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FOREWORD

NISTI, operating under the Ministry of Industry, Science, Technology & Innovation (MISTI), plays a vital role in Cambodia's research and development (R&D), training programs, STI promotion, and laboratory testing services for food and non-food items. In order to communicate valuable insights and research findings to the public, the Department of STI Promotion and Development initiated the publication called STI Focus. This publication aims to cover scientific discoveries, technology trends, and STEM education and career guidance. The latest issue of STI Focus includes articles written by local and international scholars who hold master's and Ph.D. degrees in relevant fields.

I would like to extend my congratulations to all the authors who dedicated their time and effort to produce this latest issue of STI Focus. The publication has consistently played a crucial role in advancing knowledge within our society. The articles contained in this issue will undoubtedly serve as valuable sources of information and references for both current and future readers and practitioners. They will also contribute to enhancing public understanding of science, technology, and innovation. I strongly encourage researchers and young scholars to submit their own findings for publication, as it will further promote the development of STI in Cambodia. I sincerely hope that you will find this issue as enjoyable and enlightening as I did.

Phnom Penh, 30 June 2023

Senior Minister

Minister of Industry, Science, Technology & Innovation

Kitti Settha Pandita **CHAM Prasidh**

EDITORIAL NOTE

STI Focus has been created with the aim of bridging the gap between researchers and the public by providing accessible information on science, technology, and innovation (STI). While the publication of academic papers has contributed to knowledge creation, important findings and notes on STI from universities, research institutions, and ministries often lack public outreach. To address this issue, STI Focus publishes articles on scientific findings, technology trends, and STEM education and career development, which are key areas for disseminating research findings, practical methodologies, and innovative processes that can enhance productivity in SMEs. The current issue of STI Focus, available on the MISTI website or through a QR code, features contributions from authors who have expertise and interest in these areas.

The manuscripts undergo a thorough screening process by the editorial team and invited reviewers, focusing on criteria such as usefulness, completeness, reliability, and understandability. We extend our gratitude to the authors, reviewers, and NISTI team for their efforts in making this issue possible, and we hope that readers will find it valuable.

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STI Focus Vol.1, No. 1

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01 Application of Computational Tools to Design a Universal Foot-and-Mouth Disease Vaccine

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HIGHLIGHT

- FMD is caused by a virus with seven serotypes, each requiring a different vaccine. Developing a universal vaccine that protects against all serotypes is a challenge.
- Computational analysis has played a critical role in the development and evaluation of fused VP-1 proteins as a potential universal vaccine against seven different serotypes of FMDV.
- Fused VP-1 proteins were designed using computational tools to predict the hydrophilicity and immunogenicity, demonstrating that the vaccines have the immunogenic ability to trigger a host defense mechanism.
- Bioinformatics was used to identify potential B-cell and T-cell epitopes on the fused VP-1 proteins, suggesting that the vaccines are active in the stimulation of B and T cells.
- Molecular modeling and simulation techniques were used to predict the structure and stability of the fused VP-1 proteins, resulting that the hybrid-engineered vaccines would be feasible in production.

1. Introduction and Rational

Foot and mouse disease (FMD) is a vital livestock disease that contagiously affects cloven-hooved animals, especially cattle, goats, sheep, and pigs, causing significant world-economic loss (Lee, 2022). FMD virus (FMDV) is classified into seven serotypes (O, A, Aisa1, C, SAT1, SAT2, and SAT3), and infection with one serotype does not confer immunity against another (Diaz-San Segundo, 2017). Therefore, vaccination against FMDV is a cost-effective strategy, thereby protecting animals from viral infection and increasing productivity in livestock. Moreover, vaccines that elicit cross-protection against various FMDV serotypes may significantly decrease a regional and international risk assessment.

FMDV is a positive ssRNA animal virus with symmetric protein capsids composed of 60 copies each of 4 structural polypeptides (VP-1 to VP-4) enclosing about 8.5 kb genome (Diaz-San Segundo, 2017). Different studies evaluated the antigenicity and immunogenicity of VP-1 to VP-4 proteins as vaccines (Li, 2021; Avendano, 2020). In addition, the VP-1 domain has been extensively studied (Zhi, 2021; Zhu, 2020; Mamabolo, 2020). Recently, a study has been developing a new generation of FMD vaccine. However, there still needs to be cross-protection against prevailing and circulating virus strains or insufficient protection between some subtypes of FMDV likely to be encountered in a given field situation (Singanallur, 2022).

An ideal vaccine should be generated in a combination of antigens from different serotypes into a single vial and formulated vaccine to be available, safe, and effective. However, a live attenuated or an inactivated vaccine formulating seven serotypes of a virus as multivalent for a

wide spectrum coverage is systemically tricky, and it is hard to secure vaccine safety. In this study, we proposed computational-based vaccine designs: vaccine#1 contains 4-fused protective antigens from types O, A, Asia1, and C, and vaccine#2 contains 3-fused protective antigens from types SAT1, 2, and 3.

2. Methodology

This study implemented the computational approach to predict vaccine candidates against multi-serotype of FMDV. The whole genomes and FMDV proteins were selected from the NCBI databases (https://www.ncbi.nlm.nih.gov), as shown in Table 1. The protective antigens were analyzed by VaxiJen v2.0 (www.ddg-pharmfac.net/vaxijen/VaxiJen/VaxiJen.html) with a threshold = 0.4. To align amino acid sequences, ClustalW2 (https://www.ebi.ac.uk/Tools/msa/clustalo/) was used. The IEDB Server (tools.iedb.org/bcell/) was used to demonstrate the hydrophilicity (threshold = 1), antigenicity (threshold = 1), and B-cell epitopes with a threshold = 0.5 (BepiPred and BepiPred2.0). To predict the T-cell epitopes, an IEDB combined CD4 T-cell immunogenicity prediction tool (tools.iedb.org/CD4episcore/help/) was used. At the same time, the structural simulation of proteins was acquired by AlphaFold-2 Server (https://colab.research.google.com/github/sokrypton/ColabFold/blob/main/AlphaFold2.ipynb#scrollTo=kOblAo-xetgx) and rendered with download available PyMol (https://pymol.org/2/).

Table 1. Determination of protective antigens by VaxiJen v2.0. The threshold was set at 0.4. The protective antigens should have a greater value than 0.4.

Vaccines	Serotypes (GenBank ID)	Structural proteins of FMDV: GenBank ID (amino acid location)	Protective antigen score
Vaccine #1	Type O (ARB66056.1)	VP1: ARB66056.1 (725...937)	0.5018
		VP2: ARB66056.1 (287...504)	0.4455
		VP3: ARB66056.1 (505...724)	0.4773
		VP4: ARB66056.1 (202...286)	0.4229
	Type A (OK318510.1)	VP1: UPG19725.1 (728...935)	0.6391
		VP2: UPG19725.1 (287...504)	0.4720
		VP3: UPG19725.1 (505...725)	0.5984
		VP4: UPG19725.1 (202...286)	0.4179
	Type Asia1 (MN366244.1)	VP1: QIW91859.1 (724...934)	0.4904
		VP2: QIW91859.1 (287...504)	0.5398
		VP3: QIW91859.1 (505...723)	0.5599
		VP4: QIW91859.1 (202...286)	0.4052
	Type C (MG372729.1)	VP1: AXU41408.1 (724...932)	0.5610
		VP2: AXU41408.1 (287...504)	0.5292
		VP3: AXU41408.1 (505...723)	0.5366
		VP4: AXU41408.1 (202...286)	0.4255
Vaccine #2	Type SAT1 (MN275121.1)	VP1: QEQ91190.1 (725...942)	0.5610
		VP2: QEQ91190.1 (285...503)	0.3936
		VP3: QEQ91190.1 (504...724)	0.6493
		VP4: QEQ91190.1 (200...284)	0.4338
	Type SAT2 (JX014256.1)	VP1: AFP33713.1 (757...919)	0.5896
		VP2: AFP33713.1 (314...472)	0.4692
		VP3: AFP33713.1 (559...723)	0.5948
		VP4: AFP33713.1 (200...283)	0.4185
	Type SAT3 (KJ820999.1)	VP1: AJD73194.1 (755...916)	0.6493
		VP2: AJD73194.1 (314...472)	0.4095
		VP3: AJD73194.1 (553...721)	0.6878
		VP4: AJD73194.1 (200...283)	0.4185

