**SUBSTITUTABILITY OF AUTOMATED
TELLER MACHINES FOR TELLERS:
WITH SPECIAL REFERENCE TO
BANK OF CEYLON**

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Abstract

Surrogating technology for human beings is a widely discussed topic in today's turbulent environment that has its own advantages and disadvantages. This study empirically explores the impact of Automated Teller Machines on the employment of the Bank of Ceylon, Sri Lanka. The research has been conducted using annual secondary data from 1990 to 2011, gathered from the Bank of Ceylon. The study employs the Constant Elasticity of Substitution production function in identifying the degree of substitutability between tellers and Automated Teller Machines. The results of the study confirmed that there is a negative relationship between cost per Automated Teller Machine to the cost per teller and number of automated teller machines to the number of tellers. Further it is indicated that there is a substitutability of 26 percent between Automated Teller Machines and tellers. The research findings indicate that replacing human tellers by Automated Teller Machines has led to a reduction of job opportunities at the Bank of Ceylon and suggest policy recommendations regarding the efficient re-allocation of employees in the bank.

Key Words: *Automated Teller Machines, Tellers, Constant Elasticity of Substitution.*

JEL Codes : *G20, G21*

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INTRODUCTION

Focusing on convenience and productivity, banks have transformed their traditional banking processes into technology intensive models that clearly depict the automation of the banking process by Information Technology (IT). Through technology based systems, banks have made an effort to maintain customer friendly services and to thrive amidst competition.

The concept of automated systems based on IT is expanding with the concept of 'e-finance'.¹⁴ E-banking is coming under the e-financial model of Business to Consumer and includes Automated Teller Machines,¹⁵ telephone banking, electronic fund transfers and credit cards. Gains from e-finance model include the reduction in the cost of transaction processing and improvement in the quality of services.

In the context of Sri Lanka, there are three major technology based systems that have been applied by the banking industry. They are ATMs, Internet Banking and Mobile Banking.

ATM has replaced the traditional branch model of paper based verification systems like cheques with the use of plastic cards and its special features. They have also simplified the individual work load. Information of the customer account could be accessed through the ATM itself and ATMs also have played a major role in electronic fund transfers. Internet banking facilitates a customer through virtual banking functions while mobile banking has also facilitated inter-bank and intra-bank fund transfers between bank accounts.

The major advantage of the ATM is the twenty four hour service offered during three hundred and sixty five days of the year. For the convenience of the customers, nowadays, ATMs are located by banks at convenient places such as at supermarkets, airports, railway stations etc. and not necessarily at the bank's premises. Reduction of the work pressure of bank staff is one of the other advantages of ATMs.

Sampath Bank was the first bank in Sri Lanka to operate a fully computerized database and ATM technology. Sampath Bank introduced their Automated Teller Machines to Sri Lanka, branded as "SET".

¹⁴ The 'e-finance model' could be explained using three broad categories, which provide the platform to the model of e-commerce; namely, business to business, business to consumer, and consumer to consumer models. The business to business sector includes services in corporate finance sector while business to consumer sector includes services such as online banking, online transactions, electronic bill payments and mortgages. The consumer to consumer sector includes payments for online transactions and electronic money transfers.

¹⁵ ATMs are operated by a customer himself to deposit or withdraw cash from a bank. When the Automated Teller Machine Card (magnetically coded plastic card) is inserted into the machine and keyed the password, the machine permits a customer to make entries for withdrawal or for deposit, and provided a proof document at the end of the transaction.

ATM facility was introduced by the Bank of Ceylon in 1990. The first ATM was established in the ground floor of the bank of Ceylon head office (Colombo 01). Bank of Ceylon has contacted all citizens of the country via its network over 600 branches connected online while operating ATM networks over 490, in all 25 districts of the country. Apart from that Bank of Ceylon operates in 02 overseas locations as well. They are Maldives and Chennai and 2 ATMs are located in the Maldives.

Bank of Ceylon issues automated teller cards¹⁶ to private, current and savings accounts holders and to the wholesale business enterprises under the name of the owner but not for partnerships and societies like welfare societies.

SIGNIFICANCE OF THE STUDY

Automated Teller Machines were created with the expectation of delivering efficient operations to its users. The ATM phenomenon needs to be understood in terms of productivity, quality and customer services in the banking sector. In the introductory period of ATM, customers used ATMs primarily for cash withdrawal; over time, this trend has changed and customers expect new services from ATMs.

Vendor productivity analysis and banker productivity analysis are used to examine how investments in ATMs influence the performance of the organization, overall customer satisfaction and labour replacement. Summer (1990) illustrated that the creation of ATMs has both marketing and operations implications. Marketers want to demonstrate convenient banking in order to increase deposits through service. In the case of operations, bankers tried to reduce cost by substituting ATMs for human tellers and limit the growth of paper check transactions. Banks gain more with e-banking services including ATMs. Gains are the results of lower cost, fewer physical branches and fewer employees.

