

Empirical Study of the Affecting Statistical Education on Customer Relationship Management and Customer Value in Hi-tech Industry

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ABSTRACT

Customer resources is getting important when global economic competitiveness becomes serious as well as foreign advanced technology and talents flow more rapidly and become the development mainstream of Customer Relationship Management. Successful statistics education could integrate customer resources and Customer Relationship Management as well as enhance customer acquisition and create profits for higher return on investment. Besides, providing correct product information for suitable customers at proper time could reinforce customer relationship. Aiming at supervisors and employees in high-tech manufacturers in Hsinchu Science Park, total 500 copies of questionnaire are randomly distributed, and 388 valid copies are retrieved, with the retrieval rate 78%. The research results conclude significant correlations between 1.statistics education and Customer Relationship Management, 2.Customer Relationship Management and customer value, and 3.statistics education and customer value. According to the results, suggestions are proposed, expecting to have domestic high-tech manufacturers keep long-term relationship with customers through Customer Relationship Management to further enhance customer value and create the market competitiveness.

Keywords: high-tech industry, statistics education, customer relationship management, customer value

INTRODUCTION

Due to the rapid growth of global economy, high-tech manufacturers in science parks are benefited from increasing needs for information electronics, like PC, mobile phones, digital cameras, and digital televisions. Nevertheless, in face of the fierce competition in global high-tech industry, high-tech manufacturers have to enhance customer value in the customer-oriented economic era. To leave an impression in customers' minds, manufacturers have to rely on the promotion of service quality to provide customers with richer customer value and highlight the differentiation from other businesses in the same trade. Satisfactory Customer Relationship Management could enhance the opportunities to strive for customers and profit creation, provide correct information for customers at proper time, and offer excellent services. Simply requesting customers' loyalty to high-tech manufacturers but not satisfying the needs could not achieve the goal of customer loyalty. The application of Customer Relationship Management through complete customer services to establish long-term and stable relationship and enhance customer loyalty and profit contribution becomes an important issue in business management. Nonetheless, the worsening global economic competitiveness and the fast flow of foreign advanced technology and talents to become the development mainstream of Customer Relationship Management have customer resources become critical. The management focus of modern enterprises has changed from traditional internal management of production, logistics, and finance to comprehensive Customer Relationship Management, which therefore becomes the core management of enterprises. Customer Relationship Management is getting important, while the failure is still high, possible

Contribution of this paper to the literature

- The function of statistics education could benefit high-tech manufacturers practicing Customer Relationship Management, ensure the service quality and cooperation model being more mature.
- Aiming at customers in different industries and with distinct customer characteristics, high-tech manufacturers should adopt differential Customer Relationship Management strategies meeting with customer needs.
- To match the design of interaction courses, a training team must be capable of guiding learners' capabilities of learning and participating in interaction so that the employees are willing to use statistical tools and communicate with instructors or peers.

because enterprises invest in excessive initial costs, solution-providing manufacturers show inadequate information statistics capability, and internal talents of enterprises are lack of professional capabilities to result in unobvious effectiveness. Successful Customer Relationship Management allow designing marketing activity aiming at individual customer needs and enhancing the opportunities of customer acquisition and profit creation to acquire higher return on investment as well as provide correct product information for suitable customers at proper time. In this case, applying statistics education to Customer Relationship Management could enhance the professional capabilities of internal talents of high-tech manufacturers and specify and accurate the evaluation indicators for Customer Relationship Management. However, research on Customer Relationship Management in high-tech industry is rare. It is therefore a primary issue for high-tech manufacturers reinforcing Customer Relationship Management through statistics education to keep long-term relationship with customers, promote customer value, and create the market competitiveness.

LITERATURE REVIEW

Statistics Education

Guo and Chan-Olmsted (2015) contained basic statistical knowledge and basic statistical skills in statistics education, such as being able to organize and classify data, make statistical tables with classified data, calculate means and modes, draw bar charts or broken line graphs with statistical data, read statistical charts, and be aware of longer figure in a bar chart standing for more or larger value. Statistics education aims to systematically organize and analyze data to understand the phenomenon (Miranda, Chamorro, Rubio, & Morgado, 2013; Becerril-Ángel, Castillo-Pérez, Montiel-Jarquín, Villatoro-Martínez & García-Cano, 2017). Čeněk, Smolík, and Svatošová (2016) indicated that statistics education included understanding means and modes being the representatives of population and the abstract meaning of statistical terms, realizing the phenomenon with the information in statistical charts or statistical figures, extracting meaningful information from statistical charts for analyses, explanation, and criticism, understanding the changes surrounding the life by explaining statistical charts, and proceeding reasonable prediction of uncertain situations (Shokohyar, Tavallaee, & Karamatnia, 2016). Durkin, McGowan, and Murray (2014) proposed four directions of (1) collecting data, (2) sorting data, (3) presenting data, and (4) explaining data to explain the points in the statistics teaching process. A complete statistics teaching therefore should cover dynamic activities allowing students' participation to develop necessary insight or enhance the level of understanding from collecting relevant data. Hu, Chiu, Hsu, and Chang (2015) proposed four steps of statistics teaching, namely (1) questioning, (2) collecting data, (3) analyzing data, and (4) forming and communicating the results. The points were to clarify the myth of statistics teaching, stress on the importance of statistical ideas, and explain the mutual correlation in the statistical process through the statistical process structure diagram.

