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Fuzzy Delphi Method (FDM) for developing components of the Smallholders Awareness Training (SAT) Model

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ABSTRACT Smallholders in the oil palm industry lack competitiveness, ethics, and agricultural and technological knowledge. The authority's competence in smallholder extension programs affects their livelihood in the upstream supply chain. This research aims to design and develop a prototype SAT Model to assist smallholders in following good agricultural practices (GAP) sustainably planting oil palms. It continues from the needs analysis phase and follows Richie and Klein's (2007) Design, Research, and Development (DDR) approach. Through purposive sampling, the study obtains expert opinions and consensus on the components of the proposed model using a literature review and the Fuzzy Delphi Method (FDM). Sixteen oil palm experts from academia and industry participated in the design and development process via a 7-point Likert scale questionnaire. The study meets all three FDM criteria: a fuzzy score value (A) of α-cut 0.5, a threshold value (d) of 0.2, and a percentage of expert consensus of 75%. The findings pave the way for future agendas consisting of developing a complete SAT Model with ranking-coded elements and evaluating its usability for the oil palm and related industries. The study adds to the industry's theoretical, methodological, and practical knowledge.

Keywords: Design, Development and Research (DDR); Good agriculture practices (GAP); Fuzzy Delphi Method (FDM); Competitiveness, Sustainability

1. Introduction

Smallholder farmers face obstacles in growing sustainable oil palm due to the overall situation marketing arena, a lack of understanding of GAP and the competency of the authority in imparting knowledge and agriculture technology (Marzukhi, Mawar, Latifa, & Mohd Ridhuan, 2021). Smallholders in the upstream sector face external and internal obstacles that stifle the high-yield production of fresh fruit bunches (FFB), jeopardising their livelihoods. It has resulted in a shift in customer behaviour regarding food consumption (Distanont & Khongmalai, 2018). Essentially, the issues of the ecosystem and environmental damage, displacement of endangered species and local communities, forced labour, and finally, health difficulties are all factors considered in the sustainability concerns (Che Omar, Ishak, Awang, & Hussain, 2018; Porter, 1980; Syahza, 2019; Vergura, Zerbini, & Luceri, 2019).

The overall research proper aims to develop the SAT MODEL based on the dimensions of competitiveness and IBE concerning GAP for the sustainability of smallholder farmers through expert consensus in the oil palm industry. However, this study only focuses on developing the components of the SAT model as the needs analysis to develop the model has received the experts' consensus. Also, the study does not cover the elements and their ranking of the components. It necessitates the usability evaluation of the proposed model, which is also not covered in this article issue.

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2. Literature Review

Many researchers conduct the development of a model with the inclusion of various components and elements with rankings in multiple industries. Mohd Ridhuan (2016) has five essential components in creating the SkiVes training curriculum model. The model combines TABA (1962) curriculum features and the SIM (Milano & Ullius, 1998) training models. The components arising from the merger of the two models (TABA and SIM) are Training Objectives (TO), Training Content (TC), Training Aids, Instructional Delivery Strategies, and Training Evaluation (TE). The scholar added that the *instructional delivery stage* component complements a complete creation of a training programme model for SkiVes. Thus, the study adapts the setting up of the SkiVes Model by replacing components 3 and 4 with the Role of Smallholders (RS) and the Role of the Authority (RA), respectively, making the SAT Model accordingly. Table 1.0 illustrates the formation of the SAT Model by adapting the SkiVes Model, TABA, and SIM models.

Table 1.0: Development of SAT Model Components from Base Models and Underpinning Theories

