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Behavioural factors affecting the adoption of manuring of smallholder mature rubber cultivations in Moneragala district

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Abstract

This study was carried out to identify the effective factors that influence the adoption of Manuring of Mature Rubber Cultivation (MMRC) in Moneragala District. The data were collected through a self-administrated survey from 397 smallholders owing mature rubber cultivations in 2020, using stratified random sampling. The conceptual model was developed based on the decomposed theory of planned behavior. The variables were measured with the use of validated items. The responses of rubber smallholders for items were captured on a Five-point Likert scale. Two-stage model-building process was applied in this study. The conceptualized model was empirically tested using partial least square structural equation modeling by bootstrapping procedure using the SMART- PLS 3.2 software. The composite six-predictor structural model was validly and reliably capable of explaining 78% the variability of the adoption of MMRC by rubber smallholders. Adoption of MMRC by rubber smallholders was positively and significantly correlated with the behavioural factors; behavioural intention, perceived behavioural control, whilst perceived behavioural control under adoption was the most significant influential factor. There were positive significant relationships between compatibility and attitude, perceived usefulness and attitude, perceived ease of use and attitude, out of which, compatibility had the most significant effect on attitude, whilst, the relationship between relative advantage and attitude was not significant. These findings can help boost the behavioral intention of rubber smallholders in Moneragala District to adopt on MMRC, especially by improving the aspects of facilitating conditions and subjective norms with the improvement of appropriate development and extension plan.

***Key words**:* Adoption, manuring of mature rubber cultivation, structural equation model

Introduction

Moneragala (6.7563° N and 81.2519° E) has wet, intermediate and dry climatic conditions and many agro-ecological regions, out of which IL1c, IL2 and IM2b are used for rubber (*Hevea brasiliensis*) cultivation which are distributed among eight Divisional Secretariat (DS) divisions (Wijesuriya *et al*., 2011). At present, the total extent of rubber smallholdings in Moneragala is about 5,087 ha (9,415 number of

holdings) and Moneragala is the fifth rubber growing district according to the land extent under rubber cultivation in Sri Lanka (MPI, 2019).

The Rubber Research Institute of Sri Lanka (RRISL) is the apex body in the country, which undertakes research studies in all aspects of Rubber Farming (RF) and delivers extension service to the smallholder rubber sector. Many recommended farming practices were introduced to Moneragala area by RRISL, out of which, the Manuring of Mature Rubber Cultivation (MMRC) was introduced with the aim of increasing the rubber productivity in a sustainable manner (RRISL, 2003). The recommended fertilizer dosage was 750 g per plant and should be applied in 2 to 4 points, in the area cleared of weeds around the tree within a radius of 100 - 120 cm. The fertilizer should be forked into the top 10-20 cm of soil. From an economic as well as agronomic point of view, fertilizers for mature rubber should be applied within one month after refoliation (depending on weather conditions at the time).

Many knowledge dissemination approaches have been launched by both the public and private sector extension services to enhance the adoption level of MMRC (Gunarathne *et al*., 2020) in Moneragala. The information for Moneragala on the level of adoption of practices in MMRC developed by RRISL is very scarce and not at a satisfactory level (Wijesuriya *et al*., 2011). As mentioned in the research problem, reasonable answers are expected for the research question, in order to recognize the factors, and thus influence the adoption of MMRC in the Rubber Smallholder (RS) level. Wijesuriya *et al.*, (2008, 2010, 2011) have studied RS's expectations, potentials and constraints for RF in Moneragala. However, those previous studies do not specifically focus on MMRC in Moneragala. Therefore, this study examined the factors that influence adoption of MMRC by RSs in Moneragala area. The findings can be used in the designing of more effective policy instruments to get rid of adoption barriers of MMRC in Moneragala, and it can have a greater impact on the rubber sector, and finally on the economic development of the country.

Methodology

Sampling technique

The eight DS divisions that rubber is grown in Moneragala district was selected for this study. RSs who own mature rubber lands were selected employing stratified random sampling technique. Stratification was done on the basis of geographical distribution of RSs in all rubber growing DS divisions (8) in Moneragala district.

The minimum size of the sample was 397, which of the population with 90% confidence interval using Raosoft web-based sampling calculator. Twenty-three percent of the Grama Niladari (GN) divisions, where the highest number of RSs could be found within each DS division, were selected using the statistical sources. Subsequently, the selection of individual RSs was done and the survey sample (RSs of each GN division) was randomly selected based

on the number of RSs in each GN division.