3. Results and Discussion

3.1. Selection of Vaccine Antigen

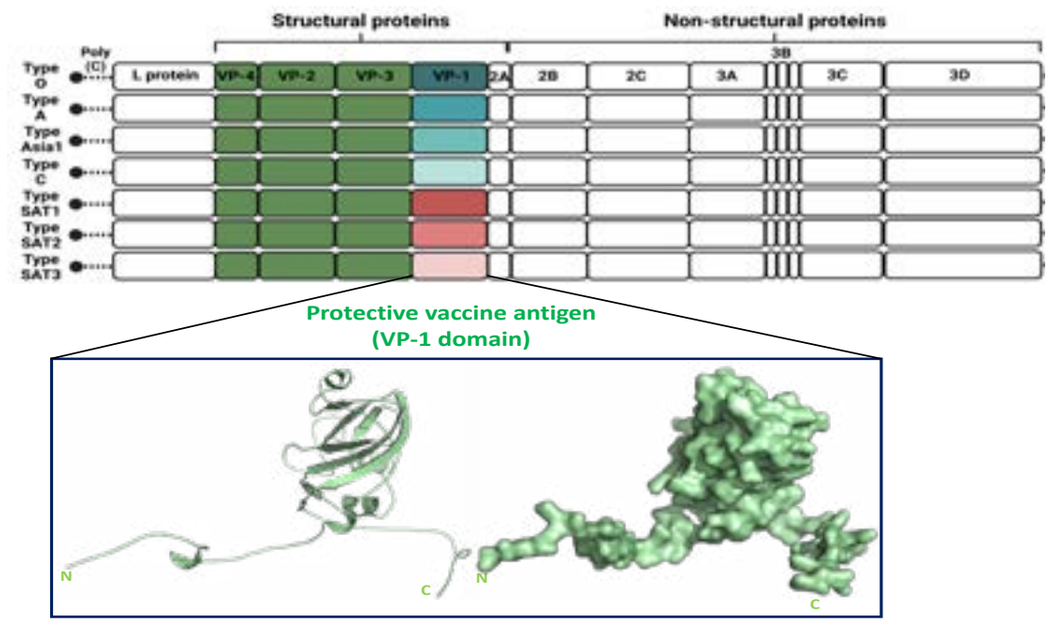
We obtained complete genomes and FMDV proteins from the NCBI databases, and we analyzed each serotype's structural proteins for defensive antigens using VaxiJen v2.0 (Table 1). The structural proteins (VP-1 to VP-4) have higher protective antigen values (higher than threshold = 0.4), except VP-2 of type SAT1 (value = 0.3936). This result indicates that all VP proteins are immunogenic as vaccines, supporting the experimental evidence (Li, 2021; Avendano, 2020). However, an effective vaccine should efficiently produce functional antibodies to block viral infection. The VP-1 was reported to be crucial in interacting with the host's protein and promoting virus replication (Zhu, 2020). Furthermore, antibodies generated from the vaccination of VP-1 potentially inhibited viral infection (Mamabolo, 2020). Thus, we selected VP-1 as an antigen candidate (Figure 1A).

3.2. Strategy forVaccine Designs

To develop FMD vaccines capable of cross-protection of all serotypes, a protein-based vaccine composed of VP-1 antigens from different serotypes is proposed. VP-1 proteins shared amino acid identity around 44.55% to 70.33% across

serotypes, indicating vaccination with a single VP-1 protein could not secure protection across different serotypes (Figure 1B). In addition, formulating a vaccine composed of all protective antigens of VP-1 from seven serotypes as an all-in-one vaccine is not an ideal option since a big molecular mass of fused protein (≥ 160kDa) may cause a problematic task in production. In contrast, separately producing vaccine#1 (≥ 90kDa) contains 4-fused VP-1 antigens from types O, A, Asia1, and C, and vaccine#2 (≥ 70kDa) contains 3-fused VP-1 antigens from types SAT1, 2, and 3 would be possible and innovative (Figure 2). To this end, vaccine #1 used in regional Asia as domestics does not necessarily include any VP-1 from serotypes of regional where else and vice versa. Universally, vaccination with vaccine #1 plus vaccine #2 is highly recommended control disease at local and international levels.

Figure 1. Selection of vaccine antigen. (A) Schematic diagram of the FMDV serotypes complete genome adopted from NCBI databases, as shown in Table 1. VP-1 domain was selected as a protective vaccine antigen, and its structure was generated using AlphaFold2 and rendered by Pymol. N, N-terminus, C, C-terminus of protein, respectively. (B) The alignment of amino acid sequences of VP-1 from seven serotypes.



3.3. Computational Validation of Vaccine#1 and Vaccine#2

To analyze whether vaccines are possibly produced and induce immune responses. The hydrophilicity and antigenicity of vaccines were analyzed using IEDB Server with a threshold value = 1. Both vaccines have relatively high hydrophilic scores and the antigenicity metric (Figure 3), demonstrating the solubility of vaccines that are likely easy to produce. To verify the immunogenicity of vaccines, potential B-cell epitopes were predicted using BepiPred and BepiPred2.0 with a threshold value = 0.5. Several potential B-cell regions were presented with high scores in both vaccine#1 and vaccine#2 (Figure 4). These results indicate that vaccines have an immunogenic ability to activate the B-cell population eliciting functional antibody responses against viral infection. Since the induction of a cellular immune response and the activation of B cells through a T-cell-dependent pathway is crucial for enhancing the clearance of FMDV (Lee, 2022), potential T-cell epitopes were also predicted. Many T-cell epitopes were identified in VP-1 of each serotype (Table 2), and a representative T-cell epitope was nicely exposed by structural simulation (Figure 2). Taken together, hybrid-engineered vaccines would be feasible in production and be active in stimulating both B and T cells, triggering a robust host defense mechanism.

Figure 2. Construction of vaccine candidates. Plasmid construction with the organization of VP-1 genes for vaccine#1 (A) and vaccine#2 (B). The G4S is a linker for stably expressed and exposed each VP-1 domain of hybrid vaccines separately. Both vaccines are 6xH-tagged for purification using the pET30a+ vector. As mentioned above, the protein structures were generated using AlphaFold2 and rendered by Pymol. Each color represents a VP-1 of each serotype, respectively, and the first potential CD4-cell epitopes from each VP-1 (Table 2) were colored Blue.