Base Model and Underpinning Theories				
a) SkiVes (Mohd. Ridhuan, (2016)	**b) TABA model (1962)**	**c) SIM model (Milano & Ullius, 1998)**	**(d) SAT Model (a+b+c=d) (Selected elements from the base models)**	**Remark on SAT Model**
1. Training Objectives (TO)	1. Students need identification	1. Goals and Objectives	1. TRAINING OBJECTIVES (TO)	It is adapted from elements 1 of SkiVes, 1 and 2 of TABA, and 1 of SIM models.
2. Training Content (TC)	2. Development of objectives	2. Principal topics	2. TRAINING CONTENTS	It is adapted from elements 2 of SkiVes and 2 of SIM models.
3. Training aids	3. Selection of contents.	3. The flow of training	3. THE ROLE OF SMALLHOLDERS	It is adapted from elements 3 and 4 of SkiVes, 3 and 4 of TABA, and 3 and 4 of SIM models.
4. Instructional Delivery Strategies	4. Arrangement of contents.	4. Training aids	4. THE ROLE OF THE AUTHORITY	It is adapted from elements 3 and 4 of SkiVes, 3, 4, 5, and 6 of TABA, and 3 and 4 of SIM models.
5. Training Evaluation (TE)	5. Selection of activities.	5. Training Evaluation (TE)	5. TRAINING EVALUATION (TE)	It is respectively adapted from elements 5 of SkiVes, 7 of TABA, and 5 of SIM models.
-	6. Arrangement of activities	-	-	
-	7. Training Evaluation (TE)	-	-	

Subsequently, the study searched the literature and elaborated on the five selected components. The components are Training Objective (TO), Training Content (TC), Role of Smallholders (RS), Role of the Authority (RA), and Training Evaluation (TE). Appendix B shows a graphic presentation of the setup. The study explains the features in the Findings and Discussion sections.

3. Methodology

This study is about implementing the FDM approach in designing and developing an awareness training model for oil palm smallholders. It is an approach that has been used and widely accepted to collect data for a study based on the validation expert in a research study (Kaufmann & Gupta, 1988; Mohd Ridhuan & Nurulrabihah, 2020). Reviewing previous literature shows that FDM combines the traditional Delphi (Classic) method and fuzzy set theory (Fuzzy). FDM combines the numbering of the fuzzy set method and Delphi itself (Murray, Pipino, & Vangigch, 1985). It is not a new approach based on a classical Delphi method where the respondents involved must be from within the circle of experts with experience in the

study context. This improvement indirectly strives to make FDM a more effective measurement approach, whereby FDM can resolve the issue of who has uncertainty for some problems of the research. This research seeks to get the consensus of experts in the oil palm industry on the components, elements and their rankings to form a prototype SAT Model.

There are three conditions to fulfil in arriving at the decision-making process of the elements in the respective component of the prototype SAT Model. It includes the Triangular Fuzzy Number, which takes in the element of the threshold value (d), experts' consensus percentage, and Fuzzy score (A) (Mohd. Ridhuan and Nurulrabihah, 2020). It leads to realising the factors that lead to the decision process accordingly. It continues from the needs analysis phase and follows Richie and Klein's (2007) Design, Research, and Development (DDR) approach. Through purposive sampling, the study obtains expert opinions and consensus on the components of the proposed model using a literature review and the Fuzzy Delphi Method (FDM). Sixteen oil palm experts from academia and industry participated in the design and development process via a 7-point Likert scale questionnaire. The study meets all three FDM criteria: a fuzzy score value (A) of α-cut 0.5, a threshold value (d) of 0.2, and a percentage of expert consensus of 75%. The triangular Fuzzy Number *m* is made up of the values of m1, m2, and m3, representing the minimum (smallest value), the most reasonable value (most plausible value), and the maximum value, respectively. Figure 1.0 shows all three values in the Triangular Fuzzy Number. The value of triangular shows that all three values are also in the range of 0 to 1, coinciding with fuzzy numbers.

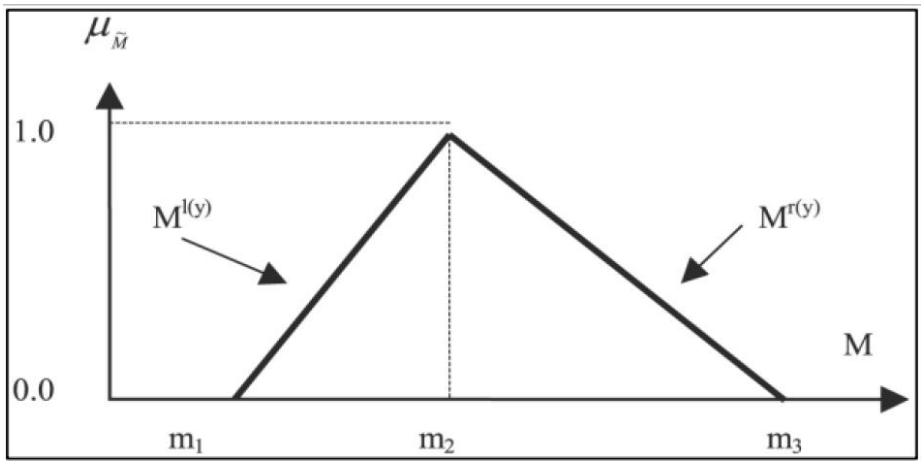

Figure 1.0: Graph Triangle Min against the Value of Triangular
Source: Mohd Ridhuan and Nurtulrabihah (2020)

