Research Journal of Business Management

ISSN 1819-1932

Academic Journals Inc.

www.academicjournals.com

Research Journal of Business Management 9 (2): 266-284, 2015
ISSN 1819-1932 / DOI: 10.3923/rjbm.2015.266.284

Structural Equation Model of the Adoption of Ozone Generator Technology by Thai Industries

Siriwat Potivejkul, Thepparat Phimolsathien and Paitoon Pimdee
Administration and Management College, King Mongkut's Institute of Technology Ladkrabang, Thailand

Corresponding Author: Siriwat Potivejkul, Administration and Management College, King Mongkut's Institute of Technology Ladkrabang, Chalongkrung Soi1, Ladkrabang Sub-district, Ladkrabang District, Bangkok, 10520, Thailand

ABSTRACT

Ozone is second only to fluorine as the most powerful oxidant in the world. It's the most powerful, natural air and water sanitizer readily available and can break down chemicals into their basic naturally-occurring component parts. The objectives of this study were therefore, to test a model of technology adoption used in the ozone generator industry in Thailand. Self-reporting questionnaires were retrieved from 500 production and engineering managers in both central and eastern Thailand enterprises from a total of 3,000 distributed. The research framework integrates Corporate Vision, Awareness, Interest, Evaluation and Trial to hypothesize a theoretical model to explain and predict adoption of ozone generator technology. All latent variables in the model have a positive influence on the adoption of Thai ozone generator technology. The model furthermore consisted of 18 observed variables with a variable latency of 6 variables which had a positive influence on the adoption of ozone generator technology. The final structural model was verified to achieve a good fit with the empirical data at 65% because of the decision to use new products in ozone generator technology. Using LISREL 8.72 Structural Equation Modeling (SEM), the results showed that that the variables that influence technology use the most are Adoption, followed by Interest and Evaluation, followed by Trial, Awareness and Corporate Vision having the effects of 0.73, 0.53, 0.42, 0.31 and 0.23, respectively.

Key words: Structural equation model, technology adoption, ozone generators, industrial sector, Thailand

INTRODUCTION

The global market for ozone technology reached $557 million in 2010 and $606 million in 2011. It is expected to grow to $838 million in 2016 which is a Compound Annual Growth Rate (CAGR) of 6.7% for the period (BCC, 2012). Along with this global growth, Thailand has also established an industrial sector based on ozone generator technology with extensive research to date showing that the production of efficient and high quality ozone generators is possible for use in the manufacturing sector.

The name "ozone" is derived from the Greek word "ozein" which means "to smell". Ozone is a pale blue gas and it has a pungent, bleach-like odour (RSC, 2014). The use of ozone leaves no toxic by-products or residues and is non-carcinogenic (Sudheer and Indira, 2007). Ozone occurs naturally in the environment. In nature, oxygen is released from plants and sea plankton during photosynthesis. Oxygen floats upward into the atmosphere and in turn is converted into ozone by ultraviolet radiation.

Ozone is classified as an "oxidant" or a substance that converts organic material into their base compounds. Oxidants can be put to work as a sanitizer and disinfection agent or simply to break down organic substances. Other examples of oxidants are chlorine and fluorine. For example, ozone can be put to use to convert air borne pollutants such as ammonia, mercaptans, sulfides and other organic chemicals into inert, non-odorous by-products, or to oxidize pollutants and organics in water. As a powerful oxidizer, it is a very effective disinfecting agent and will kill germs, viruses, bacteria, molds and yeasts. Ozone is an extremely fast-acting oxidant. After oxidizing substances, ozone then simply reverts to oxygen. The target substances are broken down into their base components. Ozone production and application is a chemical process that is predictable and well understood by chemical engineers, chemists and increasingly, doctors around the world.

Ozone generators are used to "manufacture" ozone out of one of the most readily-available substances on earth-oxygen in the air. In fact, ozone has been called "Enhanced Oxygen" for the simple reason that oxygen (O_2) can be converted to ozone (O_3). Ozone is produced naturally in the upper atmosphere (the ozone layer) through ultraviolet radiation. As well, lightning will produce ozone through electrical excitation of oxygen molecules. Ozone generators use both forms of producing ozone. Some generators will use electrical fields (corona discharge) to produce ozone. Others use ultraviolet lights (UV method) to produce ozone (EPA, 1982). Generally, the UV ozone systems produce a lower concentration of ozone. Since concentration of ozone is important, most applications will use corona discharge ozone generators. Since ozone cannot be stored, it is used as quickly as it is produced. Ozone generators are used to produce ozone at the location where it will be used. Ozone generators come in all sizes, ranging from small DC units used to clean air in your car (not recommended) to large industrial systems used to purify millions of gallons per day of water in municipal water treatment systems (Wang *et al*., 2005). Since, they require no inputs other than oxygen, they are very cost-effective.

Given the above properties combined with factors such as being environmentally and energy friendly, low cost for budget conscious organizations and a positive image for users, the sector has a sustainable future but the Adoption Process (also known as the Diffusion of Innovation) can at times be difficult.

It has been more than half a century since the Adoption Process was first described by Bourne (1959). This process has stood the test of time and remained an important marketing tool ever since. It describes the behavior of consumers as they purchase new products and services with a set of individual categories including the (1) Innovator, (2) Early adopter, (3) Early majority, (4) Late majority and finally, the (5) laggards.

Product adoption process is a mental process in which the individual goes through a process from first hearing about a new product until final acceptance (Kotler and Armstrong, 2013) with companies investing large sums of time and money to help the licensee adopt the technology or knowledge being licensed (Hisrich, 2012).

The adoption process consists of the decision-making stages consumers go through before buying a product or service-namely, awareness, interest, evaluation, trial and adoption (Michman and Mazze, 2001).

Awareness is the first step of the adoption process in which consumers become conscious of the innovation but lacks information about it. During the interest stage need is stimulated and information is sought. During the evaluation stage, the individual weighs the advantages and disadvantages of the purchase. The trial stage consists of the initial purchase to determine how well the purchase satisfies those unfilled needs. Adoption follows a satisfactory trail and subsequently the product is used on a regular basis (Michman and Mazze, 2001).

Therefore, research was undertaken to measure the relationships in which firms adopt technology in the ozone generator industry in Thailand. Ozone generators are new technological innovations for Thai people and with this technology being 'homegrown' in Thailand, often times Thais are less willing to accept locally manufactured goods as compared to foreign made goods. Reasons for this can include perceived quality, attitude and confidence, so this study aimed to study and develop a relationship of technology adoption in the industrial ozone generator industry in Thailand. This study was undertaken to discover the parameters and factors that affect both directly and indirectly technology adoption of ozone generators in Thailand. Furthermore, this study hopes to guide the development and promotion of the production and marketing of ozone generator industry in the future.

