Instructions for making your **Project Review** slides

Note 1:

1. The number of slides should be around 15 total.
2. The size of your PowerPoint PDF should be no more than 10MB.
3. Please follow the format starting from the next slide.
4. Please delete the first slide (this slide) and upload to the website.

Note 2:

1. You may submit three additional supporting files for a maximum of four files total.
2. Each additional file should be no more than 130MB.
3. Any supporting materials you submit must be saved as PDFs, where possible. This includes PowerPoint presentations, Word documents and Excel spreadsheets. Any audio you submit should be in mp3 format and any video you submit should be in mp4 or mov format.
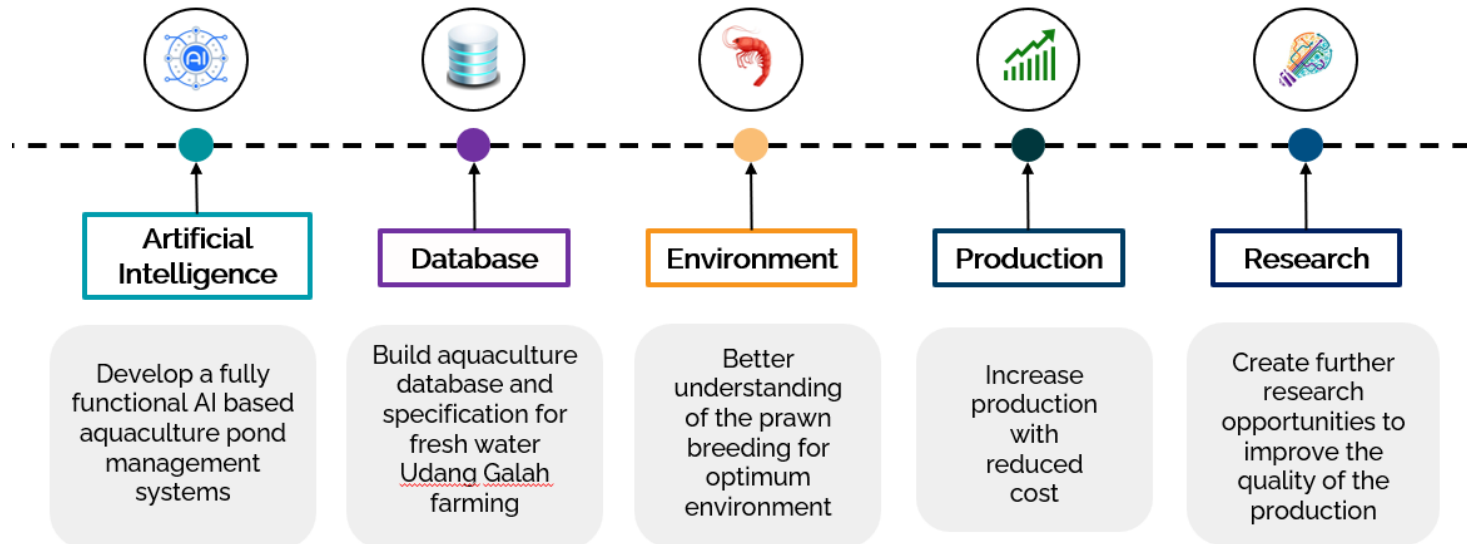
Note 3:

1. A website for "Submission" is open from September 15, 2023. (https://naivo.org/index.php/2023project/papers/instruction)
2. The website for uploading presentation files will close on October 31, 2023.

Background :

To address food security, the number of aquaculture activities for offshore and onshore fish and prawn farming have increased significantly in ASEAN countries for the last 20 years. However, the production rate from small medium enterprise has been low especially for onshore prawn aquaculture. Farmers are still rely on traditional manual approach to monitor the growth of the cultures and manage the ponds. In this interdisciplinary project, an AI based recognition system is proposed to monitor the growth of *Macrobrachium Rosenbergii* using video images and sensors data taken from production aquaculture ponds with different water qualities

Targets:

Artificial Intelligence	Database	Environment	Production	Research
Develop a fully functional AI based aquaculture pond management systems	Build aquaculture database and specification for fresh water Udang Galah farming	Better understanding of the prawn breeding for optimum environment	Increase production with reduced cost	Create further research opportunities to improve the quality of the production

Speaker: **Tiong Hoo Lim (UTB, Brunei)**

Project Members :

Leader: Tiong Hoo Lim (UTB, Brunei)

Members:

- Aida Maryam Basri (UTB, Brunei),
- Najeebah Az-Zahra Tashim (UTB, Brunei),
- Wafiq Abd Zariful (UTB, Brunei),
- Suriayati Chupra (UTM, Malaysia),
- Seno Adi Putra (Telkom U, Indonesia) ,
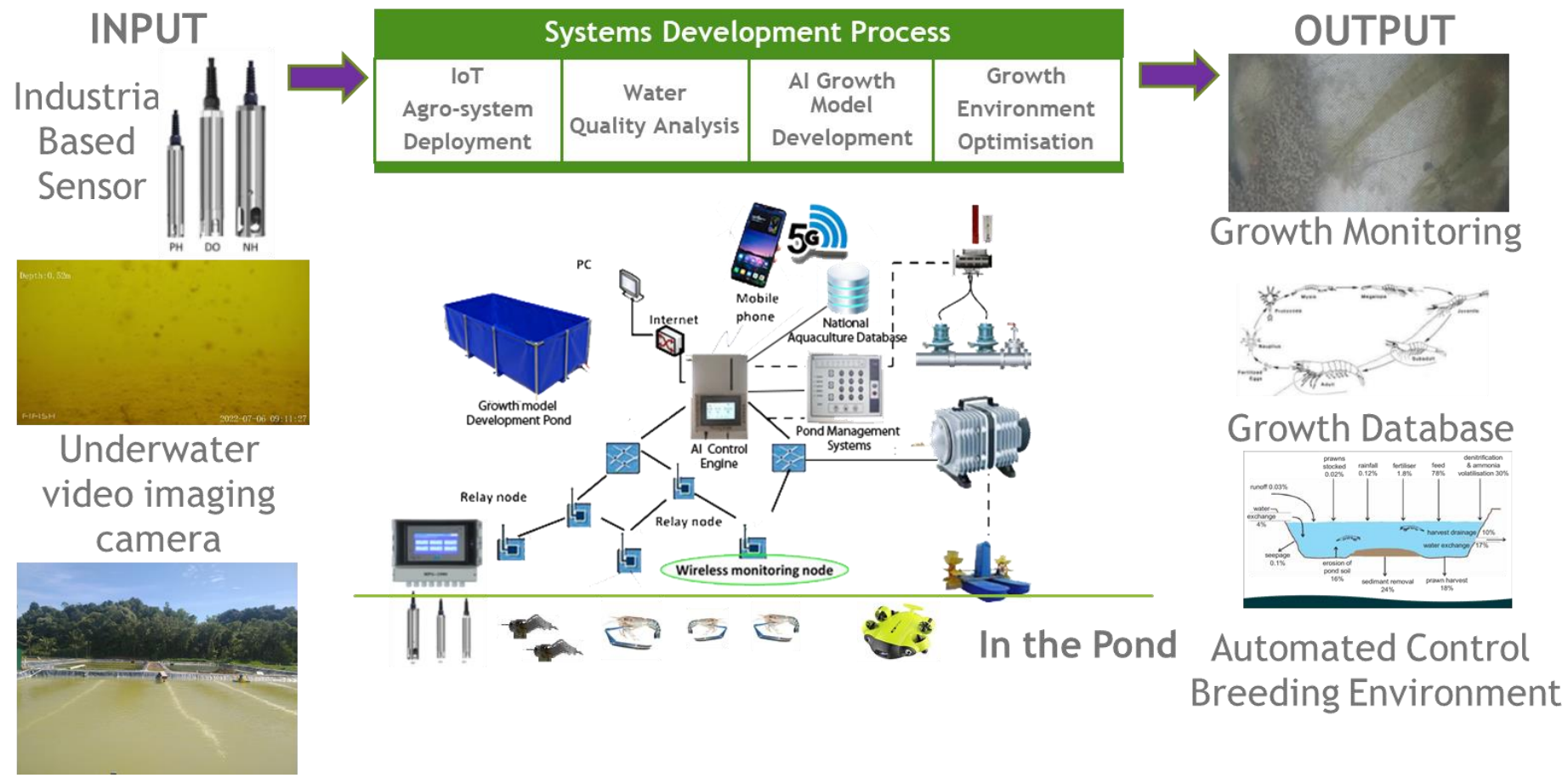- Hanif Fakhrurroja (IIS, Indonesia)

Associate Project Members:

Mr Zuhairi Hj Azahari (ODE, Aquaculture and Agriculture Company, Brunei),

Dr Aqilah Junaidi (Fisheries Department, Ministry of Primary Resource and Tourism, Brunei),

Dr Peng Cheng Liu (University of York, UK)

Project Duration :

24 Months

Project Budget:

USD $38,100

INPUT

Industrial Based Sensor

Underwater video imaging camera

Systems Development Process

| IoT Agro-system Deployment | Water Quality Analysis | AI Growth Model Development | Growth Environment Optimisation |

OUTPUT

Growth Monitoring

Growth Database

Automated Control Breeding Environment

In the Pond

- Development of IoT Aquaculture Pond (Real and Control) (UTB,BRIN, TELKOM) for water quality monitoring.
- The detection of prawn age/size/weight using machine learning and camera.(UTB, UTM, TELKOM, UoY)
- The study of prawn growth: Nutritional analysis, length and weight correlation (UTB, UTM)
- The study of the quality of the wild and breeding prawn (UTB and DoF)

