the costs for all of the services provided by consulting, systems integration and outsourcing vendors. Services include the configuration of the technologies, as well as the strategy planning, design and training, change management and business process consulting in support of CRM initiatives. The Software Vendor Professional Services cost is similar to the ESP category and includes all of the consulting services provided by software vendors’ consultants. Services include design reviews, configuration reviews, technical service reviews, and developer and end-user training.

Total variable cost can then be obtained as follows:

$$\text{Total support Cost} = \text{software maintenance} + \text{telecommunications}$$

$$+ \text{Internal resources} + \text{ESP} + \text{software Vendors consultants} + \text{other.} \hspace{1cm} (6)$$

Subsequently, the annual support cost at year $i$ ($SC_i$) is as follows:

$$SC_i = \text{Total support Cost}_i \times (1 + r)^{i-1}$$

$i = (1, 2, \ldots, \text{Life of System}), \ r = \text{interest rate.}$  \hspace{1cm} (7)

3.3. Annual opportunity cost due to customer mismanagement ($OCCM_i$)

Opportunity cost due to customer mismanagement is caused by both Type I and Type II errors. Type I and II errors related to each customer group occur from incorrect customer classification due to the capability of the CRM system. Let $\alpha_k$ and $\beta_k$ be the Type I and II error rates of group $k$, respectively. The opportunity cost of Type I error, $C_{\alpha k}$, is defined as the cost due to not categorizing a customer into group $k$ when the customer actually
belongs to group $k$. The opportunity cost of Type II error, $C_{\beta_k}$, is defined as the cost due to categorizing a customer into group $k$ when the customer does not belong to group $k$.

Annual opportunity cost due to customer mismanagement at year $i$ ($OCCM_i$) is then derived as follows:

$$OCCM_i = \sum_{k=1}^{K} \{NC_k \times \left(\alpha_k \times (1 - \pi_k + \lambda_k) \times C_{\alpha_k} + \beta_k \times (\pi_k - \lambda_k) \times C_{\beta_k}\right)\} \times (1 + r)^{i-1}$$

and let $\beta_k = 0$ (if $\pi_k > \lambda_k$)

where $NC_k$ is the number of customers, $\pi_k$ is the customer churn rate, and $\lambda_k$ is the customer acquisition rate of group $k$.

One can reflect the changes of customer segmentation over time by adding time subscript $i$ to $\lambda_i$ and $\pi_i$. To classify customers into a total number of $K$ groups, RFM (Recency, Frequency, and Monetary) score analysis is used. Once individual scores with respect to recency ($R$), frequency ($F$), and monetary term ($M$) are made, the total score of an individual customer can be found as the weighted sum of these components where $a_i$ represents weight:

$$P = a_0 + a_1 \times R + a_2 \times F + a_3 \times M.$$  \hspace{1cm} (9)

Based on this score, one can classify customers.

3.4. Annual throughput

Management throughput is the number of customers of $K$ groups and it is related to the retention rate of customers defined as

$$Retention \ rate = 1 - \pi + \lambda.$$  \hspace{1cm} (10)

Subsequently annual throughput of the CRM system at year $i$ can be calculated as follows:

$$Management \ throughput = \sum_{k=1}^{K} (NC_k \times (1 - \pi_k + \lambda_k)).$$  \hspace{1cm} (11)

Throughput analysis reflects the ability of the CRM system to perform its function on an ideal basis. This throughput rate must be scaled down to reflect the utilization of the CRM system in terms of relative time used for operation.

3.5. Annual utilization ($U_i$)

Annual utilization of the CRM system is defined as follows:

$$U_i = \left(1 - \frac{SM_i + UM_i + ST_i}{WH_i + SM_i + UM_i + ST_i}\right)$$  \hspace{1cm} (12)

where $SM_i$ is the scheduled maintenance of the CRM system per month, $UM_i$ is the unscheduled maintenance of the CRM system per month, $ST_i$ is the standby hours per month, $WH_i$ is the operation hours of the CRM system per month of year $i$. 

