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Factors Associated with Adoption of Stimulation Technology by Rubber Smallholders in Malaysia

Muhammad Fadzli bin Ali[1], Ramli bin Osman[2] and Norizatulshima Binti Ibrahim[3]
Extension and Development Department, Malaysia Rubber Board,
50450, Kuala Lumpur, Malaysia.

Corresponding email fadzli@lgm.gov.my

Article Information

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Abstract

Stimulation technology including MORTEX was developed by Malaysia Rubber Board to help smallholders increase their productivity and income. It was proven MORTEX could prolong and increase latex production however, only 1.5% of smallholders in Malaysia adopted the technology (BPP database, 2012). Theory of Planned Behaviour stated there are several processes took place before a technology was adopted including attitude, perceptive norm, perceptive control and beliefs toward the technology. Thus, this project aim to determine factors associated with adoption of stimulation technology by smallholders through these variables. Face to face interview with constructed questionnaire was executed for a total of 410 respondents. Three categories of respondents emerged where 31.22% respondents that continue using stimulant (A), 38.1% is respondents that never use stimulant (C) and 30.73% respondents that stopped using stimulant (B). Attitude, Perceived Norm, Perceived Control and beliefs were all found correlated in 'Stop Using Stimulant' and 'Never Use Stimulant' respondents while only Attitude and Perceived Control were found correlated in 'Continuous Usage of Stimulant' respondents. Some recommended actions to tackle on adoption of stimulation technology are including monitor foreigner and local workers on application of stimulant and take action, give incentive on fertilizer to smallholders that understand stimulant benefits and aggressive education on stimulation technology and frequent visit to smallholders as well as to implementer agency and agricultural stores merchant.

INTRODUCTION

The use of yield stimulants to increase rubber production has been an important technological development in the Malaysian rubber industry. The earliest attempt at yield stimulation was by periodic scraping of the bark below the tapping groove (Yee, 1983). During the late 1960s, scientists discovered the significance of ethylene which acts as an agent for the continuous flow of latex from vessels. In other words, ethylene was the most important factor in delaying the coagulation or 'plugging' of the latex vessels (Abraham et al., 1968).

In Malaysia, more than 90% of rubber productions were depending on smallholders sector thus, makes this sector the major contributor to Malaysian economy. To address decreasing area of rubber plantation each year, Malaysia Rubber Board had developed and recommended stimulation technology which is Mortex. To optimize

benefits of Mortex, MRB provided strict recommendation to be followed. First of all, the rubber tree itself must be fertile and free from diseases. In addition, sufficient fertilizing is critical for the stimulated trees to avoid panel dryness occurrence. The tapping system must not exceed d/3 (tap once every three days). In term of rubber clones, basically slow starter clones give a good reaction on stimulation. Mortex is wiped along the tapping panel that covered <1.0cm recovery bark on the tapping panel with a painting brush (type 14), once a month. Usage of Mortex is prohibited during wintering season (leaf shed) and must not be mix with other chemicals. Only 0.5 gram to 1.0 gram is used on a tree for each round. Extra usage would not give extra yield. Generally, Mortex can be used up to eight times a year (MRB Mortex Brochure, 2014).

Several factors that influence decision of rubber smallholders to adopt certain technology were including technology attributes, cost, labour and appropriateness of the technology as well as smallholders' attitude, market price of the product and status of tenure (Rahim & Maznah, 1994). However, specific factors on non-adoption of stimulation technology are not published widely. According to Zulkefly (2010), application of stimulant technology in the field is proven to increase the production of latex amongst smallholders' holdings. Based on Malaysian Rubber Board survey report as in 2012, only 1.5% from total rubber smallholders adopted Mortex. This figure was quite intriguing as the application of stimulant in the field has shown better productivity compared to the traditional practices.