The objectives of this research study were:

- To analyze the relationships of the variables in adopting of ozone generation technology in Thailand
- To check the consistency of the structural equation model of technology adoption in the industrial ozone generator sector in Thailand through the development of empirical data
- To study the direct and indirect effects and interaction of variables affecting technology adoption in the industrial ozone generator market in Thailand

HYPOTHESIS

The structural equation model of technology adoption in the industrial ozone generator industry in Thailand that was developed is consistent with the empirical data. The variables used in this study had both a direct and indirect effect and the interaction of ozone generator technology adoption in Thailand was developed with industrial sector precision.

CONCEPTURAL DEVELOPMENT

Regular users who make personal decisions to choose a certain kind of product or service is called adoption (Kotler and Keller, 2006) and the Technology Acceptance Model (TAM) is the most widely accepted framework for studying individual intentions to use or adopt technology (Fig. 1). Investigating users' intentions to accept technology has always been a crucial area in information systems research (Davis, 1989). Perceived ease of use is an individual's assessment to the extent to which interaction with a specific information system or technology is free of mental effort (Davis, 1989). It is one of the major behavioral beliefs influencing user intention for technology acceptance in both the original and the revised TAM models.

Corporate vision: This vision of leadership led to the formulation of corporate strategy (Kananurak, 2011; Harrison, 1995) with a focus on, who will create opportunities to increase revenue balanced with enhancing customer loyalty to the organization. They must provide customers with a more even value proposition (Persson, 2012) with strategies that better serve business opportunity (Hagen *et al*., 2003), because different strategies will affect different organizations as well and affect the positioning of your company (Kalafatis *et al*., 2000).

So, it is important that organizations need to define specific objectives and strategies (Chotipanich and Lertariyanun, 2011) and meet the needs of each customer group and banks need to prepare a database of information about each type of client (Edris, 1997) and provide an analysis of opportunities and threats to the organization.

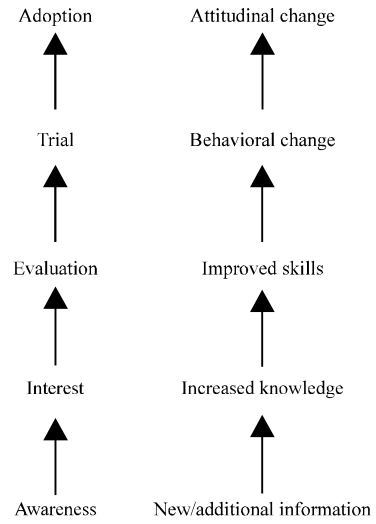

Fig. 1: Summary of the recommended methods for the different stages of adoption (FAO, 1996)

To achieve the maximum results from the methods selected at the different stages, corporate leaders must bring to bear their understanding of the learning process.

Therefore, adopting an innovation requires a decision to be made, an action to be taken. This suggests that data must become information leading in the creation of knowledge. The pioneering work of Beal and Bohlen (1955) identified a five-step process that individuals progress through as they make a decision to adopt an innovation (Fig. 1). These include the following:

Awareness: Awareness is one of the key determinants to consumers' adoption behavior which is decided through acquaintance of the particular product. Early researcher, Lionberger (1968) proposed that awareness was one of the best-known acts for utilizing the innovative product. In other words, Islam and Gronlund (2011) stated while awareness is a person's degree of attentiveness and ability to depict beliefs in a certain time and space as an object, influence is the process of creating this awareness.

According to the above arguments, the following hypotheses are concluded in the study:

H1: Corporate Vision (Vision) has a direct effect on Interest (Intere) (Fig. 2)
H2: Awareness (Acknow) has a significant and direct effect on Interest (Intere) (Fig. 2)

Interest: As the individual wants more information, they begin to wonder if the innovation can help them. They may actively seek out new information, both explicit and tacit. Their quest is informed by sources both outside and inside the community (Gayle, 2007).

H3: Interest (Intere) has a direct influence on Trial (Trial) (Fig. 2)

Evaluation: The individual mentally examines the innovation using the information gathered, trying to determine whether it will really impact their work and how it will make their effort easier or better. This is a critical stage and the first one where the voices of the community (i.e., coworkers, friends or neighbors) are often the largest influence on an individual, rather than outside contacts.

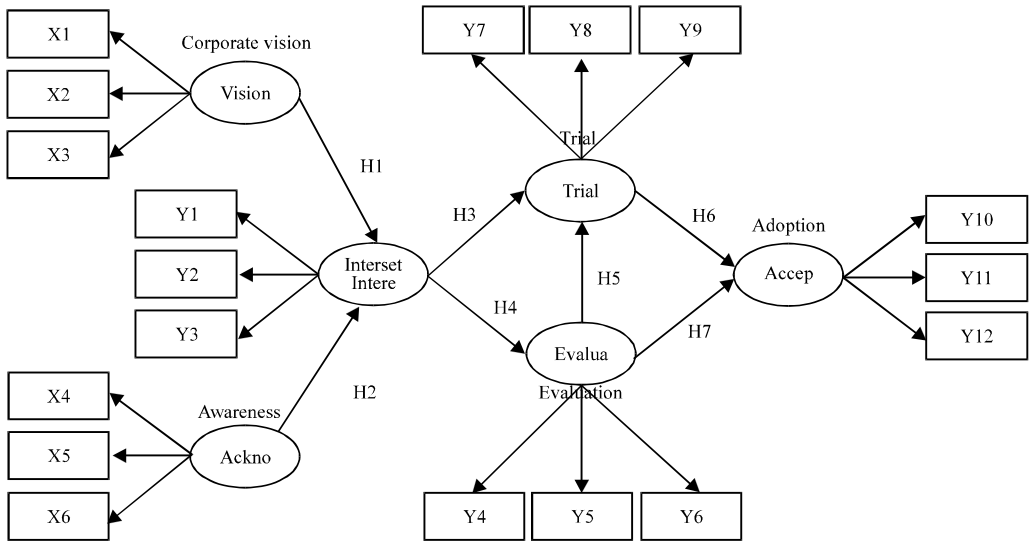

Fig. 2: Conceptual model of adoption of ozone generator technology

In studying the adoption of technology, the Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it, notably:

- **Perceived Usefulness (PU):** This was defined by Fred Davis as "the degree to which a person believes that using a particular system would enhance his or her job performance"
- **Perceived Ease-of-Use (PEOU):** Davis defined this as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989)

The TAM has been continuously studied and expanded-the two major upgrades being the TAM 2 (Venkatesh and Davis, 2000; Venkatesh, 2000) and the Unified Theory of Acceptance and Use of Technology (or UTAUT) (Venkatesh *et al*., 2003). A TAM 3 has also been proposed in the context of e-commerce with an inclusion of the effects of trust and perceived risk on system use (Venkatesh and Bala, 2008). Based on the above, it can be proposed that:

H4: Interest (intere) has a direct effect on Evaluation (Evalua) (Fig. 2)
H5: Evaluation (Evalua) has a direct effect on Trial (Trial) (Fig. 2)

Trial: The individual wants more information. They begin to wonder if the innovation can help them. They may actively seek out new information, both explicit and tacit. Their quest is informed by sources both outside and inside the community. The individual actually tests the innovation to see if reality matches expectations, usually with small-scale, experimental efforts. Often at this stage, any source of information that is determined to be helpful will be used, although close community ties are still the most important. Individuals are looking for specific help for their specific need.

