The Impact of Information and Communication Technology on VMI Performance

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ABSTRACT

The aim of this paper is to examine the impact of information and communication technology dimensions namely information sharing, quality of information, and compatibility of information system towards VMI performance. Questionnaire was the main instrument for the study and it was gathered from 101 of suppliers in manufacturing companies. The findings show that information sharing and quality of information system contributes to service performance. Meanwhile, only quality of information system contributes to cost performance. Although, literature suggest that information sharing, quality of information, compatibility of information system have a positive impact on both cost reduction and service improvement in VMI program, this study shows that there is a limited effect on cost performance. In fact, compatibility of information system has not played any major role to increase performance of VMI program. This study recommends that the supplier should urge their customer to share demand information through the quality of information system.

Keywords: information sharing, quality of information, compatibility of information system, VMI performance.

I   INTRODUCTION

VMI was first popularized by Wall-Mart and Procter Gamble in the late 1980s in the retail industry. Successful VMI initiatives also have been trumpeted by many companies such as Whitbread Beer Company, Barilla, Johnson & Johnson, Kodak Canada Inc. and Campbell Soup. Presently, VMI practice does not only belong to a particular industry, but variety of industries, which comprises of products, accessories, and raw materials (Elvander, Sarpola & Mattson, 2007).

Although many studies indicated that VMI programs significantly improved a company's performance, actual results of these studies are disappointing (Muckstadt et al., 2001). Kaurema et al. (2009) conducted five cases of VMI program and reveals that all the customers experienced an increase in material availability, but two of the suppliers had increased and no impact on inventory levels. The cases also revealed that only one supplier experienced production efficiency from implementation of VMI. Similarly, Claasen, Van Weele, and Van Raaij (2008)study indicated that there were improved in services when implementing VMI, but with finding on cost reduction were mixed. Some had the advantage of reduced transportation costs while others benefited more from reduced inventory costs. However only one buyer mentioned a reduction in administration costs. However, many manufacturing companies in Malaysia have driven to increase the number of their suppliers to engage in VMI (Panasonic Annual Report, 2010).

Align with issues confront by Malaysian manufacturing companies, which include the impact of bullwhip effect on demand, increase of inventory cost, on-time delivery, and inventory shortage (Omar et. al, 2008), VMI was believed could make a significant and crucial contribution to the current issues of manufacturing companies. In VMI program, the supplier requires sufficient information and communication technology in order to make replenishment decisions of customer's inventory. Therefore, VMI program requires customer to share the demand data with their supplier in order to assist the supplier develop a replenishment plan. The supplier also needs to monitor the inventory level to ensure availability of customer's inventory. The role of information and communication technology becomes important in VMI program.

However, there are arguments that information and communication technology should be looked as

enabler but not as a requirement for the successful VMI program (Waller et al., 1999). The literature shows that information and communication technology is an important element that contributes to successful VMI program. In addition, a good information and communication technology can be used to facilitate supplier operating VMI program to achieve better performance.

Therefore, the purposes of this research are:

a) to investigate the relationship between information sharing, quality of information, compatibility of information system and VMI performance;

b) to examine the impact of information sharing, quality of information, compatibility of information system, and VMI performance.

II SUCCESS FACTORS FOR VMI PROGRAMME

Based on literature, success factor of VMI program is identified in qualitative and quantitative researches. It has been argued that the successful implementation of VMI program often depends on computer platforms, communication technology, and product identification and tracking systems (Waller et al., 1999). Some authors (Simchi-Levi et al., 2000; Lee, Clark, and Tam, 1999) also remarked that customer and supplier require advanced information systems including Electronic Data Interchange (EDI) as a precondition to implement VMI program. Though, Waller et al. (1999) maintained that information systems should be viewed as an enabler, not as a necessity for VMI program.

According to Kuk (2004) investment in technical capability and technological know-how is essential to attract and maintain business with the right partner. He studied the connection between the technology capabilities that enhances the quality of information and the performance of VMI. The results show that the technological capability in enhancing information quality can improve the services and reduce costs supply chain members. He concluded that VMI programs require the manufacturers to invest in IT infrastructure to make the production level activity and inventory more visible to their suppliers.