There are two types of questionnaires in the development stage. The first questionnaire instrument aims to obtain an expert consensus on the components of the intended model. It covers the model's objectives, model content, the role of smallholders, the role of authority, and training evaluation components. The study was conducted simultaneously in Phase 1 – the Need Analysis. Subsequently, the second questionnaire instrument covers the components and elements in each significant part of the Awareness Training Model. It was the questionnaire for the FDM approach. The study conducted an online presentation to the selected experts with a moderator during the Covid-19 pandemic. It was to answer the following questions: i) What model to develop for the smallholder's awareness training (SAT) model?, and ii) What components are needed for the SAT Model? The study does not include the questions' What elements are needed in each component? and 'What is the priority sequencing (ranking) of the elements in the SAT Model?' These are covered in future work on this topic.

3.1 Procedures in Fuzzy Felphi Method (FDM).

Figure 2.0 details the steps involved in the approach of the FDM. It is to gain consensus from experts on the subjects presented in the research. Details include the following:

Step 1: Determination and selection of experts. It is crucial to select experts, ensuring that the chosen experts can provide detailed views on the study context.

Step 2: Construction of questionnaires. In this process, the creation of questionnaires can be carried out by several methods, namely (1) interview, (2) focus group discussion, (3) document analysis and literature review construction, and (4) open format questions. Mohd Ridhuan and Nurulrabihah (2020) exert that the Delphi method is very flexible in obtaining an expert consensus. Besides interviews, other avenues are open-ended questions (Powell, 2003). Alternatively, questionnaires

can also be outsourced from a literature review connecting to the issue of the study (Duffield, 1993).

Step 3: Dissemination and Collection of Data. Several approaches can be used, namely through (1) Workshop Seminars by inviting the experts involved; (2) Meetings with experts individually; (3) Dissemination of questionnaires to selected experts via email, and so on. (During the MCO period, meeting online is the most widely practised in writing this topic).

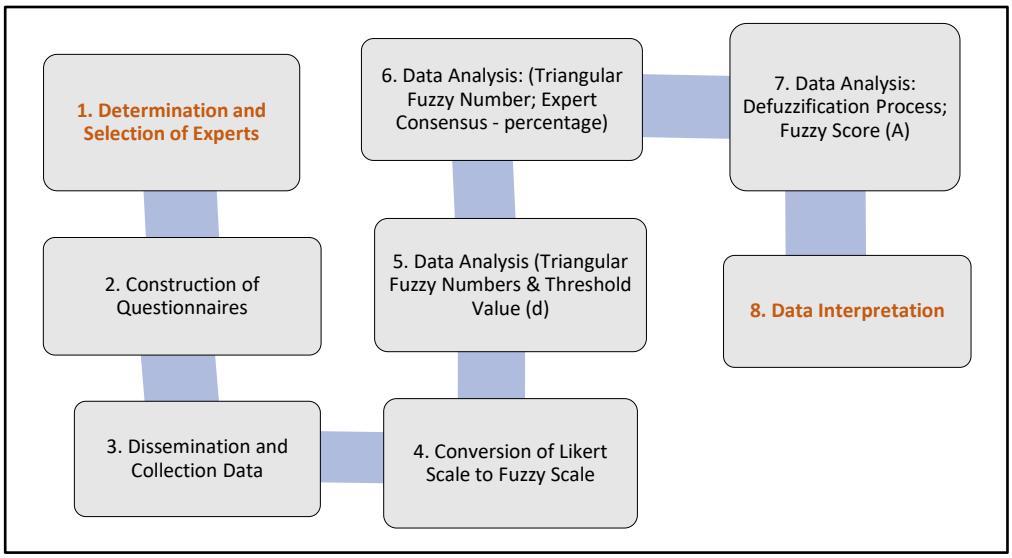

Figure 2.0: The Flowchart of the Procedure of the FDM Approach.