Referring to He, Zha, and Li (2013), three dimensions are applied to statistics education in this study.

- (1) Process teaching: Complete teaching activities should start from forming questions and transform into statistical questions. Aiming at questions, data are then collected (including deciding the sample size and the way of sampling). Representative data are then established, classified, and presented with figures or tables for analyses. Finally, the data contents are described and explained, i.e. interpreting the implications in figures and tables.
- (2) Basic idea: They are the ideas learned according to designed materials, covering sorting data, presenting data, explaining data, making and reading, and interpreting statistical charts, which are the stage knowledge in the statistical process.
- (3) Analysis capability: It refers to decide how to sort data, present data, and explain data, according to data, to further understand the phenomenon according to the organized results, extract meaningful information for analyses, explanation, and criticism, and reasonably predict or infer uncertain situations.

Customer Relationship Management

Choudhury and Harrigan (2014) regarded Customer Relationship Management as the tactic of enterprises understanding and influencing customer behaviors through meaningful communication to enhance new customers, prevent existing customers from loss, promote customer loyalty, and enhance customers' profit contribution. Somera (2014) referred it as all activities changing causal customers into loyal customers by satisfying or exceeding the needs to generate re-purchase behaviors. Jone, Taylor, and Reynolds (2014) pointed out Customer Relationship Management as a broad process and information technology to manage potential and existing customers and partnership with enterprises through marketing, sales, and services. Aichner and Jacob (2014) defined Customer Relationship Management as continuous relationship marketing, stressing on helping enterprises seek for and segment valuable customers, provide different products and channels for the satisfaction, and maintain good relationship with customers to further enhance the contribution for enterprises making profits. Moretti and Tuan (2013) referred Customer Relationship Management as to understand customer needs, provide best personalized services, satisfy customer needs, and create favorable value and interactive relationship. Enterprises should emphasize the interaction with customers and the service to constantly enhance customer service quality with various innovative products and services, manage Customer Relationship Management for the sustained-yield management of enterprises, and build long-term win-win by establishing long-term and close relationship with customers. Griffiths and McLean (2015) pointed out Customer Relationship Management as business model and strategy application where enterprises actively deepened the relationship with customers to grasp customer information and utilized such customer information to make distinct strategy application in order to satisfy different customer needs.

Referring to Chua and Banerjee (2013), the following dimensions are used for measuring the performance of Customer Relationship Management in this study.

- (1) Customer acquisition: To integrate the detailed data of various independent sources, analyze new customers' purchase behaviors, establish Propensity Model to confirm the products which customers would most possibly purchase, and further understand the possible time when customer contact with the company and the way of communication.
- (2) Customer reinforcement: To confirm the customer segmentation with the richest profits, be aware of the most possibly purchased products, and effectively apply cross-selling and up-selling so as to stabilize the relationship with customers and create more profits.
- (3) Customer contact: To apply the preferred purchase channels of customers, through customers' Propensity Model, to reduce customer loss and acquire the lifelong value of customers by analyzing the purchase behavior changes in the life cycle.

Customer Value

Guerreiro, Rita, and Trigueiros (2015) pointed out customers' distinct value, which was composed of high personalization and heterogeneity. Dootson, Beatson, and Drennan (2016) referred customer delivered value as the difference between the overall customer value and the overall customer cost; the overall customer value referred to the set of customers expecting to acquire benefits from specific products or services. Ou Yang, Shieh, and Tzeng (2013) defined customer value as consumers' comprehensive evaluation of product effectiveness according to the perceived acquisition and devotion. Alqahtani and Saba (2013) regarded "relationship" as a precious asset, rather than customer themselves, and the relationship with customers to evaluate future cash flow and measure the value of the relationship (customers' lifelong value). It meant that enterprise value would eventually be the sum of customer relationship value, and such a sum would be created merely when pursuing, developing, and keeping beneficial customer relationship. Polláka and Dorčák (2016) pointed out the direct way to understand customers' perceived value as to ask customers. Nevertheless, different customers showed distinct opinions about value that acquiring value from the broad perception could not clearly understand the relevance of value. Utilizing value-focused thinking for the understanding therefore was a better strategy. Hill (2014) regarded the items concerned by customers on the Internet purchase as value and transformed it into goals.

