Smart Aquaculture Quality Monitoring (AQM) System with Internet of Things (IoT) (SAM-IoT)

June 2018 – May 2020

Project Title:

ASEAN IVO 2018

Introduction :

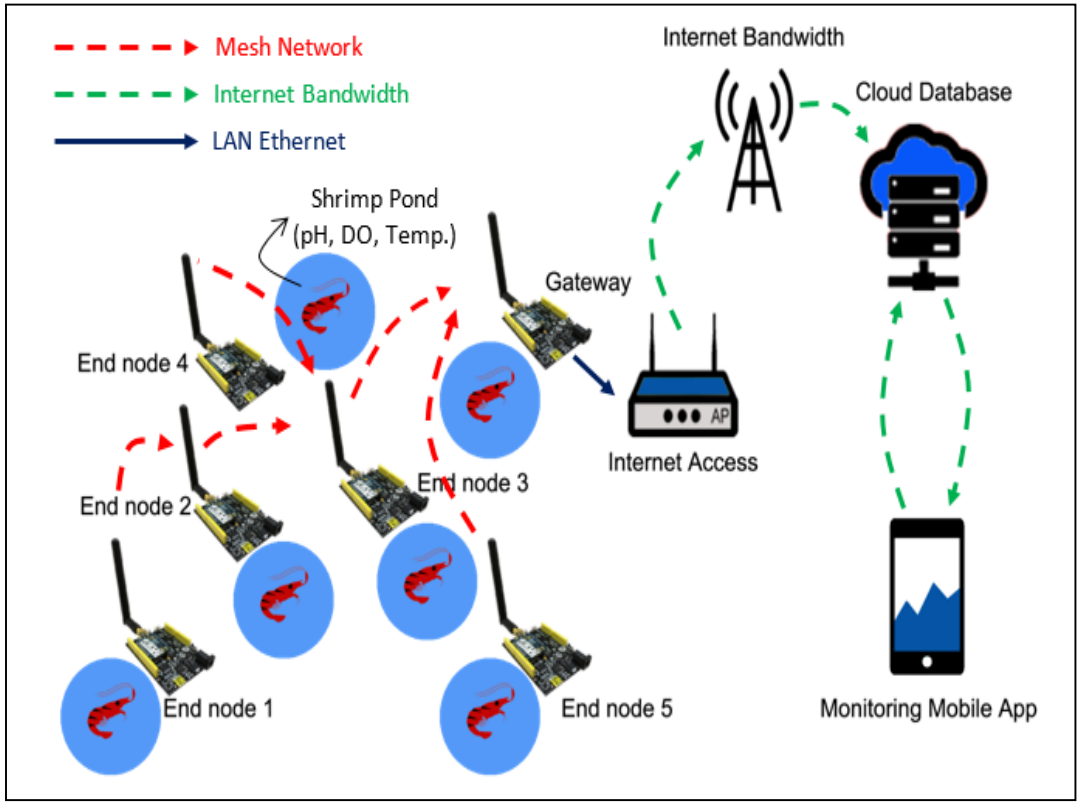
This project is focusing on enhancement of shrimp farm management through an embedment of multiple wireless communication technologies. The technologies of RFID, WSN, mobile application platform and IoT system will be embedded into one platform as an efficient solution for aquaculture quality monitoring (AQM). The proposed wireless system known as "Smart Aquaculture Monitoring with Internet of Things System (SAM-IoT)" is designed to collect data of pH level, dissolve oxygen (DO) and water temperature at shrimp ponds. The proposed active RFID tag will transmit the captured data to its reader which is also designed as an internet gateway. A low power consumption AVR microcontroller will be embed to both of proposed RFID tag and its reader for efficient power management. Fast rectification work regarding water quality of shrimp pond could be deployed through this feature. Therefore, the valuable captured data from this proposed SAM-IoT system can be accessed at anywhere on anytime as long as the internet bandwidth is available.

Project Members :

Leader : Widad Ismail, USM, Malaysia

Members:

1) USM, Malaysia – Harsa Amylia Mat Sakim, Dzati Athiar Ramli, Nur Syazreen Ahmad, Chong Yung Wey
2) Kyoto Uni., Japan – Naoki Shinohara
3) UTM, Malaysia - Sevia Mahdaliza Idrus Sutan Nameh, Farid Zubir
4) RMUTSV, Thailand – Wasana Boonsong
5) UNISSULA, Indonesia – Suryani Alifah
6) MAMPU, Malaysia – Kamarul Hafiz Kamaludin
7) UTP, Malaysia – Toni Anwar, Savita K Sugathan



INTRODUCTION

WHAT IS AQUACULTURE QUALITY MONITORING (AQM)?

- "Process of sampling and analyzing the aquaculture conditions and its characteristics." (Kitt Farrel-Poe, 2005).
- On-Site WQM (1064 spots)
- Automatic Station-based WQM (15 spots)
- AQM spots need to be identified