Theory of Planned Behavior (TPB) stated that individual's behavior is best predicted by one's intentions; intentions are, in turn, predicted by attitudes about the behavior, the subjective norms (a person's perception of important others' beliefs that he or she should or should not perform the behavior) encasing the execution of the behavior, and the individual's perception of their control over the behaviour (Fishbein & Ajzen, 1975). According to the theory, human behavior is guided by three kinds of considerations: beliefs about the likely consequences of the behavior (behavioral beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may facilitate or impede performance of the behavior (control beliefs). In their respective aggregates, behavioral beliefs produce a favorable or unfavorable attitude toward the behavior; normative beliefs result in perceived social pressure or subjective norm; and control beliefs give rise to perceived behavioral control. In combination, attitude toward the behavior, subjective norm, and perception of behavioral control lead to formation of a behavioral intention (Ajzen, 1991).

The significance of this study is to determine factors associated with adoption as well as non-adoption of rubber stimulation technology in Malaysia through Theory of Planned Behaviour parameters including attitude, subjective norm and perceived behaviour control. Through the finding, recommendations on how to tackle low adoption of rubber stimulation technology could be implemented. Gradually, latex production will increase as well as rubber smallholders' income and ensure the sustainability of Malaysia rubber industry.

FIGURE 1
MORTEX 2.5%

MATERIALS AND METHODOLOGY

Population and Sampling

Information on smallholders adopted stimulation technology was obtained from previous survey done by MRB Extension and Development Department on 2012.The study focuses on four regions of Peninsular Malaysia thus

through the survey, highest percentage of stimulant adoption by state for each region was selected as respondents. The states are Johor, Negeri Sembilan, Pahang and Kedah.

Three categories of respondent are selected, which are continuous usage of stimulant, stopped using stimulant and never use stimulant. Through previous survey, the respondent for first category was obtained and for the third category, the respondents' amount was calculated to be same amount with first category. The second category emerged after survey was done as they were originally at first category.

The details are as stated in Table 1.

TABLE 1
POPULATION OF PARTICIPANTS ACCORDING TO STATE

State	Continue Using	Stopped Using	Never Use	**Grand Total**
Johor	26	34	29	89
Kedah	30	33	43	106
Negeri Sembilan	41	21	48	110
Pahang	31	38	36	105
Grand Total	**128**	**126**	**156**	**410**

Methodology and Instrument of Study

The survey was conducted by "face-to-face" interview method and announcement through invitation letter was sent to respondents a week before survey is conducted. All respondents were gathered in village's hall or in mosque for the implementation of the survey. In order to ensure all respondents were surveyed, "house to house" survey was also implemented for those respondents that could not make it to the venue selected.

The survey was implemented through a specifically constructed questionnaire. It consists of 4 sections, which are respondent demographic, farm's information, stimulation technology usage and respondent's opinion. There are open as well as close-ended questions within these four sections. The questionnaire is attached together in this paper. Details on questions are as shown in Table 2.

TABLE 2
ITEMS IN QUESTIONAIRE

Section	Details	Items
A	Respondent demographic	12
B	Holding's information	9
C	Stimulation technology usage	14
D	Respondent's opinion	
	a) Attitude on Stimulant	12
	b) Norm Perception	6
	c) Control Perception	5
	d) Belief	11
	Factor and action	2
		71

Data Analysis

The data collected through survey forms was transferred into SPSS software. After all of the data had been arranged, they were analysed through several functions on SPSS software including descriptive analysis, principle component analysis and cross-tab. Through these functions, statistics such as mean, mode, frequency and correlation between variables were determined. PCA provides to us information on the most significant parameters by removing the less significant parameters with minimum loss of the original information due to spatial and temporal variations which describes the whole data set (Singh et al., 2004) The principle component (PC) is expressed as below:

$$zij = ai1x1j+ai2x2j+...+aimxmj$$

where z is the component score, a is the component loading, x is the measured value of the variable, i is the component number, j is the sample number and m is the total number of variables. It is a powerful technique applied to determine similarities between variables or samples by interpreting a large or complicated data matrix (Reghunath et al., 2002) Since the PCs generated by PCA are usually not readily interpreted, it is preferable to rotate the PCs by Varimax rotation. Through Varimax rotations applied, PCs with eigenvalues more than 1 are considered significant (Kim & Mueller, 1987). New groups of variables achieved through the rotation are described as varimax factors (VFs). Total number of VFs obtained by Varimax rotations is equal to the number of variables which have similar features including also those unobservable, hypothetical, and latent variable (Vega et al., 1998). The VF coefficients that have correlation greater than 0.50 are considered as "strong" while correlation between 0.50–0.30 are considered as "weak" significant factor loadings (Liu et al., 2003). Identification of variables for adoption of stimulant was made from survey derived through experts' discussion and also from previous literatures on factors associated with adoption of technology. The basic concept of PCA is expressed as below:

$$zij = af1\ f1i + af2\ f21 + ... + afm\ fmi + efi$$

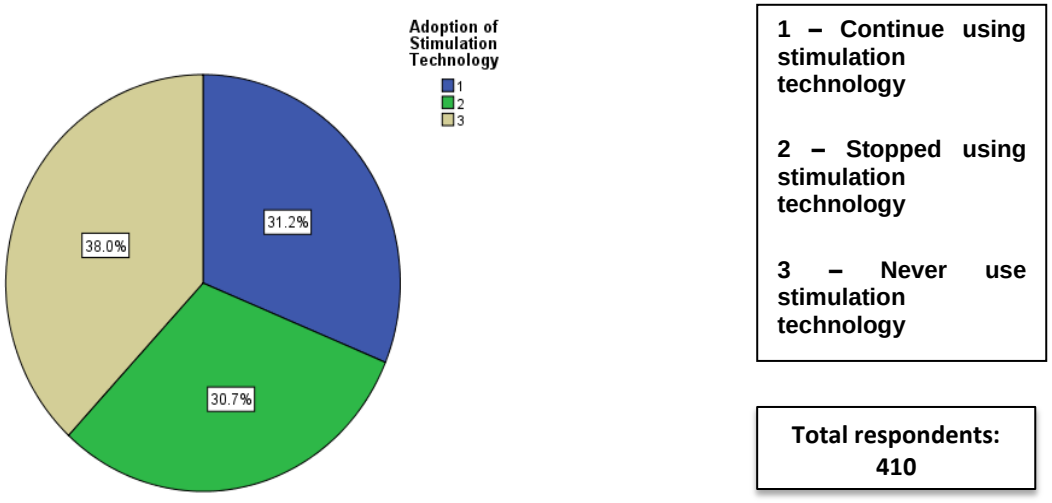
where z is the measured value of a variable, a is the factor loading, f is the factor score, e is the residual value accounting for errors or other sources of variation, i is the sample number, j is the variable number, and m is the total number of factors (Kannel et al., 2007). In this study, PCA/FA was applied to the normalized data sets separately for the four different cases (Attitude, Norm, Control and Believes).

RESULTS AND DISCUSSION

Respondent's Demographic

Through descriptive analysis, majority of respondents are male 77.8% (319) and the rest is female. For status of land ownership, most of respondents are owner and operator 71% (291), while the rest are owner non operator 14.6% (60), operator non owner 12.4% (51) and shared owners 2% (8). Three respondents were categorized as continue using stimulation technology (A), Stopped using stimulation technology (B) and never use stimulation technology (C). Based on chart 1, 38.1% is respondents (C), 31.22% respondents (A) and 30.73% respondents (B).

