

Critical Success Factors of the Implementation of Chilli Fertigation System in Pahang, Malaysia

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Abstract

Chilli (*Capsicum annum* L.) is an important vegetable crop in Malaysia and cultivated commercially in fertigation system. By developing smart farming technology by using fertigation technique, it will improve productivity and yield quality, solve challenges such as climate change, labor shortages due to difficulty regenerating crops, and increase resource efficiency. The adoption of new technology in chilli cultivation is the most important phase for integrating new system into the traditional system in farm. The objective of this study is to assess the important critical success factors that influence the implementation of chilli fertigation system among farmers in Pahang, Malaysia. Based on the extensive literature review, this study has constructed a conceptual framework based on a knowledge and awareness factor, economy factor and market information factor as the key of antecedents. The framework was developed based on previous studies that were identified as critical success factors which are knowledge and awareness factor, economy factor and market information factor. A study was carried out on a sample of 92 respondents who have adopted this fertigation system from Jabatan Pertanian Negeri Pahang. A survey instrument including 19 measurement items was designed to identify the level of implementation in chilli fertigation system context. Descriptive statistical analysis and reliability analysis were used to analyse the data using SPSS software. The findings indicate that economy factor is the most important critical success factor, followed by market information factor and knowledge and awareness factor. This study makes a new contribution to fertigation system successful implementation. This study also provides an important information for decision-makers involved in fertigation system and provides useful reference for future researchers in this research area. As well as being more environmentally friendly than conventional methods, this technique also conforms to the current national agriculture agenda and adheres to the practice of sustainable agriculture development.

Keywords: Chili Fertigation System, Critical Success Factors, Implementation, Malaysia

Introduction

Chilli or its scientific name *Capsicum* spp. is a kind of fruit vegetables from the family Solanaceae (Salehi et al., 2018). Chilli is a plant that grows upright, rooted with branched green stems and the leaves are light green to dark green and oval width. The chilli flower has five white petals grown out of the branches and a leaf-shaped pendant. The fruit is an elongated tapered shape. Chili (*Capsicum annum*) is one of the most significant vegetables and spice crops grown in tropical locations across the world (Basu & De, 2003). The hotter varieties are known as chili, while the milder to moderately hot varieties are known as capsicum (Basu & De, 2003). The most significant species grown for vegetable consumption globally is the chili crop. Due to its flavorful, fragrant fruit with a high nutritional value, it is a significant crop in tropical Asia and equatorial America with a wide genetic foundation. The most significant species grown for vegetable consumption globally is the chili crop. Due to its flavorful, fragrant fruit with a high nutritional value, it is a significant crop in tropical Asia and equatorial America with a wide genetic foundation

Chilli is widely used as flavoring in cooking and food (Mazourek et al., 2009). Chili is a variety of fruit that is theoretically similar to berries since the character of chili is tiny and is used as a supplement in cooking or converted into spices depending on the culture of various nations. In Malaysia, there are two kinds of chilli, red chilli/ small red chilli, known as the bird's eye pepper which is grown commercially, and the large chilli. Among the large chilli varieties, Kulai 469, Kulai 151, Kulai 223, 461 and Kulai 568 are the most preferred by growers, while the bird's eye chilli popular among entrepreneurs are Centel and Bara. In Malaysia, chillies are most commercially grown in the lowlands. There are two ways of chilli cultivation, which are using the conventional method and the fertigation systems. The fertigation system is divided into two planting techniques are planting under rain shelter and open fertigation (Yaseer et al., 2012).

The role of agriculture in the economic growth of developing countries is important (Piya et al., 2012). The implementation of technology is essential in improving the yield and income of farmers. Therefore, the implementation and use of new technology is important in the growth of agricultural sector. Planting chilli using fertigation technology is effective in improving the growth and yield of chilli, up to 3-4-fold compared to the conventional methods. With the total area of agriculture land that is shrinking, fertigation system can maximise the use of limited land to increase crop production capacity. Utilising fertigation technology, which also affects plant growth and production in addition to nutrient efficiency, it is possible to modify the quality and rate of nutrients in accordance with the physiological development of the plant (Susila et al., 2022). Before or during planting, drip irrigation, or a combination of preplant and drip irrigation in fertigation (split) are all possible ways to apply fertilizer (Susila et al., 2022). Fertigation systems can also assist growers by providing a fantastic chance to improve production while using fertilizers efficiently while decreasing fertilizing application and saving money on fertilizers (Suliza, 2013).