Conceptualization of the study variables and their relationships

In an effort to understand intentions of RSs to adopt to MMRC, the Decomposed Theory of Planned Behaviour (DTPB) was applied as a theoretical framework (Taylor and Todd, 1995). The DTPB focuses on the direct measures of Attitude (ATD), Subjective Norms (SN), and Perceived Behavioural Control (PBC) to predict Behavioural Intention (BI) which in turn predicts one's behaviour (Ajzen and Hartshorne, 2008). The DTPB provides increased explanatory power, with a more precise understanding of the behaviour and examination of the relationships among factors that influence the adoption and use of new technologies. The DTPB was applied by many scholars to find out the relationship between belief structures and intentions to adopt in innovations. According to the theoretical framework and literature cited, adoption on MMRC of the RSs can be conceptualized as presented in Figure 1.

Data collection

Both primary and secondary data were collected for this study in 2020. The cross-sectional pre-tested questionnaire survey was carried out to gather the information from RSs based on the objectives of the study. The questionnaire for RSs has consisted of items which measure behavioural factors. A structured direct interview schedule was used in gathering data from RSs, by the researcher himself.

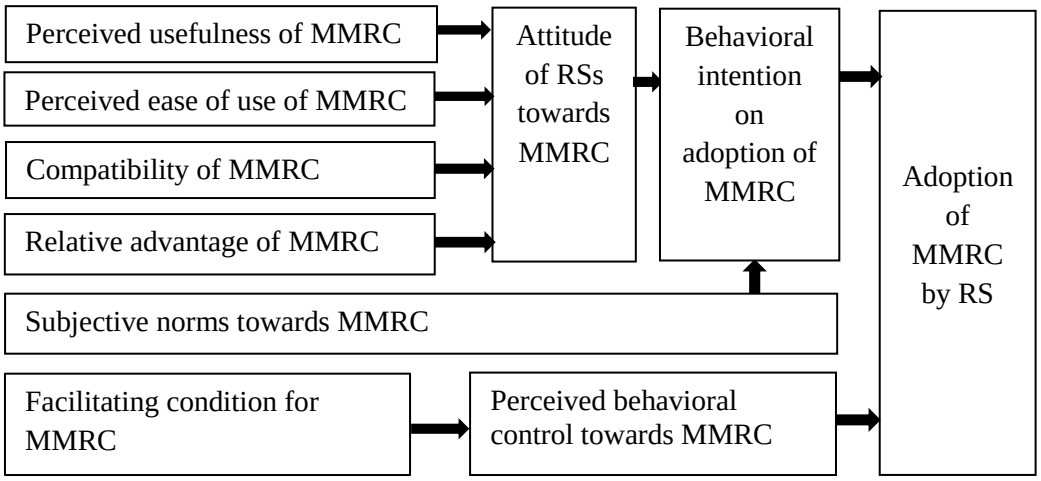

Fig. 1. The conceptual model of the study

Development of hypotheses

Relative advantage (RA)

RA refers to the degree to which an innovation provides benefits which replace those of its precursor and may incorporate factors such as economic benefits, image, enhancement, convenience and satisfaction. RA is an important factor in determining attitude of innovations (Rogers, 1983). In this study, relative advantage refers to financial advantages of MMRC. Therefore, the hypothesis was proposed as an alternate hypothesis, as "perceived RA towards the adoption of MMRC positively affects ATD of RSs" (H_{RA}).

Compatibility (CO)

According to Rogers (1983), CO is the degree to which an innovation is perceived being consistent with the existing values, past experiences and need of potential adopters. An innovation is more likely to be adopted when it is compatible with the value system of an individual. In this study, CO refers to the extent to which RSs believe that application of MMRC would be compatible with their rubber farming practices. Therefore, the hypothesis was proposed as the alternate hypothesis, as "perceived CO towards the adoption of MMRC positively affects ATD of RSs" (H_{CO}).

Perceived usefulness (PU)

Perceived Usefulness (PU) is defined as a person's subjective evaluation of the extent of using a system which would enhance the productivity. It is likely that, the attitude towards using the technology would become positive, with a higher PU (Ajjan and Hartshorne, 2008). PU has been proven to be antecedent to attitude (Taylor and Todd, 1995) hence, PU is positively related to attitude towards using MMRC. In the context of MMRC, PU would be the degree to which an individual views that MMRC would result in more productivity than previous MMRC. Therefore, the hypothesis was proposed as the alternate hypothesis, as "PU towards the adoption of MMRC positively affects ATD of RSs" (H_{PU}).

