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Socio Economic Factors Affecting Adoption and Non-Adoption of Modern Hive in Stingless Beekeeping Practices in Malaysia

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ABSTRACT
The study aims to investigate the socio-economic factors affecting the adoption of modern hives in stingless beekeeping in Malaysia. A total of 117 stingless beekeepers were selected as respondents using purposive sampling technique. The data were analyzed using descriptive statistic, factor analysis and logit regression model. The results indicated that 79% are adopters while others are non-adopters. The factor analysis results showed that there are seven factors affecting beekeepers to adopt modern hive technology namely, service of extension agent, production process, harvesting process, improvement of adopted technology, knowledge and information from extension agent, advantages of adopted technology, and source of information. Logistic regression model revealed that gender and educational level were positively and significantly influence the adoption at 5%. In summary, knowledge and information on modern hives is important for beekeepers, as the more knowledge and information they gathered and knew about the technology, the higher the influence rate to adopt the technology. Thus, the extension services from the Department of Agriculture should provide more sources of knowledge and information to create awareness on the advantages of using modern hives.

Keywords: *Stingless bee, Adoption, Modern hive, Factors, Determinants, Logit model*

1. INTRODUCTION

The stingless beekeeping, known as meliponiculture, could be operated using traditional and modern practices. It is a new and potential booming industry in Malaysia. It is believed that beekeeping in Malaysia was practiced for a very long time ago starting with *Apis species*. In fact, the stingless beekeeping project was launched by the Malaysian Agricultural Research and Development Institute (MARDI) only in 2011. The number of stingless bee species varies depending on the study areas [1]. Studied by [2] found that there are 35 species of stingless bee in Peninsular Malaysia, and it was dominated by *Heterotrigona itama, Geniotrigona thoracica, Tetragonula laeviceps, Lepidotrigona terminate* and *Tetrigona apicalis*. Of these, only two species (*Heterotrigona itama* and *Geniotrigona thoracica)* were highly sought as pollinators and for honey production [3]. At present, it is estimated that the number of known stingless honey-bee species in the world is 50 times more that of *Apis species* [4]. Apart from honeybee, stingless bee also produces honey, and it is getting popular and vastly commercialize nowadays. Labeled as superfood, honey of stingless bee was widely known for high medicinal value. It has high content of nutrients and antioxidants which is good for health. As at the end of 2017, the honey production of stingless bee was estimated at 138,580.71kg, amounted to RM16,988,308.

In terms of economics, according to a study by [5] the cost, technical and allocative efficiency of commercial

honey production particularly in Peninsular Malaysia were relatively low, and the determinants responsible for this low efficiency need to be improved further to maximize productivity. According to [6] the cost of a hive represents a significant initial investment when starting a new project of a stingless bee farm in terms of cost-benefit outcomes. Based on the net return, stingless bee farming in Malaysia might earn a sizable profit at RM 72.71 per kilogram. [7] conducted another study on the economic prospects for future potential of stingless bee farming and found that the four financial indicators of the stingless bee's project in Malaysia, namely Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), and payback period, were all attractive and financially feasible for future projection. All these data suggest that the potential for stingless beekeeping operations is very great, and that if the proper methods are used, beekeepers can earn a good living.

At present, a traditional method of stingless beekeeping is practiced throughout the country while the use of modern technology, using modern hive, is still scarce. Most of stingless beekeepers in Malaysia are still using traditional production system in original log. Basically, the log was obtained from the forest by cutting down the tree with a stingless bee nest inside. Unfortunately, this practice is not sustainable, and it will lead to deforestation and disturbance to forest ecosystem. [8] in their study argued that the practices of using natural log could give negative effect to the forest as it can disrupt the natural ecosystem and alter the habitat of flora and fauna. Not only that, the nest also would be disrupted and risk of loss of colonies might occurred during the harvesting activities [9]. [9] later suggested making some improvement in the traditional beekeeping practices such as improvement in the housing of colonies, multiplications and harvesting procedure. Having concerned about these issues, local researchers had introduced modern technology of stingless beekeeping using modern hives. [10] claimed that meliponiculture is a strategy that can preserve biodiversity and reduce the problem of deforestation. Socio economic of stingless beekeepers is important to be study especially for new industry like stingless beekeeping. This study is significant especially for the development of the stingless bee industry in Malaysia because the success of an industry is closely related to the background of individuals who are directly involved with the industry besides, this information is lacking in Malaysia.