In this system, fertilisation and irrigation are done simultaneously and directly to the plant root area. Fertigation system is also an alternative method to prevent soil-borne disease as well phytium and able to increase crop yields. Fertigation technology has proven to increase the yields of crops such as chilli, eggplant and rockmelon. Fertigation technology application in chilli can improve crop yields and ease of management. In Malaysia, planting using the fertigation technology can be carried out under a rain shelter or open fertigation (Yaseer et al., 2012). The implementation of a fertigation system is very crucial in order to get

a high quality of chili. Therefore, this study was carried out to identify the critical success factors of the implementation of chilli fertigation system.

Method

Population and Sample Size

This study focused on farmers who were involved in the implementation of chilli fertigation system. For this survey, the population lists were published by Jabatan Pertanian Negeri Pahang that contained information on farmers who work on chilli fertigation system, in which the total numbers available were approximately 120 persons.

Using Uma Sekaran table, from this population, a sample size was therefore drawn to be ninety-two farmers (92) who implemented chilli fertigation system under Jabatan Pertanian Negeri Pahang. A random sampling technique was then used in selecting the sample size. This study uses survey questionnaires and cross-sectional data to examine the instrument of the study Habidin et al (2016); Fuzi et al (2017); Habidin et al (2018) and to collect the information. This approach is adopted to provide validation and reliability towards the instrument selected. The data of survey and interview were collected and recorded using the online medium by using questionnaire in Google Document during December 2022 until January 2023. The questionnaires were available in dual languages, English and Malay. The questionnaire was then distributed using online platform which was WhatsApp application.

Research Instrument

In this study, the question was constructed through multiple choice questions and the Likert scale question. For the Likert scale question, the scale 1 to 5 was used, where number 1 represented strongly disagree and number 5 represented strongly agree. The questionnaire consists of 4 parts which are part A, part B, part C and part D in which Part A described demographic profiles of respondents such as gender, age, race, education level and monthly sales of production. While part B, the questions were developed to examine the implementation of chilli fertigation system among farmers. This part consists of 7 questions. The last part was part C. For part C, the questions were to determine the critical success factors of the study which is namely, knowledge and awareness factor, economic factor and market information factor. Thus, the total of 19 items survey questions were designed to obtain the respondents.

A pilot study is an initial step in the research and it is used for all research studies. The importance of the pilot study is to enhance the quality and the efficiency of the main research (Fuzi et al., 2017). According to Whitehead et al (2015), a reasonable sample size of at least 30 or greater is preferable for a pilot study. However, there is an argument from Johanson and Brooks (2009) stated that a sample size that range from 10 to 15 is good enough in providing for a pilot study. Therefore, the sample size is crucial for conducting the pilot study and to check the instruments used.

Cronbach's alpha provides a measure of the internal consistency of the scale used between 0 and 1 to test the reliability of the analysis (Tang et al., 2014). The acceptable values of Cronbach's alpha are ranges from 0.70 to 0.90 (Mohamad et al., 2013). Cronbach's alpha is measured to determine the internal consistency of each item and can be used to evaluate the quality of the instruments in the study. For this study, the instrument will test for reliability analysis using Cronbach's alpha.

In the pilot test, 92 questionnaires were recorded and analysed with IBM Statistical Package Social Sciences (SPSS) Statistics Version 25 software and the reliability of the instrument was

tested. In this study, an online survey was conducted by distributing the questionnaires. Out of 150 questionnaires distributed to the respondents, only 92 questionnaires were received and used for this study.

