Digitalizing Small-Scale Fish Farmers (SSFFs) with Aquaculture Virtual Extension Service Mobile Application (AVESMA) to enhance aquaculture businesses

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Abstract. The limited number of field extension services has impacted the assistance to small-scale fish farmers (SSFFs), becoming less effective and less efficient. The Aquaculture Virtual Extension Service Mobile Application (AVESMA) is a mobile-based application for SSFFs to assist aquaculture activities by providing mobile features that support technical and financial information and monitoring as well as marketing. So far, SSFFs have utilized the Internet of Things (IoT) in their aquaculture activities, but the extent of its use has not been widely researched. This research aims to determine the influence of the use of IoT that has been implemented by SSFFs on marketing and identify the challenges that arise when using the AVESMA android-based application. This research used a mixed method of qualitative and quantitative research. Qualitative research was used to identify the challenges faced by small-scale SSFFs when utilizing the AVESMA application, while quantitative research was used to analyze the influence of IoT in marketing which has already been used by SSFFs. There were 40 respondents in this study who were selected purposively based on certain criteria. Quantitative analysis was carried out with statistical tests in the form of correlation and regression analyses, while qualitative analysis was carried out descriptively. The research results show that the use of IoT has a significant influence on marketing. Meanwhile, interview results show that SSFFs utilize WhatsApp and Facebook for their businesses. Challenges in using AVESMA include signal instability, application complexity, limited cultivation information in the application, and limited technical capabilities in using the AVESMA application.
Key Words: Facebook, Internet of Things, marketing, WhatsApp.

Introduction. In the era of industrial revolution 4.0 and rapid advances in information technology, the challenges that will be faced will be greater, and most processes will be carried out automatically. The entry into the era of Industrial Revolution 4.0, where the existence of the Internet of Things (IoT) is one of the main characteristics, has made very significant changes in various sectors of life (Wortmann & Fluchter 2015). In general, IoT refers to network interactions of everyday objects that are often equipped with ubiquitous intelligence (Xia et al 2012). Mastery of technology and information that has developed rapidly, such as the use of the internet, has hit all levels of society, including small-scale fish farmers (SSFFs). Previous studies have acknowledged that SSFFs have also utilized the internet for their fish farming businesses (Elfitasari et al 2018; Apresia et al 2020; Septiara et al 2022; Elfitasari et al 2023). The internet is a network that can not only provide extensive information (Windihastuty 2021), but is also the largest buying and selling media in the world by providing marketplaces such as Shopee, Tokopedia and other world marketplaces. Witro et al (2021) stated that there appears to be competition between these marketplaces to attract buyers' interest.

The number of extension services in Semarang City is insufficient compared to the number of SSFFs who need assistance (Elfitasari et al 2019; Kusmuntono et al 2022). This situation has made assistance of extension service to SSFFs inefficient. Based on the research conducted by Elfitasari et al (2019), the limited number of extension services can be solved by developing a virtual extension service with using social media such as

WhatsApp, Telegram, etc. However, these social media do not focus on aquaculture-based activities. A more advanced and fish farming-focused mobile application that could assist SSFFs in carrying out their fish farming activities was urgently advised. Therefore, grounded from the result of this research, a mobile application called Aquaculture Virtual Extension Service Mobile Application (AVESMA) was constructed and is expected to ease the assistance of SSFFs in carrying out their aquaculture activities. Currently, the AVESMA basic application has been launched and the marketing feature is still in the construction phase. Therefore, in order to support the construction of AVESMA marketing feature, this study aims to determine the influence of the use of IoT that has been implemented by SSFFs on marketing and identify the challenges that arise when using the AVESMA android-based application.

Aquaculture Virtual Extension Service Mobile Application (AVESMA). AVESMA is an Android-based application that can be downloaded via Play Store and contains information about fish farming practices and management based on the rules of the Indonesian National Standard (SNI). The AVESMA application can help SSFFs in managing data in the form of financial monitoring data, pond information, as well as the results of water quality monitoring during cultivation activities. The AVESMA application has 5 main features: information on fish farming techniques and management in the form of articles or video links, data input for water quality monitoring, financial monitoring, marketing of harvests, and links to chat with extension workers. In the AVESMA application, there are articles and videos that can help SSFFs increase their cultivation knowledge. In addition, there are several fishery-based products that have been tested previously so that they can be directly applied by SSFFs and are suitable to be used as business ideas to add value to their harvest. Furthermore, the AVESMA application can be accessed by SSFFs anywhere and at any time via smartphone.

