# ADOPTION BEHAVIOUR OF BARN AUTOMATION TECHNOLOGY IN FLUE CURED TOBACCO INDUSTRY IN SRI LANKA

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**Abstract**
Adoption and technology diffusion are the processes governing the utilization of innovations. There is often significant interval among the time of the innovation, availability in the market, and the time it is widely used by customers. Barn automation in flue cured tobacco industry in Sri Lanka is a newly introduced innovative technology to the tobacco farmers. However, this technology has been diffused among a few farmers. Therefore, Theory of Planed Behavior Model was used to evaluate the adoption behavior of tobacco farmers to the new technology and a logistic regression model was estimated to identify the determinants of non adopter's intention to use the technology. Two surveys were conducted for 54 adopters and 150 non adopters respectively to gather data. Results proved that adopters almost agreed with the facilitating condition, external influence, self efficacy and perceived user friendliness. Interpersonal influence toward the adoption, self control of decision and perceived usefulness of the product are the dimensions which were moderately agreed with by the barn owners. Results of the logistic regression indicated that non adopters intention to use the automation technology have been significantly affected by barn owners awareness about automation technology, attendance to the training program, negative attitude towards the industrial uncertainty, perception towards the production cost, experience of the barn owners and barn owners.

*Keywords* : Barn Automation Technology; Logistic Regression ; Theory Of Planned Behaviour

## 1. Introduction

Tobacco is a very well known profitable cash crop cultivated in different areas of Sri Lanka. Curing is been identified as an important step in the primary processing of flue cured Virginia (FCV) tobacco production. This curing process is being carrying out in the special location called barn. Heat generated in a furnace is transmitted to the barn through a flue (duct) system to facilitate curing process in FCV production while maintaining desired temperature in four different stages of curing process. Therefore proper maintenance of desired temperature plays a very vital role in determining final FCV tobacco quality. However operation of

the furnaces to provide the required temperature is done manually in traditional barns. There are a lot of drawbacks observed in stabilizing barns manually at the desired temperature.

To overcome these constrains after several years of successful experimentation one farmer introduced an automated furnace to the barn owners in year 2007. Launch of barn automation technology was predicted to become a revolutionary change in the industry and diffuse among the farmer population with in a shorter period since there were significant benefits than the manual barn operations. Population of barn owners in flue cure tobacco industry is about nearly 2000 (BAT leaf system of Ceylon Tobacco Company, 2011). The automated furnace has only adopted in 54 barns up to now. Therefore even after four years of implementation the expected progress in adoption to the technology has not met. Table 1 shows the statistics of the farmer population who have adopted to the introduced technology.

Table 1: Adopters of the Automation Technology

| Adopters for Barn Automation Technology | | | |
|---|---|---|---|
| Area | Galewela | Polonnaruwa | Mahiyanganya |
| Total Barn | 45 | 9 | 0 |

Therefore this study was carried out based on two major objectives.

- Evaluate the different dimensions of adoption behavior (by using theory of planed behavior)
- Identifying the determinants of non adopter's intention to use the barn automation technology.

## 2. Literature Review

### *2.1 Adoption Innovation and Technology Diffusion*

Technology adoption is the process through which organizations or individuals decide to make full use of an innovation in their daily businesses (Rogers, 1983). According to Rogers (1983) adoption is defined as a decision to make full use of an innovation as the best course of action, and conversely, rejection is a decision not to adopt an available innovation. Rogers differentiates the adoption process from the diffusion process of innovation. Technology diffusion is the process during which an innovation is communicated among members over time (Rogers, 1995). Adoption and technology diffusion are the processes governing the utilization of innovations. Adoption to the technology innovation can not been seen as a rapid process. As organizations introduce new technologies, full implementation and successful adoption will not be achieved unless the workforce accepts technologies (Manross & Rise, 1986) .There is often significant interval between the time of the innovation is developed, availability in the market, and the time it is widely used by customers (Geroski, 2000). Various studies have demonstrated that the issue of technology adoption is a complex one, as adopting a particular technology depends on many factors that contribute to the success or failure of adoption. Diffusion studies have found that the way targeted adopters perceive the attributes of an innovation is critical and that these perception accounts for 49-87% of variance in whether or not they adopt. (Roger.E, 1995)

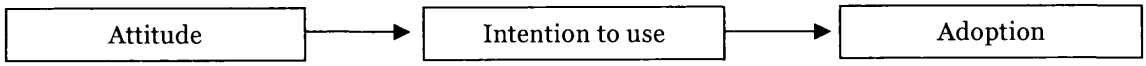
### 2.2 Determinants of Technology Adoption