However, if the decision was poorly made, stock-outs and production line disruption can occur (Kuk, 2004) due to the operational changes including frequent reorder decisions with smaller quantities, particularly for high volume products (Kaipia et al., 2002). Furthermore, Kuk (2004) argued this situation can be avoided through technology that ensured information was exchanged among supply chain members. A study by Claasen et al. (2008) exposed that buyer and supplier often made investments in an additional customized ICT tool in order to exchange information more effectively. Their survey also found that perceived VMI success was positive and significantly impacted by quality of IT systems. Additionally, the perceived VMI success has a positive and significant impact on all three types of benefits, including cost reduction, customer services and supply chain control.

A case study conducted by Danese (2005 highlights the success of extended VMI program is depending on the adoption of a central information system. The capability that encompassed in the central information systems allows the supplier to decide on how much and when to deliver based on the information concerning the different supply network members to support the production planning and order cycle processes. Sheu et al. (2006) discovered that IT capability could provide a more effective platform for both parties to engage in coordination, participation, and problem solving activities. Consequently, these would increase the supply chain performance in terms of satisfaction level, inventory cycle, fill rate, and goods return.Petersen, Ragatz, and Monczka (2005) also proves that information quality had a positive impact on the planning process.

Among the demand information that visible to the supplier comprise of sales data, stock withdrawal, production schedule, inventory level, goods in transit, back order, incoming order, and return (Vigtil, 2007; De Toni & Zamolo, 2005).With the increasing visibility of demand information the supplier will have longer time frames for replenishment arrangement (Kaipia et al., 2002). In another study, De Toni and Zamolo (2005) argued that sharing sales data and inventory level can improve the supplier's production planning with a more stable production plan. In other alternatives, demand data contain the re-setting of forecasts based on actual market trends (Elvander et al, 2007, De

Toni & Zamolo, 2005). The data related to each month was updated week by week. The suppliers can take advantage of this information and plan their own production capacity based on the customer's requests (De Toni & Zamolo, 2005). Forecasts were also can be used in combination with the current allocations. This data is based on real quantities of produced and sold items (POS), orders received and bills of material, which is updated every week. The data, usually transmitted by using EDI, is used for the daily check of target stock, replenishment needs, and for updating the delivery plan (De Toni & Zamolo, 2005). Therefore, the accuracy of the data must be high and the time required to update the data must be quick before supplier uses the data (Angulo et al. 2004; Raman, DeHoratius, & Ton, 2001). On the other hand, Vigtil (2007) studied the type of data shared by customer to indicates the importance of POS data transfer is relative to the demand uncertainty and the responsiveness of the supplier.

In summary, quality of information system and compatibility of information system is important to successful VMI program. Claasen et al. (2008) also mentioned that lack of adequate information technology that results in the sharing of out-dated or inaccurate sales and inventory data can lead to the failure of VMI program. In addition, the more the demand data were shared between the customer and supplier the more benefits can be accrued. Especially, when suppliers have sufficient information, they can make better planning and response to customer's demand in order to replenish the customer's inventory.

This study recognizes that the information and communication technology related to its information sharing, quality of information system, and compatibility of information system play important roles in achieving VMI performance.
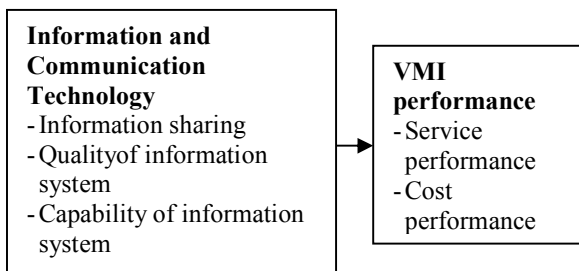
Figure 1: Research framework of VMI performance

The following hypotheses are proposed:

H1: The information and communication technology dimensions (information sharing, quality of information system, compatibility of information system) have a positive and significant relationship with service performance of VMI.

H2: The information and communication technology dimensions (information sharing, quality of information system, compatibility of information system) have a positive and significant relationship with cost performance of VMI.

H3: The information and communication technology dimensions (information sharing, quality of information system, compatibility of information system) have significantly explained the variance of service performance.

H4: The information dimensions (information sharing, quality of information system, compatibility of information system) have significantly explained the variance of cost performance.

III   RESEARCH METHOD

A. Sampling and data collection
The unit of analysis for this study is the Malaysia manufacturing companies that play a role as a supplier or vendor in the VMI collaboration. We investigate information and communication technology as independent variables and performance of VMI as dependent variable. Few empirical data have been published on this topic; therefore; a survey method of data collection was considered appropriate (Klein et. al, 1990). The sampling frame for the data collection included members of the Federation of Malaysia Manufacturer (FMM). FMM members are likely to be involved in the inventory management of the firm.