With these five terms ($FC_i$, $VC_i$, $OCCM_i$, $Throughput_i$, $U_i$), we can get the annual COO at year $i$ for the CRM system. In order to compare it with the benefit due to CRM, we also estimate the benefit as follows.

### 3.6. CRM benefit ($CB_i$)

CRM benefit ($CB$) is the profit which can be obtained due to the employment of the CRM system and is defined as follows:

$$CB_i = \left( \sum_{k=1}^{K} (NC_k \times Y_k \times (1 - \pi_k + \lambda_k)) \right) \times (1 + r)^{i-1} \quad (13)$$

where $Y_k$ is the average profit of group $k$.

Next, we get the net benefit of the CRM system per annum ($CBA$) obtained by subtracting COO from $CB$:

$$CBA_i = CB_i - COO_i. \quad (14)$$

When the present values of these $CBA_i$s are added together over lifetime $n$, $CBA(n)$ can be obtained as the NPV for a CRM system:

$$CBA(n) = CBA_0 + \frac{CBA_1}{(1+r)^1} + \frac{CBA_2}{(1+r)^2} + \cdots + \frac{CBA_n}{(1+r)^n}. \quad (15)$$

Typically we would compare one CRM system with the others which might have different lives. We assume that once the lifetime is over for one system, it will be purchased again repeatedly. Therefore the net present value of infinitely repeated $CBA(n)$, $CBA(n, \infty)$, can be obtained as

$$CBA(n, \infty) = CBA(n) \left[ \frac{(1+r)^n}{(1+r)^n - 1} \right]. \quad (16)$$

This can be used for the comparison of several different CRM systems.

### 4. Example

In this section, we consider a case to show how the proposed COO for a CRM system can be applied to the procurement decision.

Consider the new CRM system (NS) developed to reduce the OCCM caused by Type I and Type II errors so that it can achieve high net benefit. Suppose that there are two kinds of currently used customer management systems. One is the direct manual customer management by sales person (DMS) which depends on the sales person’s intuition. The other is the currently used CRM system (ES) which classifies customers into five classes with less accuracy than NS. The remaining life of ES is three years. It is necessary to decide which system to choose among DMS, ES and NS.

Related scenarios are given in Tables 1 and 2.
Table 1

Scenarios for comparison of $CBA(n, \infty)$

<table>
<thead>
<tr>
<th>TCO category</th>
<th>DMS</th>
<th>ES</th>
<th>NS</th>
<th>Currency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software licenses</td>
<td>–</td>
<td>650,826,446</td>
<td>3,705,228,468</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Software maintenance</td>
<td>–</td>
<td>2,011,361,383</td>
<td>2,513,563,126</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Hardware</td>
<td>–</td>
<td>1,021,600,300</td>
<td>2,781,157,273</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>393,750,000</td>
<td>1,211,326,071</td>
<td>1,470,558,736</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>ESP</td>
<td>–</td>
<td>1,431,818,182</td>
<td>6,051,502,630</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Software vendor’s consultants</td>
<td>–</td>
<td>86,776,860</td>
<td>572,418,893</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Internal resources</td>
<td>11,146,153,846</td>
<td>4,177,122,464</td>
<td>5,903,613,607</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Other</td>
<td>1,413,462</td>
<td>393,750,000</td>
<td>773,771,197</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Total</td>
<td>11,541,317,308</td>
<td>10,984,581,705</td>
<td>23,771,813,929</td>
<td>Currency/year total</td>
</tr>
<tr>
<td>Life of system</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>Years</td>
</tr>
<tr>
<td>Scheduled maintenance</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Hours/month</td>
</tr>
<tr>
<td>Unscheduled maintenance</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Hours/month</td>
</tr>
<tr>
<td>Standby time</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>Hours/month</td>
</tr>
<tr>
<td>Operation hours of CRM system per month</td>
<td>150</td>
<td>150</td>
<td></td>
<td>Hours/month</td>
</tr>
</tbody>
</table>

(DMS: direct manual customer management by sales person, ES: existing system, NS: new system).