1.1. Literature Review

A previous study has indicated that the use of hive can accelerate and increase efficiency of harvesting activity [9]. Harvesting process can also be done efficiently without disrupting the egg and queen [11] thus, minimize the risk of losing colonies. The beekeepers who's already used modern technology in their beekeeping project, stated that they preferred to use hive because it eased colonies inspection, monitoring and accessibility especially during harvesting, and it improved the quality of honey [12], [13]. However, the adoption of modern hives is also depending on several factors. Past studies have documented some demographic and socioeconomic factors that affecting technology transfer in beekeeping practices. [13] in their study indicated that marital status and household gender had influencing beekeepers to use modern hive. [14] identified the determinant for modern hive adoption and the result shows that age, gender, educational level of household found to be significantly affecting modern hive adoption. Other study done by [15], using logit analysis reveals that gender, age, family size and education were significantly affecting the adoption of modern beekeeping in Kenya. [16] in their study also reveals that the high usage of traditional hive and the adoption of modern hive had been significantly influenced by the beekeeper's sociodemographic profile.

In addition, there are factors that affected the adoption of modern hives in stingless beekeeping practices. As found by [17] the availability of the local materials with the experience and knowledge also influenced beekeepers to use modern hive. Besides, experience and understanding about the beekeeping practices were also influenced beekeepers to adopt modern technology [13]. Meanwhile, cost, availability, management, and quality of hive product were the factors that determined choice of hive technology as studied by [12]. In addition, access to extension information could also influence the beekeepers' decision to adopt new technology [18]. On the other hand, lack of skills and knowledge limit non-adopters to adopt new technology.

In Malaysia, MARDI has developed technology for rearing stingless bees especially *Trigona itama*. Apart from this, they also have conducted many courses and workshops to provide additional information and knowledge sharing to those who interested in stingless beekeeping. Nevertheless, the acceptance and adoption rate of stingless beekeepers to use modern hives in their practices is still low even though it can increase productivity and obtain high honey production. As a result, the production and productivity of honey from stingless beekeepers are generally not high. To improve the production and productivity of stingless beekeeping, it is important to shift from using traditional log to modern hives.

1.2. Objectives of the study

The overall objective of this study was to investigate the factors affecting technology transfer in stingless beekeeping practices in Malaysia. The specific objectives were to describe the socioeconomic characteristics of stingless beekeeping farmers, to identify the factors affecting the adoption of modern hives in stingless beekeeping practices and to identify the determinant for

the adoption of modern hives in stingless beekeeping practices.

2. METHODOLOGY

2.1. Study area

The study was carried out for the whole states of Malaysia which is 14 states in the West and East Malaysia. The data were collected from October 2017 to March 2018 through a face-to-face interview. The respondents were gathered at one place assisted by the department of agriculture, Malaysia and Koperasi Pembangunan Desa (KPD), Sabah.

2.2. Respondent selection and sampling technique

The respondents of the study are stingless beekeepers who registered under the Department of Agriculture Malaysia and Koperasi Pembangunan Desa Sabah. Based on the report by the Department of Agriculture in Putrajaya, Malaysia in 2017 there are more than 700 stingless beekeepers in Malaysia, consisting of 58,293 colonies. The selection of respondent was based on a purposive random sampling technique. It is purposively based on the number of hives (more than 10 hives) and focusing on commercialize stingless beekeepers. The stingless beekeepers include those who practiced modern or traditional hives and the total respondent involved with study was 117 stingless beekeepers.

2.3. Data collection

Primary data were employed in this research. The data were collected from stingless beekeepers through a survey using structured questionnaires and a face-to-face interview method. The required data were collected between 2017/2018. Prior to the data collection, pre-test was conducted to check the appropriateness of the questions in the questionnaire. The personal interviews were conducted with stingless beekeepers to gather the information needed for the analysis.

2.4. Data analysis

In this section, different approached were taken to address the objectives of the study. In this study, descriptive analysis approach is used to investigate the background of the stingless beekeepers in Malaysia. Factor analysis was applied to measure the factors affecting the adoption of modern hives and logit model was employed to analyze the socio-economic factors in influencing modern hives adoption.

2.4.1 Factor analysis

This study employed exploratory factor analysis to uncover factors affecting the technology transfer of stingless beekeeping practices. Factor analysis was used to assist in determining which items cluster or grouped together to form a 'factor'. The factor structure was investigated using an exploratory factor analysis with Principal Component Analysis. Varimax rotation method with Kaiser Normalization was used during the exploratory factor analysis. The factor affecting technology transfer of stingless beekeepers were measured using Likert scale: strongly disagreed (1), disagreed (2), agreed (4), strongly agreed (5). The questionnaire consisted of three variables namely technology transfer, technology dissemination and assessment of beekeeping production technology.