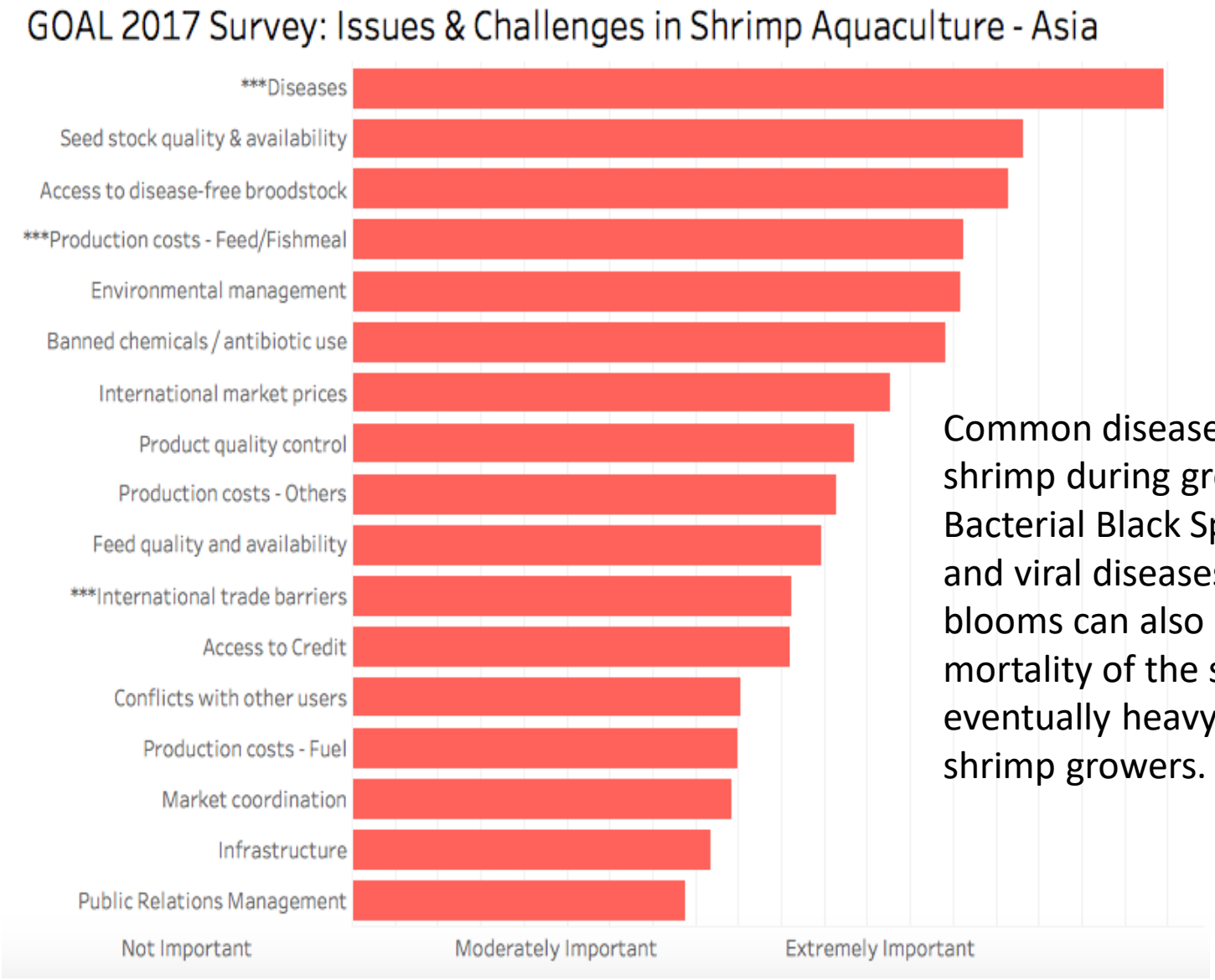
In Malaysia

WHAT IS INTERNET OF THINGS (IoT)?

- "A system in which objects in the physical world could be connected to internet by sensors." (Karen Rose *et al.*, 2015)