Additionally, there is the Expectation-Confirmation Model (ECM) which has often been applied to investigate the satisfaction with and continued use of Information Technology (IT) after its

adoption. This theory which is based in social psychology, has already proven to be useful in the evaluation of IT post-adoption behavior (Gonzalez *et al*., 2009). Bhattacherjee (2001) suggests that users' continuance intention is determined by their satisfaction with IS use and perceived usefulness of continued IS use. Based on the considered outlines above, it can be proposed that:

H6: Trial (Trial) directly influences technology Adoption (Accep) (Fig. 2)

Within the rate of adoption there is a point at which an innovation reaches critical mass. This is a point in time within the adoption curve that enough individuals have adopted an innovation in order that the continued adoption of the innovation is self-sustaining.

In describing how an innovation reaches critical mass Rogers' outlines several strategies in order to help an innovation reach this stage (Rogers, 1995). These strategies are:

- Have an innovation adopted by a highly respected individual within a social network
- Creating a instinctive desire for a specific innovation
- Inject an innovation into a group of individuals who would readily use an innovation
- Provide positive reactions and benefits for early adopters of an innovation

The rate of adoption is defined as the relative speed with which members of a social system adopt an innovation. It is usually measured by the length of time required for a certain percentage of the members of a social system to adopt an innovation (Rogers, 1995). The rates of adoption for innovations are determined by an individual's adopter category. In general, individuals who first adopt an innovation require a shorter adoption period than later adopters. Based on the above, it can be proposed that:

H7: Evaluation (Evalua) has a direct effect on technology Adoption (Accep) (Fig. 2)

Measurement

Dependent variable: Adoption (Accep) of ozone generator technology in Thailand consisted of 3 observed variables including accepted standards (Y10), performance recognition (Y11) and acceptable service quality (Y12) (Fig. 2).

Independent variables: Independent variables used in this study included 5 latent variables consisting of 3 observed variables.

The scales of Corporate Vision (Vision) have been developed with an analysis tool and questionnaire using a 5-Point Likert Scale as a measuring scale (Likert, 1972) which measures three aspects (Table 1) of corporate vision which include Modernization (X1), Organizational Development (X2) and Corporate Social Responsibility (X3) (Fig. 2).

The scales of Awareness (Ackno) have been developed with an analysis tool and questionnaire using a 5-Point Likert Scale as a measuring scale (Likert, 1972) which measures three aspects (Table 1) of awareness which include Learning/Training (X4) Competitor Recognition (X5) and Media Perception (X6) (Fig. 2).

The scales of Interest (Intere) have been developed with an analysis tool and questionnaire using a 5-Point Likert Scale as a measuring scale (Likert, 1972) which measures three aspects (Table 1) of interest which include Working Principles (Y1) Work Methods (Y2) and the Interest Benefit (Y3) (Fig. 2).

Table 1: Results of confirmatory factor analysis of the variables that influence the dependent variable

Variable/item	Loading	t-stat
Corporate vision (Vision)		
Modernization (X1)	0.34	10.64
Organizational Development (X2)	0.42	9.87
Corporate Social Responsibility (X3)	0.34	12.05
Awareness (Ackno)		
Learning/Training (X4)	0.57	17.99
Competitor Recognition (X5)	0.39	12.91
Media Perception (X6)	0.44	13.27
Interest (Intere)		
Working Principles (Y1)	0.48	10.32
Work Methods (Y2)	0.54	9.61
Interest Benefit (Y3)	0.54	9.53
Evaluation (Evalua)		
Quality Control (Y4)	0.50	19.01
Compliance Verification with Legacy Systems (Y5)	0.45	17.92
Impact Evaluation (Y6)	0.38	16.44
Trial (Trial)		
Quality Control Testing (Y7)	0.45	18.16
Legacy System Compliance (Y8)	0.53	18.78
Impact Evaluation Testing (Y9)	0.47	17.34
Adoption (Accept)		
Accepted Standards (Y10)	0.47	12.51
Performance Recognition (Y11)	0.41	11.30
Acceptable Service Quality (Y12)	0.49	13.18

The scales of Evaluation (Evalua) have been developed with an analysis tool and questionnaire using a 5-Point Likert Scale as a measuring scale (Likert, 1972) which measures three aspects (Table 1) of evaluation which include Quality Control (Y4) Compliance Verification with Legacy Systems (Y5) and Impact Evaluation (Y6) (Fig. 2).

The scales of Trial (Trial) have been developed with an analysis tool and questionnaire using a 5-Point Likert Scale as a measuring scale (Likert, 1972) which measures three aspects (Table 1) of trial which include Quality Control Testing (Y7) Legacy System Compliance (Y8) and Impact Evaluation Testing (Y9) (Fig. 2).

MATERIALS AND METHODS

Data collection: Schumacker and Lomax (2010) stated that Structural Equation Modeling (SEM) uses a variety of models to show the relationships between observed variables with the same basic goal of providing a quantitative test of a theoretical model hypothesized by a researcher. The models developed using SEM can be tested to show how sets of variables define concepts and how they are related. The goal of SEM is to determine the extent to which the model is supported by the data that is gathered during research (Schumacker and Lomax, 2010) and since SEM is capable of statistically modeling and testing complex phenomena, it has therefore, become the preferred method for confirming (or not) theoretical models, quantitatively. Another very important consideration is the intended sample size with most authors recommending a sample size of at least 100 to generate good results (Schumacker and Lomax, 2010; Weston and Gore Jr., 2006; Worthington and Whittaker, 2006), so, therefore, a sample size smaller than 100 should not be used as it is unreliable and consequently SEM should not be used (Meldrum, 2010).

As such, this study drew from a base of production and engineering managers from firms involved with ozone generators in both central and eastern Thailand in 2014. From the sample size determined by Schumacker and Lomax (2010), the researchers used the 10-20 sample size suggested for each variable. As the research consisted of 18 variables, a minimum of 360 samples were deemed as acceptable of which 500 were obtained.