2.4.2 Logistic regression analysis

In addition to the descriptive and factor analysis, an econometric model of binary logit was employed. Independent Linear Probability Model (LPM), logit and probit models are widely and mainly used in adoption studies to analyse factors influencing discrete behaviour such as adoption decision. According to [19] the output of logit and tobit models are similar but logit model is preferred because easier to compute and can provide additional interpretations regarding the adoption. Thus, in this study, a binary logit model was used to identify the socio-economic determinant of adoption of modern hives. Following [20] the logit model can be specified as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + \cdots + \beta_6 X_6 + \varepsilon \qquad (1)$$

Where X_i is the vector of independent variables correspond to demographic and socio-economic variables of the i^{th} stingless beekeeper. The dependent variable Y_i is equal to 1 if the stingless beekeeper adopts modern hives and 0 if non-adopter. The eequation (1) can be explained as describing the probability of a given beekeeper choosing to adopt modern hives. The value of the parameters, β, measures the marginal impact of a unit change in the explanatory variables on the probability of technology adoption. The above linear model can be transferred into a cumulative probability function as follow, mainly to avoid the potential errors of having the predicted values, Y_I falling outside the (0, 1) range.

$$P_I = F(X_i\beta) \qquad (2)$$

If the cumulative probability function F(.) is logistic, then we have the logit model of the form:

$$P_i = \frac{1}{1 + e^{-X_i\beta}} \qquad (3)$$

The marginal effect of a particular variable on the probability that a particular stingless beekeeper to adopt a modern hive is given by:

$$\frac{\partial \rho_i}{\partial X_i} = f(X\beta)\beta'_k \quad (4)$$

Where f(.) is the logistic density function given by:

$$f(X'\beta) = \frac{e^{-X\prime\beta}}{(1 + e^{-X\prime\beta})^Z} \quad (5)$$

2.4.3 Measurement of dependent and explanatory variables

Adoption (the dependent variable) was dichotomized such that a value 1 for adopter stingless beekeeper and 0 was given for non-adopter. The explanatory variables used are gender, marital status, beekeepers age, educational level, household size, mode of practices, experience and participation in any association.

3. RESULTS AND DISCUSSION

3.1. Demographic and Socio-Economic Characteristics of the Respondents

Table 1. Demographic profile of respondents

Demographic factor	Frequency (n)	Percentage (%)
Gender		
Male	95	81.2
Female	22	18.8
Age		
21 – 30 years	18	15.4
31 – 40 years	35	29.9
41 – 50 years	24	20.5
51 – 60 years	22	18.8
61 years and above	18	15.4
Marital status		
Single	18	15.4
Married	97	82.9
Widow	2	1.7
Household size		
1 – 3 persons	34	29.1
4 – 7 persons	67	57.3
8 – 11 persons	13	11.1
12 persons and above	3	2.6
Education level		
Primary school	10	8.5
Secondary school	48	41.0
College	22	18.8
University	35	29.9
Others	2	1.7
Participation in stingless bee beekeeping		
Part time	78	66.7
Fulltime	39	33.3
Years of experience		
Less than 1 year	28	23.9
1 – 3 years	46	39.3
4 – 6 years	36	30.8
More than 7 years	7	6.0
Involvement in any association?		
Yes	40	34.2
No	77	65.8
Stingless beekeeping practices		
Traditional practices (log)	38	32.5
Modern practices (hive)	79	67.5

From the survey result, majority of the respondents are male (81.2%). Of the 117 respondents, 29.9% were 31 to 40 years old category. Majority of the respondents (97 respondents or 82.9%) are married. More than half of the respondents (57.3%) have a household size in the range of 4 to 7 persons. Forty-one percent of the respondents had attained at least a secondary school. Further the study revealed that 78 out of 117 respondents representing 66.7% regarded stingless beekeeping as a major activity. The study also reveals 46 respondents had involved in stingless beekeeping activities between 1 to 3 years. Almost 66% of respondents were not engage

with any association, indicating their participation in stingless beekeeping practices are independent. Meanwhile, 67.5% of the respondents practiced modern technology which is using hive for their stingless beekeeping practices as compared to those using traditional log. This indicated that the targeted level of adoption and transfer of technology among the stingless beekeepers to use modern hive is still not fully achieved.