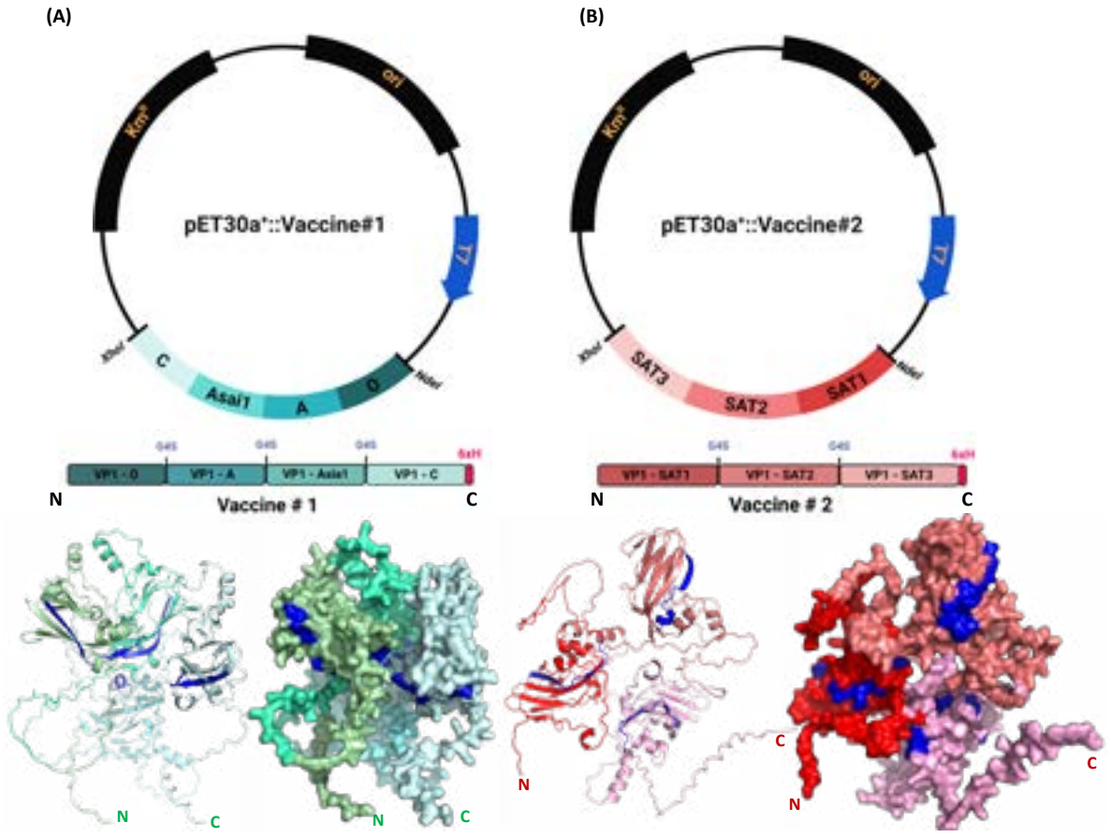


Figure 3. Computational analysis for hydrophilicity and antigenicity of vaccine#1 (A) and vaccine#2 (B). The threshold was 1 in hydrophilicity (upper panel) and antigenicity (lower panel). The amino acid regions with higher values than 1 indicate solubility (hydrophilicity score) and antigenicity (antigenic score), respectively.

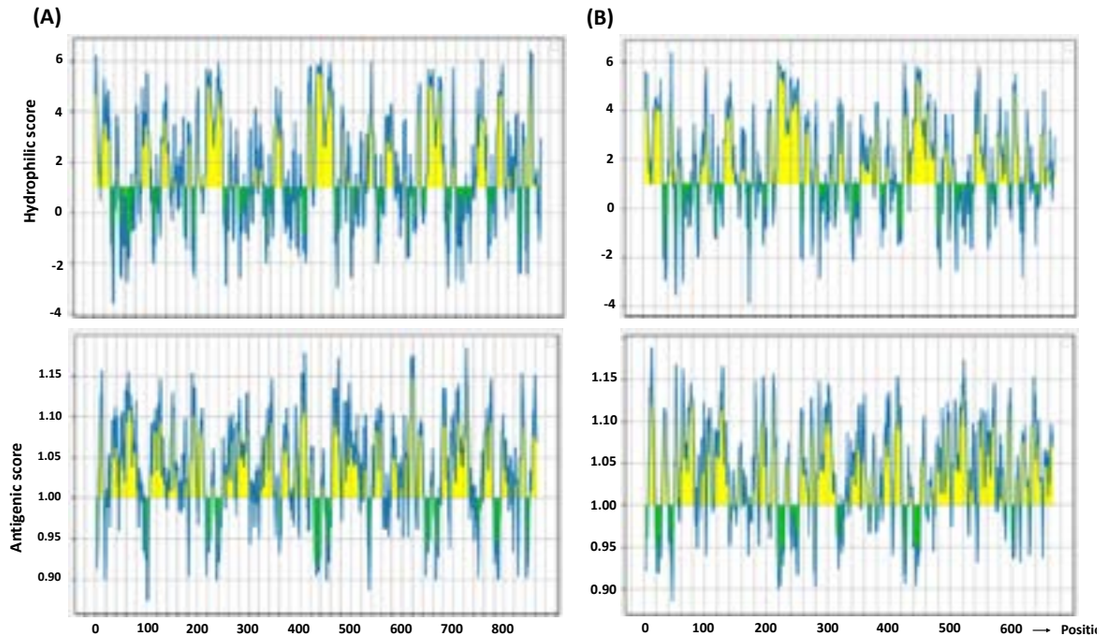


Figure 4. Computational analysis for B-cell epitopes of vaccine#1 (A) and vaccine#2 (B). The threshold was set at 0.5 for both BepiPred (upper panel) and BepiPred2.0 (lower panel). The amino acid regions with higher values than 0.5 indicate the potential B-cell epitope.

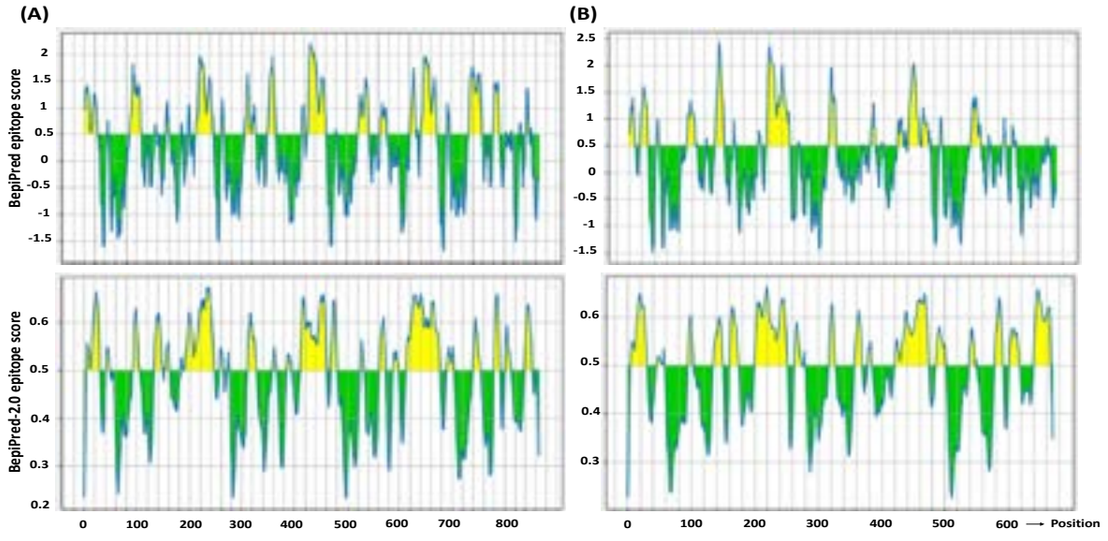


Table 2. Potential CD4-cell epitopes being recognized by T-cell receptors. As mentioned in the Methodology section, the combined method prediction was performed. First rank epitopes from each VP-1 of serotypes were further analyzed, as shown in Figure 2.