Questionnaire design: Quality and content was monitored with tools used in the research and as a measurement of quality. Both content validity and reliability was assured by 50 experts in their respective fields with a Cronbach's alpha coefficient which in this study is the reliability level of 0.97. In addition, a set of questions to measure variables with the reliability of structural (Construct reliability/ρC) ranged from 0.80-0.89.

Additionally, the index of Item-Objective Congruence (IOC) developed by Rovinelli and Hambleton (1977) was employed to carry out the screening of questions. The IOC is a procedure used in test development for evaluating content validity at the item development stage. This measure is limited to the assessment of unidimensional items or items that measure specified composites of skills. The method prescribed by Rovinelli and Hambleton (1977) results in indices of item congruence in which experts rate the match between an item and several constructs assuming that the item taps only one of the constructs which is unbeknownst to the experts. The research then proceeded to select items that with an IOC index higher than 0.5 which were considered acceptable.

Research tools: Questionnaires were constructed to be a tool to measure concept definition and practice. The instrument or questionnaire used the 5-Point Likert Scale (Likert, 1972) as the measurement scale and the conceptual framework for determining the internal consistency measured by coefficient alpha (α-coefficient) of Akron BAC (Cronbach) to calculate the average value of the correlation coefficient which ranged from 0.725-0.856 which were considered to be highly reliable as all values lower than 0.50 were eliminated from the measurement.

Data analysis and results: To assure the diagnostic accuracy of the model, the relationship of technology adoption of ozone generators was developed with the influence of the variables in the model using path analysis with the latent variables. The organisation or grouping of the items was confirmed by LISREL 8.72 Confirmatory Factor Analysis (CFA) (Joreskog and Sorbom, 1992, 2001) and the Goodness of Fit Index (GFI) Statistics to extract the following: $\chi 2$ is insignificant statistically at the 95% level ($p>0.05$) or the $\chi 2/df<2.00$ for RMSEA <0.05 for GFI >0.90 for AGFI >0.90 and SRMR <0.05. RMSEA (Root Mean Square Error of Approximation) is one potential mechanism for accommodating large sample sizes (Steiger and Lind, 1980). The SRMR is an absolute measure of fit and is defined as the standardized difference between the observed correlation and the predicted correlation. It is a positively biased measure and that bias is greater for small N and for low df studies. Because the SRMR is an absolute measure of fit, a value of zero indicates perfect fit. The SRMR has no penalty for model complexity. A value less than 0.08 is generally considered a good fit (Hu and Bentler, 1999).

The reflective model in Table 1 shows the discriminant validity of the internal latent variables and the correlation of variables. It also depicts the scale reliability which has been analyzed from Composite Reliability (CR) as well as the Average Variance Extracted (AVE) and R2. The CR value

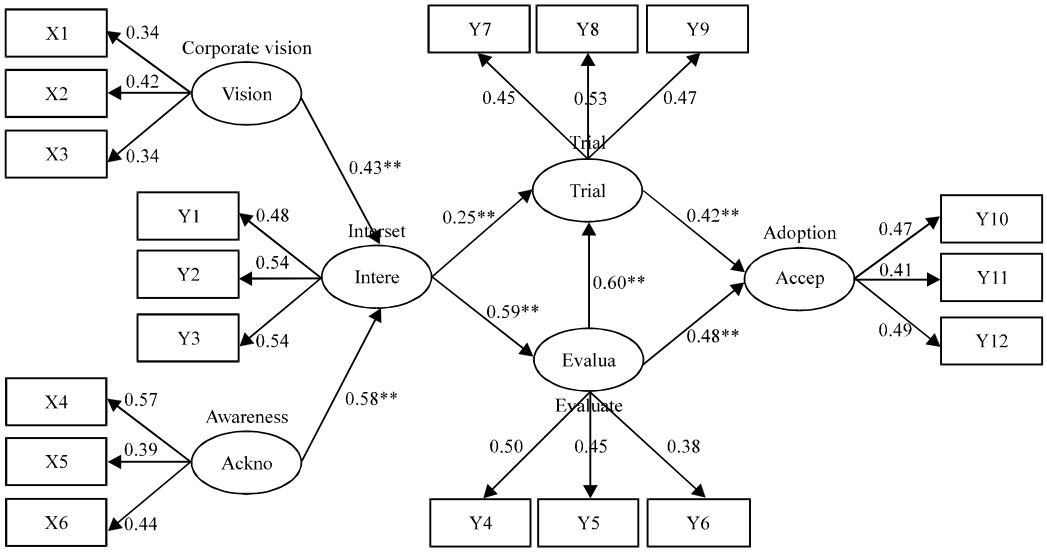

Fig. 3: Structural equation model for adoptionof Thai ozone generator technology

Table 2: Confirmatory Factor Analysis (CFA) of the independent variables of corporate vision, awareness, interest, evaluation, trial on the dependent variable, adoption

Latent variable construct	Construct reliability	Average variance extracted
Corporate vision (Vision)	0.802	0.577
Awareness (Acknow)	0.804	0.594
Interest (Intere)	0.877	0.707
Evaluation (Evalua)	0.835	0.631
Trial (Trial)	0.895	0.741
Adoption (Accept)	0.823	0.606

Statistical significance level is at 0.01 and diagonal figures mean, CR: Composite reliability, $\sqrt{AVE}$ R^2 = Square of the correlation, AVE: Average variance extracted

should not go below 0.60 and the AVE values should also drop below 0.50 and R2 values should not be under 0.20 (Lauro and Vinzi, 2004; Henseler *et al*., 2009) quoted in Wingwon and Piriyakul (2010).

Table 2 shows the results of factor analysis affecting the adoption of ozone generator technology. The data also shows the CR values are higher than 0.60, with all AEV values higher than 0.50 for all values and R2 values higher than 0.20, representing the reliability of the measurement. It found that data sets in the $\sqrt{AVE}$ have higher values than all of the corresponding values in the 'Cross Construct Correlation' in the same column, representing discriminant validity of the measure in each construct and with a greater value than 0.50 of AVE as shown in Table 2.

Figure 3 and Table 3 show the direct, indirect and total effects of influencing variables on affected variables in the adoption of Thai ozone generator technology. The model is consistent with empirical data and the harmonized index of all the criteria which includes the chi-square value not being statistically significant, p = 0.34, for the RMSEA = 0.01, GFI = 0.99 and AGFI = 0.96 and for the SRMR = 0.03.

All causal variables in the model have a positive influence on the adoption of Thai ozone generator technology. The final structural model was verified to achieve a good fit with the empirical data.