Perceived ease of use (PEU)

Perceived Ease of Use (PEU) is defined as the expectation by an individual of the degree to which the target system will be free from effort. Studies have proven that PEU has a direct relationship towards attitude (Taylor and Todd, 1995) hence, PEU is positively related to attitude towards using MMRC. In this study, perceived ease of use refers to the level of the easiness of using MMRC introduced by the RRISL. Thus, the hypothesis was proposed as an alternate hypothesis, as "PEU towards the adoption of MMRC positively affects ATD of RSs" (H_{PEU}).

Attitude (ATD)

ATD is a positive and negative feeling of an individual towards the particular object or towards the intention of performing the particular behaviour (Ajzen and Hartshorne, 2008). According to Rogers (1983) ATD refers to general feeling of an individual on favourableness or unfavourableness towards using an innovation. ATD is linked to behavioural intention as an

individual forms psychological intentions to perform behaviours toward which they have a positive feeling. Studies have proven significant direct relationship of ATD towards behavioural intention (Taylor and Todd, 1995) thus, the ATD towards using MMRC will be positively related to the intention to use it. In this study, ATD refers to the feeling of RSs about using MMRC in their rubber cultivation. Accordingly, the hypotheses was proposed as the alternate hypothesis, as "attitude toward the adoption of MMRC positively affects their behavioural intention of RSs" (H_{ATD}).

Perceived Behavioural Control (PBC)

According to (Ajzen and Hartshorne, 2008), Perceived Behavioural Control (PBC) is defined as the level of confidence of an individual about their ability to perform the behaviour based on the difficulty or ease they perceive on its performance as it relates to difficulties or facilitators. It reflects beliefs regarding access to the resources and opportunities needed to affect a behaviour (Ajzen and Hartshorne, 2008). PBC refers to the factors that may encourage the performance of the behaviour. Knowledge is one of the important components of behaviour and it plays a vital role in the adoption in improved technologies. Knowledge becomes power to a person, hence, farmers' technical knowledge determines their ability to reach and find solutions. Adoption levels of fertilizer recommendations, pest and disease management and pruning by tea smallholders show positive relationship with the knowledge level. Study of Perera (2003) on the adoption behaviour of sugarcane growers, revealed that agricultural knowledge and adoption were positively and significantly related. The type of skill has a relationship with the adoption of cultural practices. In this study, PBC refers to adequate level of knowledge and skill of MMRC. Therefore, the hypothesis proposed as the alternate hypothesis, was "PBC of RSs positively affects on adoption of MMRC" (H_{PBC}).

Facilitating conditions (FC)

Facilitating Conditions (FC) is defined, as the environmental factors that influence an individual's desire to perform a task. FC reflects the availability of resources/inputs which are needed to engage in a behaviour. Such resources may include time, money, and other specialized resources needed to perform a particular behaviour. Taylor and Todd (1995) showed that fewer obstacles can produce a feeling of greater control and in turn, positively affect intentions to use technology. Farmers did not adopt certain management practices due to resource limitations. Contact of extension officers with farmers showed a significant relationship with adoption on farming practices. One of the reasons for non-adoption of farm innovations was that the technology which is generated by researchers and disseminated to farmers by extension workers was not accompanied by adequate and timely supply of farm inputs (Gill and Sarda, 1999). In this study, availability of inputs and

advisory contacts done by extension officers and availability of training programmes refers to FC for the behavioural intention of MMRC. Therefore, the following hypothesis was proposed as the alternate hypothesis: FC towards the use of MMRC positively affects PBC of RSs (H_{FC}).

Subjective Norm (SN)

According to (Ajzen and Hartshorne, 2008), SN is defined as "the person's perception that most people who are important to him think he should, or should not, perform the behaviour in question". The determinant of SN is the sum of normative beliefs which reflects the perceived behavioural views or expectations of important referent individuals or groups. SN denotes that the behaviour is initiated by an individual's wish to act according to the thought or action of the important referent others. Referent people, such as family members and friends, represent the expectations of other people to perform a particular behaviour, thus they can potentially influence the behaviour (Pantano and Di Pietro, 2012). SN has been observed to be more important in the early stages of implementation, when users have limited direct experience from which to develop the ATD toward the innovation (Taylor and Todd, 1995;). SN refers to the individual's perceptions of broad social pressure to (or not to) perform the expected behaviour. The social pressure exerted by the significant "referent" others whose beliefs may be important to the individual whom the individual perceives to, (or perceives not to), support the behaviour, conceives more (or less) the likelihood for the individual to perform it (Borotis and Poulymenakou, 2009). The adopter's family members, friends, and colleagues are groups that will potentially influence adoption. In this study, subjective norms towards adoption of MMRC refers to the influence of Extension Officers, RSs and mass media. Therefore, the following hypothesis was proposed as the alternate hypothesis; The SNs toward the adoption of MMRC positively affect their behavioral intentions of RSs (H_{SN}).