Referring to Lee, Shia, and Huh (2016), two dimensions of self-satisfaction and group identification for customer value are used in this study.

- (1) Self-satisfaction: including the presentation of entertainment, exploration, and personal value (self-satisfaction).
- (2) Group identification: containing the presentation of saving, quality, convenience, and personal value (group identification).

Research Design

Štefko, Bačík, and Fedorko (2014) mentioned that Customer Relationship Management could reinforce an organization through statistics education to acquire, analyze, and apply various data related to customers through database, statistical tools, data mining, machine learning, business intelligence, and data report and to approach customers. Harrigan and Miles (2014) indicated that a company which was running Customer Relationship Management should acquire customer data through the information channels (multi-channel marketing). Such information could also be acquired through external resources, such as market surveys and address database. Statistics education could be used for centralizing the storage and management of Customer Relationship Management data in order to avoid data chaos caused by various versions. Yazdanparast, Joseph, and Muniz (2016) stated that Customer Relationship Management data should be true, complete, accurate, and sole and present accessibility for those who need the data being able to conveniently interview and use such data. It was doubtless for the companies which regarded Customer Relationship Management as the strategy. The following hypothesis is therefore proposed in this study.

H1: Statistics education present significant correlations with Customer Relationship Management.

Parsons (2013) indicated that researchers stressed on the spirit of Customer Relationship Management, among various definitions, as enterprises applying the entire resources, comprehensively understanding each customer, and contacting and interacting with customers through effective channels to enhance customers' lifelong value. He et al. (2013) indicated that Customer Relationship Management (CRM) was originated from the idea of relationship marketing, where customer value was first realized and customers' expected value was then transmitted to further influence customer satisfaction and repurchase behavior. Trainor, Andzulis, Rapp, and Agnihotri (2014) stated that Customer Relationship Management, aiming at marketing, customer service, and logistics support, improved business processes with information technology and integrate multiple channels for customer communication so that enterprises could choose different communication channels, according to individual customer needs, to enhance customers' perceived value. Hu et al. (2015) indicated that Customer Relationship Management could define customer groups with distinct value and enterprises could satisfy customer value in different segmentation with new products and new channels to establish long-term relationship. However, enterprises had to continuously listen to customers' voice, attempt to enhance customers' value contribution, and inspect the changes of customer needs so as to match the marketing strategies and even change the organization structure. Accordingly, the following hypothesis is proposed in this study.

H2: Customer Relationship Management shows remarkable correlations with customer value.

Rodriguez, Peterson, and Ajjan (2015) indicated that the emergence of Customer Relationship Management and the change in enterprises' marketing had customization become important in the fierce competition. Hutter, Hautz, Dennhardt, and Füller (2013) argued that customer value analysis was the key preparation for effectively setting up the customized marketing program and reducing the waste of marketing budget. For this reason, statistics education should be utilized for enterprises proposing more systematic customer value model to solve the problem in analyzing customer value. Vernuccio (2014) indicated that enterprises could no longer neglect the importance of customer value. A lot of companies therefore started to adopt customer-centered thinking to design products or services satisfying customer needs. In this case, statistics education allowed enterprises applying scientific methods to definite analyze customer needs and expectation for enterprises, when making decisions, accurately digging and satisfying customers' real value needs. The following hypothesis is further proposed in this study.

H3: Statistics education reveals notable correlations with customer value.

RESEARCH METHOD

Method and Model

SEM statistics software, AMOS, is utilized in this study for screening indicators for the measurement model. The "modification index" (MI) offered in AMOS is used for the process. The larger MI value stands for the higher expectation χ^2 to delete the question; especially, indicators with MI value higher than 3.84 should be deleted. In residual analysis, the absolute values of all standardized residuals are smaller than the suggested 2.58, revealing good fit between the measurement model and samples. Regarding the test of the composite reliability of latent variables, it is suggested being higher than 0.6. The higher composite reliability of latent variables presents that such observed variables could better measure the latent variables. The composite reliability of latent variables in this study is higher than 0.6, and not an observed variable with the factor load crossing two dimensions larger than 0.5. The measurement model therefore shows satisfactory convergent validity and discriminant validity.