CHART 1
USAGE OF STIMULANT PERCENTAGES



Knowledge on Stimulation Technology

Statements on methodology to apply stimulation technology on field were asked to respondents to determine their level of knowledge. Their responses to the statements were interpreted by interviewer whether right or wrong. Through descriptive analysis, an obvious result was obtained where respondents (A) has a very good knowledge while respondents (B) and (C) have very weak knowledge. Information references for rubber technologies was found significant as respondents (A) and (B) prefer met with extension agent whereby

respondents (C) prefer friends and stores merchant. Respondents (C) might obtained false or incorrect information on stimulation technology and led to having bad perception on the product and decided not to use it.

Respondents' Perception

Respondents' perception is determined through four parameters, which are Attitude, Perceptive Norm, Perceptive Control and Beliefs. Each of these parameters contained several statements (variables) and asked to respondents. Their responses toward variables were recorded and analysed through PCA to determine correlation between them.

Through PCA, only significant statements ($r > 0.5$) will be identified and determined whether correlated with other variables such as perceptive norm, perceptive control and belief or not. The analysis was done according to each category of respondents. Thus, significant variables obtained were different for each category. Variables that showed loadings value within each category determined correlation among them. The detail is shown at table 3.

TABLE 3
LOADINGS OF STATEMENTS' VARIABLES ON THE VARIMAX ROTATED PCS FOR ADOPTION OF STIMULATION TECHNOLOGY FROM ATTITUDE, PERCEPTIVE NORM, PERCEPTIVE CONTROL AND BELIEFS

Parameter	Questionnaire Statements (Variables)	Loadings of Varimax Rotated PCs		
		Respondent A	Respondent B	Respondent C
Attitude	A5 – Usage of stimulant increase yield			-0.617
	A6 – Usage of stimulation technology is safe		-0.584	-0.638
	A7 – Willing to purchase agricultural input when out of stock	0.783	-0.505	
	A8 – Willing to get agricultural input even if far from house	0.714		
	A10 - Willing to get agricultural input even if rubber price is low	0.615	-0.602	-0.515
	A11 – Stimulation technology is not burdening	0.546		-0.664
	A12 – Fond meeting with extension agent for references			-0.551
Perceptive Norm	B3 – Other smallholders feel that usage of stimulation technology is safe		-0.545	-0.578
	B6 – Other smallholders use stimulation technology due to family influence		0.607	
Perceptive Control	C2 – Afford to purchase agricultural inputs	0.804	-0.585	-0.758
	C3 – No problem on obtaining agricultural inputs	0.848		-0.756
Beliefs	D3 – Will adopt if easier to obtain stimulant		0.511	
	D5 – Will adopt if after see many smallholders adopt stimulant first		0.541	
	D7 – Will adopt if rubber price high			0.761
	D8 – Will adopt if product's price is reduced			0.809
	D10 – Will adopt if managed by other people			0.53

Referring to table above, there are two types of correlation values (positive and negative), means that the variables were responded either positively or negatively by respondents and the correlation between them.

As factor analysis correlate several variables together, we can observe respondents (A) had a strong correlation between Attitude and Perceptive Control variables. These correlated variables can explain each other. Two clear themes were observed from respondents (A), which are financial and accessibility. For financial, statement A7, A10 and C3 shown that respondents are willing to purchase agricultural input when out of stock or rubber price is low and can be explain by perceptive control that they afford to purchase agricultural inputs. For accessibility, statement A8 and C3 can be related because they willing to get agricultural input even if far from house and they agreed they have no problem on obtaining agricultural inputs.

Through table 3, all four parameters (Attitude, Perceptive Norm, Perceptive Control and Beliefs) are found correlated for respondents (B) that resulted for their current situation (stopped using stimulant). Through their attitude, they percept stimulant is not safe, not willing to purchase agricultural inputs when out of stocks or rubber price low, these correlated with their perception other smallholders said that usage of stimulation technology is not safe and use stimulant due to family influence.

