

Development of a Mobile Aquaculture Management Systems for Performance Monitoring of Aquaculture Players

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Abstract—Towards achieving National Transformation 2050 for Malaysia's smart communities 2050 with the Fourth Industrial Revolution, Malaysia aquaculture industry has become a targeted industry for the fast-growing food industry in the digital revolution that ranked in the top 15 world producers in 2014 with an estimated 521,000 tonnes of total aquaculture production. It is aligned to the 11th Malaysia Plan under the National Agrofood Policy (NAP), 2011-2020. However, in this recent years, the aquaculture sector in Malaysia is facing serious challenges in environmental issues and managing aquaculture systems during disease outbreak and disaster. This is due to lack of timely shared information among aquaculture players. For the purpose of the study, this paper used to address a mobile web application innovation as a disruptive technology to manage aquaculture systems in order to share the useful information of aquaculture issues on the right time and to the right person. Based on Design Science Research philosophy, Generic Design Cycle applied as the research methodology to develop mobile application development. Therefore, the advantages of the innovation and the significant impact to the industry also highlighted in this paper.

Index Terms—Aquaculture; Aquaculture Management Systems; Aquaculture Mobile Systems; Mobile Application.

I. INTRODUCTION

Malaysia was known as world major seafood contributors with an estimated 521,000 tonnes of total aquaculture production and ranked in top 25 world producer in 2014 [1]. Worldwide statistics of global output shows that the Malaysian fisheries contribute 1.1% share of global output in 2013 with 0.4% is supplied from the aquaculture industry [2] that created an approximately 1,753,900 million jobs for Malaysians [3]. It represents that the aquaculture sector not simply provide food security to the nation but the industry has been recognized as the global potential contributor to alleviating hunger and poverty [4]; [5]; [6]; [7].

Apart from providing adequate food access for the growing population around the world [8], the aquaculture industry has built continuous accomplishment in technology development. The technology development known as disruptive technologies has disrupts existing market and transform the industry in several ways including aquaculture feed improvement [9]; [10]; [11]; [12], broadening successful genetics breeding program [[13]; [14]; [15]; [16]; [17]] enhancing aquaculture development by aquaculture best management practice [18]; [19]; [20]; [21] and developing

advanced culture systems technology [22]; [23]; [24], whereas the issues in getting timely information on current aquaculture production, disease outbreak, new technology implementation, new aquaculture systems and variety of feeding practice among aquaculture players in aquaculture sectors endure the worldwide research subject.

In Malaysia, the research found that the sector has encountered several issues and challenges due to lack of timely information [25]; [26]. As we moving towards Fourth Industrial Revolution, state-of-the-art technologies of mobile application have widely used around the globe. Hence, the objective of this paper is to propose a mobile aquaculture management systems for the purpose of reporting and sharing the issues of aquaculture that further resulted as a performance monitoring to aquaculture players. The paper also describes the function of the application and the significant impact of aquaculture mobile web application, a disruptive technology in this new era.

Therefore, to understand of these innovative products, the paper starts with a literature review of the mobile application. Then, in Section 2, the paper describes the significance of the mobile web application. The third considerations applied to the approach is the importance of mobile application in managing aquaculture systems and the impact to the sector, aquaculture players, and community. Section 4 briefly describe the research methodology of AkuaHub application development. The advantages of AkuaHub application will be emphasize in detail in section 5. Section 6 suggests web application as tools of communication between stakeholders. Finally, the conclusions, limitations, and implications of the study are explored.

II. BRIEF REVIEW OF MOBILE APPLICATION

The history of application starts with the first apps have been developed in the 1970s with the built of Snake video game embedded in the Nokia mobile phone that further followed by other games namely Pong, Tetris and Tic-Tac-Toe [27]; [28]. This early phone changed the way people thought about communication as the communication has evolved with new technologies.

Apart from that, mobile applications are consists of software or set of program that developed on a mobile device and perform particular tasks for the user [29]. According to the study, the mobile application is user-friendly, economical,

downloadable and able to run in most of the cheap and entry level mobile phone.