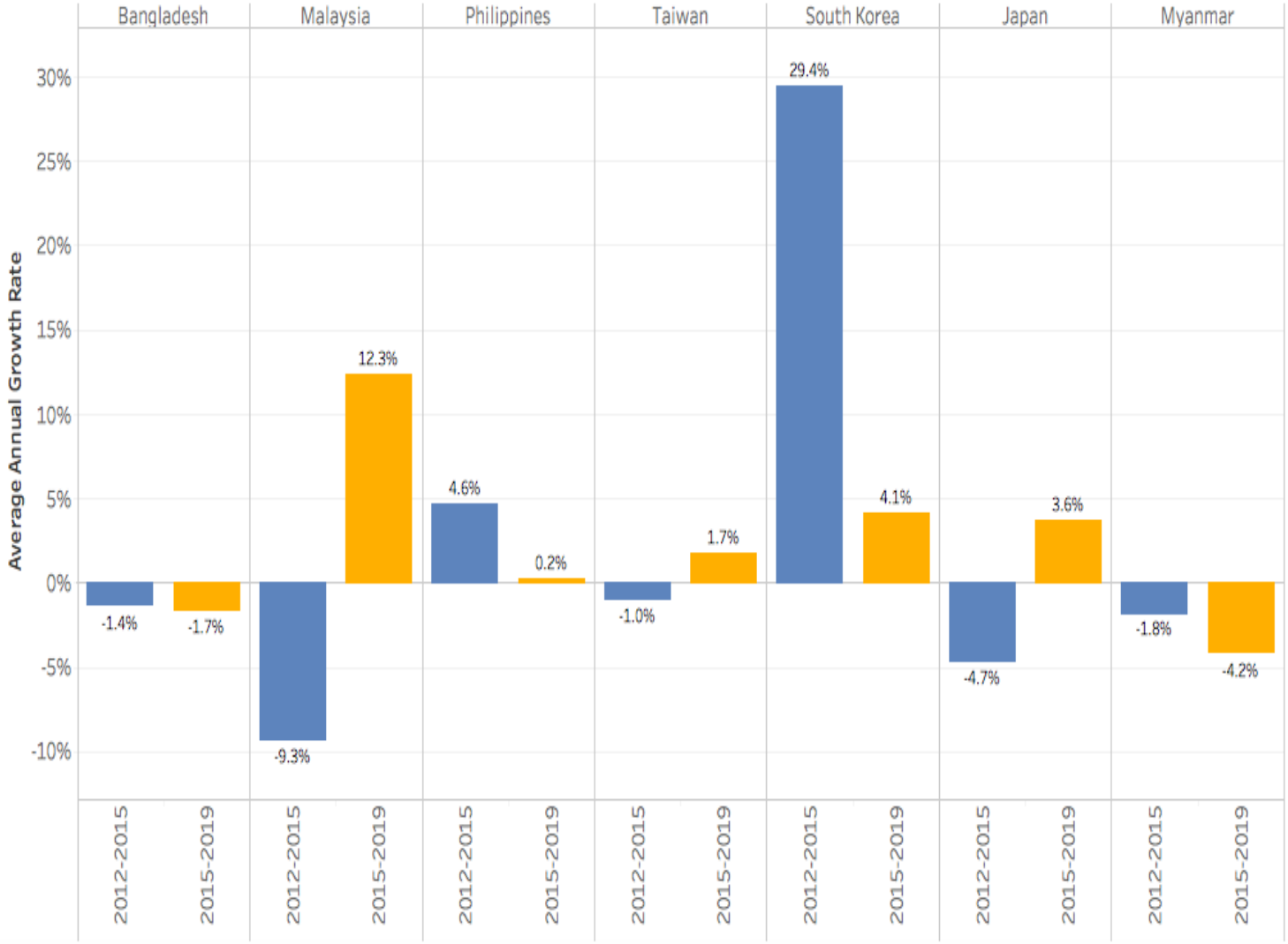
INTRODUCTION

Malaysia has a long coastline of 4,055 kilometers (km), of which 1,640 km is in Peninsular Malaysia and 2,415 km is in the state of Sabah and Sarawak. With the declaration of the 200 miles Exclusive Economic Zone (EEZ), the total fishing area of Malaysia has expended to 160,000 square nautical miles. Given this large fishing area, fisheries are a significant sector in the Malaysian economy.



Common diseases affecting shrimp during growout are Bacterial Black Spot, vibriosis and viral diseases. Algal blooms can also cause mortality of the stocks and eventually heavy losses to shrimp growers.

Shrimp Aquaculture in Asia: 2012-2015 vs 2015-2019



Sources: GOAL (2013-2016) for 2012-2015; GOAL (2017) for 2016-2019.

Southeast Asia includes Thailand, Vietnam, Indonesia, Bangladesh, Malaysia, Philippines, Myanmar and Taiwan.

M. rosenbergii is not included.

PROBLEM STATEMENTS

- **Onsite AQM method (Gulliver J.S. *et al*., 2010)**
- Requires highly trained manpower
- Inconsistent real-time
- High human error probability.

- **Automatic Station-based AQM method (Gulliver J.S. *et al*., 2010)**
- Difficult to immediate mobilization
- Fix Equipment installation
- Installed hardware vulnerable to theft problem.