Project Activities: List of activities

Devolopment and Deployment of IoT aquaculture farm
- Dr Lim Tiong Hoo (UTB)
- Seno Adi Putra (Telkom U, Indonesia) ,
- Hanif Kafhrurroja (BRINS, Indonesia)
- Suriayati Chupra (UTM, Malaysia),
- Wafiq Zariful (UTB)

Construction and optimization of the prawn growth model using machine learning
- Dr Lim Tiong Hoo (UTB)
- Suriayati Chupra (UTM, Malaysia),
- Seno Adi Putra (Telkom U, Indonesia),
- Hanif Kafhrurroja (BRINS, Indonesia)
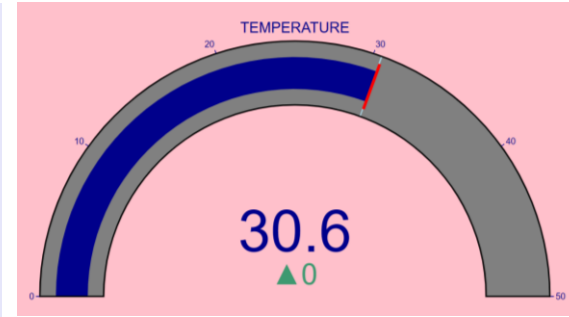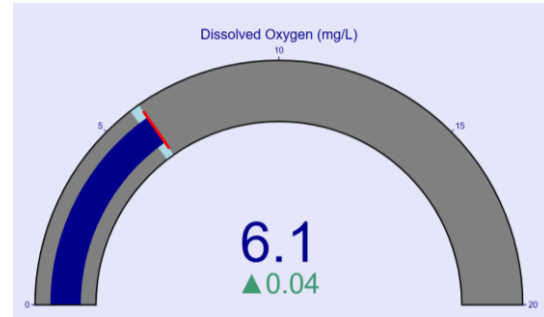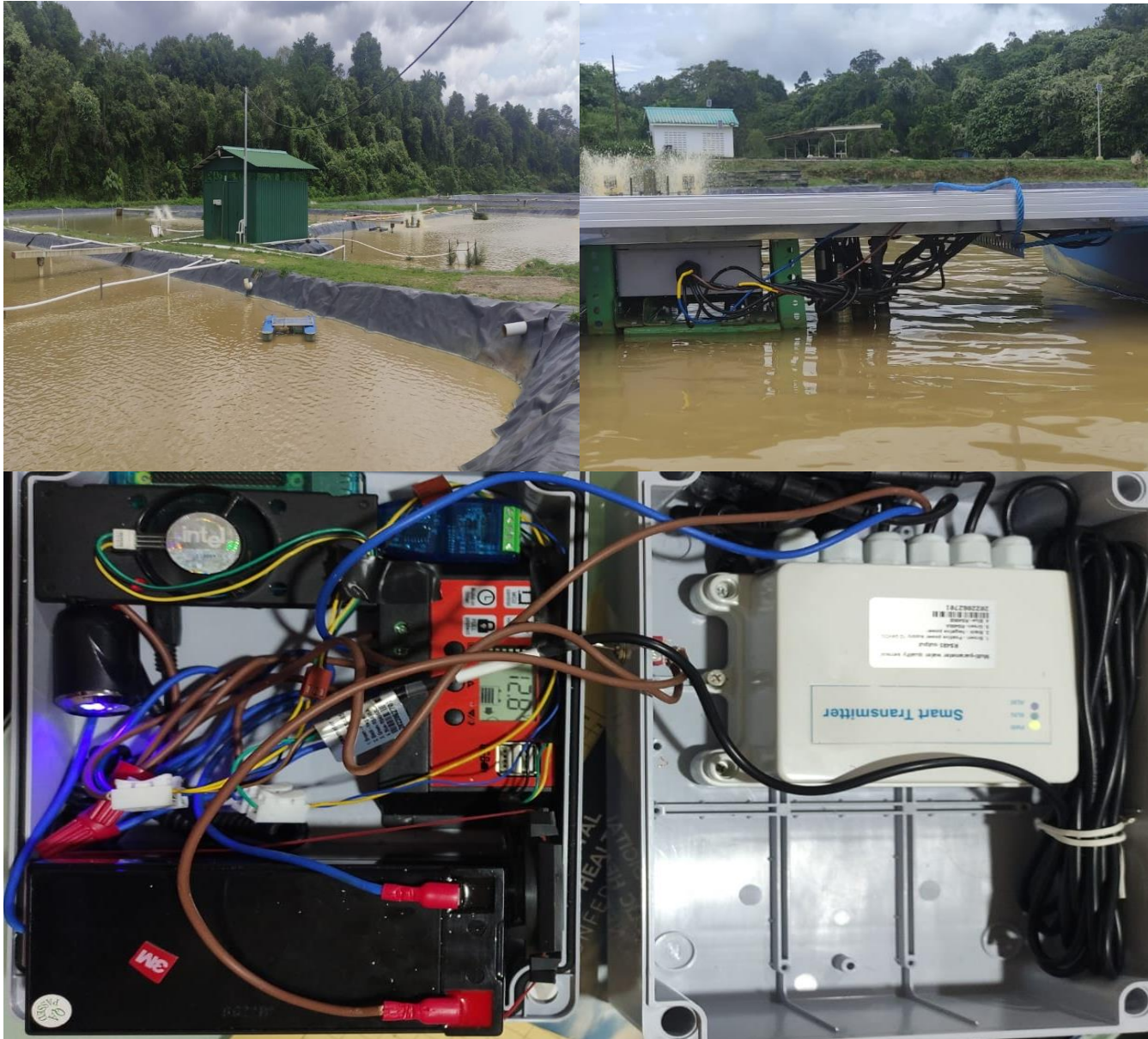- Dr Peng Cheng Liu and team (University of York, UK)
- Wafiq Zariful (UTB)

