Project Title: **Smart Aquaculture Quality Monitoring (AQM) System with Internet of Things (IoT)**

Speaker: Dr. Nur Syazreen (USM)

Project Leader: Prof Dr Widad (USM)

Background :

- Enhancement of aquaculture 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).
- Proposed name: SAM-IoT →"Smart Aquaculture Monitoring with Internet of Things"
- Designed to collect pH level, dissolved oxygen (DO) and water temperature.
- Our system allows all these three data to be accessed anywhere and anytime as long as the internet bandwidth is available.

Targets:

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

Project Title: **Smart Aquaculture Quality Monitoring (AQM)**

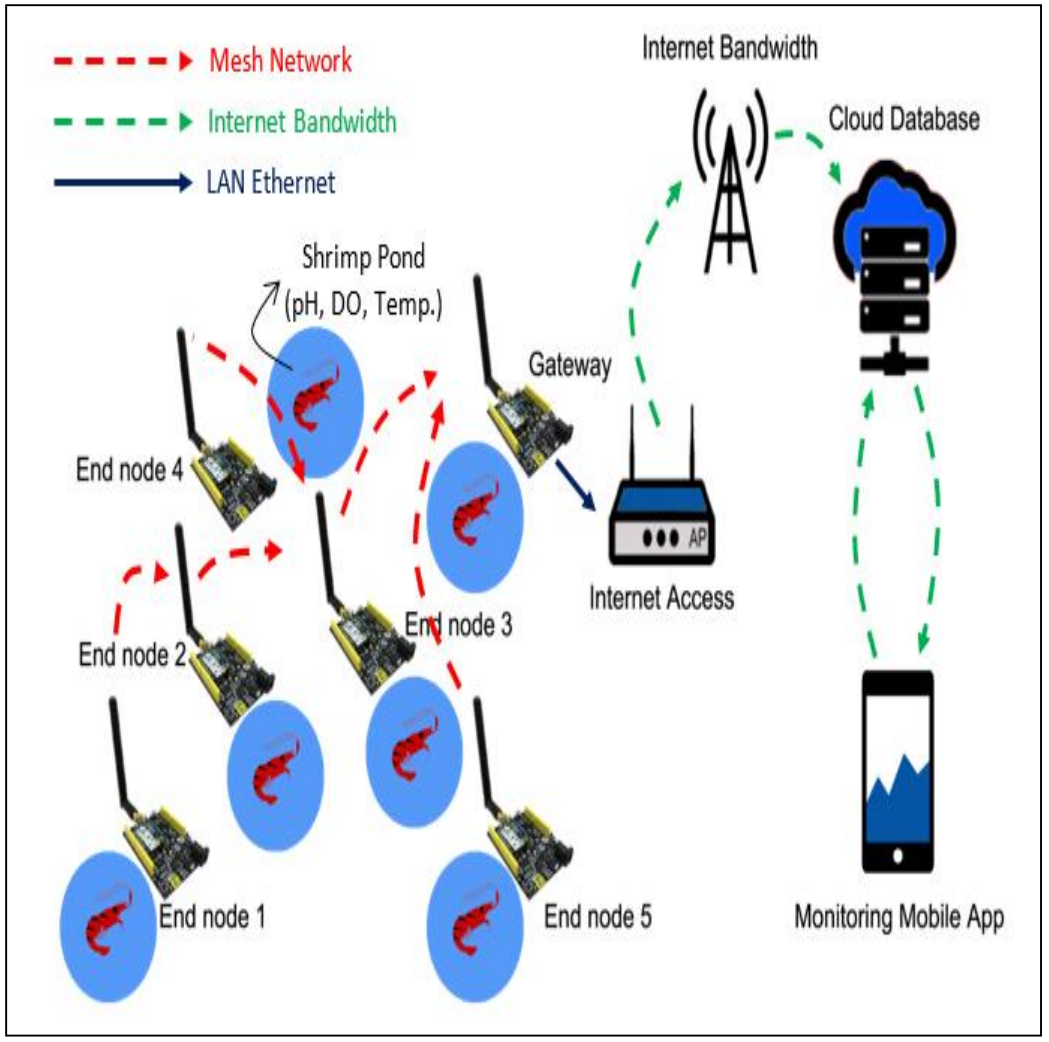
Project Members :

Leader : Widad Ismail, USM, Malaysia
Members:

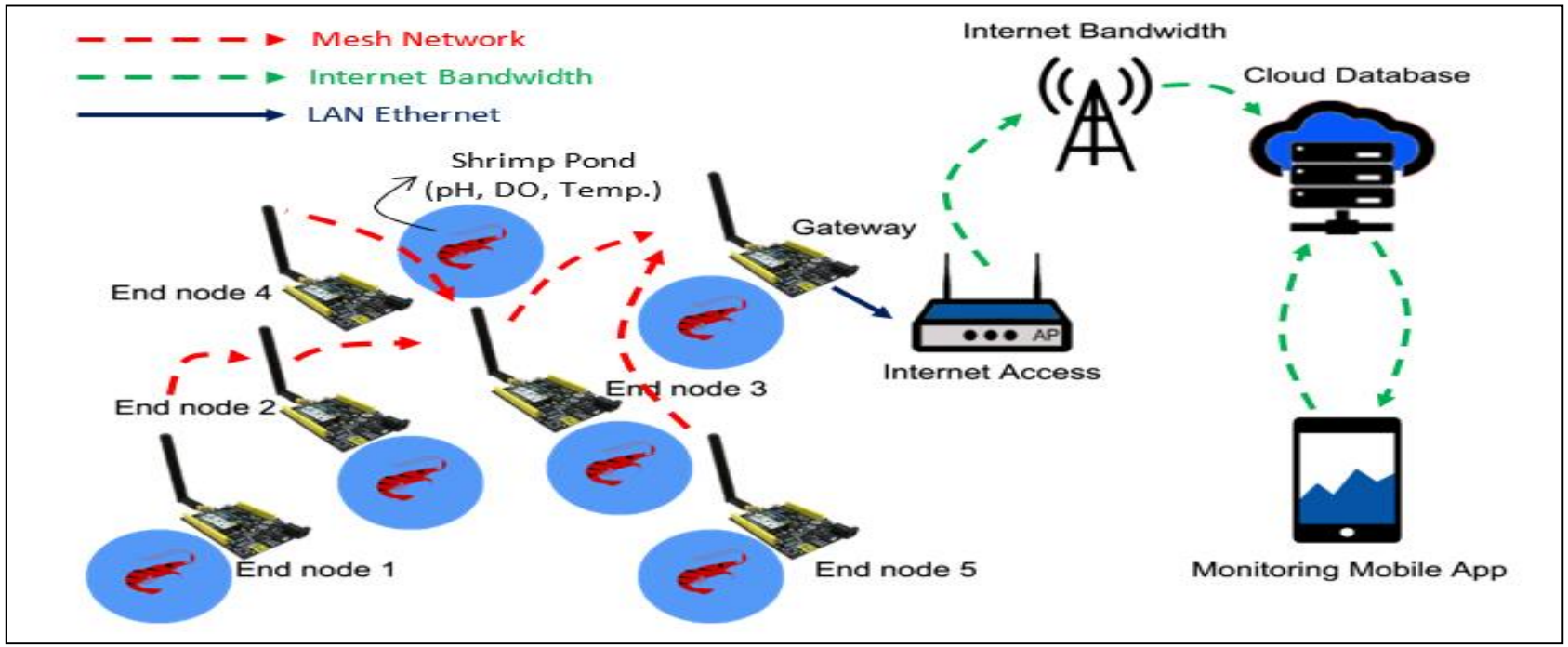
1) USM, Malaysia – Harsa Amylia Mat Sakim, Dzati Athiar Ramli, Nur Syazreen Ahmad, Chong Yung Wey
2) UTM, Malaysia - Sevia Mahdaliza Idrus Sutan Nameh, Farid Zubir
3) MAMPU, Malaysia – Kamarul Hafiz Kamaludin
4) UTP, Malaysia – Toni Anwar, Savita K Sugathan
5) Kyoto Uni., Japan – Naoki Shinohara
6) RMUTSV,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

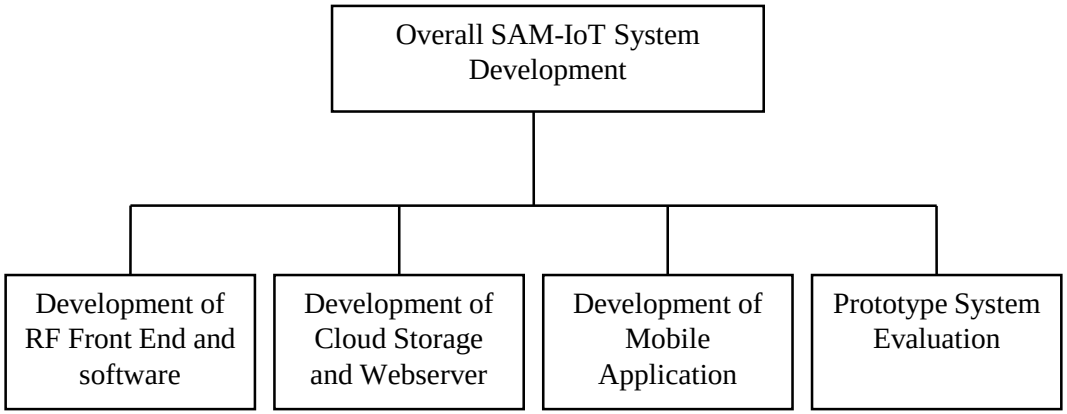
Project Duration :