The AVESMA application also provides a platform for SSFFs to market their fish harvest. The AVESMA marketing feature helps to market farmers' harvests and is connected to the product sales website called the AVESMA virtual market. This way, through the AVESMA application, SSFFs can market their harvest more easily. Marketing is one of the most important factors in running an aquaculture business because marketing is an economic action that influences the level of income of SSFFs. Therefore, high production does not always provide high profits without good and efficient marketing (Kurniasari et al 2019). The marketing system consists of three interrelated parts, namely production, consumption, and marketing channels. Production is the amount of fish produced, brought to consumers directly. Consumption is the amount of fish produced that will be utilized by consumers. Marketing channels are a series of interdependent organizations involved in the process of making a product or service ready for use or consumption (Oktaviana et al 2018). In this way, it is expected for the AVESMA application to help the role of extension services in distributing information related to fish farming. Therefore, even with a limited number of extension services in Indonesia, they can optimally assist SSFFs in running the fish farming businesses. Some examples of the AVESMA features are provided in Figure 1.

The AVESMA application currently provides features for monitoring water quality for a limited number of fish and shrimp species. It also provides features for financial monitoring, where SSFFs can input their costs and sales to calculate their profit at the end of the fish culture cycle. The application also has links to the AVESMA Academy YouTube channel, where a tutorial on how to use AVESMA is provided. It also provides links to other fish farming information and recipes to add value to the SSFF harvest. This application is also linked to the virtual fish market website to promote the SSFFs harvest.