Study of the prawn quality and growth - Sampling for data training and Analysis
- Dr Lim Tiong Hoo (UTB)
- Aida Maryam Basri (UTB, Brunei),
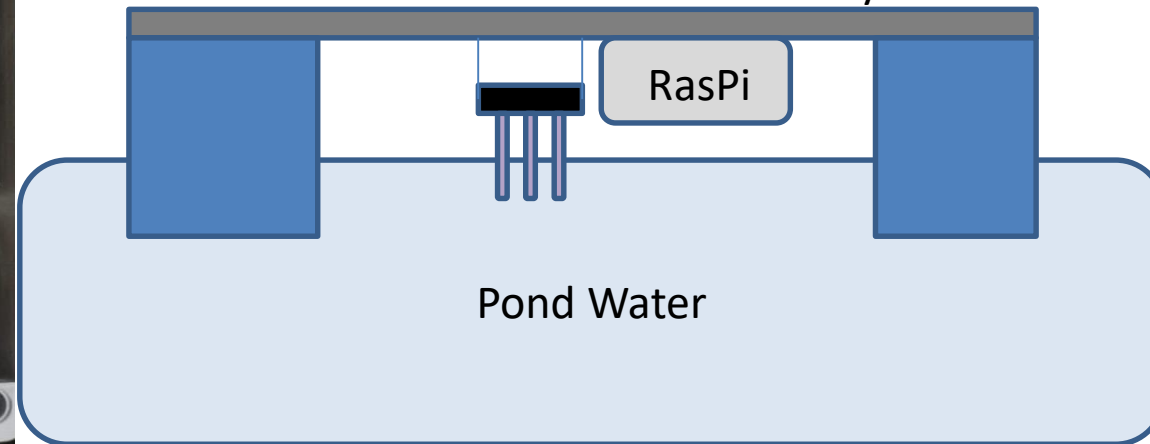- Najeebah Az-Zahra Tashim (UTB).

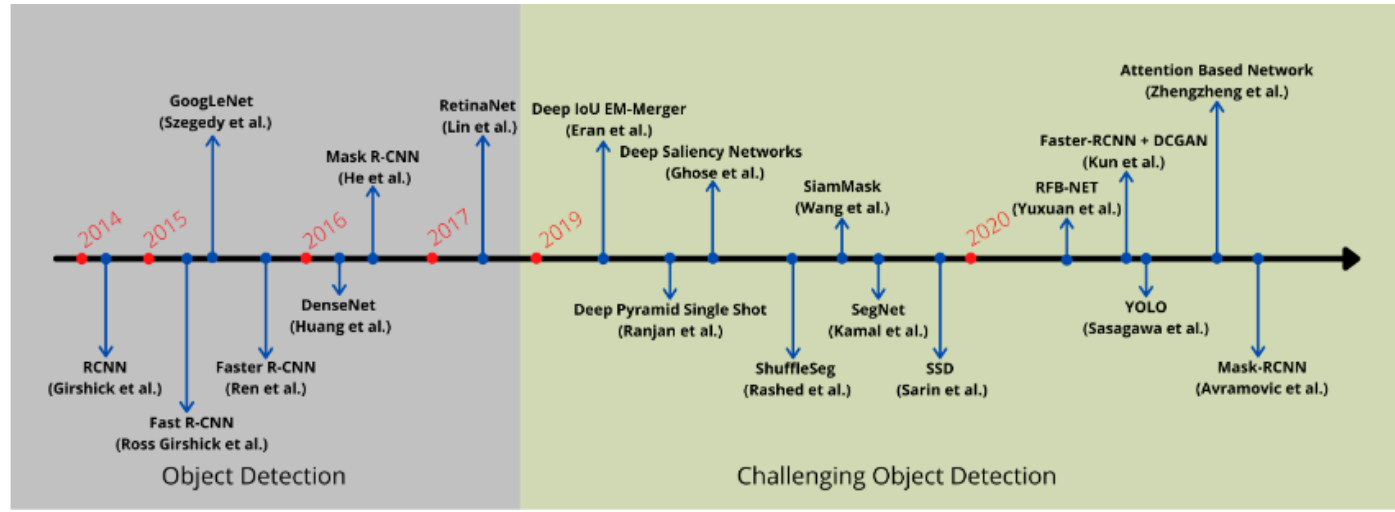**Stakeholder information sharing**
- Mr Zuhairi Hj Azahari (ODE, Aquaculture and Agriculture Company, Brunei) – Access to the pond and end user
- Dr Aqilah Junaidi (Fisheries Department, Ministry of Primary Resource and Tourism, Brunei) – Expert advice on the current breeding environment