As a result of the technology revolution there is a trend of replacing human beings with machines or devices in virtually every sector and the industry in the global economy. This is evident through the increasing trend of the cost of tellers when compared to the cost of ATMs (figure 01), and the increasing trend of number of ATMs with respect to the number of tellers (figure 02). This led researchers to investigate the degree of substitutability between ATM and bank tellers.

¹⁶ Savings or current account with the completed application form is the major requirement to request for a teller card. Bank charges five rupees commission per transaction done through ATM. Usually card holders could withdraw up to Rs 40,000 per day and could extend this limit through a discussion with a bank. Customers who have both a current and a savings account are issued with one Automated Teller card for both accounts. A special unit called Electronic Banking Unit is located at the head office of the Bank of Ceylon to handle all of the issues regarding automated teller machines and teller cards.

LITERATURE SURVEY

Over the past few decades, researches have been conducted to examine the effect of ATM and technology based systems on customer, employee and institutional point of view.

Kumar et.al (2011) have identified Automated Teller Machines (ATMs) as an important IT investment in the banking sector of India. Ramsay and Smith (1999) showed that customers act differently when they deal with human beings and technology and suggested that bank customers prefer to deal with ATMs than with the human tellers. Rugambina (1994) too confirmed the results of Ramsay and Smith (1999). Parasuraman and Grewal (2000) have explained technology as a major component of the success of a firm. However, the introduction of ATMs has posed a major threat to the employee as well. (Rifkin, 2009).

From the customers' point of view, introduction of technology based systems could be illustrated from different perspectives such as (a) the extent to which customers are satisfied with the system or the technology, (b) expectations of the customer with respect to new features, and (c) convenience for the customer in using the new and modern technology.

For instance, Ramsay and Smith (1999) investigated the channel preferences of customers and the results confirmed that customers prefer to use direct channels rather than indirect channels. This indicated that customers are satisfied when they deal with technological interventions rather than with human interventions. Rugambina (1994) has investigated perceptual and demographic variables to unearth factors that are relevant to the usage of ATMs. Rugambina (1994)'s results have shown that convenience is the most important perceptual variable of customers in engaging with automated systems. It is also evident in the literature that expectations of the customers differ with their states and type. Katono (2009) has researched to find the important qualities that are expected by university students and concluded that reliability and location are the most important qualities that are expected by students from their banks. Many studies have found that customers are more satisfied with technological interventions than human interventions [Goode and Mountinho (1995), Rugambina (1994) and Ramsay and Smith (1999)]. Service technology (including ATMs) applications are changing according to the way that the service provider serves their customers. Empirical investigation was carried out by Prooenca and Rodrigues (2011) examined the way the customer was dealing with those services. The results explained that self-service technologies have a major role in firms dealings with their customers. E-banking services have rapidly expanded in all over the world.

Apart from that, researches have been conducted to analyse the influence of IT based system from the perspective of institutions. This could be expanded in different aspects,

namely, (a) effect to the workload of tellers, (b) performance to the bank, (c) productive capacity, (d) cost effectiveness and (e) overall performance.

From the bankers' point of view, ATMs are important to reduce the workload at the bank counter and it is a good tool to provide better customer service (Rugambina 1994). Moreover, from an organizational point of view, investments in automated systems based on IT generate a positive impact on the performance of the organization (Dunne et. al., 1996 and Kumar et.al., 2011). The productive contribution of automated systems based on IT have been also examined (Wilson, 1995 as cited by Kumar et.al, 2011) and it has been found that the productive contribution of IT is insufficiently small. Dunne et. al. (1996) have examined the relationship between technology and secular changes and cyclical dynamics concluding that technology could be used for unproductive labour share or technology could be substituted for labour.

IT based systems have influenced the cost effectiveness of automated systems with a positive impact (Goode and Mountinho 1995). Kwan (2003) reported that banks employed their workers more productively in banking industry. On the other hand Hao et.al (2001) reported that contents of branch jobs were routine and time consuming tasks. Most tellers performed relatively simple services such as cash depositing and issuing process. When salary cost is a part of operating cost, higher salary cost leads to cost inefficiency. As far as overall effectiveness is concerned financial and service industries are engaging as large investors in Information Technology (IT). Productivity of those investments is very important in the modern economy. Empirical studies tried to find the relationship between increasing inputs of IT and measured output. This is called as "IT Productivity Paradox". Haynes and Thompson (2000) examined the impact of a single IT application, the ATM on productivity and found that the ATM has a strong productivity consequence. Floros and Giordani (2008) suggested that banks with large number of ATMs are more efficient than the banks that have lower number of ATMs.

However, Rifkin (2009) carried out a survey from the point of view of employees and identified their preferences towards technology based systems and found that job opportunities have been eliminated by technology. Findings suggested that technology can easily be substituted for people, thus demonstrating, systems based on IT assist people to do their work more effectively. Self-service technologies are considered as option for service delivery. Customers can fulfil their own needs using automated system that are provided by the service provider. Bitner et.al (2000) reported that self-service technologies provided by the service firm could either complement or completely replace the employee involvement. As far as the banking industry is concerned, expansion of the ATMs has generated a threat on the job opportunities (Kumar et.al. 2005).