Prior technology adoption and diffusion literature (see Rogers, 1983; Davis et al, 1989; Ajzen and Fishbein, 1980; Moore and Benbasat, 1991; Tan and Teo, 2000) argues that attitude of the innovation users are the key determinant of technology adoption. However, factors such as innovation characteristics (e.g. perceived usefulness and ease of use, compatibility, reliability, security), organizational and managerial characteristics (e.g., leadership characteristics, fear of loss of autonomy, fear of security breach), and facilitating conditions (e.g. availability of government support and availability of top management support) have been found as the key influential factors affecting users attitude towards adopting the proposed technological systems. Attitude can be a very powerful enabler or a barrier towards the adoption of the new technology (Ajzen, 1988) .To assess the influence of users attitude and reaction towards accepting and adopting new technologies, several authors (e.g., Rogers, 1983; Davis, 1986; Ajzen and Fishbein, 1975; Tan and Teo, 2000) have developed a core set of theoretical frameworks that can be used as a mediator to explain and predict the key factors (e.g., relative advantages of new technology, perceived compatibility and perceived complexity) influencing the technology adoption process. According to these studies, technology adoption is viewed as a consequence of a set of perceptions (attitude) to the technology.

### 2.3 Theory of Reason Action

The Theory of Reasoned Action (TRA) as shown in Figure 1 was developed by Fishbein and Ajzen in 1975. It has been developed, tested and used widely and it has been shown to be probably one of the most influential theories used to explain the relationship between human behaviour and intention to adopt a new innovation (Venkatesh et al, 2003). According to this theory, the behavioural intention can be explained by the attitude towards behaviour. The attitude towards behaviour is defined as an individual's positive or negative feelings about performing target behaviour" (Fishbein and Ajzen, 1975).

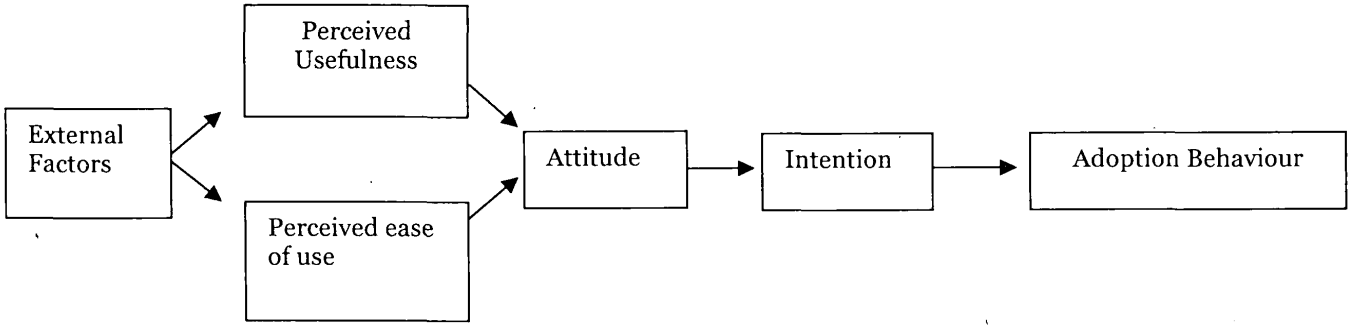
Figure 1: Theory of Reason Action (Ajzen, 1975)




### 2.4 Technology Acceptance Model

One of the most utilized models in studying information technology adoption and diffusion is the Technology Acceptance Model (TAM) (Davis et al, 1989). Developed by Davis in 1989, its goal is to provide a basis for tracking the impact of external factors on user's attitudes and intention to accept new technologies (Davis, 1989). The TAM is based on the Theory of Reasoned Action (TRA) (Fishbein, 1980), which is concerned with the behaviour of technology users towards a new technology.

Figure 2: Technology Acceptance Model (Davis et al, 1989)