Table 3: Direct, indirect and total effects of influencing variables on affected variables in the adoption of thai ozone generator technology

	Affected variables					
	Interest			Evaluation		
Casual variables	DE	IE	TE	DE	IE	TE
Corporate	0.43 (0.08)**	-	0.43 (0.08)**	-	0.26 (0.04)**	0.26 (0.04)**
Awareness (Acknow)	0.58 (0.09)**	-	0.58 (0.09)**	-	0.34 (0.04)**	0.34 (0.04)**
Interest	-	-	-	0.59 (0.08)**	-	0.59 (0.08)**
Evaluation				-	-	-
Trial	-	-	-	-	-	-
Structural equation fit R^2	R^2 = 68			R^2 = 35		
	Trial			Adoption		
Casual variables	DE	IE	TE	DE	IE	TE
Corporate	-	0.26 (0.04)**	0.26 (0.04)**	-	0.23 (0.04)**	0.23 (0.04)**
Awareness (Acknow)	-	0.35 (0.05)**	0.35 (0.05)**	-	0.31 (0.05)**	0.31 (0.05)**
Interest	0.25 (0.06)**	0.36 (0.06)**	0.61 (0.08)**	-	0.53 (0.07)**	0.53 (0.07)**
Evaluation	0.60 (0.06)**	-	0.60 (0.06)**	0.48 (0.09)**	0.25 (0.06)**	0.73 (0.08)**
Trial	-	-	-	0.42 (0.09)**	-	0.42 (0.09)**
Structural equation fit R^2	R^2 = 61			R^2 = 70		

Chi-square: 38.94, df: 36, p-value: 0.34, RMSEA: 0.01, GFI: 0.99, AGFI: 0.96, SRMR: 0.03, DE: Direct effects, IE: Indirect effects, TE: Total effects **p<0.01

Evaluation (Evalua) is the only causal variable that influences both directly and indirectly the adoption of ozone generator technology, with an influence factor of 0.73.

Trial (Trail) has a direct influenceon the adoption of ozone generator technology has an influencing value 0.42.

Considering the priority of the variables caused by the combined influence of the individual variables showed, variables that influence adoption of ozone generator technology most are Evaluation (Evalua), followed by Interest (Interest), Trial (Trial), Awareness (Acknow) and Corporate Vision (Vision) which have the effect of 0.73, 0.53, 0.42, 0.31 and 0.23, respectively.

Structural model causal variables that influence the adoption of ozone generator technology in descending order are as follows.

Evaluation (Evalua) factors underlying the external variables are influenced by Quality Control (Y4), Compliance Verification with Legacy Systems (Y5) and Impact Evaluation (Y6) with values loading from 0.48 (direct effect) and a significant level of confidence percentage 99% (t-stat >1.99), with a level of indirect influence value of 0.25 (indirect effect) which considers such factors highly reliable. These factors have the greatest influence on the adoption of ozone generator technology in enterprises and have a direct and indirect effect on adoption as shown in the Final Model in Fig. 3 and Table 4.

Interest (Intere) factors underlying the external variables are influenced by Working Principles (Y1), Work Methods (Y2) and Interest Benefit (Y3) with values loading from 0.53 (indirect effect) and a significant level of confidence percentage 99% (t-stat >1.99). These factors have the second greatest influence on the adoption of ozone generator technology in enterprises and have an indirect influence on the Adoption as shown in the Final Model in Fig. 3 and Table 4.

Trial (Trial) factors underlying the external variables are influenced by Quality Control Testing (Y7), Legacy System Compliance (Y8) and Impact Evaluation Testing (Y9) with values loading from

Table 4: Results of testing hypothesis on adoption of ozone generator technology in Thailand

Hypotheses (*Sig. <0.05)	Coefficient	t-test	Results
H1: Corporate vision (Vision) has a significant and direct effect on Interest (Intere)	0.43	5.67*	Supported
H2: Awareness (Acknow) has a significant and direct effects on Interest (Intere)	0.58	6.60*	Supported
H3: Interest (Intere) has a direct effect on Trial (Trial)	0.25	4.19*	Supported
H4: Interest (Intere) has a direct effect on Evaluation (Evalua)	0.59	7.25*	Supported
H5: Evaluation (Evalua) has a direct effect on Trial (Trial)	0.60	9.66*	Supported
H6: Trial (Trial) has a direct effect on Adoption (Accep)	0.42	4.40*	Supported
H7: Evaluation (Evalua) has a direct effect upon Adoption (Accep)	0.48	5.29*	Supported

0.42 (direct effect) and a significant level of confidence percentage 99% (t-stat >1.99). These factors have the third greatest influence on the adoption of ozone generator technology in enterprises and have a direct influence on the Adoption as shown in the Final Model in Fig. 3 and Table 4.

Awareness (Ackno) factors underlying the external variables are influenced by Quality Control Testing (Y7), Legacy System Compliance (Y8) and Impact Evaluation Testing (Y9) at a significant level of confidence percentage 99% (t-stat >1.99), with a level of indirect influence value of 0.31. These factors have the fourth greatest influence on the adoption of ozone generator technology in enterprises and have anindirect influence on the Adoption as shown in the Final Model in Fig. 3 and Table 4.

Corporate Vision (Vision) factors underlying the external variables are influenced by Modernization (X1), Organizational Development (X2) and Corporate Social Responsibility (X3) at a significant level of confidence percentage 99% (t-stat >1.99), with a level of indirect influence value of 0.23. These factors have the fifth and last greatest influence on the adoption of ozone generator technology in enterprises and have an indirect influence on the Adoption as shown in the Final Model in Fig. 3 and Table 4.

Figure 3 shows the research framework and the structural model of independent variables that influence the dependent variable of adoption of ozone generator technology. Independent variables included awareness, corporate vision, interest, trial and evaluation and their influence on 500 surveyed participants. Furthermore, the structural analysis model framework was used to research the t-test coefficients and their relationship of each path of the t-test hypothesis with significance greater than 1.95*. This explains the results obtained from analysis as shown in Table 1-3 as well as the test results presented in Table 4.

The questionnaire used in the survey is shown in Appendix 1.

RESULTS AND DISCUSSION

The research from the Structural Equation Model of the Adoption of ozone Generator Technology in Industries in Thailand' found that the variables that influenc etechnology adoption the most are Evaluation (Evalua), followed by Interest (Intere), Trial (Trial) Awareness (Ackno) and Corporate Vision (Vision) has the effects of 0.73, 0.53, 0.42, 0.31 and 0.23, respectively. All causal variables in the model have a positive influence on the adoption of Thai ozone generator technology. The final structural model was verified to achieve a good fit with the empirical data at 65% because of the adoption of products and intellectual processing. Product adoption process is a mental process in which the individual goes through a process from first hearing about a new product until final acceptance (Kotler and Armstrong, 2013).