Dissolved Oxygen (mg/L)
6.1
▲0.04

TEMPERATURE
30.6
▲0

pH
8.14

Solar Panel with 12V battery

RasPi

Pond Water

Object Detection | Challenging Object Detection

- **M**odels that will be evaluated include YOLOv8, Faster R-CNN (FRCNN), Single Shot Detector (SSD), and EfficientDet
- Model's performance accessed based on
  - inference time,
  - accuracy,
  - image input size, and
  - model memory footprint
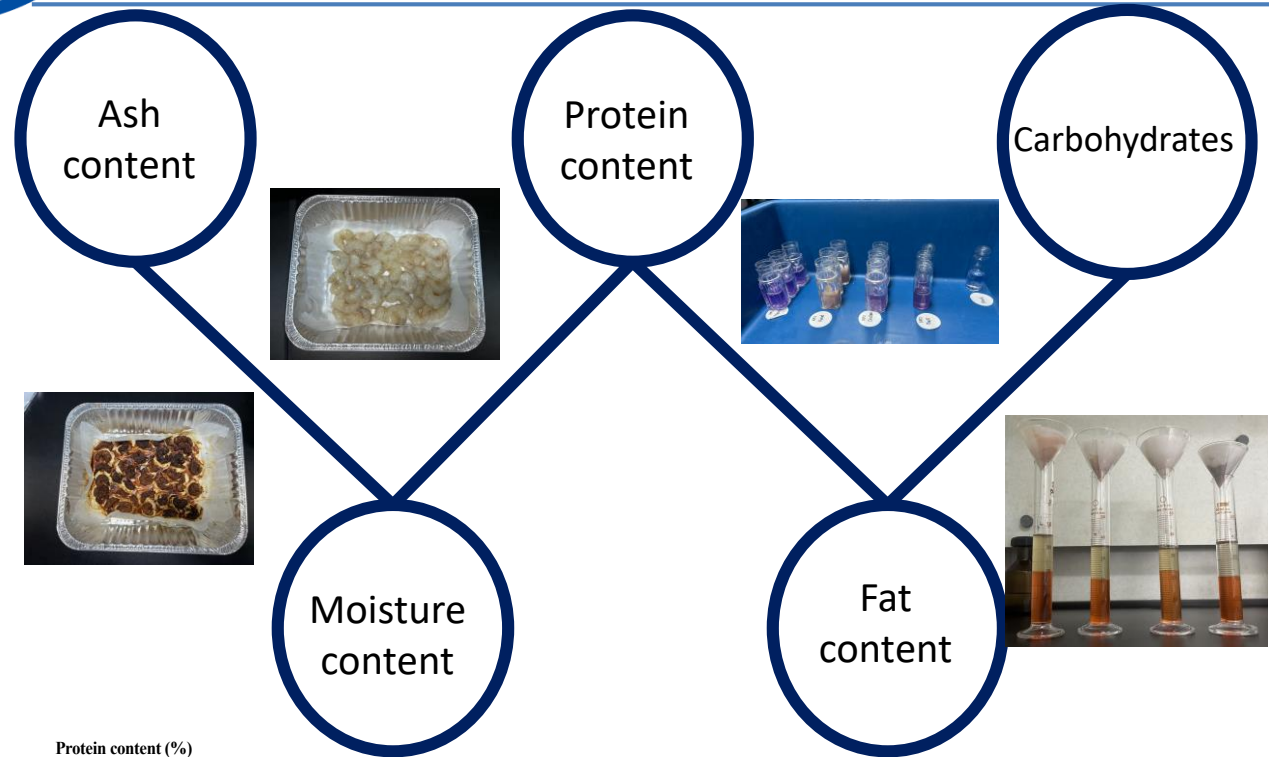- Bio marker is used to estimate the length

Data Sets

- Freshwater prawn dataset collected by: Manually capturing images and retrieving clear images from the internet
- All images are annotated using LabelImg software
- Some background images with null annotations were also included in the dataset to prevent false positive results
- Total of 2976 images in the dataset