Due to its advantages for billion of users, research by Global Mobile Application Market [30] for expected years over 2010 to 2015, approximately 6.4 billion mobile application that is free, paid or ad-supported has been downloaded from native and third-party application store with the total revenues recorded was \$4.5 billion with 2.5 billion download and their research estimates the global mobile applications market is expected to be worth \$25.0 billion in 2015.

III. THE USAGE OF MOBILE APPLICATION

The mobile application has a variety of usage. Despite widely used mobile application for calling, messaging, browsing, chatting, audio, video and gamification [29], research found that the mobile application also used for social networking [31]; [29] and education learning [32] (Table 1). Recently, the most popular mobile application has been developed for transportation (Uber), communication (Whatsapp), food market (Food Panda), accommodation (Trivago) and location maps (Waze).

Table 1
Overview of the mobile application by Islam et al., 2010

Summary of mobile application overview	Description	
Different categories of mobile application	1. Communications: Internet Browsing, email IM client, Social Networking	
	2. Games: Puzzle/ Strategy, Cards /Casino, Action/Adventure	
	3. Multimedia: Graphics /Image viewer, Presentations viewers, Video Players, Audio players	
	4. Productivity: Calendars, Calculators, Diary, Notepad/Memo/Word Processors, Spreadsheets	
	5. Travel: City guide, Currency converter, Translators, GPS/Maps, Itineraries / Schedules, Weather	
	6. Utilities: Profile manager, Idle screen/Screensaver, Address book, Task manager, Call manager, File manager	
	Past uses of mobile application	Alarm clocks, currency calculators, receiving call messaging, Communication like internet browsing (Facebook, Twitter), low-cost call (VoIP application), mobile commerce (Mobile Wallet), mobile banking (Maybank, CIMB Berhad), eTicketing, video and movie (YouTube)
	Present uses of mobile application	
Category of most apps used in 30 days by (survey by The Nielsen Company for smartphone in 2010)	1. Games: 61% 2. Weather: 55% 3. Maps/Navigation/Search: 50% 4. Social Networking: 49% 5. Music: 42% 6. News: 36% 7. Entertainment: 33% 8. Banking/ Finance: 28%	

Based on the review, it shows that the mobile web application has provided significant impact to the global community. The growth of 15,000 new apps weekly is evidence that the mobile apps growth has shown no sign of slowing [33].

IV. THE IMPORTANCE OF MOBILE WEB APPLICATION USAGE IN AQUACULTURE MANAGEMENT SYSTEMS

The mobile application could reduce time, cost and energy because the mobile application provides real-time access to the required data, works on-line and off-line operation, improve management decision-making, faster and more informed decisions, practical and cost-effective.

It was proven by the implementation of Uber application as the application has changed tremendously of public transportation market view [34]. With the existing of Uber, people will worry less about safety and the cost is cheaper than taxi transportation [35]. This scenario could be implemented in aquaculture sector as the current practice of reporting production data and other related issues to the aquaculture had consumed much time, high cost and energy waste. Based on an interview with fisheries officer in 2017, the production data were recorded manually for low-income aquaculture farmers while high cost was implemented by big companies and meanwhile, the fisheries officers are required to visit all aquaculture farms that no longer practical to some circumstances.

The advantages could benefit the aquaculture sector, the players, and community through AkuaHub application that will be introduced as a product from this study. The advantages of each differ categories were explained in details:

A. Aquaculture industry

The traditional way of reporting will be reduced continuously with the transformation of the modern way of reporting. As we learn from the past, we could create the future by transforming the way of reporting. The industry will transform not only the reporting process, it also transforms in receiving real-time data that works on-line and off-line operation. Moreover, the development of location-based monitoring systems is a significant trend for apps development while data organized through the cloud are mobile apps advantages [36]. Therefore, AkuaHub differs from other aquaculture application particularly in the useful package of the real image of the aquaculture sites and their products, the aquaculture sites location with latitude and longitude, index of aquaculture companies, and the Halal certified aquaculture companies. This will boost the economics of the industry as it provides healthy competition among aquaculture producers to produce the safe and healthy products with competitive price to the consumers.