PROBLEM STATEMENT…continue

ONSITE AQM

AUTOMATIC AQM

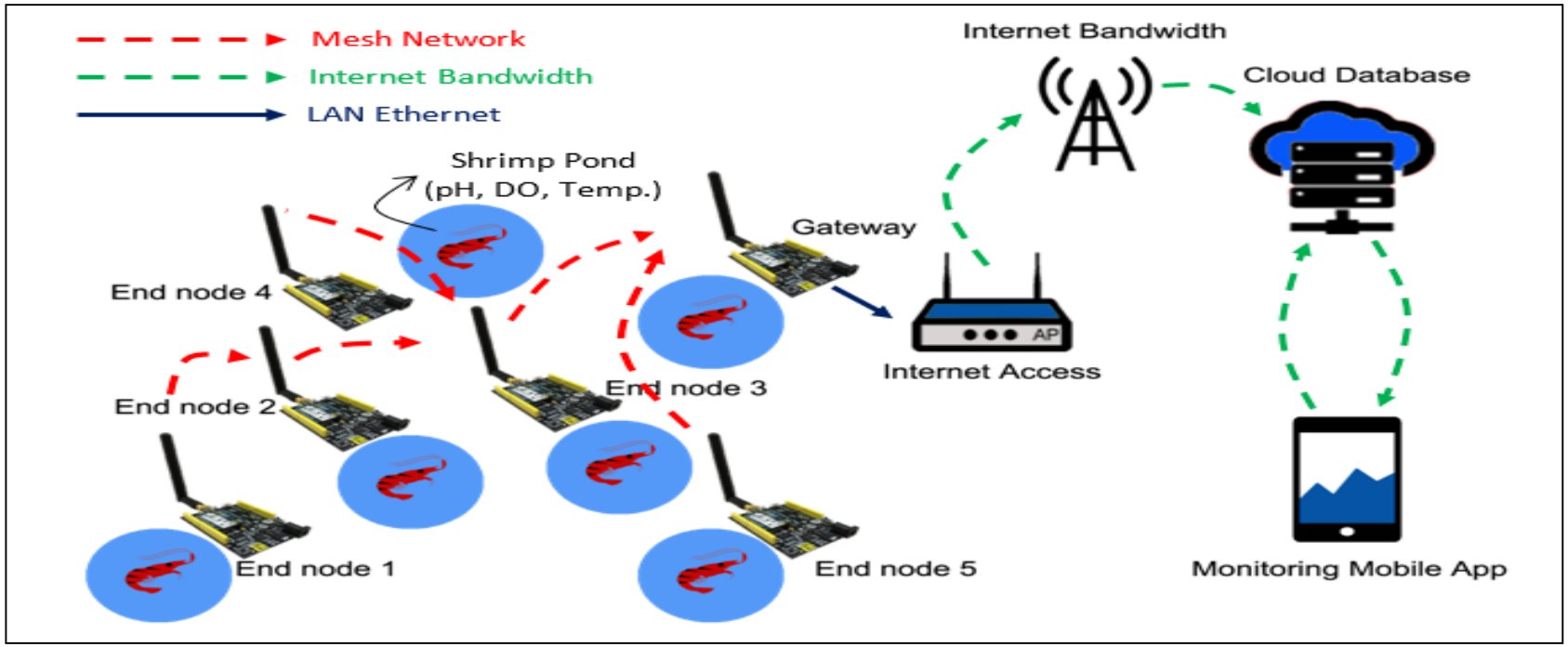
PROJECT OBJECTIVES

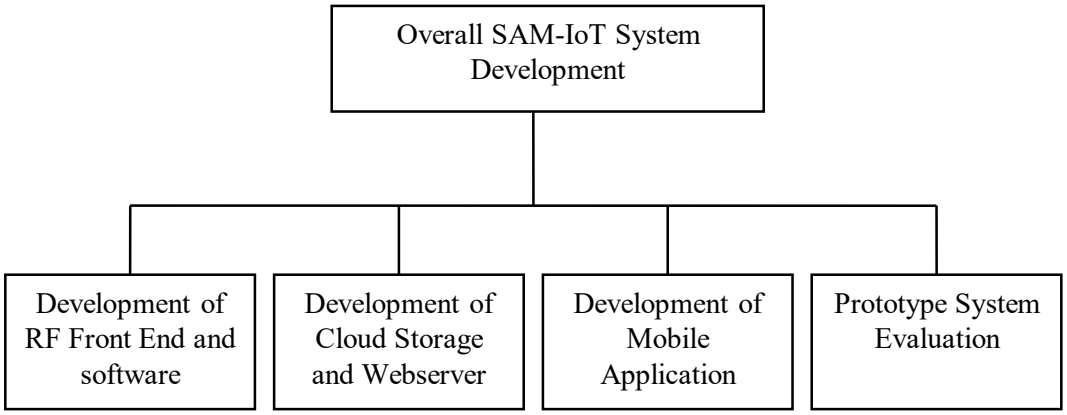
- To design portable Aquaculture Quality Monitoring (AQM) system namely as SAM-IoT system based on pH, DO and temperature measurement through IoT based system implementation by incorporating the active RFID tag into WSN platform, to allow continuous M2M communication between the IoT gateway and user's mobile device including the online monitoring mobile application through embedded circuit design.
- To fabricate and implement the prototype of SAM-IoT system as a proof of concept on real-time aquaculture quality monitoring through internet bandwidth connection.
- To analyze and characterize the proposed prototype system at real location by validating the energy analysis, data collision analysis, communication range analysis, pH measurement, DO measurement, temperature measurement, network latency and throughput evaluation.
- To promote and create awareness of multiple technologies embedment based on IoT for smart aquaculture quality monitoring

LITERATURE REVIEW

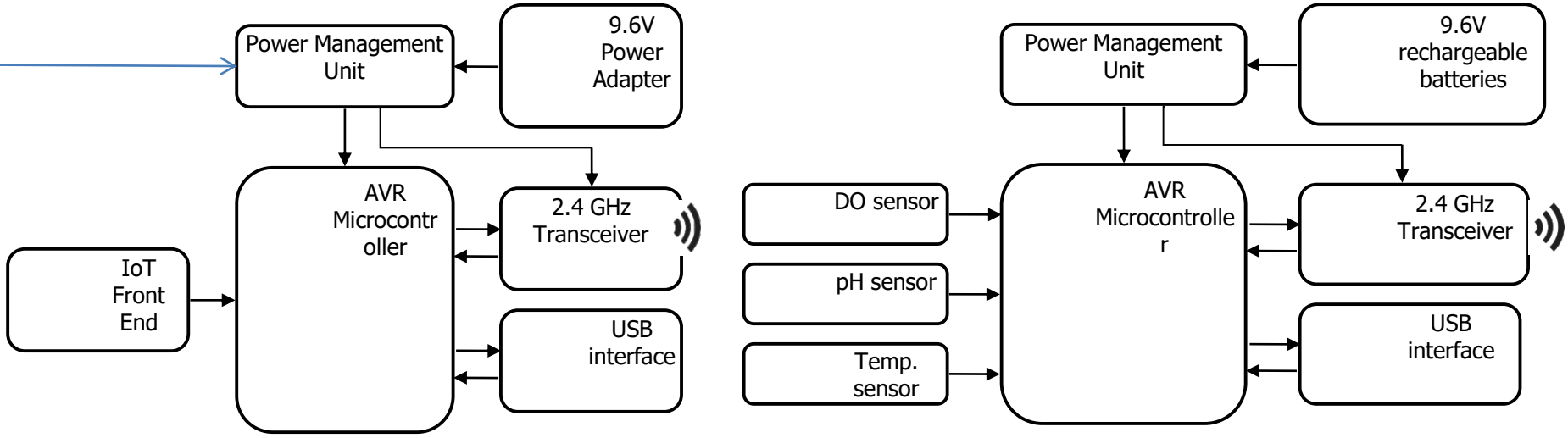
Previous Work	Advantages	Disadvantages
S. A. H. Z. Abidin et al., (2015)	• Automated IoT based system • Online monitoring through web-based system • Wireless communication	• Fixed installation • Difficult for immediate mobilization • Non mobile platform • Less significant for outdoor communication • No alert triggering system on mobile platform • Vulnerable to theft problem
S. Kelly et al., (2013)	• Online monitoring through web-based system • Wireless communication	• Fixed installation • Non mobile platform • Less significant for outdoor communication • No alert triggering system on mobile platform
S. H. Yang et al., (2015)	• Online monitoring through web-based • Wireless communication	• Fixed installation • Non mobile platform • Less significant for outdoor communication • No alert triggering system on mobile platform
Cho Zin Myint et al., (2017)	• Online monitoring through web-based and mobile platform • Wireless communication	• Fixed installation • Less significant for outdoor communication • Vulnerable to theft problem