Table 2

Scenarios for churn rate and invitation rate of customer group $k$ ($k = 1 \ldots 5$)

<table>
<thead>
<tr>
<th>Churn rate and invitation rate</th>
<th>DMS</th>
<th>ES</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>0.3</td>
<td>0.15</td>
<td>0.001</td>
</tr>
<tr>
<td>$\lambda_1$</td>
<td>0.08</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_2$</td>
<td>0.3</td>
<td>0.15</td>
<td>0.002</td>
</tr>
<tr>
<td>$\lambda_2$</td>
<td>0.08</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Group 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_3$</td>
<td>0.3</td>
<td>0.15</td>
<td>0.003</td>
</tr>
<tr>
<td>$\lambda_3$</td>
<td>0.08</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Group 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_4$</td>
<td>0.3</td>
<td>0.15</td>
<td>0.004</td>
</tr>
<tr>
<td>$\lambda_4$</td>
<td>0.08</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Group 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_5$</td>
<td>0.3</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>$\lambda_5$</td>
<td>0.08</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Numbers used in scenarios reflect Gartner’s five-year TCO sample data for a CRM system applicable to the enterprise which has revenue over $1$ billion for 2000 to 3000 users.

Information related to each customer group is displayed in Table 3.

We developed an Excel spreadsheet program for $CBA(n, \infty)$ and comparison results for the given case are given in Tables 4 and 5. Note that NS is a better choice, although the initial purchase cost for NS was about five times more expensive compared to ES.

By Verhoef’s [20] approach, the minimal total cost of ownership per customer and utilization of the new CRM system is estimated as 5.535 thousand won, while by our approach, COO for the system is estimated as 192 thousand won for five years.
Table 3
Specifications for parameters of customer group \( k \) \((k = 1 \ldots 5)\)

<table>
<thead>
<tr>
<th></th>
<th>DMS</th>
<th>ES</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( A_1 )</td>
<td>0.1</td>
<td>0.01</td>
<td>0.005</td>
</tr>
<tr>
<td>( B_1 )</td>
<td>0.03</td>
<td>0.001</td>
<td>0.0005</td>
</tr>
<tr>
<td>( C_{\alpha 1} )</td>
<td>( \text{TW} \ 1,000,000 )</td>
<td>( \text{TW} \ 1,000,000 )</td>
<td>( \text{TW} \ 1,000,000 )</td>
</tr>
<tr>
<td>( C_{\beta 1} )</td>
<td>( \text{TW} \ 1,000,000 )</td>
<td>( \text{TW} \ 1,000,000 )</td>
<td>( \text{TW} \ 1,000,000 )</td>
</tr>
<tr>
<td>( \alpha_2 )</td>
<td>0.1</td>
<td>0.02</td>
<td>0.005</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>0.03</td>
<td>0.002</td>
<td>0.0005</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( C_{\alpha 2} )</td>
<td>( \text{TW} \ 800,000 )</td>
<td>( \text{TW} \ 800,000 )</td>
<td>( \text{TW} \ 800,000 )</td>
</tr>
<tr>
<td>( C_{\beta 2} )</td>
<td>( \text{TW} \ 800,000 )</td>
<td>( \text{TW} \ 800,000 )</td>
<td>( \text{TW} \ 800,000 )</td>
</tr>
<tr>
<td>( \alpha_3 )</td>
<td>0.1</td>
<td>0.03</td>
<td>0.005</td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>0.03</td>
<td>0.003</td>
<td>0.0005</td>
</tr>
<tr>
<td>Group 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( C_{\alpha 3} )</td>
<td>( \text{TW} \ 600,000 )</td>
<td>( \text{TW} \ 600,000 )</td>
<td>( \text{TW} \ 600,000 )</td>
</tr>
<tr>
<td>( C_{\beta 3} )</td>
<td>( \text{TW} \ 600,000 )</td>
<td>( \text{TW} \ 600,000 )</td>
<td>( \text{TW} \ 600,000 )</td>
</tr>
<tr>
<td>( \alpha_4 )</td>
<td>0.1</td>
<td>0.04</td>
<td>0.005</td>
</tr>
<tr>
<td>( \beta_4 )</td>
<td>0.03</td>
<td>0.004</td>
<td>0.0005</td>
</tr>
<tr>
<td>Group 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( C_{\alpha 4} )</td>
<td>( \text{TW} \ 400,000 )</td>
<td>( \text{TW} \ 400,000 )</td>
<td>( \text{TW} \ 400,000 )</td>
</tr>
<tr>
<td>( C_{\beta 4} )</td>
<td>( \text{TW} \ 400,000 )</td>
<td>( \text{TW} \ 400,000 )</td>
<td>( \text{TW} \ 400,000 )</td>
</tr>
<tr>
<td>( \alpha_5 )</td>
<td>0.1</td>
<td>0.05</td>
<td>0.005</td>
</tr>
<tr>
<td>( \beta_5 )</td>
<td>0.03</td>
<td>0.005</td>
<td>0.0005</td>
</tr>
<tr>
<td>Group 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( C_{\alpha 5} )</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>( C_{\beta 5} )</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