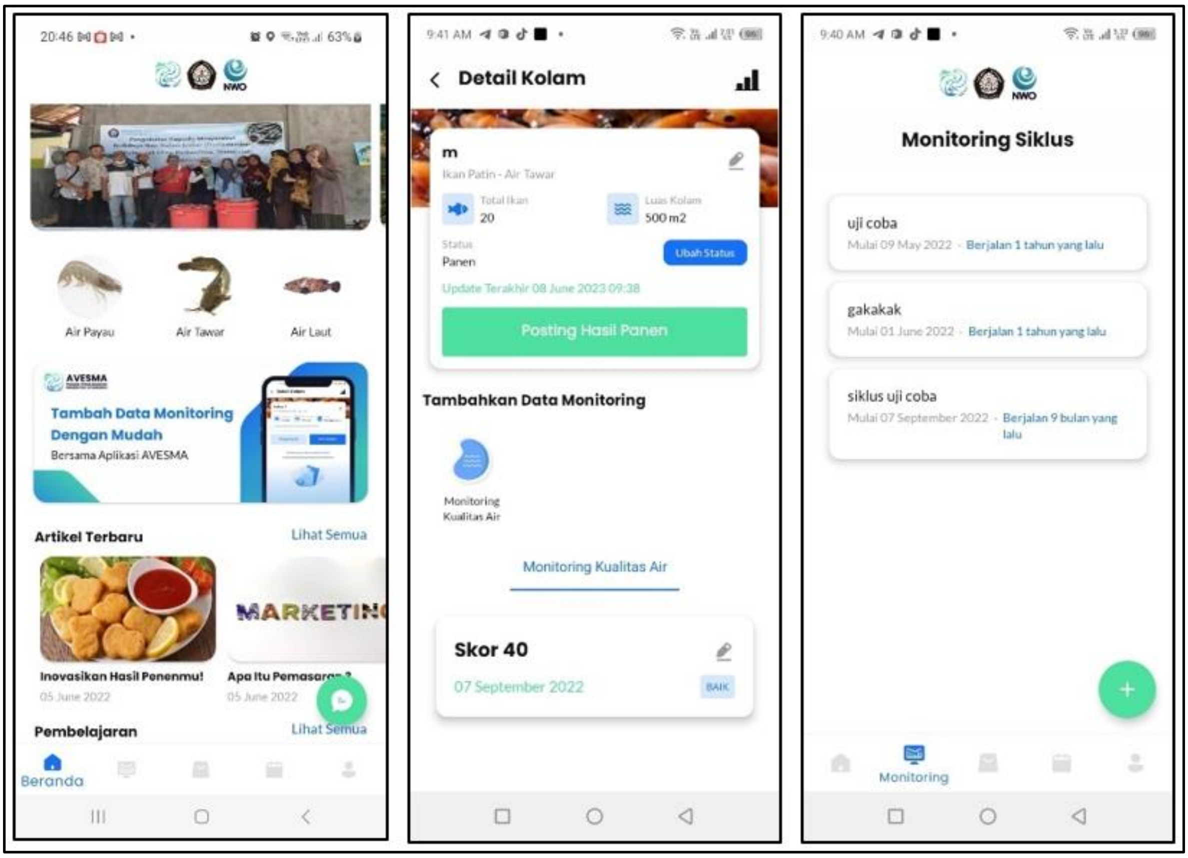

Figure 1. Some features of the AVESMA application.

Material and Method

Methodology. This research used mixed methods, namely quantitative and qualitative methods. The quantitative research method is used to analyze the influence of IoT in marketing, which has been used by SSFFs, while the qualitative method was used to identify the challenges faced by SSFFs when utilizing the AVESMA application.

The population in this study was represented by SSFFs in Tugu District, Semarang City, Indonesia. The respondents were selected purposively, with certain criteria: they are part of the Fish Farming group, own and use an Android-based mobile phone, and are willing to become respondents by downloading and using the AVESMA application. The population in this study was comprised of 86 people, but only 40 people had Android-based mobile phones, therefore, the number of samples used in this study was 40 people.

The quantitative data collection used the IoT questionnaire and the marketing questionnaire. The aspects in the IoT questionnaire were taken from Venkatesh & Davis (2000): perceived ease of use, perceived usefulness, and behavioral intention of use. Meanwhile, marketing aspects included product, place, price, and promotion according to the theory of Kotler & Keller (2021). The Likert scale used in this research had a minimum score of 1 and a maximum score of 4, to obtain the respondent's certain answer, whether they tend to agree or disagree. The in-depth interview techniques were used to collect qualitative data, where SSFFs revealed the social media they had used so far and the challenges they had experienced when using the AVESMA application.

Data analysis. The data analysis used in the qualitative research was descriptive analysis, while quantitative research used statistical tests, namely validity tests, reliability tests, assumption tests, and hypothesis tests (correlation and regression).

Results and Discussion. In testing the research instrument, the results of the validity and reliability tests can be seen in Table 1.

The results of the validity test in the first round contained invalid items. Therefore, a second round of the validity test was carried out. According to Amanda et al (2019), the validity test on the instrument must be carried out several rounds to obtain a truly valid instrument. The results of the second round were all valid (Table 2).

Table 1

The first round of the validity test of the Internet of Things questionnaire

Items	*R count*	*Sign*	*R table*	*Information*
Y.1	0.619	>	0.334	Valid
Y.2	0.325	<	0.334	Invalid
Y.3	0.298	<	0.334	Invalid
Y.4	0.620	>	0.334	Valid
Y.5	0.585	>	0.334	Valid
Y.6	0.462	>	0.334	Valid
Y.7	0.713	>	0.334	Valid
Y.8	0.516	>	0.334	Valid
Y.9	0.707	>	0.334	Valid
Y.10	0.566	>	0.334	Valid
Y.11	0.730	>	0.334	Valid
Y.12	0.694	>	0.334	Valid
Y.13	0.536	>	0.334	Valid
Y.14	0.572	>	0.334	Valid
Y.15	0.717	>	0.334	Valid
Y.16	0.782	>	0.334	Valid
Y.17	0.599	>	0.334	Valid
Y.18	0.475	>	0.334	Valid
Y.19	0.642	>	0.334	Valid
Y.20	0.625	>	0.334	Valid
Y.21	0.661	>	0.334	Valid
Y.22	0.416	>	0.334	Valid
Y.23	0.538	>	0.334	Valid