Awareness is the first step of the adoption process in which consumers become conscious of the innovation but lacks information about it. During the interest stage need is stimulated and

information is sought. During the evaluation stage, the individual weighs the advantages and disadvantages of the purchase. The trial stage consists of the initial purchase to determine how well the purchase satisfies those unfilled needs. Adoption follows a satisfactory trail and subsequently the product is used on a regular basis (Michman and Mazze, 2001).

This is consistent withthe findings of Huijts *et al.* (2012) which studied the psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. Findings revealed that environmental and societal problems related to energy use have spurred the development of sustainable energy technologies, such as wind mills, carbon capture and storage and hydrogen vehicles, with public acceptance of these technologies being crucial for their successful introduction into society. In the framework, attitude is influenced by the perceived costs, risks and benefits, positive and negative feelings in response to the technology, trust, procedural fairness and distributive fairness. Personal norm is influenced by perceived costs, risks and benefits, outcome efficacy and awareness of adverse consequences of not accepting the new technology.

Further research by Wood and Moreau (2006) confirmed these conclusions in the research From Fear to Loathing? How Emotion Influences the Evaluation and Early Use of Innovations. In it, it was stated that innovation adoption is rarely a short process for consumers and research suggests that adoption is rarely a neutral process and that consumers can experience strong emotions in the initial use of innovations. The emotional influence is sizable and importantly, not a straightforward case of "easier is better."

This is also consistent with the study by Franke *et al.* (2009) Testing the Value of Customization: When Do Customers Really Prefer Products Tailored to Their Preferences? In it the idea of marketing strategy of customization was studied. A key assumption is that customized products create higher benefits for customers than standard products because they deliver a closer preference fit. The authors conducted two studies in which they found that products customized on the basis of expressed preferences bring about significantly higher benefits for customers in terms of willingness to pay, purchase intention and attitude toward the product than standard products. The benefit gain is higher if customers have (1) Better insight into their own preferences, (2) A better ability to express their preferences and (3) Greater product involvement. The research concluded that customization has the potential to be a powerful marketing strategy if these conditions are met. In the opposite case, firms willing to serve heterogeneous customer preferences need to adapt their customization systems in such a way that they explicitly address the customers' inability to provide valid preference information.

This conforms to research by Reid and de Brentani (2010) which studied Market Vision and Market Visioning Competence: Impact on Early Performance for Radically New, High-Tech Products. It was discussed how having the "right" Market Vision (MV) in new product scenarios involving high degrees of uncertainty has been shown to help firms achieve a significant competitive advantage which can ultimately lead to superior financial results. MV is a clear and specific mental model/image that organizational members have of a desired and important product-market for a new advanced technology and MVC is a set of individual and organizational capabilities that enable the linking of advanced technologies to a future market opportunity. Based on samples of high-tech firms involved in early technology developments, the measurement study indicated that five factors comprise MV (i.e., clarity, magnetism, specificity, form and scope) and that four factors underlie MVC (i.e., networking, idea driving, proactive market orientation and market learning tools). MVC significantly and positively impacts MV and that each of these constructs significantly and positively influences certain aspects of Early Performance (EP) in new product development.

CONCLUSION

In conclusion, the main findings of this study are that in the process of implementing a technology in an organization, there are external variables that tend to have different levels of perceptions and evaluations of the technology implementation from those held in the wide social group. However, no matter which social groups Thais belong to, the members in the enterprise are likely to follow the same psychological evaluation path of the technology implementation in the organization, from the adoption stage to the implementation stage.

With the increase in sub-regional and regional cooperation and competition, especially among ASEAN member nations, with the impending ASEAN economic integration in 2015, ASEAN countries will become the world's manufacturing hub, highlighting strengths such as regional production chains and the relatively low cost of production. This economic integration will provide key opportunities, especially as the global purchasing power of a burgeoning middle class in China and India rises, but it also imposes constraints on Thailand's competitiveness development which need to be addressed.

One way to overcome some constraints is to better organize and promote domestic industries such as ozone generators. Research suggests that variables from this study including Interest and Corporate Vision should be a focus. Government agencies and state enterprises should be made better aware of these findings so that they may help in the development, adoption and promotion of domestic ozone generator technology to various target groups.

It is suggested that future research should be undertaken to study the adoption of ozone generator technology in state enterprises, government agencies, medical facilities and hospitals, hotels and other establishments where they public congregates.

Appendix 1: Structural equation model of the adoption of ozone generator technology by Thai industries

The following 5-point Likert Scale questionnaire is a survey concerning the research on the adoption and use of ozone generators in Thailand industries which aims to identify the factors that affect the adoption of industrial ozone generators Thailand. Additionally, the study was designed to expand both academic and industrial knowledge of ozone generator use and its applications and benefits in business use. It also has the potential to offer guidance to government officials in their decision making processes concerning environmental and technological innovations.

Instructions to respondents:

Part 1: Please place a mark in the box[ ] with the information that is true for you

Part 2: Please place a mark in the column that most accurately describes your opinion about the given statement

The ranking is from 1 to 5 with 3 being 'neutral'.

1. Indicates you strongly agree with the statement
2. Indicates you somewhat agree with the statement
3. Indicates you neither agree or disagree or have no knowledge about the topic's statement
4. Indicates you do not agree with the statement
5. Indicates you strongly disagree with the statement

Thank you for your cooperation in completing this questionnaire completely which is to help ensure thes uccessful completion of this research.

With sincere gratitude,
Siriwat Potivejkul
PhD Student Candidate
College of Industrial Administration
School of Management
King Mongkut's Institute of Technology
Latkrabang, Bangkok Thailand

Appendix 1: Continue

Part 1: General information about the respondents

1. Sex

[ ] 1. Male [ ] 2. Female

2. Age

[ ] 1. Less than 30 years old [ ] 2. Between 30-35 years old

[ ] 3. Between 36-40 years old [ ] 4. Between 40-45 years old

[ ] 5. Over 45 years old

3. Education level

[ ] 1. Bachelor's Degree [ ] 2. Masters Degree

[ ] 3. PhD [ ] 4. Other (Please specify.....)