B. Aquaculture players

In this sector, aquaculture players are consists of major actors namely brood-stock suppliers, hatchery farmers, culturist, collectors and related processing companies [37]. Apart from that, service providers such as the department of fisheries and financial institutions are a group that formed as aquaculture stakeholders while industry associations including importers and exporters are major associations to the sector [38].

However, the main scarcity is the poor interaction between aquaculture players and the fisheries authorities (Department of Fisheries Malaysia). This is due to lack of meaningful communication and the absent of updated information that accessible to aquaculture sector [39]. Thus, the research found that interactive and efficient communications along with social transitions among organization and the

stakeholders could be developed by using the internet [40] as the technology transmits huge information with fast and cheaper costs compared to traditional media [41]. As the mobile application is state-of-the-art technologies, information of actual aquaculture sites (as location-based monitoring systems) and the highest ranking of aquaculture companies would provide useful information to the department of fisheries to monitor the aquaculture development while exporters would gain benefit by identifying the best aquaculture companies through Index status of aquaculture companies. The aquaculture companies could easily market their products in the application to the right person.

C. Community

The development of mobile application not only helps the job vacancy in mobile application business [29], moreover it helps to boost the growth of aquaculture industry by providing the right information on job opportunities to local community, for example, aquaculture processing companies and aquaculture sites required local residents to work with the company since the aquaculture sites normally situated in remote area. Therefore, by using AkuaHub, advertisement on job vacant will be spread widely to the local community. Apart from providing job opportunities, the community could report to the authorized bodies regarding unethical feeding practice by farmers.

Malaysia as world aquaculture producers should be competitive in order to sustain in the industry as global demand is continuously increasing every year. By introducing AkuaHub mobile application, it likely gives a new paradigm of reporting, market view of aquaculture and increases interaction between stakeholders to the aquaculture industry.

V. METHODOLOGY OF DEVELOPMENT AKUAHUB APPLICATION

To achieve the objective of the study, this research will adapt to the Design Science Research (DSR) as a research philosophy with Generic Design Cycle as methodological approach. The stages of research explained briefly in form of Generic Design Cycle, beginning with awareness of problems, suggestions, development, evaluation and conclusion (Figure 1) [42]. The development of mobile application will be carried out in steps 3 of development process with the artifact of mobile application is develop based on problems awareness in aquaculture sectors and among players that further suggestion for the problems identified.

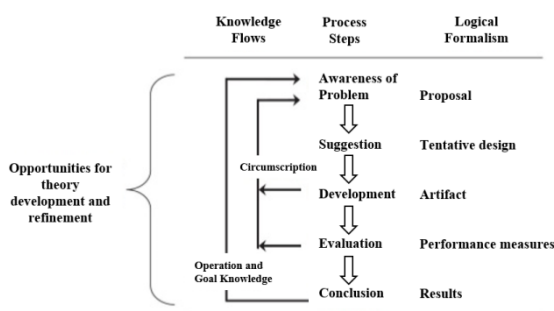


Figure 1: Generic Design Cycle

VI. THE ADVANTAGES OF AKUAHUB APPLICATION THAN OTHER AQUACULTURE APPLICATION

AkuaHub application integrates aquaculture players in one functional platform that could win both parties. The Department of Fisheries will gain real-time data to monitor the performance of aquaculture players while the aquaculture farmers could be able to market their products in the application.

Table 2
The advantages of different application for managing aquaculture systems

Entities	AquaManager	AquaMob	AkuaHub
Aquaculture industry	Produce personal farm report	Produce personal farm report	Produce personal farm report that integrated with the department of fisheries. The application also used to report environmental issue happening in aquaculture sites. Advantage to farmers, breeders, market
Aquaculture players	Advantage to specific players (farmers)	Advantage to specific players (farmers)	suppliers, consumers, department of fisheries, research institutes, corporations, exporters and financial institutions
Community	None	None	Job opportunities for local residents

Table 2 shows comparison among AkuaHub mobile application with other aquaculture application. AquaManager [43] and AquaMob [44] are a mobile application that monitoring production data and only benefit to the top management. The AquaManager application requires huge investment from farmers and it only caters to big companies while AquaMob application only limited to personal use and specific cultured species.