Table 2

The second round validity test of the Internet of Things questionnaire

Items	*R count*	*Sign*	*R table*	*Information*
Y.1	0.619	>	0.334	Valid
Y.2	0.620	>	0.334	Valid
Y.3	0.585	>	0.334	Valid
Y.4	0.462	>	0.334	Valid
Y.5	0.713	>	0.334	Valid
Y.6	0.516	>	0.334	Valid
Y.7	0.707	>	0.334	Valid
Y.8	0.566	>	0.334	Valid
Y.9	0.730	>	0.334	Valid
Y.10	0.694	>	0.334	Valid
Y.11	0.536	>	0.334	Valid
Y.12	0.572	>	0.334	Valid
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Y.17	0.642	>	0.334	Valid
Y.18	0.625	>	0.334	Valid
Y.19	0.661	>	0.334	Valid
Y.20	0.416	>	0.334	Valid
Y.21	0.538	>	0.334	Valid

Out of the 23 research questionnaire items on the IoT that have been tested, two questionnaire items were invalid, namely items number 2 and 3, and were excluded from the questionnaire. Thus, only 21 items of the IoT questionnaire instrument could be used as data collection tools.

The results of the first round of validity testing for the marketing questionnaire can be seen in Table 3.

Table 3

The first round of the validity test of the marketing questionnaire

Items	*R count*	*Sign*	*R table*	*Information*
Y.1	0.619	>	0.334	Valid
Y.2	0.535	>	0.334	Valid
Y.3	0.278	<	0.334	Invalid
Y.4	0.571	>	0.334	Valid
Y.5	0.391	>	0.334	Valid
Y.6	0.572	>	0.334	Valid
Y.7	0.198	<	0.334	Invalid
Y.8	0.522	>	0.334	Valid
Y.9	0.612	>	0.334	Valid
Y.10	0.553	>	0.334	Valid
Y.11	0.096	<	0.334	Invalid
Y.12	0.594	>	0.334	Valid
Y.13	0.557	>	0.334	Valid
Y.14	0.690	>	0.334	Valid
Y.15	0.405	>	0.334	Valid
Y.16	0.557	>	0.334	Valid
Y.17	0.578	>	0.334	Valid
Y.18	0.446	>	0.334	Valid
Y.19	0.172	<	0.334	Invalid
Y.20	0.611	>	0.334	Valid

Since some of the questionnaire items appeared to be invalid, the validity test was carried out again for the second round with the following results:

Table 4

The second round of the validity test of the marketing questionnaire

Items	*R count*	*Sign*	*R table*	*Information*
Y.1	0.619	>	0.334	Valid
Y.2	0.535	>	0.334	Valid
Y.3	0.571	>	0.334	Valid
Y.4	0.391	>	0.334	Valid
Y.5	0.572	>	0.334	Valid
Y.6	0.522	>	0.334	Valid
Y.7	0.612	>	0.334	Valid
Y.8	0.553	>	0.334	Valid
Y.9	0.594	>	0.334	Valid
Y.10	0.557	>	0.334	Valid
Y.11	0.690	>	0.334	Valid
Y.12	0.405	>	0.334	Valid
Y.13	0.557	>	0.334	Valid
Y.14	0.578	>	0.334	Valid
Y.15	0.446	>	0.334	Valid
Y.16	0.611	>	0.334	Valid

The number of marketing questionnaire instrument items tested was 20 items. The results of the validity test revealed that 4 questionnaire items were invalid, namely numbers 3, 7, 11, and 19, and were excluded. Therefore, only 16 items of the marketing questionnaire instrument could be used as a data collection tool. The results of the reliability test can be seen in Table 5.

Table 5

Internet of Things reliability test results

Cronbach's Alpha	*Minimum Cronbach's Alpha coefficient*	*N*
0.914	0.334	21

The reliability test was carried out on 21 question items. The Cronbach's Alpha value of all items in the reliability test was 0.914, which shows that this instrument was reliable for distribution to respondents. The reliability of the marketing questionnaire is presented in Table 6.