Behavioural Intention (BI)

Ajzen and Hartshorne, 2008 defined BI as a person's subjective probability in performing certain behaviour. Intention to use is defined as "indications of how hard people are willing to try, and of how much of an effort they are planning to exert, in order to perform the behaviour". A number of studies have reported a significant and strong relationship of BI being the most important factor in predicting a decision to take a specific action (Ajzen and Hartshorne, 2008). Given this close relationship between intention and behaviour, the past studies have used BI to predict specific behaviour (Ajjan and Hartshorne, 2008). Thus, it is expected that there would be a positive relationship between intention and the actual behaviour of RSs. Therefore, it is hypothesized that the behavioural intention of RSs to use MMRC positively affects their behaviour leading to adoption. In this study, BI refers to the intention to apply the

MMRC in the next season, on a regular basis and to strongly recommend it to others, too. Therefore, the following hypothesis was proposed as the alternate hypothesis; the behavioural intention of RSs positively effects on adoption of MMRC (H_{BI}).

Adoption (ADN)

Rogers and Shoemaker (1971) defined adoption as a decision to make full use of a new idea as the best course of action available. Accordingly, the process of adoption or innovation decision is a psychological process in which an individual move from awareness, interest, evaluation and to trial and finally either to adopt or to reject the practice. In this context, adoption refers to utilization and application of MMRC recommended by RRISL.

Instrument development and measurements

Ajzen and Hartshorne, 2008 was reviewed to generate an initial list of items. Pre-test interviews were conducted with RSs to assess the instrument's clarity and question wordings of proposed items. PU, PEU, CO, RA, SN, PBC and ATD were measured two items while, BI, FC and ADN were measured with three items (Table 1). The responses of RSs to these measurement items were captured on a 5-point Likert scale which ranged from 'strongly disagree' for which a 1 was given to 'strongly agree' for which a 5 was given, indicating the degree to which they agreed with the set of statements. Two-stage model-building process was applied for testing both measurement and structural models (Hair *et al*., 2013). The SMART- PLS 3.2 software was used to confirm and modify the basic hypotheses in the study.

Test of measurement model

The suitable fit for the measurement model was assessed by Communality Test (CT) (Hulland and Business, 1999). The Cronbach's alpha (α), Composite Reliability (CR) and Factor Outer Loadings (FOL) were assessed to measure the reliability, validity and internal consistency of items respectively, for covering the Convergence Validity (CV) (Hulland, 1999). The Average Variance Extracted (AVE) was assessed to measure Discriminant Validity (DV) of items. The Heterotrait–Monotrait ratio of correlations was used to assess DV of questionnaire suggested by Henseler *et al*., (2015). The measurement model was estimated using Confirmatory Factor Analysis (CFA) to test reliability and validity of the measurement model.

Assessment of the structural model

After assessing the reliability and validity criteria for all reflective measurement of the research model and ensuring the integrity of the research data, SMART-PLS Algorithm was applied after determining 300 maximum iterations with stop criterion of 7 using path scheme to maximize the R^2 value for the model on endogenous latent variables (Henseler *et al*., 2015). For predictive purposes, Partial Least Square Approach for the Structural

Equation Modelling (PLS-SEM) was applied. The coefficient of determination (R^2), effect size (f^2), Stone-Geisser (Predictive relevance) index (Q^2) and the path coefficients (β) were assessed using the blindfolding procedure which necessitates the predictive capacity measurements as suggested by Hair *et al*., 2017 and Henseler *et al*., 2015. The cross-validated redundancy method was used to measure the Q^2 by using a blindfolding procedure as recommended by Sarstedt *et al*., 2014. The Variance Inflation Factor (VIF) was applied to assess the Multi-collinearity and inter-correlations among the independent constructs within the structural model (inner model) (Hair, 2016). Both the model goodness-of-fit indices; (SRMR) and Normed Fit Index (NFI) (Hair *et al*., 2016) of the structural model were assessed to examine the model fit.