Proposed SAM-IoT Concept & System Development Stage

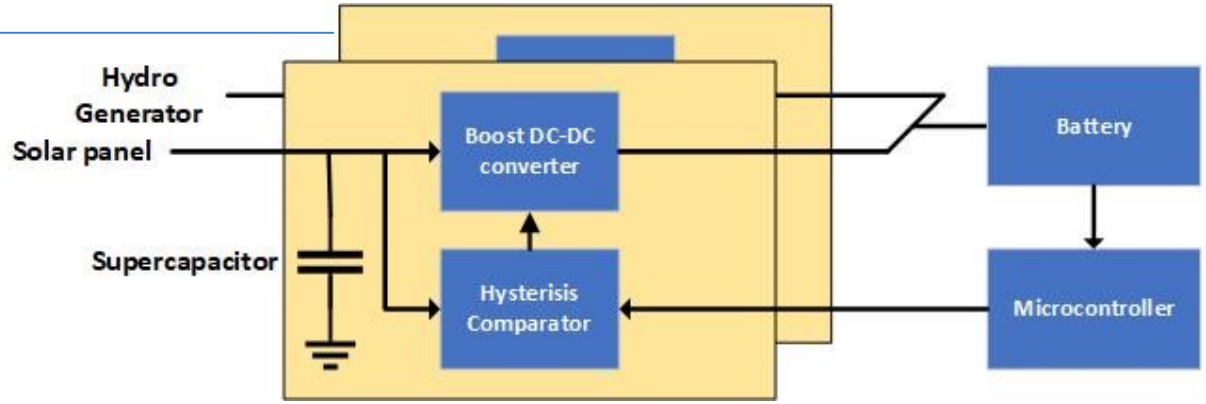




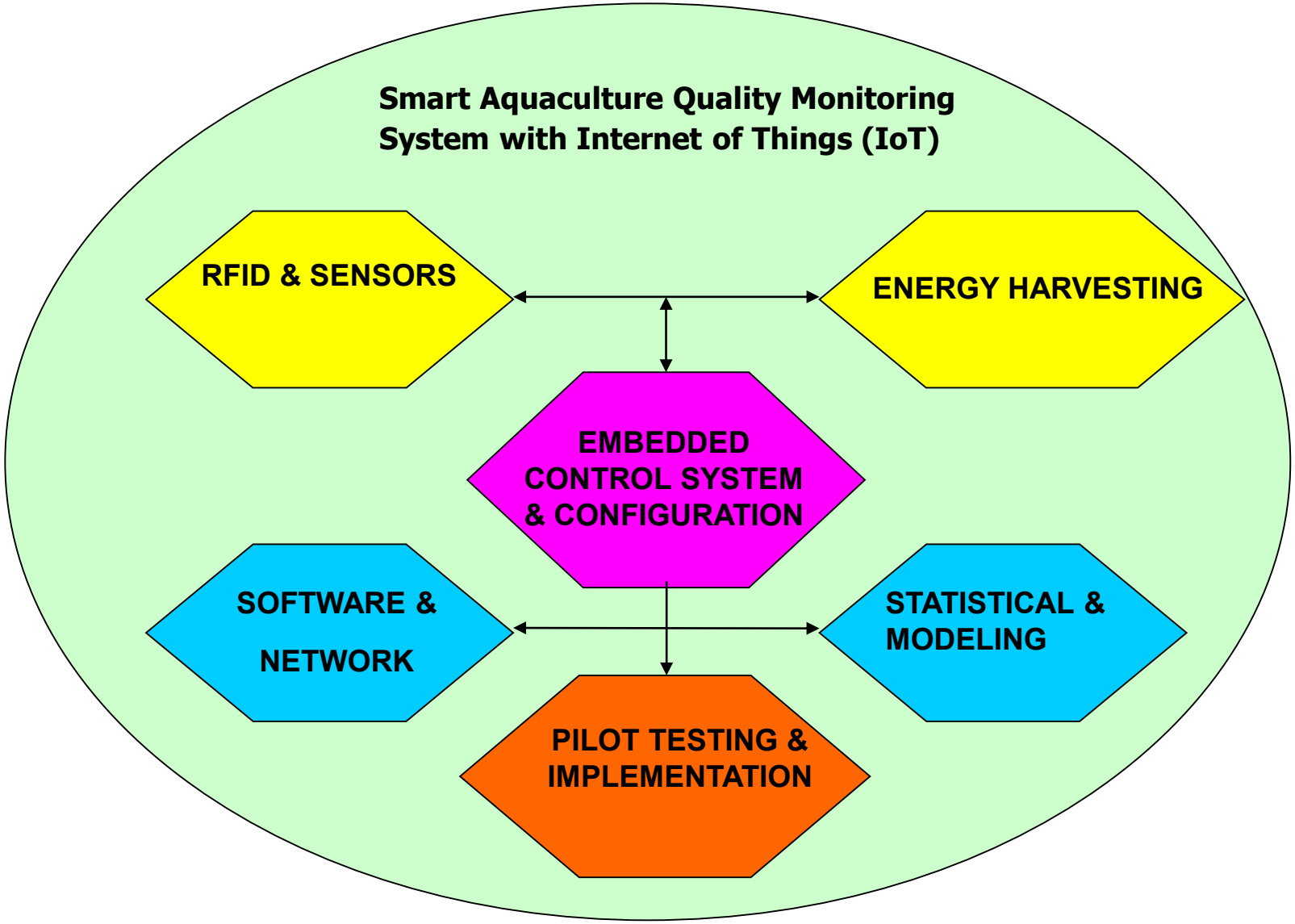
Energy Harvester – AQM power management



The proposed architecture of end node



Hybrid energy harvester for power management in the proposed internet Gateway


Smart Aquaculture Quality Monitoring System with Internet of Things (IoT)
RFID & SENSORS
ENERGY HARVESTING
EMBEDDED CONTROL SYSTEM & CONFIGURATION
SOFTWARE & NETWORK
STATISTICAL & MODELING
PILOT TESTING & IMPLEMENTATION