Vaccines	Serotypes	Rank - Potential CD4-cell epitopes	Combined Scores
Vaccine #1	Type O	1 – ELLYRMKRAETYCPR	43.31416
		2 – PTSFNYGAIKATRVT	43.79356
		3 – TDVSFILDRFVKVTP	44.31024
		4 – VLDLMQIPAHTLVGA	45.85228
		5 – YGAIKATRVTELLYR	46.71844
		6 – TLVGALLRVATYYFS	48.92228
		7 – RGDLQVLAQKAARPL	49.815
	Type A	1 – QDLLVRMKRAELYCP	38.38864
		2 - DRFVQIKPASPTHVI	41.49388
		3 - VSFIMDRFVQIKPAS	42.07312
		4 - NFGAIRATGIQDLLV	48.33336
	Type Asia1	1 - VAFVLDRFVKVQVSG	42.94732
		2 - ETITELLVRMKRAEL	43.46184
		3 - LLVRMKRAELYCPRP	44.52612
		4 - GETAHLAAAHARHLP	46.38136
		5 - DVMQVHKDSIVGALL	48.798
	Type C	1 - ELLIRMKRAETYCPR	40.89688
		2 - LHTDVAFVLDRFVKL	41.2654
		3 - TQVLDLMQIPAHTLV	41.94928
		4 - QTARRLHTDVAFVLD	43.5564
		5 - GALLRSATYYFSDLE	48.34532
Vaccine #2	Type SAT1	1 - VDVYVRMKRAELYCP	41.04508
		2 - PAAIRGDFATLAARL	43.11204
		3 - PVVFSHNGVTRFALP	44.8178
		4 - TDVAFLLDRFTKIGK	45.95468
		5 - KALVGALLRSATYYF	49.95528
	Type SAT2	1 - VAFLLDRSTHVHTNK	38.5234
		2 - DVYYRMKRAELYCPR	46.16512
		3 - LVGAILRSATYYFCD	46.37548
		4 - DNPMVFAKGGVTRFA	46.37844
		5 - VTRFAIPFTAPHRLL	46.62888
		6 - VGAILRASTYYFCDL	46.69596
	Type SAT3	1 - DSGDVYYRMKRAELY	42.32456
		2 - YSTIQRVTPRRGDLA	49.17148
		3 - YYRMKRAELYCPRPL	49.58532

4. Conclusion

The computational-based analysis may provide an essential strategy for developing a protein-based vaccine that overcomes the daunting task of cross-protecting different FMDV serotypes. By employing several immunological databases and other computational sequencing analyses, predicted universal FMD vaccines were generated. However, the vaccine being presented is based on integral computing tools, which is the only constraint of the current study. We advise further experimentation in wet labs with animal models to assess the efficacy of possible vaccine candidates.

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AUTHOR'S BIOGRAPHY

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ABOUT

Dr. Puth Sao is currently a Post-Doc researcher at the Combinatorial Tumor Immunotherapy Research Center, Chonnam National University (CNU) Medical School, Korea. He holds a Ph.D. degree in Molecular Medicine from CNU, Korea in 2019, a Master degree in Molecular Medicine from CNU, Korea in 2016, and a Bachelor degree in Biology from Royal University of Phnom Penh, Cambodia in 2013. His researches focus on "vaccine-based technologies". He has developed several vaccine candidates for prevention of infectious diseases caused by bacteria or viruses as well as for treatment of cancer. Currently, he also does a research to develop a new vaccine candidate for prevention/treatment of Alzheimer's disease as a non-infectious disease.

02 Identification and Isolation of Aliphatic Hydrocarbons Degrading Bacteria from Sea Tidal Flat

Lo Naysim, Master's Degree, Life Sciences, Chung- Ang University, South Korea

HIGHLIGHT

- The biggest concern with organic and inorganic pollutants is hydrocarbons caused by petroleum spills into the sea, so the Dangjin site was investigated for a biodegradation approach.
- Enrichment cultures use seawater and artificial seawater containing aliphatic hydrocarbons as the sole carbon source.
- Sequencing is the mechanism of defining the sequence of nucleic acid to represent the bacterial acestors.
- The genus is the biological classification ranking between family and species.
- Species is the biological unit classification encompassing related a group of organisms that consist similar characteristics and can interbreed.

1. Introduction

Environmental pollutants are divided into two categories: organic and inorganic. Among organic pollutants, hydrocarbons in all of their forms are the most concerning (Atlas and Philp, 2005). The refinement, extraction, storage, and distribution of petroleum are the dominant causes of soil and water polution. It has been reported that 0.1% of global oil output ends up in marine environments yearly (Alberges, 1989). Marine systems are unstable because wind and wave energy can move organic chemicals from crude oil, diesel, or petroleum slowly to tidal flats (Yang *et al.*, 2005). Referred to the limitation of the ability of plants and animals to degrade hydrocarbons, microorganisms, filamentous fungi, and yeasts, hydrocarbon biodegradation is the most common. Bioremediation using microorganisms under aerobic conditions has proven to be a non-disruptive, cost-effective, and highly efficient approach to cleaning polluted areas (Atlas and Hazen, 2011). Ecological studies have improved to identify bacterial populations that are functionally important at contaminated sites (Jeon *et al.*, 2003; Jin *et al.*, 2012), and numerous biodegradation studies have been carried out with pure or mixed bacterial cultures in laboratories (Kim *et al.*, 2008; Liu *et al.*, 2011). It is clear to understand the bacteria community changes during aerobic bioremediation of aliphatic hydrocarbon-contaminated soil, but there is lacked in marine ecology (Militon *et al.*, 2010).

A city in South Chungcheong Province of the Republic of Korea, Dangjin shares a maritime border with Incheon, Pyeongtaek, and Hwaseong. To link Korea to the opposite side of the Yellow Sea, the historical site of Dangjin's harbor was built. It is significant for the city's economy, which is supported by a combination of agriculture and heavy industry (steel mills, thermal power plants, etc.) (Dyer *et al.*, 1998). Therefore, the Dangjin site was investigated for a biodegradation study.

2. How to Identify Bacteria

There are four characteristics to identify a bacterial including bacterial shape, chemical testing, genetic analysis, and antigenic with the chemical reaction

(Figure 1).

1. By observing it directly (Morphological Characters), bacteria shape is identified by eyes in the culture media and microscope.
2. By studying what it eats and what it rejects (Chemical Characters), the atmosphere for bacteria growth is one condition for bacteria culture. Gram Staining and respiratory enzyme research (catalase and oxidase test) are other chemical testing to study the nature of bacteria.
3. By studying the programming (Genetic Material), Polymerase Chain Reaction (PCR) assay is the most popular assay to identify bacteria species, genus, and families by using genetic sequencing.
4. By using the composition of the "packing" (Antigenic & Chemical Characters), sometimes the combination of antigenic and chemical reactions in one packing is also one method to identify bacteria characters in a short time, but this method is expensive.