Hypothesis testing

The conceptualized model was empirically tested using PLS-SEM to evaluate the set of predictive relationships. The Bootstrapping procedure was applied to examine β significance which is a variance based method used to estimate structural equation models, using Smart PLS 3.1. The advantage of using PLS-SEM lies in the fact that no assumption on the distribution of data is needed (Chin *et al*., 2010). The t-statistics were used to test the statistical significance of both the indicators (outer model) and the structural model constructs (inner model). Two-tailed t-test of significance at 5% level was carried out, with t-statistic values larger than 1.96 indicating significance of the structural path significance tests. The results were interpreted with standardized β and coefficients of determination (R^2), with the bootstrap samples set at 5000 and the standard error at a 95% confidence level as suggested by Hair *et al*., 2017.

Results and Discussion

Test of measurement model

The results of CT of items were more than 0.40 and acceptable for suitable fit for measurement model (Hulland and Business, 1999). The Cronbach α values ranged from 0.71 to 0.93, which were above the acceptable threshold 0.70 (Table 1). The FL for all items exceeds the recommended level of 0.6 (Table 1). CR values of all items exceeded recommended level of 0.7 (Table 1). According to α (>0.07), CR α (>0.7) and FL (>0.6) which were greater than standard values, indicated the questionnaire had high reliability, validity and internal consistency. The AVE of all items exceeded recommended level of 0.5 (Sarstedt *et al*., 2014) (Table 1).

According to Henseler *et al*., (2015), DV was well established across all the constructs as no item is cross-loaded higher on another construct than on its own construct. In summary, the measurement model demonstrated adequate communality, reliability, CV, DV and fitness of model.

Table 1. *The results of convergent validity assessment, average variance extracted of measurement and variance inflation factor of items*

Item	Convergent validity			Average variance extracted	Variance inflation factor
	Cronbach's alpha	Factor loading	Composite reliability		
PU1	0.820	0.701	0.766	0.508	1.133
PU2		0.717			1.333
PEU1	0.732	0.585	0.714	0.547	1.271
PEU2		0.668			1.271
CO1	0.793	0.688	0.721	0.666	1.233
CO2		0.780			1.233
RA1	0.715	0.604	0.745	0.565	1.244
RA2		0.892			1.244
SN1	0.844	0.651	0.715	0.504	1.065
SN2		0.730			1.065
FC1	0.852	0.615	0.868	0.594	1.235
FC2		0.602			1.235
FC3		0.734			1.235
PBC1	0.875	0.764	0.745	0.864	1.432
PBC2		0.711			1.432
ATD1	0.766	0.784	0.837	0.765	2.254
ATD2		0.897			2.254
BI1	0.857	0.674	0.761	0.781	1.818
BI2		0.666			1.314
BI3		0.738			1.700
ADN1	0.932	0.812	0.912	0.993	1.882
ADN2		0.782			1.934
ADN3		0.678			1.969

Assessment of the structural model

The R^2 is a measure of the predictive power of a model for the dependent variables (Sarstedt *et al*., 2014). R^2 with a value of 0.67, 0.33 and 0.19 is considered substantial, moderate and low, respectively. R^2 of ATD towards BI, BI towards to ADN and PBC towards to ADN were 0.755 (Substantial), 0.671 (Substantial) and 0.516 (Moderate), respectively.

The R^2 of the structural model of this study was 0.785 and it was considered substantial in line with the recommended value. The four exogenous variables (ATD, BI, PBC, SN) explain 78% of the ADN of SDTS by RSs. Effect size (f^2) of 0.02, 0.15, and 0.35 indicates small, medium, and large effect, respectively (Chin *et al.*, 2010). Four hypothesis (H_{PEU}, H_{ATD}, $H_{PBC,}$ $H_{FC,}$ H_{SN} and H_{BI}) were in the large effect category, whilst the rest (H_{RA}, H_{CO} and H_{PU}) were medium effect size (Table 4). Since Q^2 values for all latent variables (ADN = 0.762, ATD = 0.609, BI = 0.449 and PBC = 0.304) of the inner model were greater than zero

Sarstedt *et al*., 2014, the path model had a favorable strong predictive relevance. All the VIF values for all the independent latent variables were less than five and fulfill the requirement of data according to the Multi-collinearity test and thus there was no collinearity problem according to Hair *et al*., 2009. The recommended value of SRMR should not exceed 0.08, while NFI value ranges from 0 to 1, where the closer the NFI to 1 means better fit (Hair *et al*., 2013). The SRMR value for the study model was 0.074 and NFI value was approximately 0.8. It could be concluded that both indices represent an acceptable fit for the research model and a good fit. The previous analytical and statistical outcomes gave adequate answers to test research hypotheses.