B. Measurement scale
A survey instrument was developed and pretest with business executives and managers. A six-point Likert scale was mainly used in this study to indicate the degree of agreement for each criterion, with 6 (strongly agree) as the maximum and 1 (strongly disagree) as the minimum. After modifying the questionnaire to incorporate panel's suggestions, 495 of the companies were recognized through the random sampling. The surveys were then sent to

these companies, with reminder cards being sent two weeks later. After reminding, 114 questionnaires were returned. However, 13 were excluded due to incomplete questionnaires, not engage with the VMI program, and reluctant to answer. Thus, this study had achieved 20 percent of respondents rate from the total amount distributed and 31 percent of the sample size required.

C. Data analysis

Before testing the hypotheses, the data were evaluated in terms of missing values, normality, multivariate outlier, linearity, and homoscedasticity test. All the constructs in the research variables have a skewness value lower than 2.0 and kurtosis value smaller than 7.0. Therefore, the variables were normally distributed (Cohen & Cohen, 1983). Meanwhile, the Mahalanobis Distance showsa minimum value of 0.017 and maximum value of10.642, Chi-square value = $\chi2$ (3 independent data variable, 0.001) = 16.27. As the rule of thumb, the maximum Mahalanobis distance should not exceed the critical chi-squared value with degrees of freedom equal to number of predictors and alpha = .001, (Tabachnick&Fidell, 2007), thus, it confirms the normality of the outlier. The other test also was performed in order to comply with the assumptions under multiple regressions. To assess multivariate multicollinearity, this study used tolerance or VIF (variance influence factor) (Hair et al., 1998). The VIF shows less than 10 while tolerance value should not be 0.01 or less to indicate that independent variables were not highly correlated each other. Meanwhile, the scatter plot also shows an oval shape as an indicator of linearity and homoscedasticity. In addition, to test the autocorrelation of the model, the Durbin-Watson coefficient results were ensured within the acceptable range of 1.5-2.5 (Cohen & Cohen, 1983), while the condition index should not be more than or equal to 30. The above assumptions were checked and the data was complied with the assumptions.

IV   FACTOR ANALYSIS

Factor analysis was conducted to group the items related to each other under the same construct (Hair et al., 2006). A Varimax rotation method was applied to all variables. The selected factors were based on eigen values equal to or greater than 1.00. Within a factor, the cut-off point for significant factor loading were at least 0.55 to be considered

necessary for the practical significance (Hair et al., 2006).

Factor analysis was performed on 16 items in the information dimension's scale. The result is shown that KMO was 0.854 and Bartlett's test of sphericity was significant at the 0.01 level for information dimension scales. The anti-image correlation matrix ranged from 0.787 to 0.900 (> 0.50), so there were sufficient correlations among the items. Three factors were extracted, which include information sharing, quality of information system, and compatibility of information system. These factors accounted for 70.27% of the variance. Then, the factor analysis also was performed on 25 items in the VMI performance scale. The KMO was 0.874 and Bartlett's test of sphericity was significant at the 0.01 level. The anti-image correlation matrix ranged from 0.787 to 0.891 (> 0.50), so there were also sufficient correlations among the items. Finally, only two factors were extracted. These factors accounted for 64.544% of the variance. The first component focused more on cost performance and the second component focused on service performance. During the factor analysis process, a few items were removed for several reasons. Among the reasons was due to low communalities, low factor loading, and load few items on the component. During the factor analysis process, two items deleted due to low of communalities (<0.5) and cross-factor loading.

V   FINDINGS

In order to evaluate the strength and direction of the linear relationships between two variables, a correlation analysis was used. The result shows that service performance has a moderate and positive association to the information sharing (r = 0.479), and significant at the 1 % level (p=< 0.01). While, the study also found a positive relationship, but an insignificant association between cost performance and information sharing (r = 0.166; p= 0.097). There was significant (p< 0.01) and the moderate positive relationship between the quality of information system and service performance (r= 0.349). However, a weak positive and significant relationship was found between quality of information system and cost performance (r= 0.292). The research also established that compatibility of information system has a significant relationship with service performance of VMI at p<0.01. Although, the majority of the respondents showed that compatibility of information system was

positively associated with the service performance at a weak level (r= 0.268), the cost performance of VMI has not significantly associated with compatibility of information system.