There is strong empirical evidence showing that a significance lag exists between the launch of a new technology in the market and its adoption by industry (Parasuraman

and Grewal 2000). Hannan and McDowell (1984) examined the relationship between the decisions of new IT adoption and its determinants. Their analysis found that wage rate and firm size had positive effects on deciding ATM adoption. That is in regions of higher wage rates, bank tends to install more ATM to replace expensive labour. In addition, larger banks tends to introduce more ATM than small banks owing to economies of scale. According to them, the reduction of operating cost is a key factor in the decision to invest in innovations such as ATMs.

However, apart from Kumar et.al (2011), few researchers explored the research area of the substitutability of the teller and ATMs. This present study poses the research question as “How much is the degree of substitution between ATMs and Tellers?” and follows Kumar et.al (2011). The specific objective of the study was to measure the degree of substitution of ATMs for number of tellers by the Bank of Ceylon (BOC), Sri Lanka.

METHODOLOGY

The study uses annual secondary time series data from 1990 to 2011.

There are several ways of specifying a production function. In general mathematical form, a production function can be expressed as,

$$Q = f(X_1, X_2, X_3, \dots, X_n) \quad 1$$

Where Q is the quantity of output and $X_1, X_2, X_3, \dots, X_n$ are factor inputs (such as capital, labour, land or raw materials). One formula is as a linear function,

$$Q = a + bX_1 + cX_2 + dX_3 \quad 2$$

Where, a, b, c and d are parameters that are determine empirically.

In many fields of economics, a particular class of function called constant elasticity of substitution (CES) function is privileged because of its invariant characteristics, namely, that the elasticity of substitution between parameters is constant on their domains. This functional relationship is assumed in identifying the relationship between ATMs and Tellers.

The Cobb-Douglas production function is derived in the following manner. Consider a two input cases and one output case. Let the inputs be tellers (labour) and ATMs (capital). The profit functions could be formulated as follows;

$$\pi = p * f(A, T) - (P_A A + P_T T) \quad 3$$

Where p is the price of the banking service, $f(A, T)$ is the production function with respect to ATMs and Tellers, A is the number of ATMs, T is the number of Tellers, P_A is the cost per ATM, and P_T is the wage bill per teller.

The constant elasticity of substitution (CES) production form is the most general case, where the degree of substitutability between two input resources is represented by ρ which will be estimated through the data.

The CES production function is defined as,

$$F = f(A, T) = \{\alpha A^\rho + (1 - \alpha)T^\rho\}^{(1/\rho)} \quad 4$$

Where α is the share parameter (Amount invest in number of tellers or number of ATMs) and ρ is the degree of substitutability between the inputs.

Partially differentiating $f(A, T)$ with respect to A , obtains the following.

$$\partial F / \partial A = (1 / \rho) \{\alpha A^\rho + (1 - \alpha)T^\rho\}^{1-\rho/\rho} * (\alpha \rho A^{(\rho-1)}) \quad 5$$

Similarly partially differentiating $f(A, T)$ with respect to T , obtain the following.

$$\partial F / \partial T = (1 / \rho) \{\alpha A^\rho + (1 - \alpha)T^\rho\}^{1-\rho/\rho} * (1 - \alpha) \rho T^{(\rho-1)} \quad 6$$

In order to maximize profit π , one could choose A and T such that

For ATMs:

$$p \frac{\partial F}{\partial A} = P_A \quad 7$$

For teller:

$$p \frac{\partial F}{\partial T} = P_T \quad 8$$

Dividing equation (7) by (8) we get

$$\frac{\left(\frac{\partial F}{\partial A}\right)}{\left(\frac{\partial F}{\partial T}\right)} = \frac{P_A}{P_T} \quad 9$$

It implies that

$$\frac{\alpha A^{(\rho-1)}}{(1-\alpha)T^{(\rho-1)}} = \frac{P_A}{P_T} \quad 10$$

$$\left(\frac{A}{T}\right)^{(\rho-1)} = \frac{1-\alpha}{\alpha} * \frac{P_A}{P_T} \quad 11$$

Taking logs,

$$(\rho-1)\log\left(\frac{A}{T}\right) = \log\left(\frac{1-\alpha}{\alpha}\right) + \log\left(\frac{P_A}{P_T}\right) \quad 12$$

Or

$$\log\left(\frac{A}{T}\right) = \frac{1}{(\rho-1)} * \log\left(\frac{1-\alpha}{\alpha}\right) + \frac{1}{\rho-1} * \log\left(\frac{P_A}{P_T}\right) \quad 13$$

The above is the standard double log linear that can be estimated using ordinary least square regression this equation enables modelling $\frac{A}{T}$ in terms of $\frac{P_A}{P_T}$.

In order to estimate the above double log linear function, the following model has been used.

$$\log NR = \beta_1 + \beta_2 \log CR \quad 14$$

where NR is the number of ATMs to number of tellers, CR is the cost per ATM to cost per teller, β_1 is the constant term and β_2 is the extent to which a change in the cost per ATM to cost per teller changes the number of ATMs to number of tellers.