Table 6

Marketing reliability test results

Cronbach's Alpha	*Minimum Cronbach's Alpha coefficient*	*N*
0.850	0.334	16

The results of reliability testing of marketing research instruments after reliability testing were carried out on 16 items. The Cronbach's Alpha value of all items in the reliability test was 0.850, so this instrument was reliable.

After the instruments were assured to be valid and reliable, questionnaire were distributed to respondents and data was collected to analyze the correlation between the IoT and marketing. The result are presented in Table 7.

Table 7

Internet of Things correlation test results with marketing

		IoT	*Marketing*
IoT	Pearson Correlation	1	0.411**
	Significance(2-tailed)		0.003
	N	40	40
Marketing	Pearson Correlation	0.411**	1
	Significance(2-tailed)	0.000	
	N	40	40

Note: IoT - Internet of Things.

IoT variables on marketing show a significant positive correlation between the impact of the IoT and marketing factors. This means that IoT plays an important role in marketing for SSFFs. This is in line with Ismet & Indiarto (2006), noting that information and communication technology plays an important role in marketing, especially in creating an efficient marketing system to achieve higher productivity and support economic growth. The results of the simple linear regression test can be seen in Table 8.

The regression test results in Table 8 show a positive value, so it can be said that the direction of the influence of the IoT on marketing is positive. The significance value obtained was 0.003<0.05, so it can be concluded that the IoT variable (X) has an effect on the marketing variable (Y). This indicates that the more IoT was used, the higher was the marketing outcome of respondents.

Table 8

Simple linear regression test results

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. error	Beta	Q	Sig.
Constant	27.391	7.382		3.711	0.001
IoT	0.313	0.112	0.411	2.781	0.003

Based on the results of correlation tests and simple linear regression tests that have been carried out, it can be said that the IoT influences SSFFs marketing. This shows that the internet has an important role in the marketing of fish farmers. This confirms the research results of Septiara et al (2022), which determined that the use of IoT in the form of social media has a significant effect on the marketing of small-scale farmers' harvests. This is supported by interview results which show that respondents utilize social media in their marketing, as depicted in Figure 2.

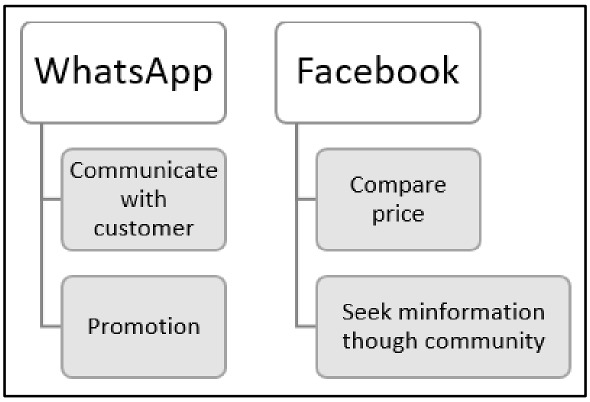

Figure 2. Internet of Things used as a marketing tools by small-scale fish farmers.

Based on the results of interviews, it is known that SSFFs use two social media, which are WhatsApp and Facebook, to help their cultivation activities. These two social media have different functions for SSFFs. WhatsApp is increasingly being used by SSFFs as a means to promote their harvests and to communicate with customers. WhatsApp is an application for exchanging messages without any fees because WhatsApp uses the same internet data package as email and web browsing. The WhatsApp application uses a 3G or WiFi connection for data communication. WhatsApp is commonly used to chat online, share files, and send photos or videos, as well as promote a product (Anjani et al 2021). Apart from that, the research results of Apresia et al (2020) showed that SSFFs who use WhatsApp have a higher level of income and aquaculture knowledge compared to SSFFs who do not use WhatsApp.

In this research, the social media Facebook was found to be mostly used by fish farmers to compare selling prices with other farmers so that their offering prices were not too different. Apart from that, SSFFs use Facebook to join the SSFFs community and look for important information related to fish farming. The results of this research are in line with Elfitasari et al (2018), who found that SSFFs who are part of the fish cultivator community on Facebook have a higher level of knowledge and finances compared to their counterparts who do not utilize Facebook.