4. Monthly salary

[ ] 1. Less than 40,000 baht a month [ ] 2. Between 40,001-50,000 baht

[ ] 3. Between 50,001-60,000 baht [ ] 4. Between 60,001-70,000 baht

[ ] 5. Over 70,000 baht a month

5. Does your organization currently use ozone generator technology?

[ ] 1. Yes [ ] 2. No

○ Interested in future use ○ Not interested

6. Position in organization: _____

7. Millions of baht in registered capital in your company: _____

8. How long has your company been in business? _____

Part 2: Variables related to industry adoption of ozone generator technology

Item	Strongly agree (1)	Agree (2)	Not sure (3)	Not agree (4)	Strongly disagree (5)
Corporate vision: Are you a visionary organization?					
My organization has a policy to find and develop current and modern technologies.					
It is important to reduce energy consumption in an organization.					
It is important to focus on good Corporate Governance.					
My organization strives to develop efficient processes.					
My organization uses new technologies to reduce costs.					
My organization promotes the development of quality products by the use of new technologies.					
My organization promotes Corporate Social Responsibility (CSR).					
My organization feels that employee safety is very important.					
My organization feels that it is important to engage with the local community in a sustainable way.					
My organization promotes a good employee environment.					
Trial: Has your organization acknowledged or encouraged the use of ozone generator technology before?					
Employees are encouraged to learn firsthand by themselves.					
Employees are encouraged to take training classes.					
Employees are encouraged to attend professional conferences.					
Employees are encourage to seek out expert advice.					
My organization is concerned with product demonstrations.					
Employees are encourage to learn from other industries.					
Employees are encourage to learn from the competition.					
Employees are encouraged to learn from professional Organization and academic institutions.					
Employees are encouraged to learn from professional publications and journals.					

Appendix 1: Continue

Item	Strongly agree (1)	Agree (2)	Not sure (3)	Not agree (4)	Strongly disagree (5)
Employees are encouraged to learn from radio and TV.					
Employees are encouraged to learn from personal presenters.					
Employees are encouraged to learn from the internet.					
Awareness: My organization is interested in ozone generator technology because of the following reasons:					
Ozone is a substance that has the ability to kill bacteria.					
Ozone is at least ten times stronger than chlorine as a disinfectant.					
Ozone decomposes into oxygen which is beneficial to life and health.					
Ozone can decompose easily and with the use of ozone generators has no residue.					
Ozone generators help solve environmental problems.					
Ozone helps in environmental cleaning and energy conservation in cooling tower systems.					
Ozone reduces the need for chlorine in swimming pools.					
Ozone skill germs in drinking water and disinfects drinking water supply system.					
Ozone helps in color dyeing processes.					
Ozone helps improve the quality of air and waste water.					
Ozone reduces the energy and chemicals in washing machines.					
Ozone helps kill bacteria in vegetables and fruits.					
Evaluation: Criteria used for ozone generator technology consists of the following items:					
It is worth the money spent.					
Ozone technology solves problems in the manufacturing					
Ozone technology is environmentally friendly.					
Ozone technology reduces costs.					
Ozone technology saves time.					
Ozone generator technology has to be professional and trustworthy.					
Ozone generator technology has to be modern.					
Ozone generator technology has to be safe.					
Ozone generator technology has to work better and more efficient than previous technology					
Ozone generator technology has to have a high standard.					
Ozone generator technology has to have a high level or social and community responsibility.					
Ozone generator technology has to have innovative technology.					
Trial: Are you trying to use ozone generators for:					
Quality assurance					
To build performance confidence.					
To evaluate the effectiveness of the technology.					
To verify operational safety concerns.					
To assure confidence in the standard.					
To assure compatibly with the original system.					
To verify that there is no impact on existing production systems.					
To check and verify that the technology contributes to the production system.					
To prove the versatility of the applications.					
To verify the robustness of the technology.					
Adoption: Are you adopting ozone generator applications because:					
I am in favor of the use of ozone generators.					
My organization likes to use standard products.					
Ozone generators are effective in cleaning and disinfection.					

Appendix 1: Continue

Item	Strongly agree (1)	Agree (2)	Not sure (3)	Not agree (4)	Strongly disagree (5)
Ozone generators represent a good value in cleaning and disinfecting.					
Ozone generators are efficient in saving energy.					
Ozone generators acquisition is recaptures in future cost savings.					
Ozone generators are effective in reducing pollution.					
Ozone generator technology represents new innovation technology.					
Ozone generators can increase system performance.					
Ozone generators are safe.					
Ozone generators are easy to use.					
The after sales services and manufacturer's warranty is good.					
Manufacturer provides solutions to maintenance and service problems.					
Manufacture's service is quick and reliable.					
Your organization will continue using ozone generators in the future because:					
Ozone generators represent new innovation.					
Our organization has to be a leader in technology.					
It represents a better product quality over the competition.					
The product is more effective than the competition.					
The product has a greater benefit than before.					
The product can reduce manufacturing costs.					
Helps the organization increase profits.					
It creates a positive image for the organization.					
It provide the organization with good corporate governance.					
It provide for good Corporate Social Responsibility (CSR).					

In-depth interviews for the Adoption of Ozone Generator Technology by Thai Industries

Part 1: General information about the respondents

1. Sex: _____
2. Age: _____
3. Education Level: _____
4. Position: _____
5. Company or Organization's Name:_____ Department: _____

Part 2: Interview issues/topics

1. Procedures/steps for the operation of ozone generators.
2. Reasons for the use of ozone generatorsin industry.
3. The effectiveness of ozone generators.
4. Satisfaction and adoption of industrialozone generators.
5. Cost and cost-effectiveness of the use of ozone generators in the production process.
6. The development and marketing of ozone generators.

Interviewer: ……

Date: ……/……/……

REFERENCES

BCC., 2012. Ozone generation: Technologies, markets and players. BBC Research Chemical Report CHM044D, February 2012, pp: 1-4.

Beal, G.M. and J.M. Bohlen, 1955. How farm people accept new ideas. Special Report No. 15, Cooperative Extension Service, Ames, IA., USA.

Bhattacherjee, A., 2001. Understanding information systems continuance: An expectation-confirmation model. MIS Q., 25: 351-370.

Bourne, F.S., 1959. The adoption process. Foundation for Research on Human Development, pp: 1-8.

Chotipanich, S. and V. Lertariyanun, 2011. A study of facility management strategy: The case of commercial banks in Thailand. J. Facilities Manage., 9: 282-299.

Davis, F.D., 1989. Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Q., 13: 319-340.

EPA., 1982. Emerging technologies for the control of hazardous waste. Environmental Protection Agency (EPA), Washington, DC., USA.

Edris, T.A., 1997. Services considered important to business customers and determinants of bank selection in Kuwait: A segmentation analysis. Int. J. Bank Market., 15: 126-133.

FAO, 1996. Improving Agricultural Extension: A Reference Manual. Food and Agriculture Organization of the United Nations, Rome, Italy.

Franke, N., P. Keinz and C.J. Steger, 2009. Testing the value of customization: When do customers really prefer products tailored to their preferences? J. Market., 73: 103-121.

Gayle, R., 2007. The adoption of change in a community. Spreading Science. http://www.spreadingscience.com/our-approach/diffusion-of-innovations-in-a-community/4-the-adoption-of-change-in-a-community/

Gonzalez, V., P. Ibarraran, A. Maffioli and S. Rozo, 2009. The impact of technology adoption on agricultural productivity: The case of the Dominican Republic. Working Paper No. OVE/WP-05/09, Inter-American Development Bank Office of Evaluation and Oversight, Washington, DC., USA.