Step 4: Conversion of Likert Scale to Fuzzy Scale. Convert all linguistic variables into fuzzy numbering (triangular fuzzy number). The Likert is based on seven pointer scale. It involves the conversion of the Likert scale to the Fuzzy scale. It exhibits the readings of m1, m2, and m3 based on the Likert scale used in respondents' scores.

Step 5: Data Analysis (Triangular Fuzzy Number) - The aim is to obtain threshold value (d). Therefore, the first condition to be complied with is that the value must be less than or equal to 0.2 (Cheng & Lin, 2002). The threshold value (d) of two fuzzy numbers, m = (m1, m2, m3) and n = (n1, n2, n3), is calculated using the formula:

Where,

$$d(\tilde{m},\tilde{n}) = \sqrt{\frac{1}{3}\left[(m_1-n_1)^2+(m_2-n_2)^2+(m_3-n_3)^2\right]}.$$

d = threshold value

m1 = average of minimum value

m2 = average of plausible value

m3 = average of maximum

n1 = minimum value

n2 = plausible value

n3 = maximum value

Step 6: Data Analysis (Triangular Fuzzy Number): Expert Consensus Percentage. It is a follow-up to stage 5, in which the value of the percentage of the expert agreement is determined. It must be equal to or greater than 75.0% (Chu & Hwang, 2008; Murry & Hammons, 1995).

Step 7: Data Analysis (Fuzzy Evaluation Process): Fuzzy Score Value (A)

The third stage deals with the Fuzzy numbers (the first and second) in steps five and six. The fuzzy Evaluation Process is intended to obtain the value of the fuzzy score (A). The fuzzy score value (A) must exceed or equal the median value (α - cut value), which is 0.5 (Bodjanova, 2006; Tang & Wu, 2010). According to expert consensus, the fuzzy score (A) value can

determine the element's position and priority. The equation involved in obtaining the fuzzy score (A) is as follows:

Step 8. Data Interpretation. It is a follow-through of the process – the FDM.

3.2 The Number of Experts in FDM

The selection of several experts for the FDM is a total of 16 people. Jones & Twiss (1978) point out that the number of experts for the Delphi technique is as many as 10 to 50 people if the experts agree. However, an opinion also states that the minimum number of experts for the Delphi technique is five (Mahmud, Ismail, Mustapha, Din, & Yasin, 2006). On the other hand, Adler & Ziglio (1996) suggest the number of experts involved in the Delphi method approach is 10 to 50, and Burn (1998) 15. The study's criteria and characteristics applied to practitioners and implementers in the oil palm industry and academics. Berliner (2004) states that the expert is competent if they are in a particular field consistently exceeding five years. Other scholars point out that experts are highly skilled and experienced in the studied areas.

The study selected sixteen experts (Mohd. Ridhuan and Nurlrabihah, 2020; Jones & Twist, 1978) for the survey. The participants are directly involved in the upstream sector's supply chain. One of them is the heading of a public company of an oil palm plantation and sits on several chairs of oil palm-related organisations. The second participant is a board member of the Malaysian government statutory body overlooking the national oil palm industry, also heading a smallholders' national association of oil palm smallholder farmers. To add to the homogeneous representation of the industry, the third person is a consultant in the oil palm industry who serves advisory services about the agronomical aspect of the industry. It is about getting the experts' opinion on developing the SAT-Mode concerning the smallholder farmers in sustainably producing FFB. It concerns focusing on the GAP concerns while incorporating the industry's determinants of competitiveness and the Islamic ethical aspects.

4. Findings and Discussion

4.1 Demographics of SAT Model Development Experts

The study selected sixteen experts for the model development from the industry for this stage, which is in line with Joe & Twist; 10 to 50 participants are allowable for the survey. Eighty per cent of the experts have more than 15 years of experience, and three per cent are within 5 to 9 years. The participants are directly involved in the upstream sector's supply chain. Almost 40% have agricultural backgrounds, with about 20% being oil palm-related managers. Also, about 20% are academicians who can understand the industry's agriculture and social sciences aspects. The researcher also obtained the contribution of two agronomists and listing agents to add to the in-depth consideration of the research work. The presence of the oil palm dealer and the cooperative representative also add to the homogeneous representation of the industry. It is about getting the experts' opinion on developing the SAT Model concerning the smallholder farmers in sustainably producing FFB. It covers the scope of practice (SOP), emphasizing GAP while merging the sector's competitiveness factors and Islamic ethical components toward establishing the SAT Model.