3.2. Factors affecting the adoption of modern hives

Table 2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.909
Bartlett's Test of Sphericity	Approx. Chi-Square	9060.501
	Df	2211
	Sig.	.000

Factor analysis applied to create the new factors influencing the adoption of modern hives in stingless beekeeping practices in Malaysia. Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy are both used to determine the factor ability of the matrix. The result of KMO measure in this study is 0.909, which the values is greater than 0.6. It indicates that the sampling is adequate and appropriate to proceed with Factor Analysis. The Bartlett's Test of Sphericity should be significant ($p<0.05$, $p=0.000$) for factor analysis to be suitable.

There was a total of three constructs consisted of 39 items that were originally tested to identify the factors affecting technology transfer in stingless beekeeping. The result reveals that seven factors consisting of seventeen items have high relations with the factors affecting technology transfer (Table 3). The items are then regrouped into a new factor due to some other items which are not related with the factors. The total variance of 88.327 is achieved from these factors (32.818%, 8.292%, 7.567%, 5.676%, 5.336%, 4.591%, and 4.505%) and these variances are explained by F1, F2, F3, F4, F5, F6 and F7 respectively. The identified factors were based on factor loading 0.5 and above.

Service of extension agent (F1) is the main factor affecting technology transfer in stingless beekeeping practices. The role of extension agent especially in terms of distributing knowledge and guidance is important in increasing the level of awareness among beekeepers to adopt the modern hive technology. As studied by [18], he found that the role of extension agent in providing information is significant in influencing the adoption of modern technology in beekeeping production. While [16] claimed that training and extension agent supports is important as it increased the awareness about modern technology.

The second factors that influences technology transfer is the production process (F2), which involved post-harvest process. Basically, the aim of the beekeepers is to get high-quality honey with low water content. The process of reducing water content in the honey can increase the quality of honey and can fetch high market value. The high concern about the production process had led the beekeepers to use the modern technology. Next is the harvesting process (F3). It is easier to harvest the honey if they use hive as compared to using traditional log. By using hive, the harvesting activities will become easier, and the honey production will increase. [17] in their study indicated that in Ethiopia, the beekeepers prefer to use frame hive in their honeybee production as it shows high honey production than using traditional and traditional hive.

It is undeniable that the transfer of technology would give a positive feedback and return to beekeepers. The fourth factors affecting technology transfer is the improvement of the modern hives. It means that the improvement in many aspects such as in the production process, harvesting process, management aspect will motivate them to change to modern hive in their practices. For example, [12] stated that, those already adopt the modern technology (hive) found that it is easier for colonies inspection, easy access, and monitoring, and produce high quality honey.

While the fifth factor that affects technology transfer among stingless beekeepers is knowledge and information from the extension agent. It is important for the beekeepers to get a clear information and gain knowledge about the technology, and thus, it is easier for them to accept and adopt the technology. Extension related bodies and agencies should play an important role in providing information and technical skills to beekeepers probably through workshops, and seminars, so that the beekeepers will be exposed to modern technology. [17] claimed that knowledge gap among beekeepers influenced their preference to use modern hive technology in their beekeeping practices.

Table 3. Factor Analysis

Factor	Loading	Variance	α
F1 (service of extension agent) Extension agent renders adequate extension services to me. The extension agents in my area knowledgeable in beekeeping management. Information on pure honey attributes is easy to find. I have more contact with extension agent on how to improve beekeeping management. There is proper demonstration on how to adopt improved beekeeping technology.	0.850 0.812 0.740 0.599 0.597	32.818	0.896
F2 (production process) The process of reducing water content from harvested honey by using machine will prolong shelf life. Reducing water content will remove bubbles in raw honey	0.887 0.856	8.292	0.802
F3 (harvesting process) There is no problem of harvesting Trigona honey using vacuum pump. Good harvesting machine is easy to find in Malaysia.	0.852 0.695	7.567	0.912
F4 (improvement of the adopted technology) There is an improvement in my beekeeping because of improved practices adopted. I have access to improved beekeeping practices.	0.735 0.659	5.676	0.884
F5 (knowledge and information from extension agent) I receive knowledge on good agricultural practice in beekeeping organized by the Department of Agriculture. Extension agents are my best source of information on beekeeping.	0.881 0.571	5.336	0.767
F6 (the advantages of the adopted technology) The adopted technology (modern hive) minimizes risk of absconding and contamination. The adopted technology (modern hive) does aid me to harvest clean and pure honey.	0.940 0.585	4.591	0.831
F7 (source of information) Private companies are another source of information to me. I normally search the information from the internet for beekeeping management.	0.904 0.526	4.505	0.937

The advantages of the adopted technology become the sixth factor affecting beekeepers to use modern technology. Such advantages are minimized contamination and produced high-quality honey. These advantages will benefit beekeepers where they can be guaranteed of producing high quality local honey. This finding was also supported by [13] where they claimed that the use of modern technology has eased harvesting process and obtained high-quality honey.