2 years

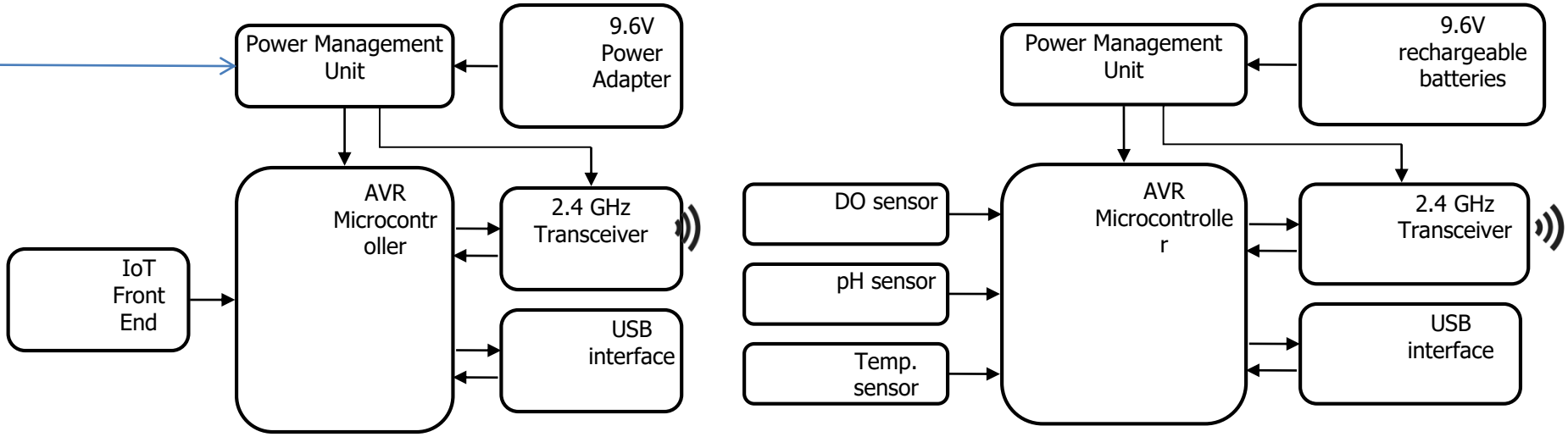


Proposed SAM-IoT Concept & System Development Stage

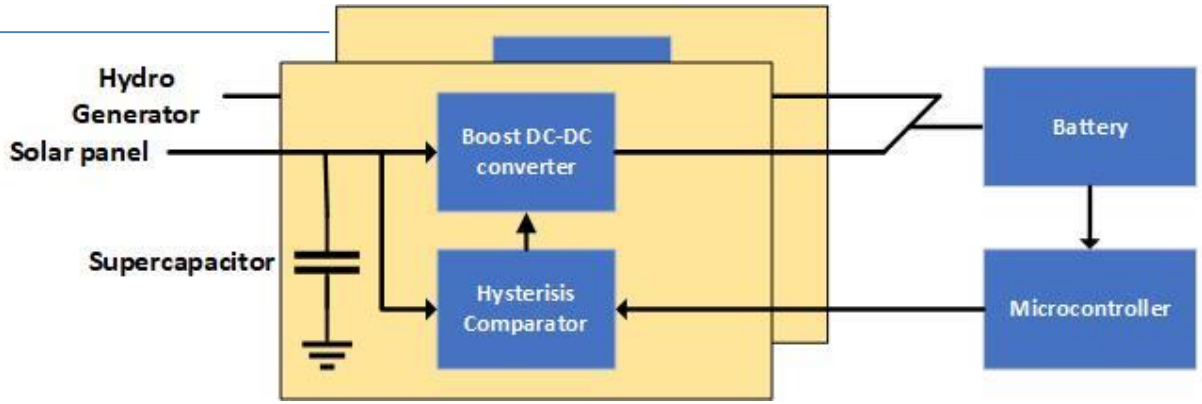




Energy Harvester – AQM power management



The proposed architecture of end node



Hybrid energy harvester for power management in the proposed internet Gateway

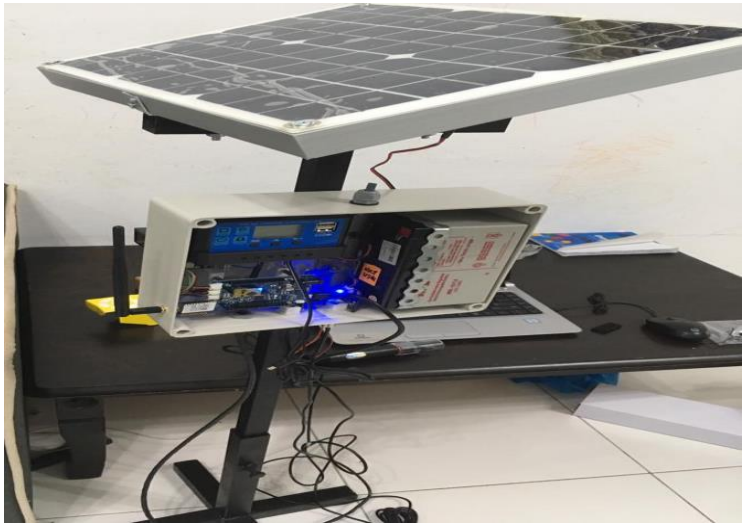
MILESTONES & ACTIVITIES

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/opportunities**	Month 24

CURRENT PROTOTYPE DEVELOPMENT

Smart Aquaculture Main Processing Unit

Energy Harvester using solar panel



The installed Unit in Thailand

Mobile apps

MEETING, TRAINING AND KNOWLEDGE SHARING

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

2nd. meeting: 25 -26 th. July 2019 in RUTS, Songkhla, Thailand

Training and Smart Aqua Data Logging Software Installation to each member