3. Isolation Novel Species

Sea tidal flat is the first step to choose as a sample. Enrichment Culture medium (seawater and artificial seawater containing octane, hexadecane, tetracosane, and hydrocarbon mixture as carbon sources) is also the place where bacteria will grow and need to be selected depending on the bacteria's condition. After the colonies were grown, the bacteria were identified by using morphological characteristics such as the colonies' size and color. For economic issues, Amplified Ribosomal DNA Restriction Analysis (ARDRA) was used to amplify bacteria's genetics before sequencing by PCR Assay. Sequencing data was uploaded to National Center for Biotechnology Information (NCBI) for Blasting. The sequencing data was considered as novel species when the similarity was less than 97%. Still, it required chemical character testing such as selective media, catalase testing, oxidase testing, Analytical Profile Index (API) kit, antibiotic testing, and Gas Chromatography (GC) (Figure 2).

Figure 1. Identity of bacteria based on their characterise

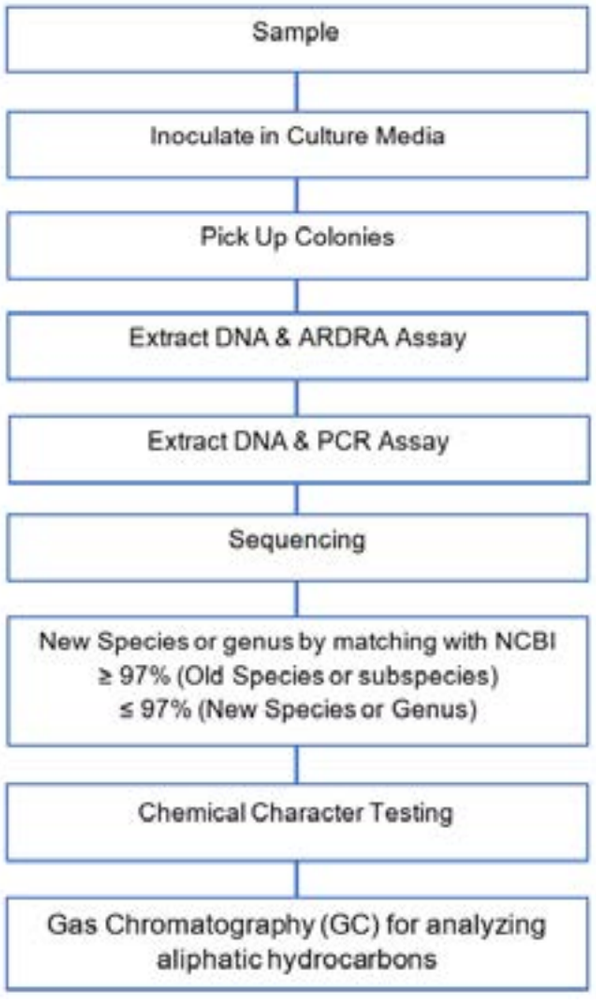

Figure 2. Isolation of new species or genus process

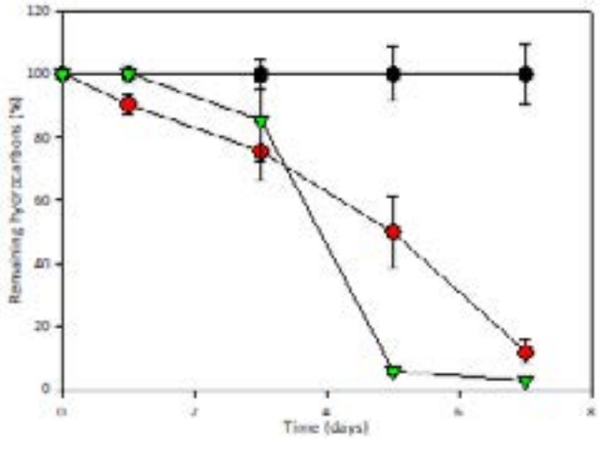

Figure 3. Isolation of degraders in the medium by Gas Chromatography (GC)

4. Results

The majority of the bacterial groups from seawater enrichment were separated from various carbon sources and distinct dominant and minor groups of microorganisms. Even though most of them were seen in each carbon source, the dominating genus in artificial seawater isolates from distinct carbon sources was revealed to be a different main genus (octane, hexadecane, tetracosane, and hydrocarbons mixture). Due to nutritional constraints compared to seawater, the GC analysis revealed that the two new strains chosen could degrade various aliphatic compounds and show strong degradation activity in artificial seawater medium (Figure 3). Therefore, further study suggests that novel strains have the potential in field application for bioremediation of contaminated seawaters if supplemented with the optimum amount of nutrients.

5. Conclusion

To isolate aliphatic hydrocarbon-degrading bacteria, enrichment cultures as seawater and artificial seawater were performed using aliphatic hydrocarbon as carbon sources. Based on the GC Analysis result, both strains from the artificial seawater were a higher degradation activity than seawater as the enrichment cultures.

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ABOUT

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03 Improving Flood Forecasting System Using Hybrid Approach of Hydrological Model and Machine Learning: Case Studies in Cambodia and Japan

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Sok Ty, Ph.D., Engineering, Institute of Technology, Cambodia
Phy Sophea Rom, Master's Degree, Engineering, Kyoto University, Japan
Oeurng Chantha, Ph.D., Engineering, Institute of Technology, Cambodia

HIGHLIGHT

- This study successfully predicted flood forecasting in the Prek Thnot River, Cambodia, and the Kamo River, Japan, at 5 days and 6 hours ahead from real-time, respectively.
- The proposed hybrid approach predicted flood forecasting more accurately than each single approach.
- Implementing the proposed approach would benefit the flood early warning system and reduce flood-related damages in the study area.

1. Introduction

Flood forecasting is a precursor to warning systems for flood risk management in all flood-prone areas, such as rivers in Cambodia and Japan. The Prek Thnot River, Cambodia, is subject to recurrent flash floods from September to November. Frequent heavy rainfall from the mountainous upstream causes rapid discharges and floods in the urban region further downstream. Climate change and land-use change have been increasing flood risks in recent years. In fact, 2000 and 2020 saw the most destructive Prek Thnot floods in terms of damages. In Japan, the Kamo River is vulnerable to flash floods during the events of typhoons. The peak flow at the river outlet arrives around 4 hours after heavy hourly rainfall due to the short and steep river.

Artificial intelligence (AI) has been surging in popularity and emerging as a powerful problem solver over the past decades. A subset of AI, machine learning (ML), is a method worth leveraging, given its high efficiency and accuracy. ML is active in various applications, from medical diagnosis to stock market forecasting to hydrological modeling. In hydrology, ML has been used to forecast river stage, rainfall, and flood, monitor water quality, and model groundwater.

A recognized drawback of ML is the lack of physical interpretability and inaccurate extrapolation for unseen data (Xu & Liang, 2021). Generally, ML processes are hidden; interpretability is therefore elusive, unlike hydrological models based on physical processes. Yet, hydrological models contain some notable limitations, such as a large number of model parameters, long computation, and the requirement of good quality and quantity of input data. A better approach to compromise both methods' disadvantages is to hybridize ML and hydrological models. To illustrate, previous studies integrating both models to forecast typhoon-induced and river flood discharges (e.g., Noymanee and Theeramunkong, 2019; Young *et al.*, 2017) confirmed significant improvements in overall forecast skills and reliability. This study aims to improve the flood forecasting performance in two case studies in the Prek Thnot River, Cambodia, and the Kamo River, Kyoto Prefecture, Japan.