The last factor affecting technology transfer is source of information. Most of the stingless beekeepers are working independently without engaging with any association. It is because they tried to get the information by themselves through internet, attending workshop, seminar, sharing with other beekeepers. When greater numbers of information on modern technology were available, they were then exposed to the advantages of the technology and consequently, influencing them to transfer the technology being practiced.

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3.3 Determinants of adoption of modern hive

The current study revealed that both traditional log and modern box hives are used in Malaysia. However, there are high preferences in this study for stingless beekeepers to use modern hives in their practices. It was found that 67.5% of the respondents used modern hives while the rest used traditional log. Though, the adoption

rate of the beekeepers on the use of modern hive is high as compared to those using traditional log, it still does not achieve full adoption. In determining the adoption of modern hives, the role of some socio-economic profile of stingless beekeepers were assessed using logistic regression. The result showed that 67.5% of the total variation for the adoption of modern hives was described by logistic model. The model correctly predicted sample size of 87.3% and 34.2% for adopters and non-adopters, respectively. The explanatory variables that fit the model are age, gender, marital status, household size, education level, mode of practices, years of experience and association with any bodies of organizations. The variables that significantly influence the adoption of modern hives are gender and educational level. However, age of respondents, marital status, household size, mode of practices and experience were insignificant in influencing the adoption of modern hives practices (Table 4).

Gender plays an important role as it can influence the way of thinking and decision making. The result of logistic regression reveals that gender is positively and significantly influenced the adoption of modern hives of stingless beekeeping in Malaysia at 5%. The odds in favor of adopting modern hives are increased by a factor of 3.847 for male beekeepers. One of the reasons why men are more likely to accept the modern hive method is that in the process of making the modern hive itself, it involves carpentry activities that are usually dominated by men compared to women. These carpentry skills, to some extent, helped the men to make their own modern hives to increase the number of existing colonies.

The finding was supported by [13]. Educational level is positive and significant at $p<0.05\%$. The odds in favor of adopting modern hives are increased by a factor of 0.191 for stingless beekeepers who had higher educational level. The higher educational background of beekeepers is related with more knowledge that he/she could obtain and would increase their access to information. Education level could increase understanding of a given technology, which in turn, would help beekeepers to easily apply the technology. This study was in line with [16] and [21] findings.

Table 4. Logistic regression of determinants of modern hives adoption in stingless beekeeping

Variables	B	S.E.	Wald	df	Sig.	Exp (B)
Age	0.210	0.983	1.059	1	0.901	1.234
Gender	1.347	0.653	4.257	1	0.039**	3.847
Marital status	-21.090	25887.947	0.000	1	0.999	0.000
Household size	0.368	1.351	0.074	1	0.785	1.445
Educational level	-1.656	1.807	12.479	1	0.014**	0.191
Practices	-0.719	0.546	1.732	1	0.188	1.568
Experience	0.450	1.523	1.143	1	0.887	1.357
Constant	20.226	25887.947	0.000	1	0.999	608421960.1

4. CONCLUSION

The results revealed that the level of adoption of modern hives is 79.1%. There are seven factors identified in affecting the adoption of modern hives practices. The main factor is service of extension agent. It includes information and knowledge dissemination by extension services and beekeepers' access to extension services. While in determining the factors influencing the adoption of modern hives, the finding indicated that gender of the respondent and educational level is positive and significantly influence the adoption of modern hives. This means that the higher the education level of beekeepers, the higher possibility for the beekeepers to adopt new technology as they have more knowledge and information. The study recommends the related agency, such as Ministry of Agriculture and other development agencies working in the area, should promote the adoption of modern hives in Malaysia among the retirees. It can be done via enhancement of extension services and support, improving and increase the dissemination of information and knowledge on stingless beekeeping practices. On the other hand, the government should also encourage and promote stingless beekeeping practices among female especially single mothers to generate additional income. Finally, more studies should be conducted to identify factors preventing the adoption of modern hives and determining the way to increase the adoption rate among stingless beekeepers.

AUTHORS' CONTRIBUTIONS

All authors were involved in the process of writing and producing this journal article.

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