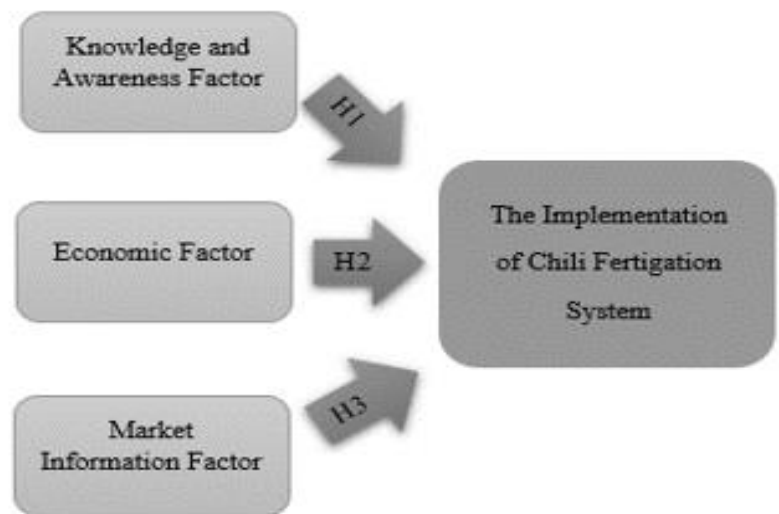


Figure 1: Conceptual Framework of Study

Data Analysis

The data analysis that used in this study was quantitative research or approach. Several methods were used to analyse the data which consisted of descriptive analysis and reliability analysis. The methods were chosen in order to understand the concept, thoughts, and experience of sample size by using open and close ended questions.

Descriptive analysis was computed for all socio-demographic variables. It gives brief summaries on the sample and findings. Descriptive analysis enables us to make a meaningful simplification of vast volumes of data. Each description simplifies a large amount of data to a concise summary. Therefore, descriptive analysis allows researcher to make it more relevant to display the data in a form that makes it easier to analyse the data (Zikmund et al, 2010).

Reliability analysis is defined as the degree to which measures are free from error and therefore yield consistent results (Zikmund, 2003). Cooper and Schindler (2006) explained that reliability is a necessary contributor to validity but is not a sufficient condition for validity.

Results and Discussion

Descriptive Analysis

The demographic profile of the respondents is shown as in Table 5 below. Table 5 shows the reliability analysis of this study. Table 5 and Table 6 shows the output of critical success factors of this study based on average mean.

The majority of gender involved in this study is male (59.8 per cent) and followed by 40.2 per cent female. This result presents that majority of farmers implemented chili fertigation system is dominated by male. Then, in term of respondent's age, majority of respondents are from 18-25 years old (33.7 percent). In terms of education, 20.7 per cent of respondents are from primary and secondary school, 28.3 per cent are diploma holders, 38 per cent is degree holders, 1.1 per cent is master and PhD holder, respondents with Malaysian skill certificate

are 7.6 per cent. This result shows that majority of these respondents have qualification other than tertiary education. Most of the respondents come from Islam region who are 85.9 per cent, followed by respondents from India who are 5.4 per cent and the least are from Chinese with 2.2 per cent. The average monthly sales production among respondents are below M500 (26.1 per cent), RM500-RM999 (10.9 per cent), RM1000-RM1999 (18.5 per cent), RM2000-RM2999 (28.3 per cent) and above RM5000 consist of 7.6 per cent.

Table 4

Demographic Information (n=92)

Respondent's Demographic	Details	Frequency	(%)
Gender	Male	55	59.8
	Female	37	40.2
Age	< 18 years	3	3.3
	18 – 25 years	31	33.7
	25 – 29 years	16	17.4
	30 – 39 years	27	29.3
	40 – 49 years	12	13.0
	50 – 59 years	3	3.3
	> 60 years	0	0
Regions	Islam	79	85.9
	Chinese	2	2.2
	India	5	5.4
	Others	6	6.5
Educational Level	Primary School	3	3.3
	Secondary School	16	17.4
	Diploma	26	28.3
	Degree	35	38.0
	Master/PHD	1	1.1
	Malaysian Skill Certificate	7	7.6
	Illiterate	4	4.4
Monthly sales production	RM 0 – RM 499	24	26.1
	RM 500 – RM 999	10	10.9
	RM 1000 – RM 1999	17	18.5
	RM 2000 – RM 2999	26	28.3
	RM 3000 – RM 4999	8	8.7
	>RM 5000	7	7.6

Source: Own survey (2022)

Meanwhile, Table 5 below shows the pilot results of reliability analysis for all factors of this study. All reliability analysis of this study showed good alpha values and (a) values within the

range of 0.768 and 0.805. In conclusion, the reliability analysis of the pilot data indicated that all the factors have alpha (α) value more than 0.7 (range from 0.768 to 0.805). Hence, it would be used to collect the actual data for chili fertigation system from Malaysian context.