Ash content

Protein content

Carbohydrates

Moisture content

Fat content

STAGE 1
Sample collection and preparation

STAGE 2
Experimental analysis

STAGE 3
Statistical analysis
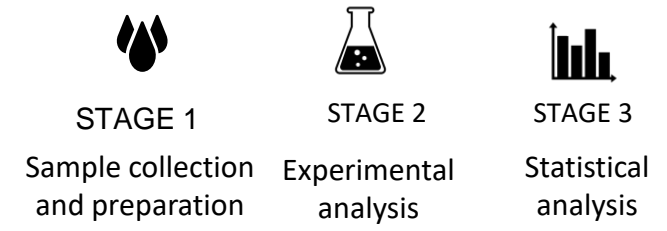
	Pond A2	Pond 7	Pond 10
Length (cm)	13.7 ± 1.47[a]	14.9 ± 1.62[b]	12.7 ± 1.07[c]
Weight (g)	43.2 ± 15.1[a]	40.8 ± 15.5[a]	28.8 ± 7.31[b]
Meat protein content (%)	1.27 ± 0.01[a]	0.84 ± 0.03[b]	3.78 ± 0.02[c]
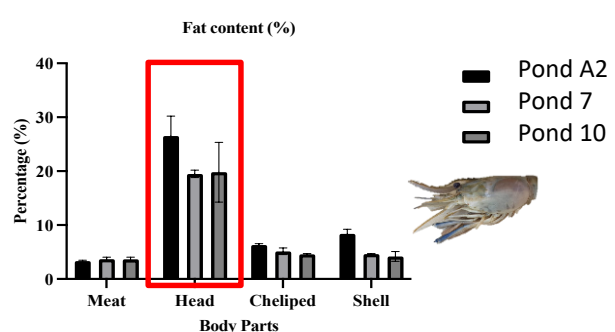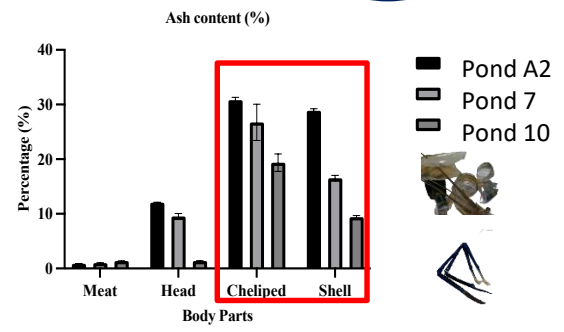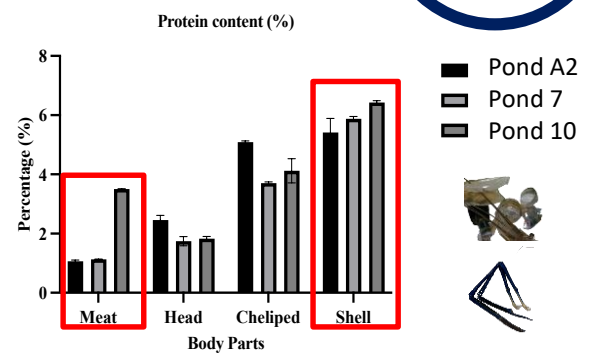
Protein content (%)

- Both cheliped and shell has significantly the highest protein content, compared to the other prawn parts up to 7 %

Ash content (%)

- Cheliped and shell recorded the highest ash content across all ponds

Fat content (%)

- This study revealed that the head part recorded the highest fat content at around 20%

Field testing of the Prawn Growth Model in the real pond

1. Analysis of different types of object detection model for giant freshwater prawn in turbid and murky water
- YOLOv8 provides the best result combining both processing speed and accuracy

2. Biomass comparison between YOLO length detection using reference code and manual measurements
- Conducted statistical analysis (t-test), found significant difference ($p < 0.05$) between the two measurements. The values in YOLO are higher than the manual reading.
- Need to refine the size through segmentation for a more accurate length measurement.
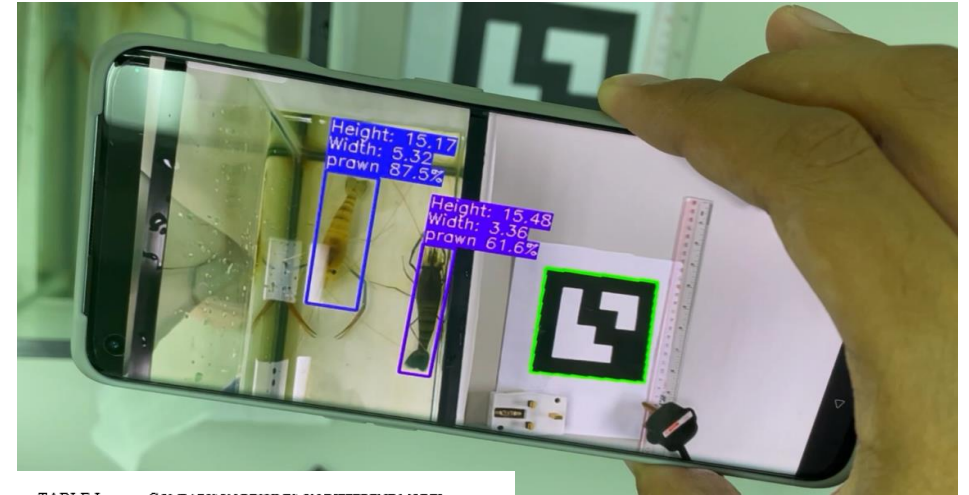
3. Evaluated of Segment Anything Model