Table 1. Model analysis result

	evaluation indicator	judgment standard	result
Overall model fit	<i>p</i> -value	<i>p</i> -value > 0.05	0.002
	χ^2 /d.f.	< 3	1.766
	GFI	> 0.9	0.983
	AGFI	> 0.9	0.914
	CFI	> 0.9	0.969
	RMR	<0.05, better lower than 0.025	0.016
	RMSEA	0.05~0.08 Good Better lower than 0.05	0.022
	NFI	> 0.9	0.954
	IFI	> 0.9	0.928

Table 2. SMC of variables and dimensions

Statistics Education			Customer Relationship Management			Customer Value	
process teaching α_1	basic idea α_2	analysis capability α_3	customer acquisition β_1	customer reinforcement β_2	customer contact β_3	self-satisfaction σ_1	group identification σ_2
0.73	0.77	0.80	0.75	0.83	0.88	0.84	0.90

Research Sample and Object

Aiming at high-tech industry, supervisors and employees of high-tech manufacturers in Hsinchu Science Park are randomly sampled for 500 copies of questionnaire. Total 388 valid copies are retrieved, with the retrieval rate 78%. Hsinchu Science Park is the first science park in Taiwan and is the major technology town for highly developing high-tech OEM that it is named “Taiwan Silicon Valley”. Manufacturers in the park concentrate on Electronic Manufacturing Services. There are more than 400 high-tech OEM and service manufacturers, with the industries covering semiconductors, computers, telecommunications, opto-electronics, refined mechanics, and biotechnology. It is one of the places with densest semiconductor manufacturers globally and is a primary town for semiconductor manufacturing in the world. A lot of economic and work opportunities are created in Hsinchu Science Park, e.g. famous companies, like TSMC, establishing offices there.

Reliability and Validity Test

Validity refers to a measuring scale being able to actually measure what a researcher would like to measure. Common validity contains “content validity”, inclined to qualitative concept, “criterion validity”, evaluating with identified external criteria and the correlation coefficient of this test, and “construct validity”, used for evaluating the measurement being consistent with other observable variables. The questionnaire contents in this study are based on past theories and referred to the actual situations of researched objects to design the measuring tool which could truly express the essence of objects and the complete representativeness and to ensure the questionnaire conforming to content validity. Besides, the ultimate common estimate of factor analysis results is applied to test the construct validity of questions. The acquire validity appears in 0.7~0.9, showing the satisfactory validity test result of this research questionnaire.

EMPIRICAL RESULT ANALYSIS

Test of Model Fit

“Maximum Likelihood” (ML) is used in this study, and the acquired analyses achieve the convergence. Overall speaking, the indicators of the overall model fit in this study pass the test, **Table 1**, thoroughly reflecting good external quality of the model.

In regard to the test of internal model quality, the SMC of manifest variables is higher than 0.5 (**Table 2**), revealing good indicators of various latent variables. Furthermore, latent variables of statistics education, Customer Relationship Management, and customer value show the reliability higher than 0.6, and the average variance extracted of dimensions is higher than 0.5 (**Table 3**) that they conform to the test requirement of internal model quality.

Table 3. Composite reliability and average variance extracted of variables

Item	Statistics Education	Customer Relationship Management	Customer Value
composite reliability	0.843	0.871	0.866
average variance extracted	0.80	0.83	0.82