Hagen, A., S. Haile and A. Maghrabi, 2003. The impact of the type of strategy on environmental scanning activities in the banking industry: An international perspective. Int. J. Commerce Manage., 13: 122-143.

Harrison, E.F., 1995. Strategic planning maturities. Manage. Decis., 33: 48-55.

Henseler, J., C.M. Ringle and R.R. Sinkovics, 2009. The use of partial least squares path modeling in international marketing. Adv. Int. Market., 20: 277-319.

Hisrich, R.D., 2012. International Entrepreneurship: Starting, Developing and Managing a Global Venture. 2nd Edn., Sage Publications, New York, USA., ISBN-13: 9781452217390, Pages: 536.

Hu, L.T. and P.M. Bentler, 1999. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct. Equat. Model. Multidiscip. J., 6: 1-55.

Huijts, N.M.A., E.J.E. Molin and L. Steg, 2012. Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. Renew. Sustain. Energy Rev., 16: 525-531.

Islam, S.M. and A.G. Gronlund, 2011. Factors influencing the adoption of mobile phones among the farmers in Bangladesh: Theories and practices. Int. J. Adv. ICT Emerg. Regions, 4: 4-14.

Joreskog, K.G. and D. Sorbom, 1992. LISREL VIII: Analysis of Liner Structural Relations. Scientific Software International Publications, Mooresville, NC., USA.

Joreskog, K.G. and D. Sorbom, 2001. LISREL 8: User's Reference Guide. Scientific Software International Publications, Lincolnwood, IL., USA.

Kalafatis, S.P., M.H. Tsogas and C. Blankson, 2000. Positioning strategies in business markets. J. Bus. Ind. Market., 15: 416-437.

Kananurak, N., 2011. Leadership role for producing professional employees. J. Univ. Thai Chamber Commerce, 31: 123-133.

Kotler, P. and G. Armstrong, 2013. Principles of Marketing. 15th Global Edn., Pearson Education, Lodon, UK., ISBN-13: 9780273786993, Pages: 720.

Kotler, P. and K. Keller, 2006. Marketing Management. 12th Edn., Prentice Hall, New York, ISBN: 0131457578, Pages: 412.

Lauro, C. and V.E. Vinzi, 2004. Some contribution of PLS path modeling and a system for the European customer satisfaction. Dipartimento di Matematica e Statistica, Universita Federico II di Napoli, pp: 201-210. http://www.sis-statistica.org/old/htdocs/files/pdf/atti/RSMi0602p201-210.pdf

Likert, R., 1972. Likert Technique for Attitude Measurement. In: Social Psychology: Experimentation, Theory, Research, Sahakian, W.S. (Ed.). Intext Educational Publishers, Scranton, USA., ISBN-13: 9780700223879, pp: 101-119.

Lionberger, H.F., 1968. Adoption of New Ideas and Practices. Iowa State University Press, Ames, IA., USA.

Meldrum, K., 2010. Structural equation modelling: Tips for getting started with your research. Proceedings of the Contemporary Approaches to Research in Mathematics, Science, Health and Environmental Education, November 25-26, 2010, Deakin University, Melbourne.

Michman, R.D. and E.M. Mazze, 2001. Specialty Retailers: Marketing Triumphs and Blunders. Greenwood Publishing Group, Santa Barbara, CA., USA.

Persson, A., 2012. Profitable customer management: Reducing costs by influencing customer behaviour. Eur. J. Market., 47: 857-876.

RSC, 2014. Chemistry in its element: Compounds. Royal Society of Chemistry (RSC). http://www.rsc.org/chemistryworld/podcast/CIIEcompounds/transcripts/ozone.asp.

Reid, S.E. and U. de Brentani, 2010. Market vision and market visioning competence: Impact on early performance for radically new, high-tech products. J. Prod. Innov. Manage., 27: 500-518.

Rogers, E.M., 1995. Diffusion of Innovations. 4th Edn., Free Press, New York, USA., ISBN-13: 9780029266717, Pages: 518.

Rovinelli, R.J. and R.K. Hambleton, 1977. On the use of content specialists in the assessment of criterion-referenced test item validity. Dutch J. Educ. Res., 2: 49-60.

Schumacker, R.E. and R.G. Lomax, 2010. A Beginners Guide to Structural Equation Modeling. Routledge, New York, ISBN-13: 9781841698915, Pages: 536.

Steiger, J.H. and J.C. Lind, 1980. Statistically-based tests for the number of common factors. Proceedings of the Annual Meeting of the Psychometric Society, May 1980, Iowa City, pp: 1-10.

Sudheer, K.P. and V. Indira, 2007. Post Harvest Technology of Horticultural Crops. New India Publishing, New Delhi, India, ISBN-13: 9788189422431, Pages: 291.

Venkatesh, V. and F.D. Davis, 2000. A theoretical extension of the technology acceptance model: Four longitudinal field studies. Manage. Sci., 46: 186-204.

Venkatesh, V. and H. Bala, 2008. Technology acceptance model 3 and a research agenda on interventions. Decis. Sci., 39: 273-315.

Venkatesh, V., 2000. Determinants of perceived ease of use: Integrating control, intrinsic motivation and emotion into the technology acceptance model. Inform. Syst. Res., 11: 342-365.

Venkatesh, V., M.G. Morris, G.B. Davis and F.D. Davis, 2003. User acceptance of information technology: Toward a unified view. MIS Q., 27: 425-478.

Wang, L.K., Y.T. Hung and I.K. Shammas, 2005. Physicochemical Treatment Processes. Vol. 3, Humana Press Inc., Totowa, New Jerset, USA., ISBN-13: 9781588291653, Pages: 724.

Weston, R. and P.A. Gore Jr., 2006. A brief guide to structural equation modeling. Counsel. Psychol., 34: 719-751.

Wingwon, B. and M. Piriyakul, 2010. Determinants of perceived performance perceived CSR, perceived product and service quality, customer citizenship behavior of modern trade in Northern region Thailand. Proceedings of the International Conference on Toward Enhancement of Economic, Social, Technological and Environmental Development for Welfare Implications in the Greater Mekong Sub-region and Asia-Pacific, July 31-August 5, 2010, Yogyakarta, Indonesia, pp: 1-18.

Wood, S.L. and C.P. Moreau, 2006. From fear to loathing? How emotion influences the evaluation and early use of innovations. J. Market., 70: 44-57.

Worthington, R.L. and T.A. Whittaker, 2006. Scale development research: A content analysis and recommendations for best practices. Counsel. Psychol., 34: 806-838.