A simple regression analysis was conducted to examine the relative impact of organizational factors on VMI performance. The result of data analysis showed that two predictor variables, which are information sharing and quality of information system (with the population of study size =101) were predictors to service performance of VMI. Meanwhile, the compatibility of information system was not factored for the service performance of VMI. Significantly, information sharing [F (1, 99) = 29.501, p<0.01] contributed a total of 22.2 percent of variance (R^2 0.222) in-service performance. The result showed that information sharing (β=0.300, p< 0.01) was a primary indicator to the service performance. The combination of information sharing [(β=0.300, p< 0.01] and quality of information system [β=0.148, p< 0.01] contributed at 24.5 percent (R^2 0.245) or an increase of 2.3 percent of the variants in variable criterion of service performance [F (2, 98 = 17.223, p<0.01]. Meanwhile, only quality of information system [F (1, 99) = 9.219, p<0.01] significantly contributed a total of 7.6 percent of variance (R^2 0.076) to the cost performance of VMI. Therefore, the quality of information system (β=0. 279, p< 0.01) was solely an indicator of cost performance of VMI in this study.

Table 1: Model parameter estimates of VMI performance

	service performance	cost performance
Constant	2.810 (7.953**)	3.352 (7.731**)
Information sharing	0.300 (4.275**)	-
Quality of information system	0.148 (2.010*)	0.279 (3.036**)
Compatibility of information system	-	-
Adj R2	0.245	0.076

*p value <0.05, **p value <0.01

As a conclusion, the results of Pearson's correlation supported the hypotheses H1 and partially support hypotheses H2. For hypotheses H3 and H4, multiple regression analysis shows that VMI performance can

only explain 24.5 percent of the variance in service performance, but it only explains 7.6 percent of the variance in cost performance.

VI   DISCUSSION

Though this study fails to support the direct relationship of information sharing, compatibility of information system and cost performance; however collectively, the overall information dimension was significantly and positively related to VMI performance. Meanwhile, the results of multiple regression analysis indicated that the information dimensions VMI elements (information sharing, quality of information system, compatibility of information system) had significantly influence on VMI performance (service, cost) of the suppliers of manufacturing companies. More specifically, the results showed that two predictor variables, which are information sharing and quality of information was predictors to service performance of VMI. This study provides findings on level of information sharing between partner in VMI and complement the previous research that sharing information can increase performance of VMI (Irungu&Wanjau, 2011; Claassen et. al, 2008; Ramayah et. al, 2005). The implications of providing information on demand in time are faster replenishments can be achieved, slow and fast moving goods can be identified, accurate demand forecasts can be made to match the inventory flow, and high level of customer service through product availability (Irungu & Wanjau, 2011). Meanwhile, the role of quality of information system is also crucial to increase service performance of VMI program. Although, the contribution of information system quality toward service performance is small, supplier can use the advantage of the system to get an accurate, timely and updated information on managing inventory flows. This finding was contradict to study by Claasen et al. (2008), which quality of information was not significant to VMI success. Perhaps, the contradict result explains that from the perspective of suppliers the quality of information system is critical in achieving better service performance since they are responsible for customer inventory. On the other hands, a probable explanation a small contribution of quality of information system toward cost performance in VMI program was a tight inventory control limit imposed by buyers (Claasen et al., 2008). The cost reduction in VMI program cannot be realized if the supplier

was did not cater with full authority to decide how much ad when to replenish the customer inventory. However, suppliers may not need to invest heavily in communication technology in order to engage in VMI program. The results show that compatibility of information system does not influence VMI performance. It indicates that with the moderate compatibility of information system, VMI program still can be successfully implemented.

VII CONCLUSION

Based on the findings, the manufacturer should focus on sharing demand information among partners in the VMI program in order to benefit of service improvement. The quality of information also should be a focus to ensure supplier replenish customer's inventory at the right quantity and timing. Therefore, this study also recommends that the supplier should urge their customer to share demand information through the quality of information system. Meanwhile, the low quality of information systems can lower the cost performance of VMI program. Thus, information must be accurate, easily used, timeliness, and updated to assist supplier make replenishment decisions of customer's inventory. In addition, the suppliers should not hesitate to engage in VMI program, although they do not have a good communication technology infrastructure. The effect of compatibility of information system on performance in VMI program is limited.

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