WORK SCOPES & RESPONSIBILITIES

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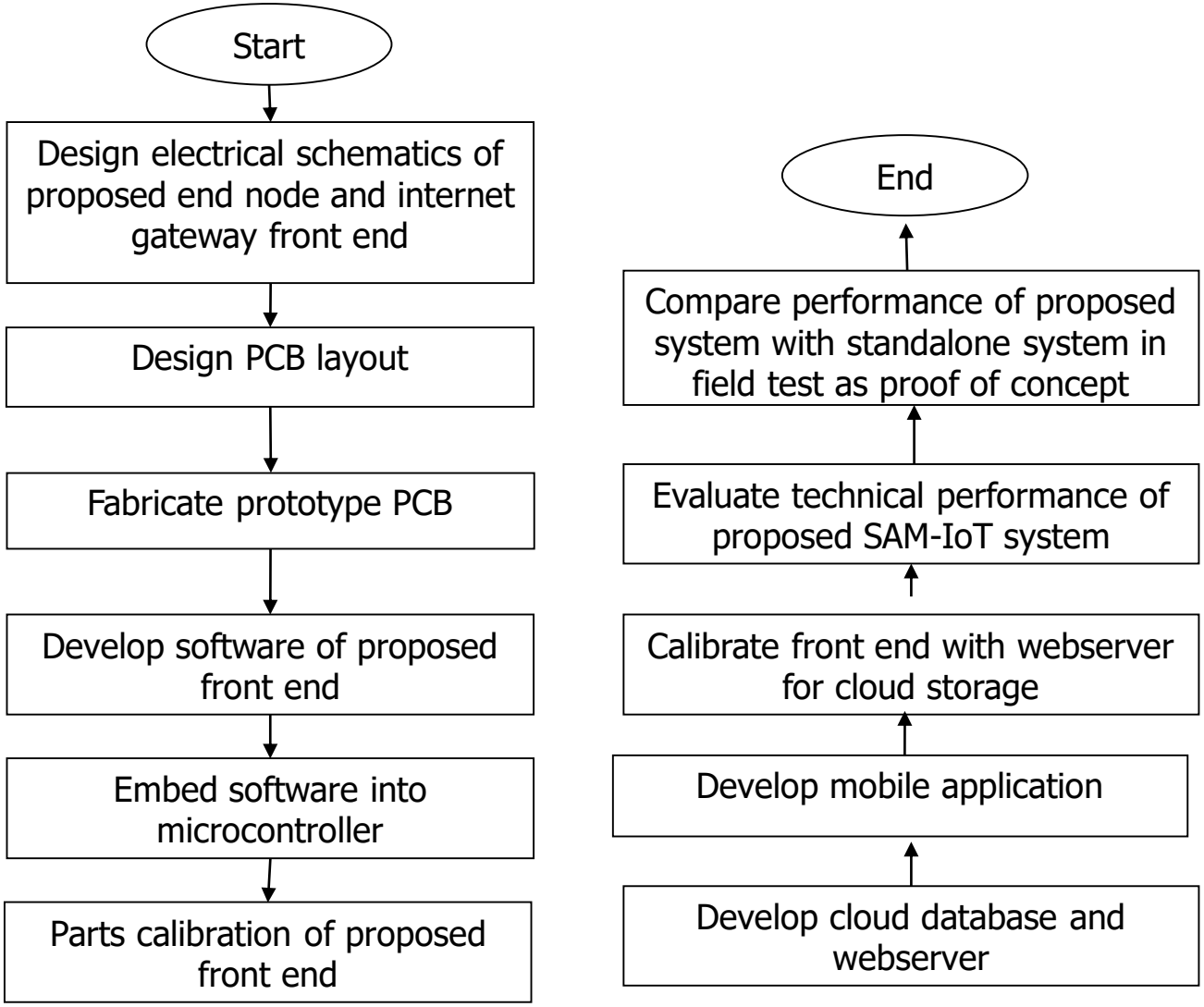
NO	RESEARCHER	JOB DESCRIPTIONS
1	**Universiti Sains Malaysia (USM)** Address: Auto-ID Laboratory, School of Electrical & Electronic Engineering, Engineering Campus, 14300 Nibong Tebal, Pulau Pinang, Malaysia	
	a) Prof. Dr. Widad Ismail (Project Leader) E-mail: eewidad@usm.my / ismailwidad@gmail.com	- Monitoring the whole development of the prototype development including hardware, software and network design - Extra focus on the devlopement embedment of different RFID hardware developments with WSN for the proposed automated SAM-IoT - Preparing and supervise pilot plant for validation purposes.
	b) Associate Prof. Dr. Harsa Amylia Mat Sakim (Project Member) E-mail: amylia@usm.my	-Implement data mining techniques on transmitted data. - Analyse captured data using neural network techniques and propose predictions method to utilize potential information which shall be incorporated in the mobile application development.
	c): Dr. Nur Syazreen Ahmad (Project Member) Email: syazreen@usm.my	- Investigate and develop control mechanisms for the proposed SAM-IoT in prolonging the performance lifetime for sustainability and green technology - Modeling and evaluate feasibility of proposed control mechanism into the proposed system - Analysis on the accuracy of the data (eg: pH level, dissolved oxygen (DO) and water temperature), and improvement on the mechanisms to read the data.
	d) Associate Professor Dr. Dzati Athiar Ramli (Project Member) Email: dzati@usm.my	- Proposed study evaluation based on DOE and statistical approach in real environment for the prototype development - Signal processing of prototype performance for reliability approach in smart AQM implementation.
	e) Ms. Chong Yung Wey (Project Member) Email: chong@usm.my	- Software and network development to incorporate the mult-i platform mechanism to the prototype - Hybrid energy harvesting element development for the proposed prototype
2	**Kyoto University, Japan** Address: Research Institute for Sustainable Humanosphere (RISH) , Kyoto Universit , Uji 611-0011, Japan	
	Prof. Dr. Naoki Shinohara (Mainmember) Email: shino@rish.kyoto-u.ac.jp	- Focuses on development of Hybrid Energy Harvester and green technology embedment for SAM-IoT system - Testing of technical energy requirements for the proposed prototypes. - Knowledge and expert sharing on data analysis
3	**Universiti Teknologi Malaysia (UTM)** Address: Faculty of Electrical Engineering, Universiti Teknology Malaysia (UTM), 81310 UTM, Johor Bahru, Johor Darul Ta'zim, Malaysia	
	a) Prof. Dr. Sevia Mahdaliza Idrus Sutan Nameh (Main member) Email: sevia@utm.my	- Monitor the operation portal check out prototype testing and advice for any problems arise during implementation - Provide accessibility to communication lab at UTM for the RF equipment sharing and anechoic chamber testing. -Ensure the proposed system meet the standard and regulations to be used in ASEAN region.
	b) Dr. Farid Zubir (Project Member) Email: faridzubir@utm.my, farid@fke.utm.my	- Assist in the hardware development of the embedded RFID and WSN prototypes for the smart AQM system. - Focus on pilot development and testing of SAM-IoT system in Malaysia site.