As a result of interviewing respondents regarding challenges in using the AVESMA application, it is known that respondents experienced several challenges (Figure 3).

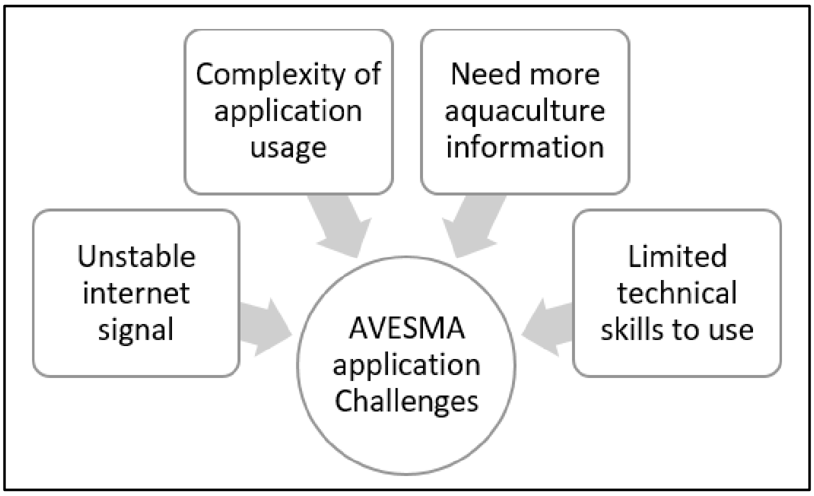

Figure 3. Challenges encountered by small-scale fish farmers in using the AVESMA application.

The interview results show that several challenges in using AVESMA include signal instability, application complexity, limited cultivation information in the application and limited technical capabilities. Remote locations are often unreachable by signal, so the AVESMA application sometimes takes a long time to load. Stable internet signals are important to successfully connect production and marketing centers, thus facilitating the flow of goods and services from one area to another (Pertiwi et al 2018).

For some SSFFs, the AVESMA application is considered rather complex and less simple to use, especially for inputting the monitoring data. There is information about the lack of simplicity in inputting monitoring data in the application, so it is necessary to improve the application, to simplify the data input system. Furthermore, SSFFs feel that the cultivation information in the application is inadequate. Based on information from these SSFFs, it is necessary to add information to the application according to the SSFFs' needs. The final challenge is the limited ability of SSFFs to operate the application. This often happens to SSFFs of older age. According to Gupta & Dey (2015), age can influence the role of cultivation activities. Young and middle-aged SSFFs have differences in running a cultivation business. Young SSFFs will be more enthusiastic and energetic than middle-aged SSFFs in responding to new technology. Middle-aged or older SSFFs would tend to be conservative in not choosing to try new things. According to Guzzo et al (2022), the age of the workforce can influence productivity, where older workers are less productive than younger workers. For this reason, there is a need for continuous assistance in using the AVESMA application until SSFFs understand its use. Apart from that, simplifying the application system also needs to be done.

One feature that is not yet used is the harvest marketing feature, which is connected to the AVESMA virtual market website. This is because there is still poor connectivity between input data on the application and the website, so improvements are still required in developing the application in the future. The improvements that need to be made include simplifying the data input flow, adding more complete and varied cultivation information, as well as connectivity with the virtual market website. Apart from that, the interview results also identified the expectation of SSFFs in improving the AVESMA application, namely providing a platform in the form of a fish farmer community and a sales market for not only fresh fish products, but also processed products.

Conclusions. The influence of the Internet of Things on the marketing of fish harvest shows a positive relationship. This shows that the use of IoT has an important role in marketing by SSFFs. The social media currently used by respondents is WhatsApp and Facebook, with different usage purposes. WhatsApp is used for promotions and to communicate with consumers, while Facebook is used to compare selling prices and search for information within the fish farmer community. Some of the challenges for SSFFs in using the AVESMA application are signal instability, application complexity, limited cultivation information in the application, and limited technical capabilities in using the application. Based on information from SSFFs regarding the use of the AVESMA application, it is necessary to improve it by simplifying the data input flow, adding more and varied fish farming information, as well as application connectivity with the virtual market website.

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