Table 5

Reliability Analysis of the Study

Dimensions	No of items	Alpha (α) values	Item deletion	for Alpha (α) if item is deleted
<i>Knowledge and awareness factor</i>	7	0.768	None	
KAF1				0.711
KAF2				0.741
KAF3				0.738
KAF4				0.735
KAF5				0.742
KAF6				0.707
KAF7				0.795
<i>Economy factor</i>	6	0.804	None	0.770
EF1				0.776
EF2				0.757
EF3				0.747
EF4				0.800
EF5				0.786
EF6				
<i>Market information factor</i>	6	0.805	None	
MIF1				0.742
MIF2				0.785
MIF3				0.765
MIF4				0.788
MIF5				0.773
MIF6				0.786

Notes: KAF = knowledge and awareness factor, EF = economy factor, MIF = market information factor

Source: Own survey (2022)

Next, the results show all means for critical success factors of implementation for chili fertigation system in Table 6. The overall mean for each factor was obtained to identify the level of implementation in fertigation system context. The results are based on the five-point Likert scale and are illustrated in Table 6 and Figure 2. As presented in Table 6 and Figure 2, the mean values range from 4.0248 to 4.1866 which is good for chili fertigation system implementation. The three highest critical success factors of the dimension in this study are

economy factor (4.1866). Meanwhile, the remaining critical success factors of chili fertigation system are market information factor (4.1649) and knowledge and awareness factor (4.0248). It indicates that an economy factor is given the highest mean score in successful implementation in chili fertigation system.

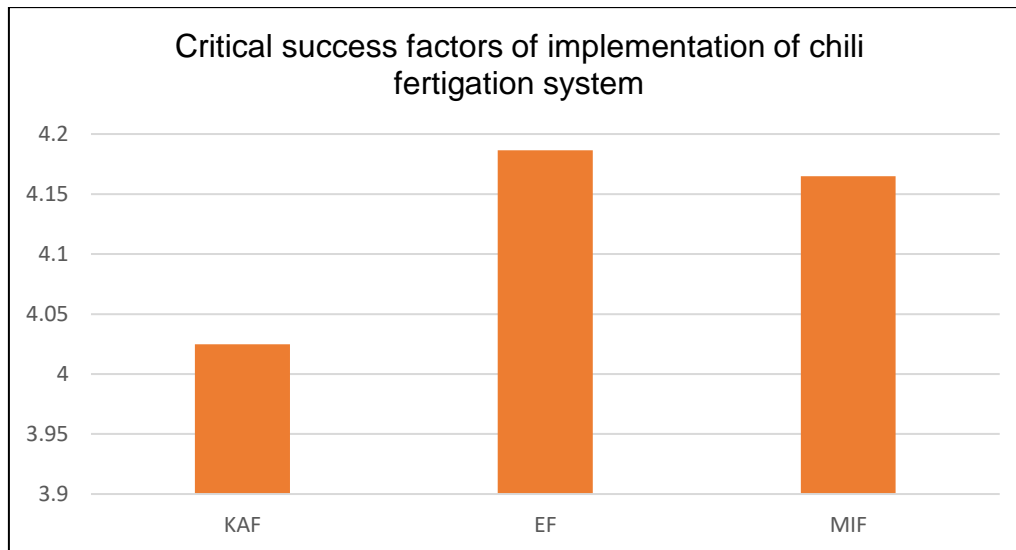


Figure 2: Critical success factors of implementation of chili fertigation system

Table 6

Average rating for critical success factors

Factor/items	Mean	Average Mean	Rank
<i>Knowledge and awareness factor</i>		4.0248	3
KAF1	4.0217		
KAF2	4.0870		
KAF3	4.3152		
KAF4	3.8370		
KAF5	4.2391		
KAF6	4.0217		
KAF7	3.6522		
<i>Economy factor</i>		4.1866	1
EF1	4.4239		
EF2	4.1087		
EF3	4.1739		
EF4	4.3478		
EF5	4.1522		
EF6	3.9130		
<i>Market information factor</i>		4.1649	2
MIF1	4.1739		
MIF2	4.3261		
MIF3	4.2283		