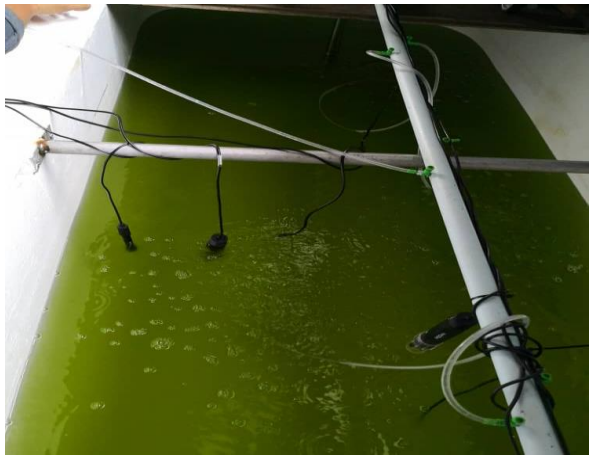
Project discussions and knowledge exchange

PROTOTYPE INSTALLATION AND TESTING AT HATCHING CRAB CULTURE CENTRE, SONGKHLA, THAILAND (26th. July 2019)

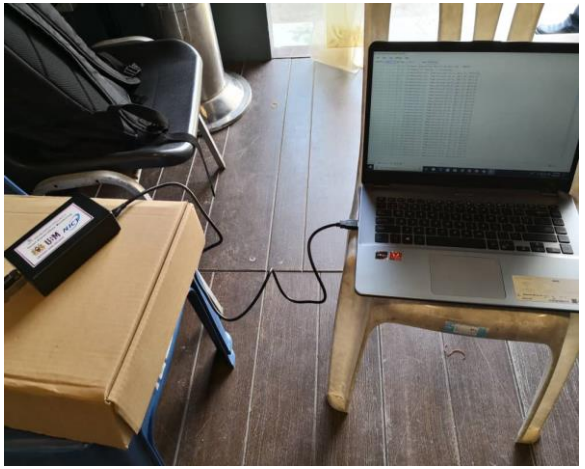
In front of Hatching Crab Culture Centre (Ban Hua-Khao), Singhanakorn, Songkhla

Description by the Centre Manager of Hatching Crab Culture Centre (Ban Hua-Khao)

Installation of the Smart Aquaculture End Node System at the crab pond



Installed embedded sensors for crab baby pond monitoring



Smart Aquaculture IoT gateway installation and data logging system

OTHER ACTIVITIES & COMMUNITY VISIT

Student MPU 4 trip to Denpasar, Indonesia. Visiting communities of Aquaculture, Eco Village and Eco farm for trials of prototypes.

1-day short course on IoT at Bali, Indonesia.

Knowledge sharing on Smart Aqua Controlling System.