TABLE I. COMPARISON RESULTS ON DIFFERENT MODEL ARCHITECTURES INCLUDING ITS INPUT SIZE, INFERENCE TIME, MAP UNDER 0.5:0.95 THRESHOLD, AND MODEL SIZE

Model	Input Size	Inference Time (ms)	mAP @ 0.5:0.95	Model Size
SSD MobileNet V1 FPN 640x640	640x640	124.2	78.66 %	48.3 MB
SSD MobileNet V2 320x320	320x320	80.2	60.53 %	28.3 MB
SSD MobileNet V2 FPNLite 320x320	320x320	96.2	78.22 %	17.4 MB
SSD MobileNet V2 FPNLite 640x640	640x640	101.4	77.37 %	17.4 MB
EfficientDet D0	512x512	195.4	73.72 %	40.6 MB
EfficientDet D1	640x640	209.6	61.92 %	50.4 MB
EfficientDet D2	768x768	323.6	36.10 %	65.8 MB
Faster R-CNN ResNet50 V1 640x640	640x640	516.4	47.92 %	117.9 MB
Faster R-CNN ResNet101 V1 640x640	640x640	742.6	33.89 %	198.3 MB
Faster R-CNN ResNet152 V1 640x640	640x640	794.8	36.83 %	264.8 MB
Faster R-CNN Inception ResNet V2 640x640	640x640	601.3	53.26 %	252.3 MB
YOLOv8	640x640	32.9	83.71 %	103.7 MB

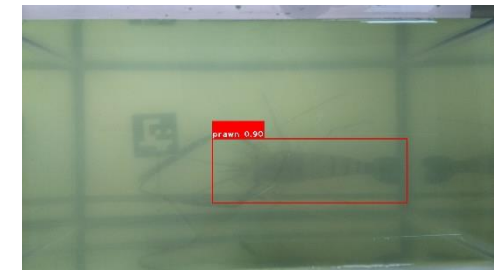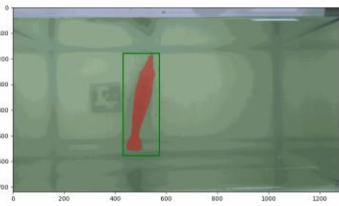|	Manual (cm)	App/YOLO/length (cm)	Image from App
	13	13.20	Width 8.9 cm Length 13.2 cm prawn 0.84
	12	15.30	Width 15.3 cm Length 4.1 cm prawn 0.65

Fig. 4. High turbidity underwater freshwater prawn detection result using YOLOv8, with a confidence score of 94%

Scientific Contribution:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1	Analysis of Deep Learning Algorithms for Prawn Aquaculture in a Challenging Environment	Wafiq Zariful, Najeebah Az-Zahra Tashim, Tiong Hoo Lim, Aida Maryam Basri, Suriayati Chuprat, Seno Adi Putra, Hanif Fakhrurroja and Pengcheng Liu	Universiti Teknologi Brunei, Universiti Teknologi Malaysia, Telkom University Indonesia, National Research and Innovation Agency Indonesia, University of York	The 6th International Conference on Applied Computational Intelligence in Information Systems	25/10/2023	International Conventional Centre, Brunei Darussalam
2	Nutritional Quality of Cultured Giant Freshwater Prawns (*Macrobrachium rosenbergii)*	Nurul Fithriyani Mohamad Saifol Rizal, Najeebah Az-Zahra Tashim, Zuhairi Azahari, Aida Maryam Basri, Tiong Hoo Lim, Aqilah Junaidi, Suriayati Chuprat, Seno Adi Putra and Hanif Fakhrurroja	Universiti Teknologi Brunei, ODE Aquaculture and Agriculture Farm, Department of Fisheries Ministry of Primary Resources and Tourism Brunei, Universiti Teknologi Malaysia, Telkom University Indonesia, National Research and Innovation Agency Indonesia	International Conference on Agrotechnology, Beverage and Food (ICABF 2023)	25/10/2023	International Conventional Centre, Brunei Darussalam

Societal Impact:

- **Improve farm management and water treatment.**
- Better working environment.
- Support green and blue Aquaculture.

- **Reduce growth time from 5 to 4 months.#**
- **Increase survival rate by 20%.#**
- Reduce wastage on feed.

- **Increase Aqua-tech activities.**
- Create new job opportunities.
- Attract investment.
- Encourage Agro-business.