Moreover, those variables also correlated with respondents' perceptive control, where they percept they do not afford to purchase agricultural inputs and are willing to adopt stimulant if it is easier to be obtained and after see many smallholders adopt it first. On the whole, we can described respondents (B) had bad perception on safety of using stimulant (A6 & B3), lack of financial and access (A7, A10, C2 & D3) and influenced by perception from or on others (B6 & D5).

All four parameters (Attitude, Perceptive Norm, Perceptive Control and Beliefs) from table above, are determined correlated for respondents (C) that resulted for their current situation (never use stimulant). Through their attitude, they percept usage of stimulant will not increasing yield, not safe to be used, burdening to use, not willing to get agricultural input even if rubber price is low and they are not fond meeting with extension agent for references, these correlated with their perception other smallholders said that usage of stimulation technology is not safe.

Moreover, those variables also correlated with respondents' perceptive control, where they percept they could not afford to purchase and have problem on obtaining agricultural inputs and only willing to adopt stimulant if rubber price increases or high, agricultural inputs' price decrease and if their holdings are managed by other people. On the whole, we can described respondents (C) had Bad Perception on Stimulant (A5, A6, A11 & B3) and they do not fond meeting with extension agent, facing financial and accessibility issues (A10, C2, C3, D7 & D8), as well as total dependency on others regarding adoption of stimulant (A12 & D10).

CONCLUSION

Through this study, correlation between variables was determined and found out to be different for each category of respondents. Attitude, Perceived Norm, Perceived Control and beliefs were all found correlated in 'Stop Using Stimulant' and 'Never Use Stimulant' respondents. Only Attitude and Perceived Control were found correlated in 'Continuous Usage of Stimulant' respondents. From findings above as well as face-face interview with respondents, concluded that smallholders adopted stimulation technology based on three reasons. Firstly, their attitude where they are willing to purchase agricultural inputs such as fertilizer and stimulant by their own and are willing to get agricultural input even if rubber price is low.

Next, their financial and accessibility advantage where they afford to purchase agricultural inputs and have no problem to obtain agricultural inputs. Lastly is their knowledge on stimulation technology. They truly understand the benefits of using stimulant to their trees. They have the knowledge and know how to apply stimulant properly. They also aware that in order to use stimulant, fertilizer is needed to avoid dryness. Thus, they do not experienced dryness that damaging their trees. Moreover, they handle their farm on their own and applied agricultural inputs themselves. They can control the amount or frequency of stimulant used on the trees and avoid overused of it that resulting in dryness and damaging trees.

For smallholders that stopped adopting stimulation technology, concluded that they had bad perception and attitude, where they percept that usage of stimulation technology is not safe and will cause dryness. They also influenced by others that experiencing dryness due to incorrect application of Stimulant. They do not follow the guideline, where they overused the application of stimulant or tapping and do not applied fertilizer. Hiring foreign workers also led to those results because they tend to abuse the trees by overusing stimulant and tapping. In addition, they are only hoping for subsidy if they want to adopt the stimulation technology. In addition, they have financial issue to purchase agricultural inputs especially fertilizer, which is essential if stimulant is to be used. Moreover, they lack of knowledge and do not understand correct method to applied stimulant at farm as

well on application of stimulant regarding the frequency, amount and fertilizer is needed. For smallholders that never use stimulation technology, concluded that they have similar reasons with smallholders that stopped adopting stimulation technology. However, they are dependent on others regarding their decision to adopt stimulation technology and rely information on peers rather than extension agent.

Some recommended actions to tackle on adoption of stimulation technology are including monitor foreigner/local workers on application of stimulant and take action, give incentive on fertilizer to smallholders that understand stimulant benefits and aggressive education on stimulation technology (theory/practical/more frequent visit) to smallholders as well as implementer agency and agricultural stores merchant. In addition, incentive for smallholders who achieved 2000kg/ha/year productivity to attract them to change their attitude and purchase inputs by themselves rather than subsidy and involve successful smallholders on educational campaign to other smallholders for better penetration and trust should also implemented to raise rate of stimulant' adoption.

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