With Head of Desa Danau Batur, Kintamani for Aquaculture community

Fish farm at Danau Batur

Scientific Contribution:

Presentations at International Conferences:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1.	**Development of Smart Aquaculture Quality Monitoring (AQM) System with Internet of Things (IoT)**	*W. Ismail, Naoki Shinohara, Sevia Mahdaliza Idrus Sutan Nameh, Wasana Boonsong, Suryani Alifah, Kamarul Hafiz Kamaludin, Toni Anwar*	Universiti, Sains Malaysia, Kyoto University, Universiti Teknologi Malaysia, Rajamangala University Technology of Srivijaya, Universitas Islam Sultan Agung Semarang, Malaysian Administration Modernization and Planning Unit (MAMPU), Universiti Teknologi Petronas	2019 IEEE SYMPOSIUM ON ACOUSTIC, SPEECH AND SIGNAL PROCESSING (SASSP)	20/03/2019	Centre for Advanced and Professional Education (CAPE), Kuala Lumpur, Malaysia

Innovation Award: **GOLD AWARD, "S-AQUA SMART AQUACULTURE CONTROLLING SYSTEM", INNOVATION, INVENTION & CREATION EXHIBITION 2019 (IICE 2019), UiTM PUNCAK ALAM, SELANGOR MALAYSIA, 7th. NOVEMBER 2019**

Impacts:

IMPACTS

1. **Scientific and Technological** - The benefit to the multi platform design of ICT infrastructures with respect to the smart AQM system and IoT based platform in improving the aquaculture industry and users.
2. **Economic impact –**

   Spot Trouble Earlier – Instead of waiting to get end of the day reports, aquaculture managers can get updates from their staff in real time and address issues as they come up to avoid unnecessary mortalities and waste.

   Increased Efficiency –With software and more advanced computing power, aquaculture farmers have the capability to uncover unprecedented levels of insight from their farm to improve, save money, and grow faster.
3. **Knowledge exchange -** Better understanding on the aquaculture characteristics with the help of IoT infrastructures.
4. **Societal Impact** – Preserving endangered species and ecosystems

(In Songkla) The crab hatching center is a non-profit organization run by the local villagers to preserve the natural life and growth of the Horse crab which was threatened by human activities. A crab mother can hatch up to 1.8 to 2 millions crab babies. Normally it will require 4 months of special care and growth before the crabs can be taken for consumption. The most critical months are from November to January each season due to heavy rain and storm. It will require about 1 month from the crab egg to be grown and preserved for baby crab, then 3 to 4 months to be fully grown.

In this particular site, the target of using SAM-IoT is more on helping the villagers to preserve this crab species and ecosystems.

Conclusion:

Current outputs/outcome:

1. **Scientific and technological** – Scientific knowledge on the aquaculture life sciences and cycle is very important to be matched to the requirements of the technological designs in solving the real problems by the aquaculture communities. All members study on the different life sciences background at respective selected sites in each region.

2. **Application (or system) development** – USM has developed the Smart Aquaculture prototypes for the experiments and pilot testing according to the requirements by other members in the regions.

3. **Experiments including field testing** – Prototype testings have been conducted and first installations was done in Songkhla, Thailand. Dr. Wasana Boonsong from RUTS is in charged on the prototypes installation and will monitor and collect the data from the Crab Hatching Centre continuously.

4. **Aquaculture Community engagement** – The engagement involved non-profit organizations in Songkla and Danau Batur in handling the production of sustainable aquaculture.

Future works: Project Next Plans

Item	Scope & deadline
a) Smart Aqua Equipment purchase for full site testing 15 units for 5 site testing.	It is targeted that 3 units will be installed at each members' institutions selected site for testing as following: i. Songkhla, Thailand testing – 3 units (under RUTS monitoring) ii. Semarang, Indonesia – 3 units (under UNISSULA monitoring) iii. Johor, Malaysia – 3 units (under UTM monitoring) iv. Perak, Malaysia – 3 units (under UTP monitoring) v. Penang, Malaysia – 3 units (under USM monitoring) The complete sets can be ready and delivered by December 2019.
b) Full installation of the Smart Aqua at the proposed site	All 5 sites will be installed with the Smart Aqua equipment's by February 2020
c) Data collection and comparison for different aquacultures sites	Data logging software are already installed and provided to each collaborator. The full integration can be done to the equipment's once the installations are completed. It is targeted that December 2019 – February 2020 will be the initial trial for full data collection between different sites.
d) Comprehensive mobile/IoT monitoring of the aquaculture between countries with central server in USM, Penang	Dedicated mobile applications development for the Smart Aquaculture will be delivered for mobile/remote monitoring by January 2020
e) Next meeting schedule, end of February 2020	UNISSULA, Semarang, Indonesia will host the meeting and site visit.