Hypotheses testing

Table 4 shows β, t-values, and p-values for all hypotheses concerning the path analysis supported by empirical data using the bootstrapping method. All nine hypotheses in the conceptual model achieved the β standard. The results showed that RA, had not effect on attitude towards adoption of MMRC and intention to use MMRC for adopters (H_{RA}). CO had positive effects on attitude towards adoption of MMRC (H_{CO}) (t-value=6.826, $p<0.01$). It reveals that RSs perceive practicing the MMRC being consistent with their existing cultural practices of RF, lifestyle and past experience. PU had positive effects on attitude toward MMRC (H_{PU}) (t-value=6.617, $p< 0.05$). PEU had positive effects on attitude towards MMRC adoption (H_{PEU}) (t-value=5.512, $p<0.01$).

Table 4. *Hypothesis test results*

Hypothesis	Path coefficient (β)	Standard Deviation	t-value	Effect size (f^2)
H_{RA}	0.111	0.054	5.678	0.135
H_{CO}	0.488	0.067	6.826**	0.278
H_{PU}	0.384	0.073	6.617*	0.257
H_{PEU}	0.242	0.067	5.512**	0.567
H_{ATD}	0.334	0.067	3.912**	0.843
H_{PBC}	0.566	0.234	3.910*	0.459
H_{FC}	0.647	0.098	4.567**	0.832
H_{SN}	0.866	0.135	6.035***	0.459
H_{BI}	0.344	0.198	5.891*	1.121

Notes: * $p<0.05$; ** $p<0.01$; *** $p<0.001$

However, effect of CO on attitude towards MMRC was comparatively high. Therefore, extension personnel should emphasize the benefits in aspects of MMRC. In addition, extension personnel should provide adequate information and clearer guidance to encourage RSs to use the MMRC in their rubber lands. Eventually, they should educate RSs the benefits of MMRC, using training and awareness programmes covering rubber farming areas in Moneragala area. ATD had significant positive relationship with BI

and thus supported H_{ATD} (t-value = 3.912, $p < 0.01$). ATD was also the most influential factor that predicts intention of RSs to use MMRC in this area. This result implies that if RSs have a positive attitude, they will certainly be more attracted to use MMRC. ATD is considered as a powerful factor that motivates to develop a positive intention.

It signifies that when ATD is favourable, that the chances of RSs to use a MMRC will definitely be increased. The H_{SN} hypothesis results (t-value = 6.035, $p < 0.001$) significantly and positively showed the influence of SN on BI. This implies that opinion of specific referent groups is also important in the development of an intention towards the use of MMRC. This result can be explained by the fact that the MMRC have been just introduced to Moneragala, and hence the knowledge of RSs remains rather limited. As a result, they may consult people from their own social environment to seek for advice in the process of adoption of this new MMRC. The positive relationship also denotes that, the more a person has a favourable social influence in ADN of MMRC, that the more favourable his intention would be. The H_{PBC} hypothesis of this study that PBC affected on ADN of MMRC was positively and significantly supported (t-value = 3.910, $p < 0.05$). The H_{FC} hypothesized relationship *i.e.* that of FC and PBC too was significant. Hence, H_{FC} too was supported. The H_{BI} hypothesis of relationship of BI to ADN was significantly and positively supported too (t-value = 5.891, $p < 0.001$).

As effects of SN on BI towards MMRC were comparatively higher than that of AT, policy makers should give more attention to improve the SN, which could be helped by improvement in the advisory services. Effect of PBC on ADN was seen to be comparatively higher than that of BI. This result concludes that RSs in Moneragala are likely to engage in practicing the MMRC, when they have the required resources to perform the behavior. Therefore, the availability of necessary fertilizer requirements in the market and skills of MMRC should be improved to enhance adoption of MMRC among the RSs in Moneragala.

Conclusion

The nine-predictor conceptualized model explained 78% of the variance in adoption of MMRC of rubber smallholders in Moneragala. This study identified eight behavioral factors; perceived usefulness, perceived ease of use, compatibility, behavioral Intention, attitude, subjective norms, facilitating condition and perceived behavioral control that act as drivers for adoption of MMRC. In order to enhance the adoption of MMRC, a favorable environment contributing to these psychological factors should be improved through proper extension and development plan in rubber smallholder sector in Moneragala.

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