MIF4	3.9565
MIF5	4.0978
MIF6	4.2065

Source: Own survey (2022)

To ensure that the continuation of implementation is the actual outcome of chilli fertigation system, knowledge and awareness, economy and market information are used as a direct predictor to the implementation of chilli fertigation system. Based on the results, the top three critical success factors of knowledge and awareness, economy and market information are considered as the critical success factors that play the key role in determining the continued implementation of chilli fertigation system in agriculture. On the other hand, the three critical success factors of chilli fertigation system successful implementation in agriculture context are knowledge and awareness, economy and market information factor. These variables provide insights into the respondent's knowledge towards the system/technology, extant studies have less emphasised on organisational support, thus focusing on individual user's capacity such as cognitive absorption that play more important role in academic setting (Masrek and Gaskin, 2016).

Based on the results, the first important success critical factor that influenced the implementation of chilli fertigation system is economy factor. This is supported by Mohd et al (2016) who found that the economy factor led to successful implementation of chilli fertigation system by high net income received which is resulted from high yield for chilli. This is because this fertigation system able to increase chilli yield and high viability. Even though the cost of production to implement this system is quite high but it can be set off by high production yield of chilli. Thus, economy factor can be considered as an important determinant to encourage the implementation of chilli fertigation system. The second important critical success factor is market information factor. This is supported by Yuan et al. (2021) noted that the farmer's information processing ability and information acquisition channels influence the implementation of chilli fertigation system among farmers.

The lowest of critical success factor of chilli fertigation system implementation is knowledge and awareness. From the findings, knowledge and awareness is less influence the implementation of chilli fertigation system. This is supported by Al-Shadiadeh (2011) stated that farmers tended not to be aware or have low levels of awareness with respect to fertigation system which further lower the adoption of chilli fertigation system. In addition, Bakhsh et al (2020) mentioned that the major constraints regarding less adoption was lack of awareness. Further, Bakhsh et al (2020) declared there is a dire need for creating awareness among the farming community. It is a need of the time to train and educate farmers regarding drip fertigation system so that dissemination and implementation of chilli fertigation system can be ensured on sustainable basis (Bakhsh et al., 2020).

Therefore, based on the results and literary evidence, all three critical success factors of economy factor, market information factor and knowledge and awareness factor are valid and reliable and thus are also considered as the critical success factors that play the key role in determining the successful implementation of chilli fertigation system.

Conclusion

Based on the empirical data survey, the three factors of economy, market information and knowledge and awareness have been shown to be the successful factors, valid and reliable for chilli fertigation system implementation in Malaysian agriculture. Based on the reliability analysis, all factors were accepted for this study. The critical success factors of this study are ranked through average mean and it concludes that the three constructs of the dimensions are the highest with net benefits tops the ranks. The economy recorded for the highest rank in this study, meanwhile, the second rank is market information and the last rank critical success factor is the knowledge and awareness factor.

For practical implications, the development of instruments in this study may be valuable tools to evaluate critical factors of chilli fertigation system. This study also provides important guidelines for Malaysian agriculture to implement this system among farmers. This research finding would provide new insights for the critical success factors of chilli fertigation system to improve yield in this industry. Nevertheless, the improvement on chilli production system will have positive effect on the farmer's income.

In order to reach their goals and meet changing trends, obstacles and to be competent to flourish in the agricultural field, the farmers must be appropriately moulded with essential technology and system. Government support for farmers would be a prominent factor for them to increase the implementation level of chilli fertigation system. They also have to ensure farmers have secure funds and provide them with vital funding and support for farming, by providing the right plan or giving a platform to highlight the products from farmers. Other than that, creating more courses, seminars, campaigns that can open the eyes of farmers to grow their business especially in chilli planting should be fully encouraged.

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