2. Methodology

This study used a fully distributed rainfall-runoff-inundation (RRI) model for river discharge and water level simulations (Sayama *et al.*, 2012). The RRI model was calibrated and validated with gauged observed rainfall—the forecasted rainfall from NICAM-LETKF numerical weather prediction (i.e., GSMaP×NEXRA) dataset. The GSMaP×NEXRA data is produced by Global Cloud Resolving Model with Data Assimilation with hourly 1° × 1° spatial resolution of a 5-day forecasting period. The GSMaP×NEXRA is used for the evaluation of forecasting of flood in the PTR (Try *et al.*, 2022). Moreover, the composite rainfall product from gauged observation and radar from Japan Meteorological Agency (JMA) and its forecasting rainfall product was used as input to simulate and forecast flood in the KR river with 1km x 1km of spatial resolution and 6-hour lead time of forecast. On the other hand, Support Vector Machine (SVM), a supervised learning model with associated learning algorithms, is used to improve the output result of the RRI model. Figure 1 shows the proposed framework for assessing flood forecasting in the PTR. The predicted flood forecasting information will be publicly achieved and shared across online platforms (e.g., websites, news, and social media).

Two statistical indicators, the coefficient of extrapolation (CE) and the coefficient of persistence (CP), were used to evaluate the predictive capacity of forecasting performance (Kitanidis & Bras, 1980).

where j is the prediction lead. Q_1 is the forecast from the linear extrapolation of the two most recent measurements. Q_s^t and Q_o^t are simulated and observed

$$CE = 1 - \frac{\sum_{t=1}^{n}(Q_s^t - Q_o^t)^2}{\sum_{t=1}^{n}(Q_o^t - Q_1^t)^2}$$

$$CP = 1 - \frac{\sum_{t=1}^{n}(Q_s^t - Q_o^t)^2}{\sum_{t=1}^{n}(Q_o^t - Q_o^{t-j})^2}$$

datasets at time step t. For real-time prediction, the best model prediction is represented by the latest measurements. This study used the coefficients of CE and CP to evaluate the flood forecasting performance by using the latest measurement of observed river water level and flow.

3. Results and Discussions

Initially, the RRI model was calibrated and validated for accuracy using gauge and radar-measured precipitation data in the PTR and KR areas. Afterward, the same model configuration was employed to simulate flood forecasting extrapolation through real-time simulation, utilizing the actual current conditions as the initial condition of the RRI model.

The results of the flood forecasting were compared and evaluated using river discharge in the PTR and river water level in the KR. Figure 2 compares the performance of forecasted discharge from the RRI model before and after the application of machine learning. Before applying machine learning, the predictive capacity's accuracy showed statistical indices of CE = 0.56 to 0.85 and CP = 0.30 to 0.81 for the forecasting periods of 1 to 5 days. After applying machine learning, these indices significantly improved to CE = 0.69 to 0.87 and CP = 0.51 to 0.84.

In addition, the flood forecasting performance in the KR was also assessed for a 6-hour lead time (Figure 3). At Kojinbashi station, the outputs from the single RRI model were performed with the coefficient of extrapolation CE = 0.04 ± 1.14 and coefficient of persistence CP = -0.53 ± 0.87. The ML alone performed with CE = 0.55 ± 0.09 and CP = 0.27 ± 0.08. Finally, after combining RRI and ML, these performances could tighten up the accuracy to CE = 0.70 ± 0.27 and CP = 0.47 ± 0.14. On the other hand, we have also compared the performance of ML with ordinary correction methods of flood forecasting by adjusting the forecasting information with the current value in real-time. The results showed that applying ML to enhance the precision of flood prediction outperformed the ordinary correction methods. Considering suitable input information and selecting the most effective type of ML are essential to boost the accuracy level of flood prediction.

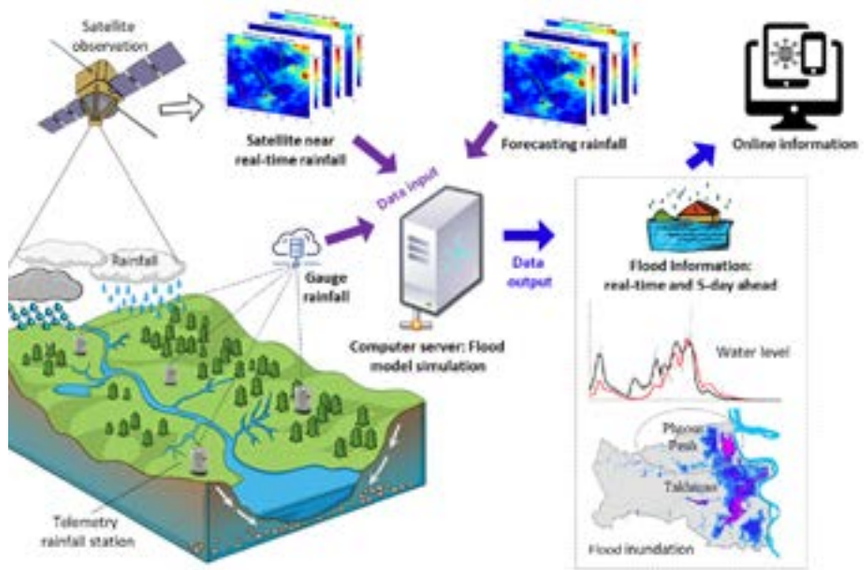

Figure 1. The proposed approach for flood forecasting implementation for Prek Thnot River, Cambodia

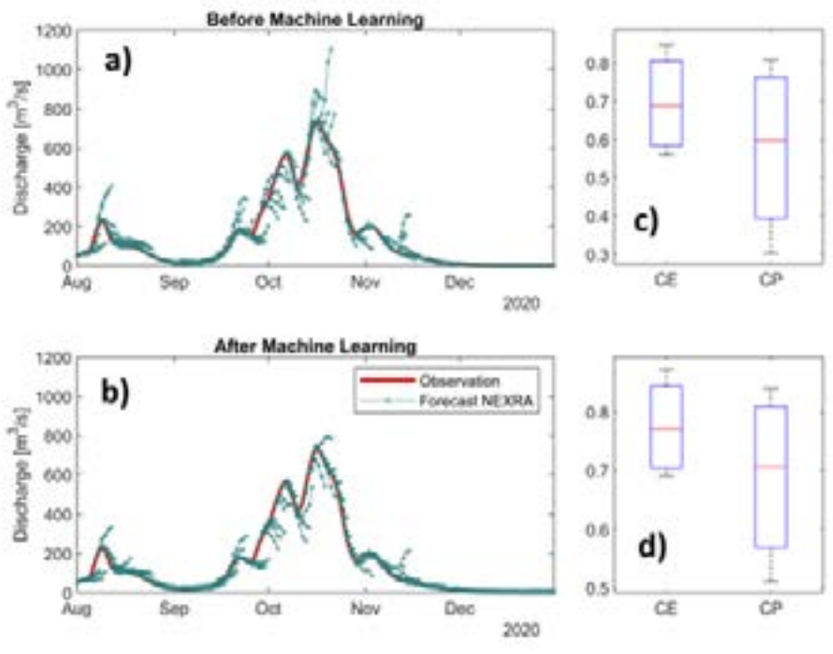

Figure 2. Performance comparison of flood forecast before (a) and after Machine Learning application (b) with their performance index (c and d) for Prek Thnot River, Cambodia