Time series data related to ATMs are available from 1990. Researcher has adopted 22 observations from 1990 to 2011. A large number of observations would provide a robust result, but we are limited by the availability of only annual data.

RESULTS

According to the results of the Augmented Dickey –Fuller test, both Log *CR* and Log *NR* are stationary at the level, and therefore they are used for analysis (Table 01).

Regression results indicated that all variables are significant at 5 percent level of significance. One percent increase in the cost per ATM to cost per teller, have decreased the number of ATM to number of tellers by 1.36 percent. 81.31 percent of variation of the dependent variable is explained by the model. For 22 observations and one explanatory variable, $d_L = 1.24$ and $d_U = 1.43$ at the 5 percent significance level. Thus, no autocorrelation is present in this model (Table 2).

COMPARISON OF CES PRODUCTION FUNCTION WITH OTHER CASES

Case 1: Cobb–Douglas production function

CES production function could be converted into a Cobb-Douglas production function, in the limit when $\rho \rightarrow 0$. As this expresses the linear substitution, setting $\rho = 0$ in the limits, the derived function is,

$$F = f(A, T) = ZA^{\alpha}T^{(1-\alpha)} \quad 15$$

The calculated Cobb–Douglas production function received sum squared residual of 1.470454. The obtained sum squared residual in the CES function is 1.2694. Therefore we infer that the CES production function is a better representation of the functional form than the Cobb-Douglas production function.

Case 2: No substitution

CES production function could be used to depict the situation of no substitution, in the limit when $\rho \rightarrow -\infty$. Setting $\rho = -\infty$ in the limits, obtained the constant term of the Leontief production function. The obtained sum squared residual in CES function is 1.2694 while in the case of no substitution it is 9.51, which depicts that CES production function is more appropriate to conduct the analysis

Figure 3 is the graphical presentation of the data with other cases.

Estimation of the degree of substitutability between ATM and Teller (ρ)

Considering equation 13, one can derive, the elasticity of substitution as

$$\beta_2 = \frac{1}{(\rho - 1)} \quad 16$$

Solving equation 5 for ρ ,

$$\rho = \frac{1}{\beta_2} + 1 \quad 17$$

According to regression result, $\beta_2 = -1.36$ and therefore, the value of ρ is 0.26. Thus, the degree of substitutability between ATM and teller is 0.26.

CONCLUSION AND POLICY RECOMMENDATION

The study has investigated the substitutability of ATMs and tellers in the context of Sri Lankan bank (Bank of Ceylon). The purpose of the current study was to determine the degree of substitutability of ATMs and tellers. The study has found that generally there exists a degree of substitutability, however, ATMs were not perfectly substitute for tellers because the degree of substitutability is less than one.

Results of the study indicate that one automated teller machine has replaced 0.26 tellers. According to the findings of the Kumar et.al (2011) degree of substitutability between teller and ATM is 0.56. Chang and Schorfheide (2003) as cited by Kumar et.al (2011) have reported 0.4 substitutability of technology in the household sector. Differences in these results are likely to arise from the differences in context and sectors under study.

This study provides an original contribution to the literature in terms of data and application with regard to the selected bank and country, and to the best of the researcher's knowledge is the first of its kind in relation to any Sri Lankan bank. Although the current study is based on a small sample of participants, the findings suggest that the decreasing cost per ATM against cost per teller was one of the major reasons for the expansion of ATMs. This requires identifying new or enhancing policies regarding employment and investment in ATMs. As any increase in ATMs cause a threat to employment opportunities in the bank, there is a need for the bank to consider re- training facilities to redundant staff and expanding activities in the bank, so that they can be relocated to new areas. Apart from that, technological innovations would help increasing productivity of the bank, thereby contributing to economic growth in Sri Lanka.

Findings of the study could be generalized to a similar bank that has similar characteristics to Bank of Ceylon but further investigations need to be done in order to generalize the scenario into different contexts. Thus, there is scope for further research be undertaken in different sectors and with respect to banks with different characteristics to the Bank of Ceylon.

Annexure

Figure 1: Recent Trends on Cost Per ATM and Cost Per Teller in Bank of Ceylon Sri Lanka

Source – Authors preparation using data from Electronic Banking unit, Bank of Ceylon Sri Lanka

Figure 2: Recent Trends on Number of ATM and Number of Tellers from 1990 to 2011 in Bank of Ceylon

Source – Authors preparation using data from Electronic Banking unit, Bank of Ceylon Sri Lanka

Figure 3: Log NR (Number of ATMs/ Number of Tellers): Data, CES Production Function, Cobb-Douglas Production Function and No Substitutability

Source – Authors preparation

Table 1: Results of the Unit root Test

Variable	t - statistic	Prob.
$\log NR$	-4.720298	0.0013**
$\log CR$	-6.084946	0.0392*

Notes

** and * indicate significant levels at 1% and 5% respectively

Source: Authors calculation using E-views 7.