(\( \text{TW} \) is Korean Currency; $1 is around \( \text{TW} \ 1,050 \)).

Table 4
Output of COO

<table>
<thead>
<tr>
<th>Life value (year)</th>
<th>DM</th>
<th>ES</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7,184,381</td>
<td>162,631</td>
<td>32,728</td>
</tr>
<tr>
<td>2</td>
<td>7,902,820</td>
<td>178,138</td>
<td>36,648</td>
</tr>
<tr>
<td>( COO_i )</td>
<td>8,693,100</td>
<td>194,364</td>
<td>37,783</td>
</tr>
<tr>
<td>4</td>
<td>–</td>
<td>–</td>
<td>41,122</td>
</tr>
<tr>
<td>5</td>
<td>–</td>
<td>–</td>
<td>44,310</td>
</tr>
<tr>
<td>Total</td>
<td>23,780,301</td>
<td>535,132</td>
<td>192,591</td>
</tr>
</tbody>
</table>

(\( \text{TW} \) is Korean Currency; $1 is around \( \text{TW} \ 1,050 \)).

See Eq. (2) for detailed calculation for the Verhoef’s approach. If one wants to estimate the total cost of operations over a fixed period, for example the first three years after delivery, then it is necessary to make an assumption about the shape of the cost allocation function for operation over the expected lifetime of the system. We assume a uniform distribution of the operation cost over the expected lifetime = constant yearly amount of the operation effort, then we replace \( y(d) \) by 3 to estimate the total cost of operation during the first three years.
Table 5
Output of CBA

<table>
<thead>
<tr>
<th>Life value (year)</th>
<th>DM</th>
<th>ES</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>369,157</td>
<td>4,782,601</td>
<td>3,712,266</td>
</tr>
<tr>
<td>2</td>
<td>406,073</td>
<td>5,261,615</td>
<td>4,082,847</td>
</tr>
<tr>
<td>3</td>
<td>446,681</td>
<td>5,789,366</td>
<td>4,493,466</td>
</tr>
<tr>
<td>4</td>
<td>–</td>
<td>–</td>
<td>4,943,466</td>
</tr>
<tr>
<td>5</td>
<td>–</td>
<td>–</td>
<td>5,438,738</td>
</tr>
<tr>
<td>CBAi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBA(n, ∞)</td>
<td>2,655,894</td>
<td>34,414,748</td>
<td>44,525,525</td>
</tr>
</tbody>
</table>

(₩ is Korean Currency; $1 is around ₩1,050).