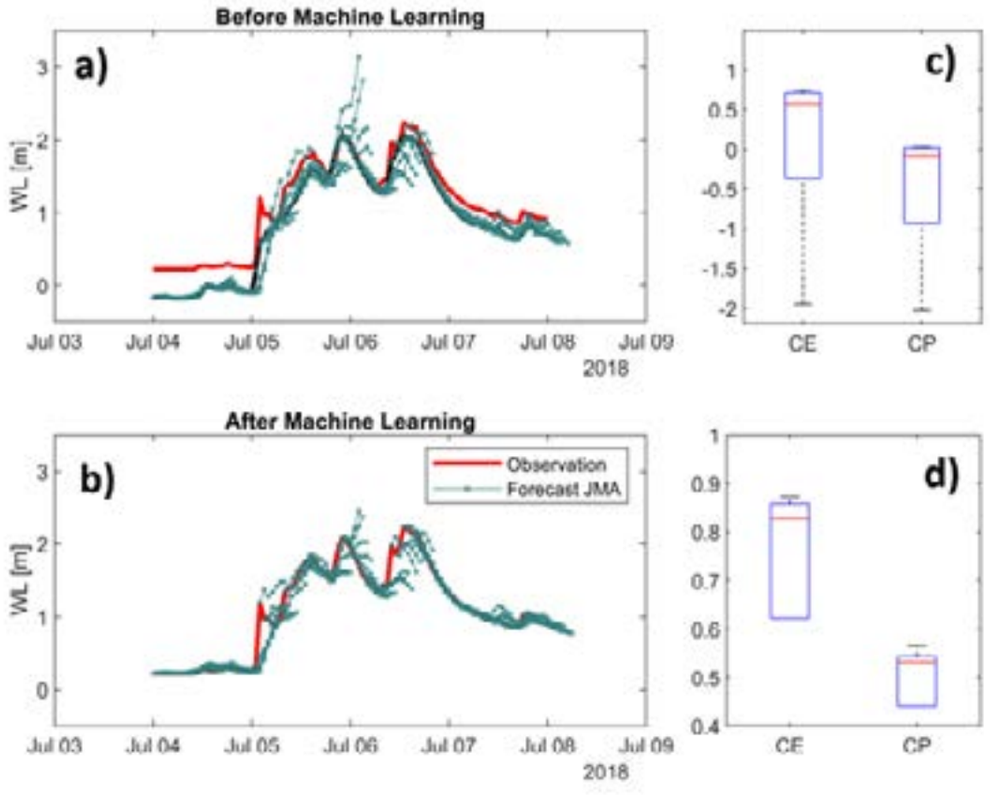

Figure 3. Performance comparison of flood forecast before (a) and after Machine Learning (b) with their performance index (c and d) at Kojinbashi station, Kamo River, Japan

4. Conclusions

This study successfully assessed the real-time flood forecasting in the PTR in Cambodia and the KR in Kyoto Prefecture, Japan. The hybrid approach of a physical-based hydrological model and machine learning significantly enhanced the performance and accuracy of the flood forecasting predictive capacity in both the PTR and KR. As a result, it would be advantageous to implement this approach in operational real-time flood forecasting in these two river basins to raise awareness of early flood warnings and minimize the damage caused by severe flooding.

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ABOUT

Currently, Dr. Try Sophal is a JSPS Research Fellow at Disaster Prevention Research Institute, Kyoto University, Japan. He received PhD in Engineering from Kyoto University, M.Sc. from Kyungpook National University (Republic Korea), and Engineer degree from Institute of Technology Cambodia. He has been working with various research projects related to flood forecasting, flood inundation modeling, climate change impact, hydrological extreme analysis, flood damage assessment, remote sensing, machine learning application to water resources, and other water-related fields. Dr. Try Sophal has published more than 20 peer-reviewed articles, including 10 as leading author and other more than 10 as co-author in reputable journals.

04 The Potential of Drinking Water

Pollution at Various Stages of People's Consumption by Using H_2S Test

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Vimol Ouddom Monyneath, Bachelor's Degree, Science Research, University of Puthisastra (UP), Cambodia
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HIGHLIGHT

- Water storage and uncleaned tanks are the main factors that cause the drinking water to be re-pullulated.
- E. coli is one of microbial for water quality testing
- H_2S test kit is a low-cost microbiological field-based test which can be used in areas where water testing facilities are limited.

1. Introduction

In developing countries, about 88% of the population suffers from diarrhea, which is a problem caused by unsafe water supply, sanitation, and limited sanitation practices for drinking water (WHO, 2009). In addition, unsafe water and sanitation, especially drinking water that is not cleaned before drinking and water contaminated with microbial, is estimated to cause 485,00 deaths from diarrhea yearly (WHO & UNICEF, 2019). In addition, approximately 4,500 children under 5 years of age die from malnutrition (Poirot *et al.*, 2020). In 2019, according to the results of the research on the "National Action Plan Rural Water Supply, Sanitation and Hygiene 2019-2030" of the Ministry of Rural Development, it shows that in 2017, approximately 57.8% of the rural population in Cambodia received safe water supply and 71.2% received sanitation and hygiene services (NISMP, 2018). However, unsafe drinking water is still a major cause of diarrhea and cholera to humans, especially children living in low-income areas (Poirot *et al.*, 2020). Furthermore, the presence of coliform and E. coli bacteria were found at the collection point and point of use. Approximately 76.6% of coliform and 46.3% of E. coli were found in point-of-collection water samples. This result showed that if the coliform bacteria are also present, other microorganisms and chemical compounds are likely to be present as well (Poirot *et al.*, 2020). Therefore, this study aims to evaluate the water quality by following the different stages of water storage and consumption of people along the railroad in Phnom Penh that focus on microbiological indicators.

2. Material and Method

2.1. H_2S Test Kits Preparation

H_2S (Hydrogen sulfide) test kit was prepared by mixing 40 g of Bacteriological peptone, 3 g of Dipotassium hydrogen phosphate (K_2HPO_4), 1.5 g of Ferric Ammonium Citrate ($(NH_4)_5[Fe(C_6H_4O_7)_2$), 2 g of sodium thiosulphate ($Na_2S_2O_3 \cdot 5H_3O$), 2 mL of liquid detergent and 100 mL of DI water. 10 mL of the solution was sprayed on Cellox towel paper and put in the oven at 60 °C for 30 min. Cut it into 12 pieces and put it in a test tube for future use.

2.2. Study Site and Sample Collection

50 households who live along railroad in Phnom Penh were selected to conduct the interview . Among 50 households, 11 households could not participate in this interview. Three types of water samples such as point of collection, point of storage and point of use were sampling. 10 mL of each water sample were taken from each household and put in H_2S test kits.

2.3. *E. coli* Incubate

Put the test kits in the dark room with room temperature for 2-3 days until the color changes and evaluate the risk by following the information below.

Table 1. Risk assessment based on the color change in H_2S test kit.

Color change	Risk	Evaluate
Yellow less	-	Safe to drink (No *E. coli*)
Gray less	+	Low risk (less *E. coli*)
Bold gray	++	Moderate risk (High *E. coli*)
Black	+++	High risk (Excess *E.coli*)

3. Results and Discussion

3.1. Water Cleaning Technique

The number of females who participate and answer the survey question is higher than the number of males. Among 39 households, 71.80% are female and 28.20% are male with the age between 18-35 (28.20%), 35-55 (41%) and 55-70 (30.80%). Two sources of water were used: supply from the government and companies with 64.10% is using tap water and 35.9% used bottled water as drinking purpose. After conducting the interview (Figure 1), the people used two cleaning methods which are boiling (41%), to clean the water before they drink but some people (18%) did not clean the water before drinking. This result shows that the different drinking water sources also make a different cleaning method. In addition, the impact of unclean water before drinking suffers from chronic obstructive pulmonary disease and diarrhea caused by parasites (WHO, 2017). Therefore, 18% (7 households) that do not clean the water before drinking are likely to cause some diseases and other contamination.