Table 2: Results of the Log Linear Regression Model

Variable	Coefficient	SE	t-statistic	Prob.
Intercept	-0.115758	0.097532	-1.18687	0.0492*
Cost per ATM/Cost per teller	-1.361964	0.143446	-9.32914	0.0230*
R-squared	0.813141			
Adjusted R-squared	0.803799			
Sum Squared Resid	1.269394			
Prob. (F-Statistic)	0.021000			
Durbin - Watson stat.	1.473309			

Notes

* indicates the significant level at 5%.

Source: Authors calculation using E-views 7.

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FIRMS' RESPONSIVENESS TOWARDS QUALITY MANAGEMENT IN BOTTLED DRINKING WATER MANUFACTURING INDUSTRY IN SRI LANKA

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Abstract

Economic incentives that motivate, and the constraints and negative perceptions that impede, firms operating in a bottled drinking water manufacturing industry in Sri Lanka to adopt an enhanced food safety and quality meta system such as Hazard Analysis and Critical Control Points (HACCP), are examined using Discriminant Analysis. The outcome suggests that firms' response towards adoption of the HACCP is influenced by both market-based (sales, reputation, efficiency) and regulatory (existing, anticipated, judicial) incentives; yet, prevailing constraints at the level of firm (financial, technical) and negative perceptions of decision makers (awareness, hard work) hinder their propensity to adopt such systems.

Key Words: *Adoption, Bottled drinking water, Economic incentives, Food safety and quality management*

JEL Codes : *B21, L15, M11, Q12*

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INTRODUCTION

Accessibility to safe drinking water in right quantities is considered an important topics in economic literature and scientific forums as well as in the political circles worldwide. Provision of drinking water in various forms, for example “pipe-borne water”, to society has long been a part of the government-based utility provision in most countries, regardless of the state of the economy, i.e. developed or developing. Food markets too have responded to the persistent consumer demand for safe water by supplying it in various forms, including the manufacture of “bottled drinking water”, which by standard definition is ‘drinking water packaged in bottles for individual consumption and retail sale’. In fact, this ever increasing demand for drinking water is interconnected, to a larger extent, with changing consumer lifestyles and rapid urbanization. In this connection, consumer faith on enhanced product safety and quality attributes has also been played a major role (Veeman, 1999).

Water, though one of the most precious gifts of nature, or in economic terms a ‘pure public good’, has, in light of this paradigm shift in consumer life, overtime, been transformed to a money-making private good. Further, like in many other food items, food marketers tend to charge a premium for its improved safety and quality attributes. The global bottled water market has grown by 5.2 percent in 2011 to reach a value of US\$ 135,064 million, while the market volume grew by 5.3 percent to reach 205,902.8 million liters. In the context of Asia-Pacific region, it has grown much faster, where the value and volume grew by 10.0 and 8.9 percent to reach the total of US\$ 25,075 and 43,156.2 million liters, respectively (Market Line, 2013). Parallel to many other food products that are susceptible to food-borne hazards, if adequate measures were not taken along the food value chain to minimize the issues linked with safety and quality (e.g. meat, seafood, eggs, processed fruits and vegetables), the safety and quality of drinking water available in the marketplace is also subject to suspicion by consumers. Whereas those unsafe sources of water that are freely available for drinking form a growing demand for “purified” bottled water in the market, a firm that manufactures this product may also face a greater threat, if the product does not conform to stringent food safety and quality standards. The case may be further aggravated by the fact that many attributes of quality associated with bottled water, similar to other products mentioned above, are ‘credence’ in nature. As a result, the firm concerned may automatically face the problem of ‘signaling’ the quality of its product. As such, the safety and quality of bottled water needs to be assessed like any other food categories showing ‘credence’ characteristics (Nelson, 1970; Shapiro, 1982).

In the light of this, the registration of bottled drinking water with the Ministry of Health has become a ‘mandatory’ requirement for the sale of imported as well as locally manufactured bottled water in the local market. In the Gazette No. 1420/4 of 21st November 2005, connected to the Food Act No. 26 of 1980, it is stated that ‘no person is allowed to: (a) bottle or package natural mineral water or drinking water or, (b) import and distribute bottled or packaged natural mineral water or drinking water without obtaining a certificate of registration from the Chief Food Authority of the Ministry of Health’. This registration has to be renewed annually after conducting special audits of the water source, its environment, and water samples. Brands which fail to continue this annual renewal process of registration are, in turn, considered as “unofficial” and they are not included to the ‘list of registered firms’ published by the Food Control Administration Unit (Wijesekara, 2007). Moreover, the unofficial sources imply that there are over 100 brands of bottled drinking water currently available in the Sri Lankan markets, and deterioration of safety and quality of one or few such products can pose a threat all other firms in the market, since consumers may not be in position to identify quality products due to asymmetry in the provision of information.

Like many food processing firms in Sri Lanka, bottled water manufacturers also tend to obtain the product certification mark issued by the Sri Lanka Standard Institution (SLSI), which is commonly known as the “SLS”. However, for the said industry this is “voluntary”, and is independent from the mandate to get registration from the Ministry of Health. In fact, this voluntary scheme for obtaining the “SLS” from the SLSI is based on the primary requirement that the particular product complies with the relevant Sri Lanka standard specifications for the product; SLS 894:2003 - specification for bottled (packaged) drinking water, and SLS 1038:2003 - specification for natural mineral water (Wijesekara, 2007).