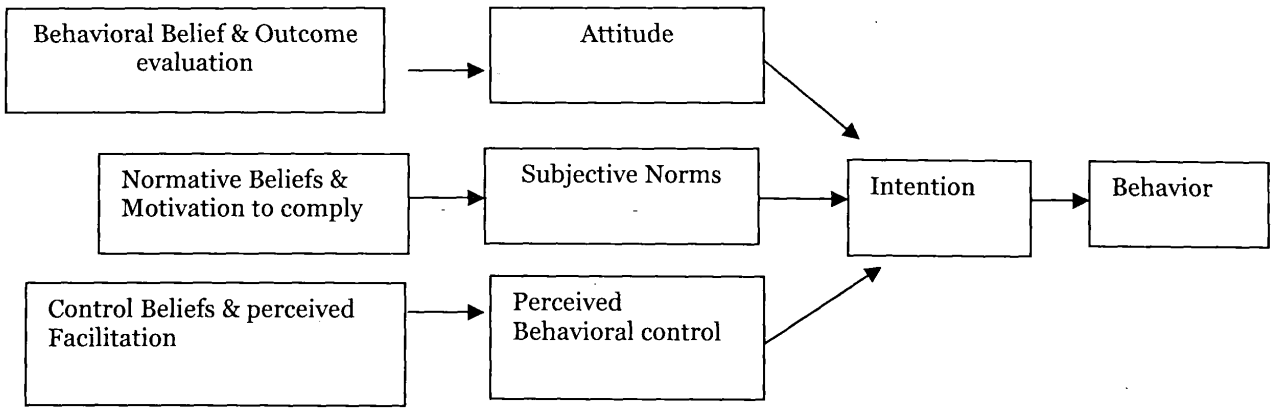



The TAM suggests that when users are presented with a new technology, there are two main factors that influence their attitude to use it, namely: perceived usefulness and perceived ease of use of the technology.

Perceived usefulness was defined by Davis (1989) as the degree to which individuals believe that using a particular system would enhance their performance whereas perceived ease of use refers to the degree to which individuals believe that using a particular system would require no effort. According to Davis et al (1989), perceived easiness of use and perceived usefulness have the capability to determine the actual use (usage behaviour) of the new technology.

### *2.5 Theory of Planned Behaviour (TPB)*

Figure 3: Theory of planed behaviour TPB (Mathieson, 1991)




The Theory of planned behaviour (Figure 3) was proposed by Ajzen (1985) as an extension to the TRA, which does not consider situations where people do not have complete control of their behaviour, and hence, is limited. The TPB refers to how easy or difficult people believe it would be to be able to perform certain behaviours (Ajzen, 1985). In the TPB, behaviour itself is a function of an innovation.

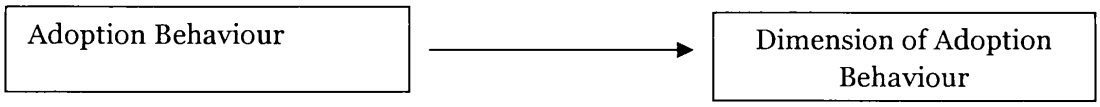
The TPB consists of three conceptual determinants of the adoption of new technology. The first is the attitude towards the behaviour, and refers to the degree to which a person has a favourable or unfavourable evaluation of the technology in question. The second predictor is a social factor, termed subjective norm; it refers to the perceived social pressure to use or not to use the technology (Fishbein and Aizen, 1975). The third antecedent of intention is the degree of perceived behavioural control, which refers to the facilitating conditions such as availability of government support and technology support to use the new technology (Aizen and Madden, 1996). The absence of facilitating resources represents barriers to usage and may inhibit the formation of intention and usage (Taylor and Todd, 1995). The TRA is based on the assumptions that individuals would use the new innovation if they had a feeling that there could be positive benefits associated with its use (Compeau and Higgins, 1995).

## 3. Study Design and Methods

### *3.1 Research Framework for Survey One*

Two field surveys have been conducted to achieve the objectives of the study. Survey one was conducted to evaluate the adoption behaviour through different dimensions which were illustrated in the theory of planned behaviour (Mathesion, 1991). Perceived user friendliness, perceived usefulness, external influence, interpersonal influence, self efficacy, self control and facilitating conditions are the dimensions which were evaluated in this research model one.

Figure 4: Research Model for Survey One




A survey was conducted in Galewela and Polonnaruwa (Table 1) since technology adopters were spread in those areas. Structured questionnaire was used to collect the data. Five point likert scale was used to gather necessary information in relevant to the different dimension of the adoption behavior.

Table 2: Dimensions Illustrated in the Theory of Planed Behaviour

| Dimensions of Adoption Behaviour | | | |
|---|---|---|---|
| | Dimension | Data Type | Data Collection tool |
| Attitude towards the use | Perceived user friendliness | Primary Data | 5 Point liket scale |
| | Perceived usefulness | Primary Data | 5 Point liket scale |
| Subjective Norm | Interpersonal Influence | Primary Data | 5 Point liket scale |
| | External Influence | Primary Data | 5 Point liket scale |
| | Self Control | Primary Data | 5 Point liket scale |
| Behavioral Control | Self Efficacy | Primary Data | 5 Point liket scale |
| | Facilitating Conditions | Primary Data | 5 Point liket scale |

Uni variant analysis and Bi variant analysis have used for analyse the above dimensions.