4.2 Main Components of SAT Model based on Fuzzy Delphi Method (FDM)

The study sourced from the literature review into the arrangements depicting the details of the objectives, Training Content (TC), the Role of the Smallholders (RS), Roles of the Authority (RA), and Training Evaluation (TE). Table 1.0 depicts the unanimous consensus on the expert panel's decision on the components of the prototype SAT Model using the FDM. All outcomes meet the conditions of the *threshold value (d)*, experts' consensus percentage, and Fuzzy Score (A), which lead to the acceptance consequence accordingly. Other data details precede the formation of Table 2.0, which include the threshold value (d) for each item, experts' acceptance percentage, and fuzzy Score (A). Appendix B depicts the main components created and agreed upon by the experts. In another future stage, the study examines the usability of the model components using the Modified NGT.

Table 2.0: SAT Model Key Components

No	Main Components of SAT Model	Requirement of Triangular Fuzzy Numbers		Fuzzy Evaluation Process Requirement				Expert Consensus
		Threshold Value, d	Expert Group Consensus Percentage, %	m1	m2	m3	Fuzzy Score (A)	

1	Training Objectives (TO)	0.136	100.0%	0.738	0.894	0.975	0.869	ACCEPT
2	Training content (TC)	0.158	100.0%	0.738	0.888	0.969	0.865	ACCEPT
3	The role of smallholders (RS)	0.112	100.0%	0.738	0.900	0.981	0.873	ACCEPT
4	The Role of the Authorities (RA)	0.148	100.00%	0.775	0.913	0.975	0.888	ACCEPT
5	Training Evaluation (TE)	0.124	100.00%	0.763	0.913	0.981	0.885	ACCEPT

The prototype SAT Model consists of six hexagons housing each component surrounding the design's focus to the caption, SAT Model. It is on a circular backdrop and denotes the oil palm supply chain. The explanation for each component is as follows:

a) Training Objectives (TO) Component

This study refers to understanding smallholders' and fruit traders' application in the dimension of competitiveness and IBE regarding adherence to the recommended quality. Integrating the Islamic ethical aspect of the approach to handling FBB with the operation's competitive factors enhances smallholder livelihood (Mohammed et al., 2018). Managing the delivery activity of collected FFB to millers also plays a crucial role in competitiveness and the awareness of compliance with the running industry standard practices (Jamian, 2014; Mahat, 2019). These industry players account for the supply chain's inbound, process, and outbound stages. It is in line with Mohd Ridhuan (2016) with the underlying models of TABA and SIM, and Khairul (2021) that stress the need for an objective component in developing a training model and the study suit to this setup well.

b) Training Content (TC) Component

Training content refers to the elements taught and trained participants to increase their knowledge of a particular training subject. In the context of this study, the scope for developing the training model encompasses the elements of awareness of GAP, competitiveness, and IBE. The definition of awareness is the overall picture of the training programme. Smallholders need conditioning to recognise the importance of quality in FFB's business in the open market (Che Omar, 2018). That relates to the production of the FFB following GAP and the sustainability of oil palm production. It establishes an ecosystem where many market players in the sector are in quality compliance with a substantial majority of smallholders (Vermeulen & Goad, 2006). It leads to exposure to competition among the smallholders and dealers. Both players are susceptible to market factors ranging from the effect of weather conditions, uncertainty in the price of palm oil, the high cost of agricultural inputs, the impact of buyer-seller bargaining power, over-reliance on the selling of FFBs by fruit dealers, ignorance of the content of fertiliser nutrients, and low-yielding clones (Kotler, 200; Aznie et al., 2018; Che Omar et al., 2018; Syahza, 2019). This component also applies to the SkiVes and the underlying models. It is from element 2 of the SkiVes model – the Training Content (TC) and main topics in the SIM model, respectively. Other future work will present the elements of the component programme concerning the authority.