Table 3
The important criteria of AkuaHub compared to other mobile application

Important Criteria	AquaManager	AquaMob	AkuaHub
Access real-time	Yes	Yes	Yes
Works online and off-line	Yes	Yes	Yes
Image of locations and aquaculture products	No	No	Yes
Map of aquaculture sites	No	No	Yes
Index of aquaculture companies	No	No	Yes
Halal aquaculture company directories	No	No	Yes
Aquaculture Marketplace	No	No	Yes

The important criteria to be considered in developing the mobile application are presented in Table 3. This important criterion is vital to the growth of aquaculture economics and proof to the validity of the data provided by farmers. The AkuaHub application is obviously different in terms of additional features particularly in the image of locations and aquaculture products, aquaculture map embedded in the application, index of aquaculture companies, directory of halal aquaculture companies and market search.

Features for instance locations and products images required aquaculture companies to upload a related image and the real-time data will be displayed in AkuaHub application. Aquaculture map feature provides a map for aquaculture players specifically aquaculture competitors, exporters, and

community to locate the aquaculture sites. Other than that, criteria index of aquaculture companies will obtain by using classification and grading of aquaculture company that complies with the certain standard. Furthermore, the application has unique criteria that none of the aquaculture application provides the feature of Halal aquaculture companies directory that implement Halal aquaculture produce that might give great impact and transform the Halal aquaculture industry in Malaysia. Finally, the application also provides marketplace features that give advantages to exporters and aquaculture community.



Figure 2: Proposed mobile application design for aquaculture management system

The innovation of mobile application can be seen from Figure 2 that emphasize on monitoring performance of aquaculture players. The figure also describes reporting systems with details of aquaculture companies' information.

VII. WEB APPLICATION AS TOOLS OF INTERACTION BETWEEN STAKEHOLDERS

Nowadays, the majority of the fishermen use mobile phones for safety and communication purpose replacing the traditional way of communicating [45]. Based on the important criteria provided by AkuaHub application, it is possible to replace traditional way of communicating that has added value to the aquaculture players. The advantages of the mobile web systems could increase the confidence level among aquaculture players that further give positive growth to the aquaculture industry.

Research by McKinsey Global Institute Analysis (2013) shows that approximately 4.3 billion people around the world connected to the internet, potentially through the mobile internet as the mobile phone increasingly inexpensive and capable as mobile computing devices with Internet connectivity [46]. The mobile internet was identified as potentially disruptive technologies due to the capacity of the technology to potentially transform or give impact to the global economics [47];[46].

Due to its capability of potentially disruptive technologies, the mobile internet could assist in delivering right information with introducing mobile web systems in the industry. However, there are limitations of the mobile application innovation particularly in small screen size to view text and graphics like a desktop computer screen, lack of windows at a time, absent of navigation flexibility, slow connectivity and processing speed, limited number of characters in message or email and high cost of mobile phone, mobile application and internet bandwidth, but nowadays, the

modern mobile applications are more capable and more usable for the use [29]. This is because of the current application has undergone constant improvement in mobile computing hardware in order to enhance capabilities of mobile devices, for instance, better processing power and substantial wireless network bandwidth [48]. Although none of the mobile web services in Malaysia aquaculture industry could engage the stakeholders with effective, interactive, profitable and agreeable to all parties, AkuaHub is the suitable choices for systematic and informative aquaculture management systems.

VIII. CONCLUSION

This innovation of aquaculture management systems could disrupt aquaculture industry with state-of-the-art technology in altering the market view which resulted in indexing of aquaculture sites and Halal requirements for aquaculture companies. This disruptive technology could capture accurate and timely data with lower cost but applicable and manageable to all stakeholders that perhaps give impact to the regional and global economics of aquaculture industry. Although there are limitation for the innovation of mobile application, this technology capabilities has improved rapidly that the modern mobile applications are more competent and more user friendly. Therefore, less risk of investment will be adopted with the development of AkuaHub application.

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