### *3.2 Research Frame work for the Survey Two*

Survey two was conducted to evaluate the impact of the different determinants of non adopter's intention to use the automation technology.

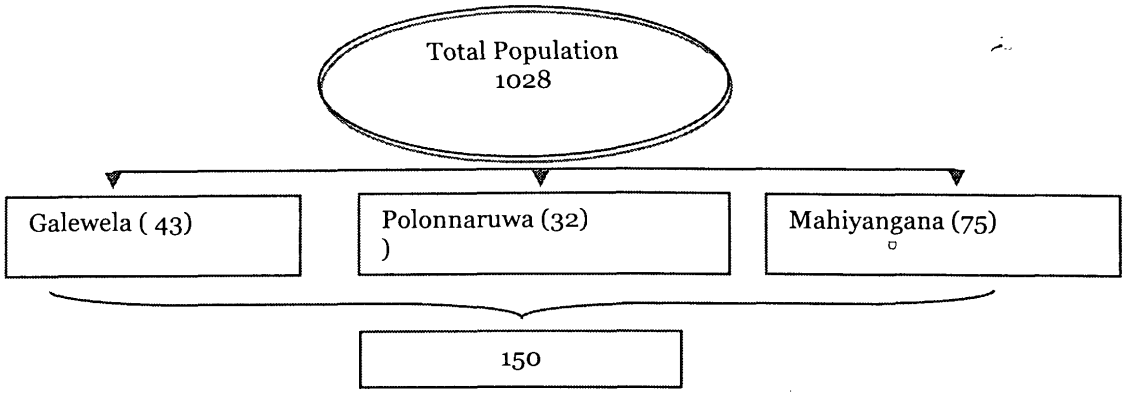
Figure 5: Research Model for Survey Two


Researcher Own Conceptualization

### *3.3 Sampling and Data Collection*

All the technology adopters have been used for the survey one since there are only 54 technology adopters existing. 150 non adopters' sample was selected for the survey two. Stratified random sampling technique was used to select the best representative sample. Research was carried out in yala region of tobacco cultivation of Sri lanka since production of other areas can be negligible comparatively to yala production. Galewela ,Polonnaruwa and Mahiyanganya areas have being operated under the Yala region. Each area is considered as the strata. Structured questionnaire was used to collect data. Figure 6 demonstrate how total non adopers sample was chosen.

Figure 6: Sampling Frame Work




### *3.4 Variable Description*

Logistic regression was used as the analytical tool to analyse the data. 14 variables have been considered as predictor variable in the regression model.

The implicit relationship of the variables were represented and specified as follows.

I = f (Awareness, Attendance, Experience, Education, Age, Income, plant, barn, load, Production, Exposure, Uncertainty, Cost)

Table 3: Variables evaluated in the model

| Variable | Variable Description |
|---|---|
| Awareness | Barn owners awareness about the automation technology |
| Attendance | No of training programmes attended by the barn owners regarding barn automation technology |
| Experience | Years of experience in the tobacco industry |
| Education | Education level of the barn owner |
| Age | Age of the barn owner |
| Income | Annual income of the barn owner from tobacco cultivation |
| No of plant cultivated | Number of plant cultivated in the Season |
| No of Barn | Number of barn owned |
| Barn Load | No of barn load cured in the season |
| Production | Amount of dry leaf production in the season |
| Practical Exposure | Whether barn owner seen the automation under operational condition |
| Uncertainty | Barn owners attitude towards the industrial uncertainty |
| Production cost | Barn owners attitude towards the production cost |

## 4. Results and Discussion

Table consists with the analytical figures evaluated through the responses of farmers who have used automated barns (survey 01). These figures have been used to analyse different dimension of adoption behaviour.

Table 4: Correlation between Variables

| | Mean | SD | Covariance | EI | II | SC | SE | FC | PU |
|---|---|---|---|---|---|---|---|---|---|
| **EI** | 3.5836 | 0.3811 | 0.1452 | | | | | | |
| **II** | 3.2628 | 0.7023 | 0.4933 | 0.0195 | | | | | |
| **SC** | 3.3333 | 0.3409 | 0.1162 | **-0.044 | 0.387 | | | | |
| **SE** | 4.5256 | 0.5281 | 0.2789 | 0.2087 | -0.0142 | 0.134 | | | |
| **FC** | 4.2179 | 0.5262 | 0.2769 | -0.002 | **0.375 | 0.2628 | **0.3108 | | |
| **PU** | 3.3713 | 0.4066 | 0.1653 | 0.0022 | **0.4875 | ***0.5113 | 0.1009 | 0.1844 | |
| **PUF** | 4.5705 | 0.4831 | 0.2334 | 0.203 | 0.0264 | 0.213 | **0.4226 | **0.3585 | 0.2089 |