c) The Role of Smallholders (RS) Component

The smallholders are part of the industry's upstream supply. There are two types of smallholder farmers: independent smallholder farmers (ISH) and the other is supported farmers with direct government or private sector support for oil palm production (Vermeulen & Goad, 2006; Bronkhorst et al., 2017; Gympo, 2018). The government provides technical assistance and inputs for seed stocks, fertilisers, and pesticides on loan or partially subsidised by the government (Bronkhorst et al., 2017; Aznie et al., 2018). Aznie et al. (2018) also stress that palm oil grown by independent smallholders (ISH) is without direct government or private aid. The ISH forms part of the supply chain process for delivering inbound stocks to millers directly or through fruit dealers). The communities have a land title or recognised customary land rights and rent to a plantation company or receive a share of income based on the equity value of their land (Khatun et at. 2017). It outlines the outsourced dimensions and literature review of the role of smallholders in the Awareness Training model. The study adapted from Skive's (2016) element number 3 and 4 – Training aids and instructional delivery stages, and numbers 3 and 4 of the SIM models – the flow of training and training aids, respectively.

d) The Role of the Authority (RA) - MPOB Component

The MPOB's main task is to promote and develop national goals, strategies, and priorities for the Malaysian palm oil industry. To comply with its 35:25 scheme, it tracks the productivity of palm oil mills, which stands for the production of 35 metric tonnes per hectare per year of yield and the achievement of a 25 per cent oil extraction rate (OER), respectively (Kushairi et

al., 2019b). The ability of FFB to sustain good yield, productivity, and quality determines the competitiveness of producers at regional or even national levels (Hadi, 2004). The MPOB's extension arm, TUNAS, delivers extension education services through designated officers, such as technical talks, demonstration methods, advice, and on-site guidance. They provide up-to-date palm oil-related information and technology and channel government assistance schemes to participating smallholders. However, independent oil palm smallholders still face numerous advancement constraints when there is no support and assistance in the fieldwork. Limited knowledge of emerging technology and agricultural techniques makes it difficult for smallholders to fulfil the RSPO requirement (Ibrahim Awang & Manaf 2018). The study adapts from the SkiVes model's elements 3 and 4 of the SIM model, denoting Training Aids and Instruction Delivery Strategies, respectively. It also covers TABA model numbers 5 and 6, representing selecting and organising activities. Other future work will present the elements of the component programme concerning the authority.

e) Training Evaluation (TE) Process

It is about the usability and integrity of the model development with the oil palm industry's competitiveness, and ethics are the focus dimensions in the SAT Model. In the design and development stage, an evaluation process is crucial to determine the usability of the developed product, and in this context, it is a model (Fernandes, Reis, Paula, Serio, & Di, 2017; Habidin, Shazali, Ali, Khaidir, & Jusoh, 2016; Rentes et al., 2019). These assessment processes enable the study to discover a broader understanding of the method in the evaluation phase of the DDR approach (Ridhuan 2016). It also reflects a model's feasibility, effectiveness, and importance (Deitmer & Heinemann, 2009; Megheirkouni, 2016; Rohmah, Mustaniroh, Deoranto, & Nharawasthu, 2019). The study adapts similar elements from the SkiVes and the underpinning models of TABA and SIM with Training Evaluation (TE) in the final setting up of the SAT Model components, which appear in. It is from the final stage of all the models mentioned above.

The study does not discuss the evaluation elements of the intended training model in this research. It is undergoing internal evaluation to ensure the model's validity and industrial applicability. The internal evaluation assesses the model's relevance to various research design projects, whereas external evaluation is concerned with a model's influence and efficacy. The study does not discuss the external evaluation process because it is outside the scope of this study.

5. Conclusions and Future Agendas

The SAT Model is what smallholders need to produce oil palm sustainably based on competitiveness and IBE dimensions. The study establishes the components of the design and development of the training model the authority and smallholders need to implement the awareness training programme. It incorporates various features adapted from established scholars and duly endorsed by the relevant experts in the industry. Good agriculture practice (GAP) plays an integral part in it. The SAT Model necessitates the inclusion of Training Objective (TO), Training Content (TC), Smallholder Role (RS), Authority Role (RA), and Training Evaluation (TE) components (TE). The research establishes the future incorporation of various elements and rankings into each principal component of the SAT Model. The final phase is evaluating the usability of the developed model using the Nominal Group Technique.