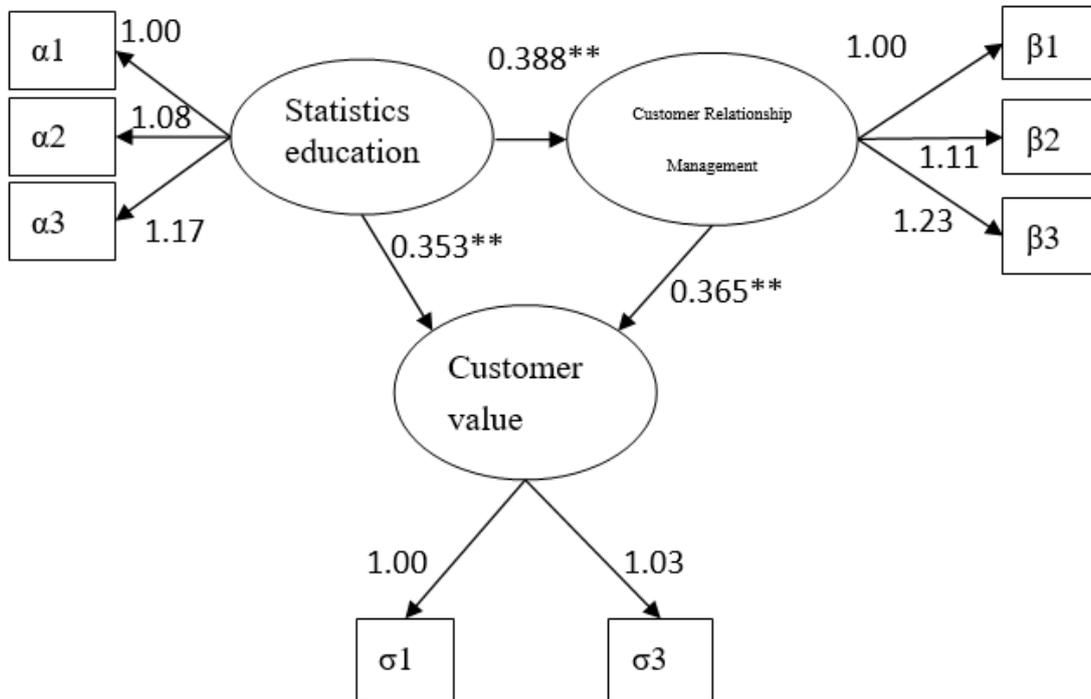


Figure 1. Path relationship diagram

Table 4. Hypothesis test

Research hypothesis	Correlation	Empirical result	P	Result
H1	+	0.388	0.00	Supported
H2	+	0.365	0.00	Supported
H3	+	0.353	0.00	Supported

Test of Path Relationship

When latent variables of process teaching, customer acquisition, and self-satisfaction are regarded as the reference indicators fixed 1, the cause-effect relationship path diagram in **Figure 1** shows the significant estimate of the relationship between dimensions and variables. Basic idea $\alpha 2=1.08$ presents better explanation than process teaching $\alpha 1$; customer reinforcement $\beta 2=1.11$ and customer contact $\beta 3=1.23$ show better explanation than customer acquisition $\beta 1$, and group identification $\sigma 2$ appears relatively higher customer value than self-satisfaction $\sigma 1$. The hypothesis test results are shown in **Table 4**.

CONCLUSION

From the research results, statistics education reveals significantly positive effects on Customer Relationship Management. High-tech manufacturers could train the personnel’s statistics education through the interaction behavior and information with customers to establish the structure and content of customer data, proceed segmented and differential services for customers, and establish correct customer value to create customer value and establish good Customer Relationship Management. The operation regulations for Customer Relationship Management should be made and the customer database should be established to allow the sales personnel in high-tech manufacturers proceeding statistics with customer data and the consumption habits, to enhance the satisfaction by reinforcing differential services, and to dig out the potential benefits and long-term profits of customers to maximize the effectiveness of Customer Relationship Management and further increase new customers and prevent old customers from loss. By keeping up with modern customers’ consumption habits step-by-step and applying and reinforcing the integration of hardware and software, it could provide more convenient

services and real-time information for customers as well as comprehensively enhance the service and information provision. It is not simply the innovation of service, but Customer Relationship Management should be properly done to enhance customer value. It is the improvement to which high-tech manufacturers have to make efforts for the sustained-yield management. What is more, employees' statistical capability, Customer Relationship Management, and customer value concepts could be reinforced through statistics education so that the concepts could be used in practice, allowing high-tech related services be more comprehensive to present better competitiveness in the competitive market and to enhance the profits.

SUGGESTION

By organizing the important results and findings, following practical suggestions are proposed.

1. High-tech manufacturers stress more on the supply chain partnership with precision division that the needs for Customer Relationship Management should be particularly emphasized. The function of statistics education could benefit high-tech manufacturers practicing Customer Relationship Management, ensure the service quality and cooperation model being more mature, and further enhance customer value and co-development with customers.
2. The establishment of Customer Relationship Management should inspect and confirm the operation procedure conforming to customer needs and reinforce the requirement for employee quality, especially those directly interacting with customers, e.g. drivers, OP personnel, sale representatives, and customer service personnel. Constantly reinforcing the professional knowledge and professionalism of first-line employees could acquire larger customer trust and loyalty. Aiming at customers in different industries and with distinct customer characteristics, high-tech manufacturers should adopt differential Customer Relationship Management strategies meeting with customer needs. Different service and interaction models would benefit the maintenance of long-term relationship with customers.
3. High-tech manufacturers should also emphasize the training team of statistics education. To match the design of interaction courses, a training team must be capable of guiding learners' capabilities of learning and participating in interaction so that the employees are willing to use statistical tools and communicate with instructors or peers. Moreover, a training team must spend more time and energy to respond to employees' problems so that the employees perceive the concerns and emphasis of the training team, without giving up the learning because of the sense of loneliness.

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