* P value < 0.1

** P Value <0.05

*** P Value < 0.01

External influence toward the adoption, self efficacy of the technology, facilitating conditions to innovation, perceived user friendliness were gain 3.5836, 4.5256, 4.2179 and 4.5705 mean values respectively. It depicts that respondents almost agreed with these dimensions. Considering the interpersonal influence toward the adoption, self control of decision and perceived use fullness, 3.2628, 3.3333 and 3.3713 mean values have been recorded. It denotes that respondents are moderately satisfied with these dimensions. Standard deviations of these dimensions have dispersed from 0.3 to 0.7.

When concern about the inter relationship between these variables, few significant correlation can be identified. Self control of decision has shown negative correlation with the external influence to adopt to the technology. Both interpersonal influence and self efficacy of the technology were indicated positive relationship with the facilitating condition of the technology. Other than these, perceived user friendliness to technology have pointed positive relationship with the self efficacy of the product.

Table 5: Reduced Logistic Regression Model for the Intention to use for the Barn Automation Technology

| Variable | Marginal Effect | Coefficient | Std.Err | Z | P value |
|---|---|---|---|---|---|
| Constant | | 6.2808 | 1.9188 | 4.34 | 0.085 |
| Awareness *** | 0.7370 | 8.3306 | 1.5963 | 1.86 | 0.000 |
| Attendance* | 0.0778 | 2.9717 | 0.0441 | -0.41 | 0.063 |
| Experience * | -0.0004 | -0.0181 | 0.2547 | 1.75 | 0.068 |
| Education * | 0.0117 | 0.4468 | 0.7312 | -2.52 | 0.079 |
| Industrial uncertainty** | -0.0342 | -1.3073 | 0.6425 | -2.03 | 0.012 |
| product cost** | -0.0482 | -1.8425 | 3.6429 | 1.72 | 0.042 |

* P value < 0.1 Number of observation = 150

** P Value <0.05 LR chi2 (6) = 161.46

| | | |
|---|---|---|
| *** P Value < 0.01 | Prob > chi2 | = 0.0000 |
| | Pseudo R2 | = 0.8305 |

Six variables have indicated significant relationship with non adopter's intention to use the automation technology. Technology awareness, attendance to the farmer training programmes and barn owner's education level have shown positive relationship with the non adopter's intention to use the technology. Barn owners technology awareness was significant in the 99% confidence level while other two significant in the 90% confidence level.

Barn owners experience in the industry, attitude towards the industrial uncertainty and production cost have indicated negative relationship with the non adopters intention to use the technology. Attitude towards the industrial uncertainty and attitude towards the production cost were significant in the 95% confidence level. Barn owners experience have significant in the 90% confidence level. Considering the overall suitability of the model, probability value is recorded as 0.0000. It was highly significant in the 99% confidence level. Considering the overall readability of the model, pseudo R squared is recorded as 0.8305. It denotes that 83.05% variation of the non adopter's intention to use the automation technology can be described by the variable combination of the model. Finally this model is identified as the best fit model to explain the non adopter's intention to use the automation technology.

**Intention to Use** = 6.2808 + 8.3306 AWA + 2.9717 ATT + 0.0117 EDU - 0.0004 EXP -0.0342 IUN - 0.048 COST

**AWA** = Awareness about the barn automation technology
**ATT** = No of training programme have been attended by the barn owners
**EDU** = Educational level of the Barn owners
**EXP** = Bar owners experience in the tobacco cultivation
**IUN** = Barn owners attitude about the industrial uncertainty
**COST** = Barn owners attitude towards the production cost

## 5. Conclusions and Recommendations

This is the summary of entire research with major findings and recommendations which were drawn up through the analysis.

- Facilitating conditions for the barn automation technology have improved the interpersonal influence to adoption and self efficacy of the technology
- External influence has reduce the barn owners self control of decisions and perceived user friendliness improves the self efficacy of the technology
- Lack of awareness regarding the barn automation technology has highly affected for reduce the non adopters intention to use the automation technology.
- Lack of training regarding the barn automation technology have affect negatively to the non adopters intention to use
- Non adopters believe that automation technology is a additional cost for their production since they already reach to high production cost. This negative attitude have discouraged the non adopters intention to use the technology
- Industrial uncertainty also affect negatively to the intention to use the automation technology since majority haven't confidence about the future stability of the industry

- Barn owners who have long term experience in the industry are reluctant to adopt for automation technology since they used to the manual barns
- Non adopters intention to use the technology is enhanced with the education level of barn owners

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