4	**Rajamangala University of Technology Srivijaya (RMUTSV), Thailand** Address: Department of Electronic and Telecommunication Engineering, Faculty of Industrial Education and Technology, Rajamangala University of Technology Srivijaya (RMUTSV), No.1 Ratchadamnoen Nok, Bo Yang, Muang, Songkhla 90000, Thailand	
	Dr. Wasana Boonsong (Mainmember) Email: wasana.b@rmutsv.ac.th, boonsong.was@hotmail.com	- Develop the processor part of the hardware part of the prototype to suit the requirements for smart AQM system with IoT. - Embed and analyze the data acquisition system to the processor functionality. - Prepare Site for field test and implementation for proof of concept in thailand
5	**Universitas Islam Sultan Agung Semarang (UNISSULA), Indonesia** Address: Smart System Research Group of Unissula, JI RayaKaligawe KM. 04, Semarang 50012, Indonesia	
	Associate Professor Ir. Dr. Suryani Alifah (Main member)	- Prepare Site for field test and implementation for proof of concept in Indonesia - Focus on communication data transfer and feedback survey of the field testing
6	**Malaysian Administration Modernization and Planning Unit (MAMPU), Malaysia** Address; Development Division of ICT Shared Service and Security, MAMPU, Prime Minister Office, Building MKN Embassy Tachzone, Block B, No. 3200, Jalan Teknokrat 2, 6300 Cyberjaya, Selangor, Malaysia	
	Mr. Kamarul Hafiz Kamaludin (Mainmember) Email: kamarulhafiz@mampu.gov.my, khafiz4g@gmail.com	- Internet and networking infrastructure for the whole development of the smart AQM system - Data comparison with aquaculture agencies and industries across ASEAN region
7	**Universiti Teknologi Petronas (UTP), Malaysia** Address: Computer and Information Sciences, Faculty Science and Information Technology, Universiti Teknologi Petronas, Jalan Desa Seri Iskandar, 32610 Bota, Perak, Malaysia	
	Associate Professor. Dr. Toni Anwar (Main member) Email: toni.anwar@utp.edu.my, toni_anwar@yahoo.com	- Validation on network infrastructure and integration of the proposed SAM-IoT - Prepare Site for field test and implementation for proof of concept in Peninsular Malaysia
	Dr. Savita K Sugathan (Project Member) Email: savitasugathan@utp.edu.my	- Knowledge Management expert and analysis - Promote Greener IT in supply chain management adoption for the smart AQM system for related aquaculture industries

Methodologies Flow for AQM



MILESTONES & ACTIVITIES

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NO	MILESTONE	ACTIVITIES	COMPLETION DATE
1	Milestone 1: **COMPLETION OF INTEGRATED SENSORS, RFID & ENERGY HARVESTING BASED INFRASTRUCTURE**	• Upscaling embedded sensors & RFID with AQM requirements • Capture data frame through proposed prototype • To embed energy harvesting for power management system • Verification of AQM data to sensors & RFID performance	Month 6
2	Milestone 2: **COMPLETION OF EMBEDDED CONTROL FUNCTION TO THE PROPOSED SYSTEM**	• Embedding developed hardware & software according to adaptive AQM system requirements on a single data acquisition platform • Testing & validation of data transfer within the proposed platform in controlling & monitoring focusing on the aspects of fault & data security	Month 12
3	Milestone 3: **COMPLETION OF INTELLIGENT SOFTWARE, NETWORK & MOBILE APPLICATION WITH STATISTICAL APPROACH**	• Integration of back-end & data management system using the developed hardware & software system. • To integrate the proposed SAM-IoT system to WSN and Cloud platform with real time internet and mesh networking infrastructure for the whole development of the system for pilot testing. • Data synchronization & security including the setup of mobile network system • Testing, evaluating and finalizing the application (software, hardware, network and mobile apps) based on statistical approach	Month 18
4	Milestone 4 **COMPLETION OF PILOT TESTING & IMPLEMENTATION**	• Site preparation and installation considering coverage area, samples type and test specifications • To setup the complete infrastructures & networking of proposed SAM-IoT system at specified location • To measure, optimize and characterize the performance of the SAM-IoT system with IoT according to design specification • To validate the whole system with acceptance from potential users and feedback on market survey/oppurtunities	Month 24