If not a mandate, now it has become an industry norm that in certain sensitive food markets, especially those in the developed countries such as Australia, Canada, Japan, the UK, and the US, that food manufacturing firms have progressively been moved towards adoption of enhanced food safety meta systems such as Hazard Analysis Critical Control Point (HACCP) and ISO 22000 in the firm (Mortimore and Wallace, 1994). In many economies where there is no such a mandate, firms adopt such systems in light of the economic incentives that they are faced with, along with market-based, regulatory and legal (Henson *et al.*, 2000; Henson and Heasman, 1998) considerations.

Although there is an enormous literature published in this area, especially in the context of economics of food industry certification, that which is particularly focused on adoption of a meta system like HACCP in the context of Sri Lankan food markets is thinner (e.g. Jayasinghe-Mudalige *et al.*, 2014 in the context of agri-food processing sector; Gajanayake *et al.*, 2006 on tea sector). To the best knowledge of the authors, there is none in the context of bottled water manufacturing industry.

In this study, we specifically examine the relative importance of various economic incentives as well as the constraints faced by bottled water manufacturing firms with a higher propensity to adopt an enhanced food safety and quality meta system like HACCP and those that have the least propensity to do so.

METHODOLOGY

Theoretical Framework

For the purpose of this analysis, HACCP has been considered as the enhanced food safety and quality Meta system that a firm which operates in the bottled drinking water manufacturing industry adopts to show its responsiveness to food safety and quality. Therefore, to facilitate analyzing the discriminating factors of “adopters of HACCP” [named: *Embracers* (EMB)] and “non-adopters of HACCP” [named: *Deferrers* (DEF)] the following criteria were applied.

Following Jayasinghe-Mudalige and Henson (2006) as well as a number of subsequent studies by the same authors and others (e.g. Herath and Henson, 2010), nine individual economic incentives that prevail at the level of a firm that motivates firms’ private action on adoption of food safety and quality meta system like HACCP were selected for the purpose of this study, including: (1) Cost/financial implications (CST); (2) Efficiency of human resources (HRE); (3) Efficiency in technical procedures (TCH); (4) Sales and revenue (SLR); (5) Reputation (REP); (6) Commercial pressure (CPR); (7) Existing government regulation (EGR); (8) Anticipated government regulations (AGR), and (9) Liability laws (LBL).

Further, a number of potential constraints that a food processing firm may face in its attempt to adopt HACCP were taken into account, including: (1) To retrain the staff in new practices; (2) Negative attitudes of the employees; (3) Inflexibilities associated with the production process; (4) To renovate the plant with new equipment; (5) Lack of reliable information about food safety/ quality controls; (6) Lack of financial support from external sources; and (7) Lack of space to accommodate new practices. Moreover, it was considered that several firm and market-specific characteristics that are likely to influence in differentiating HACCP Embracers from Deferrers, include: (1) Vintage; (2) Firm size; (3) Water source; (4) Major markets, and (5) Sales strategy (Herath *et al.*, 2007). In addition to the screening of firm characteristics, incentives and constraints to differentiate EMB and DEF of HACCP, several different negative perceptions that distract a quality assurance manager from adopting an enhanced food safety and quality Meta system were also considered to evaluate the relative importance of each on the firms to act on adoption of HACCP.

DATA COLLECTION AND ANALYSIS

Based on the list of bottled drinking water manufacturing firms in Sri Lanka, which was updated by 01st February 2013 by the Food Control Administration Unit, the 61 firms

that produce 77 different brands with a valid registration were selected as the sampling framework. A structured questionnaire was developed utilizing the first hand information gathered through a series of face-to-face discussions held with quality assurance managers of certain firms and through inspection of manufacturing facilities, which was administered with the quality assurance managers during January to March 2013 to collect data.

After several attempts to obtain an appointment for a personal interview to participate in the study, the consent to get a full information on their practices could be obtained from 30 firms, which represent nearly 50 percent of firms in full-scale operation. The quality assurance managers were asked to respond to the underlying phenomenon explaining each individual incentive and constraint in the list forwarded to them using a five-point Likert scale ranging from “very important” (5) to “very unimportant” (1), and also to each statement regarding negative perceptions on a five point Likert scale ranging from " very true" (5) to “not at all true" (1).

Discriminant Analysis (DA) was carried out to differentiate HACCP Embracers and Deferrers based on firm characteristics, economic incentives, and constraints. DA involves deriving a variate. The discriminant variate is the linear combination of the two (or more) independent variables that will discriminate best between the objects in the groups defined *a priori*. There are several purposes of DA, one of the most common and rational for application here is to investigate differences between groups on the basis of the attributes of the cases, indicating which attributes contribute most to group separation (Hair *et al.*, 1998).

The percentage of variance accounted for by each discriminant function was shown by Eigen values. The significance of Wilk's Lambda was used to interpret the statistical significance of the discriminatory power of the discriminant function. The Wilks' Lambda and Univariate ANOVA were used to assess the significance between means of each predictor variable for the two groups. The 0.05 significance level with the lowest Wilks' Lambda value was used to enter variables into the discriminant function. The variables which could not satisfy these criteria have not been included (denoted NI in Tables 3 and 4) to the discriminant function.