We obtain both tcd and mco in the following manner:

\[ tcd(24) = 1000 \times \frac{200}{1800} \times 24^{3.564} = 9.2 \text{ million dollar} \]

\[ mco(3) = 3 \times 1000 \times \frac{200}{750} \times 24^{2.564} = 2.766 \text{ million dollar} \]

\[ TCO(24) = tcd(24) + mco(3) = 11.966 \text{ million dollar} \]

For comparison, we apply the Korean currency rate and divide it by the number of customers managed during the utilization period. Then Verhoef’s TCO turns out to be 5.535 thousand won for five years. The difference of the estimated COO is due to the fact that Verhoef’s approach does not consider the opportunity cost of the IT system, while our approach does. If the opportunity cost due to the system performance is considered, Verhoef’s approach would result in a larger TCO which would be similar to that obtained from our approach.

Next, we employ sensitivity analysis in order to see whether NS is still the best choice even after some changes are made in certain factors, such as Type I of group k and acquisition cost. For easy comparison, we adapt the marginal changes made on the CBA(n, ∞) of NS compared to that of ES or DM.

Fig. 2 indicates that as Type I error of NS increases by 10%, CBA(n, ∞) for NS decreases by about 0.15%, marginal CBA(n, ∞) of NS to DM decreases by about 0.16% and marginal CBA(n, ∞) of NS to ES decreases by about 0.7%.

Likewise, from Fig. 3(a) and (b), one can see how insensitive CBA(n, ∞) is related to AC. Fig. 3 shows that as AC of NS increases by about 1000%, CBA(n, ∞) for NS decreases by about 0.67%, marginal CBA(n, ∞) of NS to DM decreases by about 0.72% and marginal CBA(n, ∞) of NS to ES decreases by about 3.3%.

It is interesting to note that the marginal CBA(n, ∞) for NS to DM and that for NS to ES does not decrease much until FC of NS increases by about 400%. A large decrease of marginal CBA(n, ∞) appears with 1000% increase of AC of NS. Furthermore, Fig. 3(a) and (b) also indicate that even though there are large changes, such as 5000% increase on AC of NS, NS has better CBA(n, ∞) than the other systems.

In conclusion, sensitivity analysis shows that the change of Type I error is more sensitive than AC to the change of CBA(n, ∞) and NS is still the best choice among three alternatives regardless of adverse changes of Type I error and AC.
Fig. 2. Relationship between $CBA(n, \infty)$s and Type I error.

Fig. 3. Relationship between $CBA(n, \infty)$ and $AC$. 
5. Discussion

A CRM system designed to acquire more customers for more profit may hold the burden of high expenses. Various approaches have been proposed for a cost–benefit analysis for such CRM systems. However their cost–benefit analyses mainly depend on the initial purchase cost instead of the effect of operating cost and utilization over the lifetime. In this paper, we proposed a COO model for a CRM system which takes into account not only the initial cost, but also the operation, and customer mismanagement cost over a life-cycle. In particular, opportunity cost due to customer mismanagement was used as a key cost factor. We also showed how to compare CRM systems with different life spans by using lifelong NPV of the net profit of CRM system (CBA). Using a numerical example comparing the new CRM system (NS) to direct manual customer management by a sales person (DMS) and an existing CRM System (ES), we showed that the NS with low classification errors can surely reduce COO of the CRM system. Lastly, sensitivity analysis showed how Type I and Fixed Cost are related to the change of \( CBA(n, \infty) \) for the NS and the marginal \( CBA(n, \infty) \)s of NS to ES, and that of NS to DM during the CRM system’s life span. As a result of sensitivity analysis, it was indicated that the change of Type I error is more sensitive than Fixed Cost to the change of \( CBA(n, \infty) \) and NS is still the best choice among the three alternatives regardless of adverse changes of Type I error and Fixed Cost.

We expect that our COO model would help in decision making procedures for practitioners who are involved in procurement of a CRM system in the CMM level 2+ organization.

Some more issues that deserve further attention in COO for the CRM are as follows.

We assumed the opportunity costs due to customer mismanagement to be completely known (deterministic). It would seem more realistic, however, to assume the opportunity costs to be stochastic with an unknown probability distribution of which the parameters (mean, variance, etc.) have to be estimated. Another macro issue is how to reflect interacting features with the SCM and ERM. This is left for further research.

References