The research supports the industry's theoretical, methodological, and practical aspects, which connect to social justice, commerce, academics, technology, law, religion, and the sustainability of oil palm production. The SAT Model applies to the study for future research initiatives and for other studies to utilise as a reference when contributing to industry and linked industries.

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Conflict of Interest

The authors declare no conflicts of interest.

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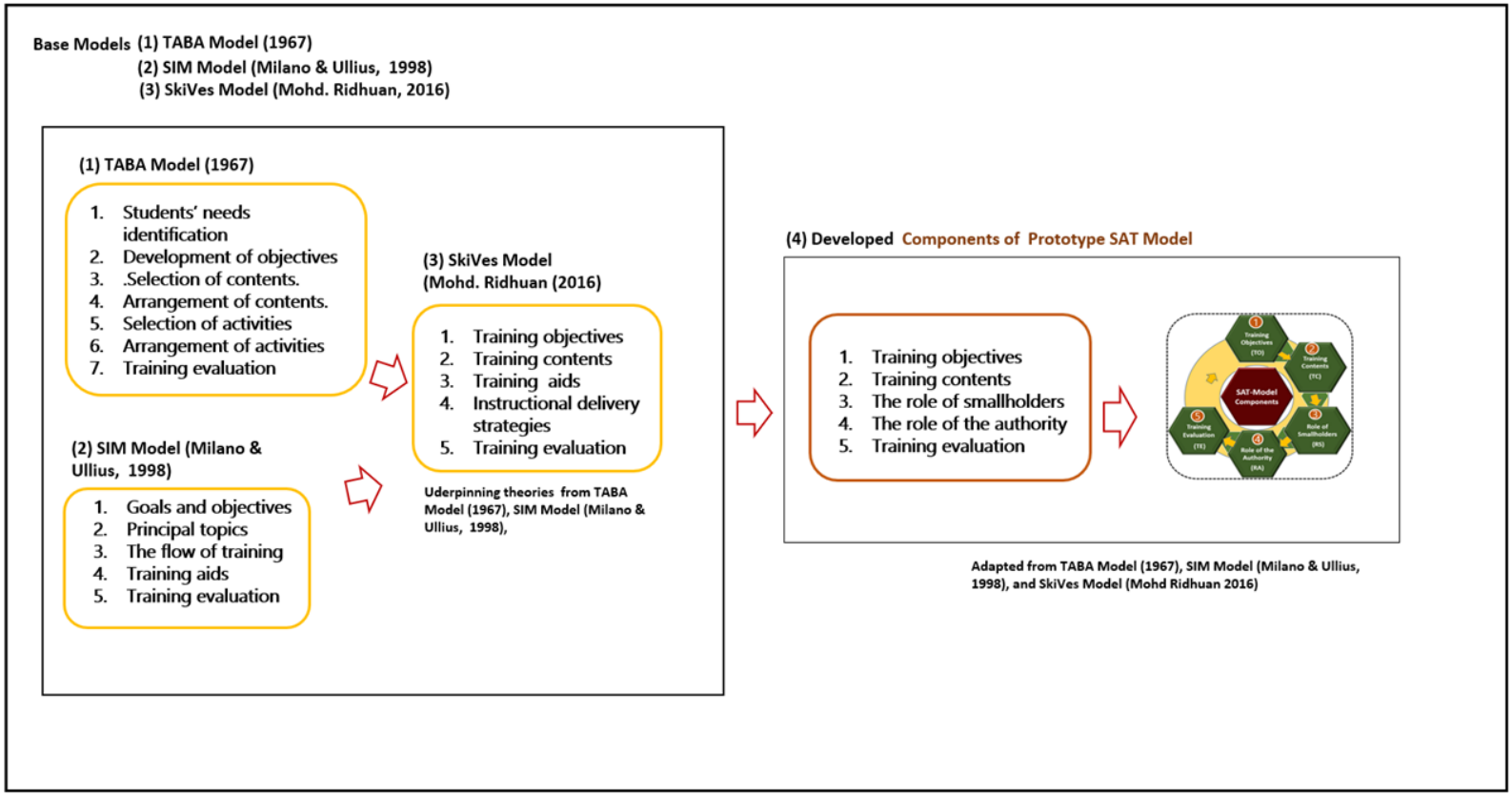
APPENDIX A

Development of SAT Model from Base-models



APPENDIX B

The Main Components of SAT Model