Discriminant Loadings (DL) which assess the relative contribution of each predictor variable to the discriminant function were considered the most appropriate measure of discriminatory power, but the discriminant weights were also considered. Variables exhibiting a loading of ± 0.40 or higher were considered substantive. Generally, 0.40 is seen as the cut-off between important and less important variables. The cross validation approach was used to test the validity of the discriminant results as the original sample was relatively small to divide into analysis and holdout samples (Hair *et al.*, 1998).

RESULTS AND DISCUSSION

Descriptive Statistics of the Sample

Table 1 summarizes descriptive statistics of the sample. Sixty seven percent of firms in the sample were classified as “small”. The majority of firms supply their products to domestic markets only. Further, nearly 23 percent of firms supply their products to special customers, including designated hotels, restaurants, and organizations. With regard to the status of adoption of HACCP, nearly 30 percent of firms were able to be classified as “HACCP embracers”.

Table 1. Characteristics of Firms in Sample

Firm character	Description	% of firms
Vintage	< 10 years	53%
	> 10 years	47%
Employees	< 30 (small)	67%
	> 30 (large)	33%
Water source	Public water supply	0%
	Dug well	27%
	Tube well	53%
	Spring	20%
Major markets	Domestic only	80%
	Domestic + Export	20%
Sales strategy	Own brand	77%
	Own brand + Customer brands	23%

The results, overall, show that firms’ potential investments towards enhanced food safety and quality meta systems such as HACCP is triggered by both market-based and regulatory incentives side-by-side. However, prevailing constraints at the level of firm block such efforts to a greater extent. More importantly, firms’ further investments on enhanced quality management systems can largely be motivated by the “existing” and “anticipated” government regulation.

Top two box reporting, i.e. the two most favorable response options on a scale that has been used by respondents to indicate their answers (“*Very True*” and “*Somewhat True*”), was used to examine the relative importance of those negative perceptions of managers in the firms towards HACCP. The percentages of respondents who have given top two box scores for each statement are shown in Figure 1.

Effect of Economic Incentives, Constraints and Negative Perceptions

The Mean likert scale value of each statement representing individual incentives and constraints faced by firms are reported in Table 2.

Table 2. Mean values of economic incentives and constraints

Factor Item	Mean
<i>Incentives</i>	
I1: Cost/financial implications	4.1
I2: Efficiency of human resources	4.4
I3: Efficiency in technical procedures	4.0
I4: Sales and revenue	4.2
I5: Reputation	4.0
I6: Commercial pressure	4.1
I7: Existing government regulation	4.6
I8: Anticipated government regulations	4.6
I9: Liability laws	4.1
<i>Constraints</i>	
C1: To retrain the staff in new practices	3.9
C2: Negative attitudes	3.7
C3: Inflexibilities associated with the production process	4.0
C4: To renovate the plant with new equipment	3.6
C5: Lack of reliable information about food safety/quality controls	4.3
C6: Lack of financial support from external sources	4.3
C7: Lack of space to accommodate new practices.	3.6

Figure 1. Top Two Box Scores for Negative Perceptions about HACCP

ng certification'; 'For us, SLS standard is very much enough'; 'Certification does not

have an impact on profitability’, and ‘Certification having low value among customers’ had a high level of top two box scores, and HACCP deferrers were the majority who

have given the highest top two box scores for all attitudinal statements. Essentially, the outcome of analysis state that it is of paramount importance to raise the awareness of managers towards possible weakness of already established food safety controls in the firms.

Outcome of Discriminant Analysis

Firm Characteristics

In the DA for firm characteristics, the canonical correlation of 0.67 indicates that $(0.67)^2 = 0.45$ or 45% of variance in the dependent variable can be explained by the independent variables. The Wilk’s Lambda test was also significant with p-value 0.000 proves that there is a statistical significance of the discriminatory power of the discriminant function. Univariate ANOVA indicated that rank mean of firm size displays a significant difference between group means, while vintage, water source, major markets, and sales strategy showed an insignificant difference (Table 3).

Based on the outcome of this analysis, vintage, water source, major markets, and sales strategy cannot be used to differentiate among EMB and DEF. The DL for the firm size exceeded ± 0.40 threshold. As a result, firm size can be used in the discriminant function and be used to discriminate among EMB and DEF. According to the discriminant coefficient, there was a positive relationship between firm size and the level of HACCP adoption, i.e. large firms were more likely to embrace HACCP.