SITE PREPARATION FOR TESTING

1. MALAYSIA

Test Site 1: CPF Desaru Hatcheri, Bandar Penawar Johor

Test Site 2: Asia Culture (M) Sdn. Bhd. Kota Tinggi, Johor

*Test Site 3: A*quatic Dynamics, Jalan Batu Maung, 11960 Bayan Lepas, Penang

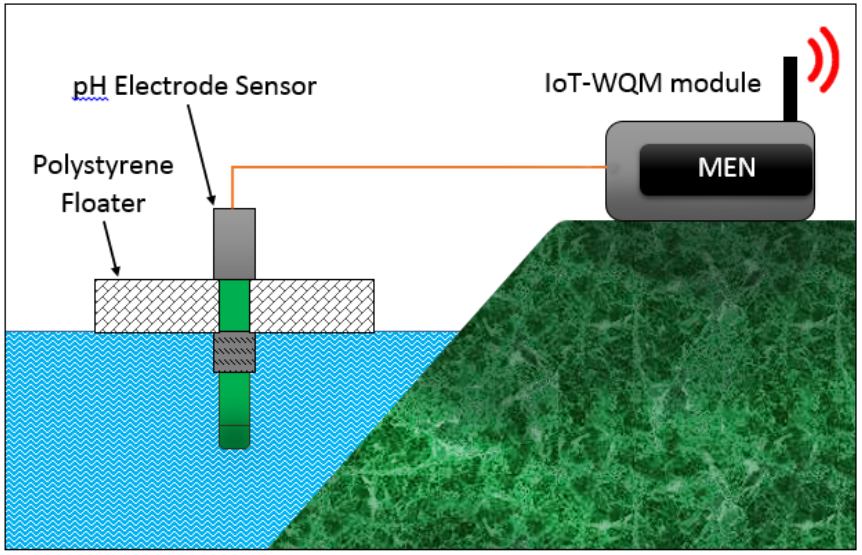
2. THAILAND

Test Site 1: Klaeng, Rayong, Thailand

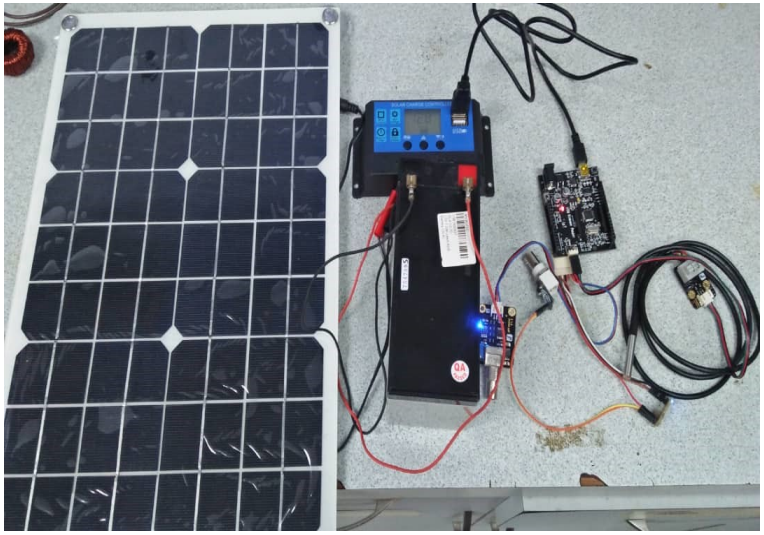
Test Site 2: Thai Prawn Farm & Hatchery Co. Ltd. Bangkok Thailand

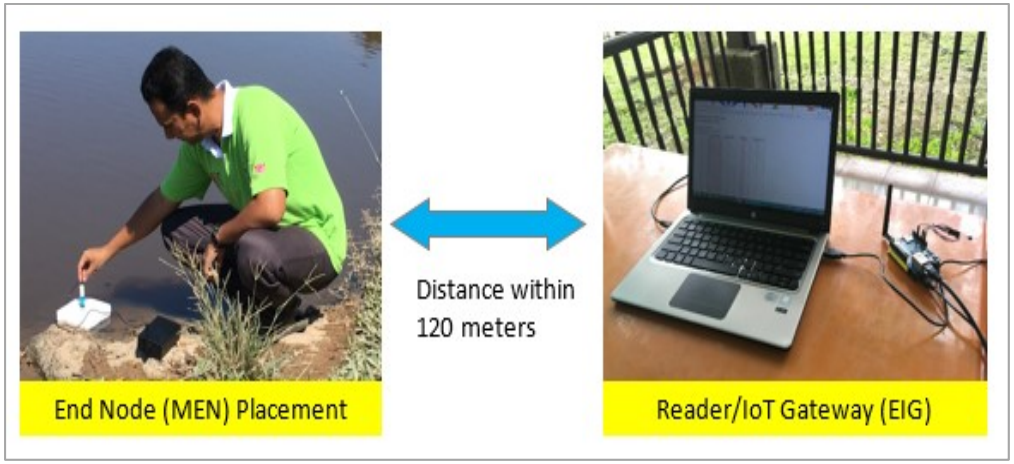
3. INDONESIA

Test Site 1: Semarang, Indonesia



CURRENT & NEXT PROGRESS





CURRENT:

- 1st. AQM Prototype is being tested for site testing
- Sensoring calibration also completed

AQM
Aquaculture Quality Monitoring

NEXT:

- Prototypes fabrications for ASEAN site testing
- IoT based system development with mobile apps.

Meeting/Seminar Schedule

- Kick-off meeting: 27th. September 2018 in USM, Penang

- Next meeting: Tentatively April 2019 in Semarang, Indonesia