- **Increase productions (from 7980 kg to 9576 kg).***
- **Lower operation costs.**
- Increase ODE contribution to Brunei freshwater prawn production to **44.7%.***

- **Generate new knowledge.**
- Improve aquafarm methods.
- Identify best practices.
- Provide innovative farming.

- **Address food security through sustainable aquaculture.**
- Improve socio-economic independence.
- Provide source of protein.

- **Sharing of Aqua-cloud with farmers.**
- Digitalization and Agro-data analytics.

- **IR-4.0 Ready Aquaculture systems.**
- Technology transfer to new industry.

Optimum & Economical Breeding — Goal 2

New Opportunities — Goal 3

Economical Benefit — Goal 3

Brunei Wawasan 2035

Knowledge Transfer — Goal 1

Social Benefit — Goal 2

Digital Wealth — Goal 1

Conclusion:

Research and Development:

- YOLOv8 provides the best result combining both processing speed and accuracy

- A mobile app has been produced and has won the Brunei ICT Award

- Segmentation model such as segment anything has been applied to improve the prawn detection algorithm

Future works: (Next 3 months)

1. Development of an underwater drone to test prawn size detection model in real pond using feeding platform and evaluate the accuracy and the effect of turbidity on the camera and the model

CAMERA

Pond Water
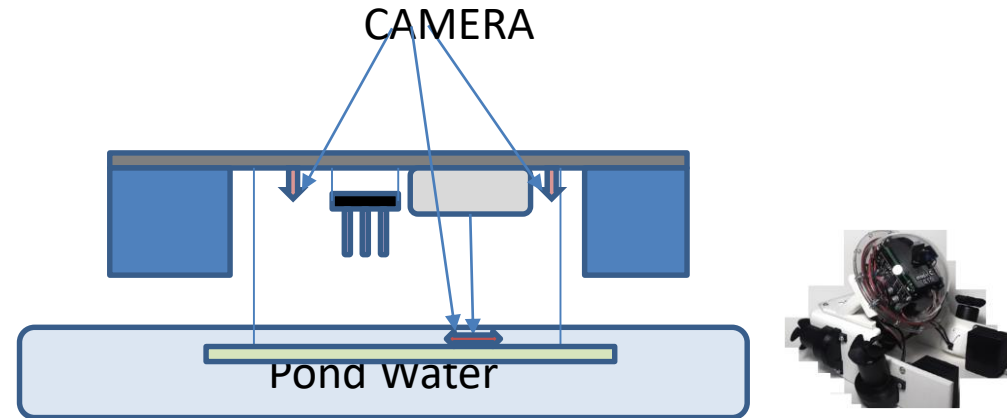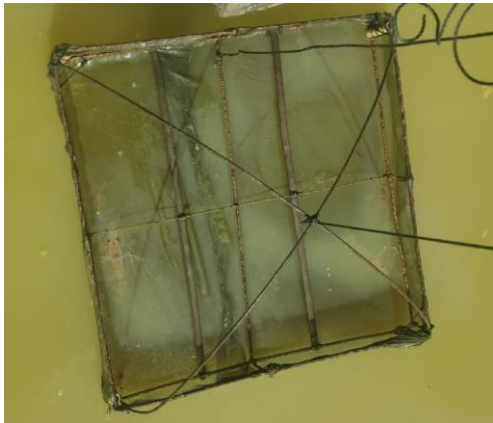
2. Developing mathematic model using the relationship between the length and weight using AI based optimization techniques. [Mane 2019]

3. Use segmentation for better measurement accuracy.

4. Evaluate the model on different aquatic model

5. Sharing session with industries and others researcher locally and internationally through workshop

Han, Y. (2022). Comparison on object detection algorithms: A taxonomy. *2022 3rd International Conference on Electronic Communication and Artificial Intelligence (IWECAI)*. https://doi.org/10.1109/iwecai55315.2022.00047

Shin, H.-C., Roth, H. R., Gao, M., Lu, L., Xu, Z., Nogues, I., Yao, J., Mollura, D., & Summers, R. M. (2016). Deep convolutional neural networks for computer-aided detection: CNN Architectures, dataset characteristics and transfer learning. *IEEE Transactions on Medical Imaging, 35*(5), 1285–1298. https://doi.org/10.1109/tmi.2016.2528162

Mane, S., Sundaram, S., Hule, A., Sawant, M. & VD, D. (2019). Length weight relationship of commercially important penaeid prawns of Maharashtra, India, 7(1), 35-40

Sethi, S. N., Ram, N. & Venkatesan, V. (2012). Length-weight relationship of *Macrobrachium lar* (Fabricius, 1798), an endemic freshwater prawn in streams and ponds of Andaman and Nicobar Islands. Indian J. Fish, 59(4), 157-161

Poonnoy, P. & Chum-in, T. (2012). Estimation of sushi shrimp weight using image analysis technique and non-linear regression models. International Conference of Agricultural Engineering (CIGR-AGENG), Spain.