Table 3. Summary of Interpretive Measures of DA for Firm Characters

Firm Characters	Wilks' Lambda Value	Univariate F Ratio		Discriminant Coefficients		DL
		F value	Sig.	UNST	STAD	
Vintage	0.969	0.884	0.355	NI	NI	-0.270
Firm size	0.786	7.636	0.010	2.237	0.968	0.792
Water source	0.971	0.845	0.366	NI	NI	0.264
Major markets	0.952	1.400	0.247	NI	NI	0.339
Sales strategy	0.976	0.687	0.414	NI	NI	0.238

UNST – Unstandardized; STAD – Standardized;

NI = Not included in estimated discriminant function

Economic Incentives

Table 5. Summary of Interpretive Measures of DA for Constraints

Constraints	Wilks' Lambda Value	Univariate F Ratio		Discriminant Coefficients		DL
		F value	Sig.	UNST	STAD	
To retain staff	0.987	0.362	0.552	NI	NI	-0.100
Negative attitudes	0.788	7.553	0.010	-1.272	-1.420	-0.456
Inflexibilities with process	0.998	0.062	0.805	NI	NI	-0.041
To renovate plant	0.942	1.721	0.200	NI	NI	-0.218
Lack of information	0.997	0.083	0.775	NI	NI	0.048
Lack of financial support	0.804	6.830	0.014	-1.387	-0.909	-0.434
Lack of space	0.999	0.015	0.904	NI	NI	-0.020

UNST – Unstandardized; STAD – Standardized;
NI = Not included in estimated discriminant function

power of the discriminant

function. Univariate ANOVA indicated that rank mean of SLR displayed a significant difference between group means (Table 4).

Table 4. Summary of Interpretive Measures of DA for Economic Incentives

Economic Incentives	Wilks' Lambda Value	Univariate F Ratio		Discriminant Coefficients		DL
		F value	Sig.	UNST	STAD	
CST	0.938	1.843	0.185	NI	NI	0.503
REP	0.940	1.792	0.191	NI	NI	0.496
TCE	0.890	3.470	0.073	NI	NI	0.691
SLR	0.859	4.586	0.041	0.545	0.466	0.794
HRE	0.897	3.211	0.084	NI	NI	0.665
CPR	0.955	1.312	0.262	NI	NI	0.425
EGR	0.958	1.222	0.278	NI	NI	-0.410
AGR	0.958	1.222	0.278	NI	NI	-0.410
LBL	0.971	0.847	0.365	NI	NI	0.341

UNST – Unstandardized; STAD – Standardized;
NI = Not included in estimated discriminant function

As the outcome of analysis highlights that the CST, HRE, TCH, REP, CPR, EGR, AGR and LBL showed an insignificant difference between two groups, they cannot be used to differentiate EMB from DEF. Since DL for the SLR exceeded ± 0.40 threshold, it was the most important incentive that differentiate EMB from DEF.

In the DA for nine incentives, the canonical correlation of 0.66 indicates that $(0.66)^2 = 0.43$ or 43% of variance in the dependent variable can be explained by the independent variables. The Wilk's Lambda test was also significant with p-value 0.000 proves that there is a statistical significance of the discriminatory

According to the discriminant coefficient for SLR, there was a positive relationship between SLR and the level of HACCP adoption, i.e. major motivation factor to embrace HACCP was increase in sales and revenue.

Constraints

In the DA for seven constraints used in the analysis, the canonical correlation of 0.75 indicates that $(0.75)^2 = 0.56$ or 56% of variance in the dependent variable can be explained by the independent variables. The Wilk's Lambda test was also significant with p-value 0.005 proves that there is a statistical significance of the discriminatory power of the discriminant function. Univariate ANOVA indicated that rank mean for 'Negative attitudes' and 'Lack of financial support' displayed a significant difference between group means (Table 5).

Since other five constraints showed an insignificant difference between two groups, they cannot be used to differentiate EMB from DEF. The DL for 'Negative attitudes' and 'Lack of financial support' exceeded ± 0.40 threshold; thus, they can be taken as the most important constraints that differentiate EMB from DEF.

As the discriminant coefficients of 'Negative attitudes' and 'Lack of financial support' possess a negative relationship with the level of adoption of HACCP, it is vital for firms to take remedial action to make sure that the entire process of adoption of HACCP is transparent and each and every employer in the firm needs to be educated in order to increase their awareness on it, and allocate sufficient resources to guarantee an uninterrupted adoption at every critical point to make it an effective food safety and quality management mechanism.

CONCLUSIONS

The outcome of analysis implies that large firms were more likely to adopt the meta system and sales and revenue was the major incentive for a firm to adopt HACCP in compared to a non-adopter. The major barriers faced by the firms in this process include lack of finance and negative attitudes of the employees. Further, according to the two top box scores for the negative perceptions of HACCP, the low demand for food safety standards and lack of customer awareness about the HACCP played a significant role as the reason for slow uptake of adoption of HACCP by the industry.

The implementation of HACCP might be facilitated and enhanced through cooperation and coordination between policy makers and industry organizations. First, there is a fundamental need to raise awareness of the weakness of established food safety controls. Here, information dissemination and training can play a key role. Second, finance is obviously a critical issue. Many firms, especially small and medium-sized enterprises, have difficulty accessing the required capital to fund investments. This failure of existing sources of finance may require action on the part of government. Finally, there is clearly a need to make the process of HACCP implementation and the

firm-level impacts visible to firms that are contemplating implementation. This could take the form of firm-level case studies or demonstration plants.

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