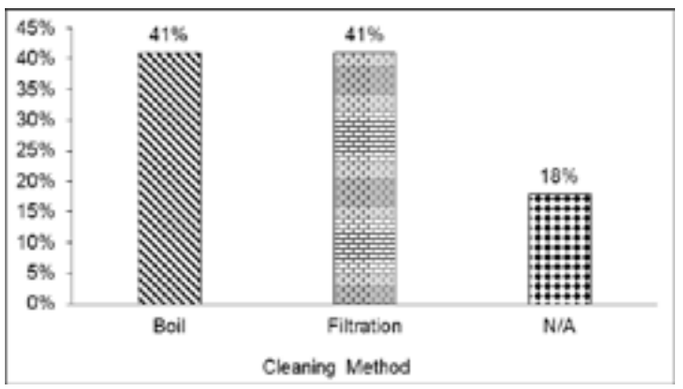

Figure 1. Water cleaning method before drinking.

3.2. Drinking Water Storage Technique

Figure 2. showed that the people along the railroad used different techniques for drinking water storage. There are 4 materials that they used such as kettle, plastic tank, plastic bottle and filtration tank with 20.51%, 38.46%, 15.38%, and 20.51%, respectively. 5.14% did not use any material for storage. In addition 66.67% of the people cleaned the storage tank every day, 12.82% cleaned within one week and 20.51% never cleaned the tank. Some people prefer to drink bottled water instead of tap water. Therefore, if the water is stored in plastic bottles for a long time, it might leach out some harmful materials into the water, affecting human health (Ahmed *et al.*, 2021).

3.3 Total Coliform

Figure 3. presents the results of the water quality tests for *E. coli* bacterial contamination. 84.62% of drinking water samples were free of coliform at the point of collection, but 15.38% was contaminated. Additionally, for tests taken at the time of storage and point of use, 17.95% (Fig. 3) showed Comparing the result between point-of-collection, point-of-storage, and point-of-use showed that the point-of-collection was less contaminated (15.38%) than point-of-storage and point-of-use. This is due to the water storage and daily cleaning (Fig. 1 & Fig. 2). In addition, acceptable bacterial limits

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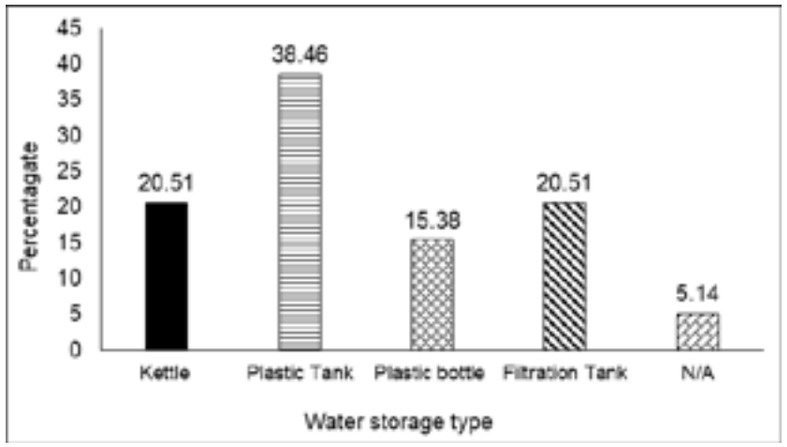

Figure 2. The water storage technique of the people along railroad

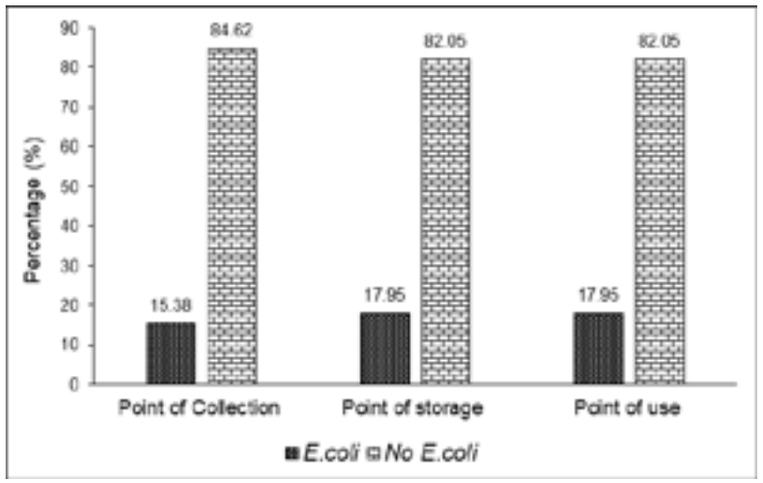

Figure 3. E. coli presents in drinking water after incubate in dark room for 3 days (room temperature)

Figure 4. E. coli test result in drinking water after incubate in dark room for 3 days (room temperature)

have been defined in legislation by among others (WHO, 2003). 5, 3, and 1 household were contaminated with high risk, moderate risk, and low risk (Table 1), respectively. Although coliforms do not usually cause serious illness, they are used to indicate the presence of more pathogenic bacteria and viruses (Price, 2017).

4.Conclusion

According to the interview and tests on the quality of drinking water, different water sources were used, such as water supply from the government and bottled water supply from companies. In addition, some households clean the water before drinking and some are still not. Among 39 households, 9 households were contaminated with *E. coli* bacteria due to the material used to store water and daily cleaning. However, sizable portions of people know the importance of purifying water before consumption.

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TECHNOLOGY TRENDS

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05 Why Firms Should Develop its Business Intelligence and Analytics Strategy?

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HIGHLIGHT

- The The world is changing, and firms are doomed to fail if they do not modernize the way they do business.
- Business intelligence and analytics (BI&A) refers to various organizational information practices that encompass the applications of information technologies and analytical techniques.
- Firms can reach their untapped potential by utilizing BI&A to gain a better understanding of consumers and competitors, formulate better marketing strategies, generate practical insights, mitigate future risks, and improve business operations.

Introduction

The ability of firms to pursue innovation and technology adoption becomes more important than ever in the modern era, as it determines firms' success in keeping up with market demands shaped by constantly evolving technological trends. It is under this condition that the roles of business intelligence and analytics (BI&A) come into play. BI&A comes from the combination of the terms "business intelligence" and "business analytics", which refers to various organizational information practices that encompass the applications of information technologies and analytical techniques (Torres *et al.*, 2018). It is worth noting that if done correctly, the BI&A strategy will allow various styles of reporting and real-time visualization of data in the dashboards, including sale and employee performance information, which would grant the management team the ability to identify and make a quick response to imperfection and hence enhance the efficiency of the firms and reduce costs. In addition, having access to real-time data enables firms always to stay informed about the current health status of their businesses. Other benefits of having a BI&A strategy the following:

• Ability to understand the customers:

With effective BI&A, firms can better understand their customers by analyzing consumers' general profile/information and purchasing patterns, namely what they buy, when they buy, from where they buy, and how often they buy it. In doing so, firms can improve their products and services and customer experiences with the company. For example, Amazon collects data on what products that customers are looking for and where they are living, and it uses a predictive analytics model to determine whether or not customers are likely to purchase the product and will pre-order the product at the warehouse close to the potential customer's residents even before they ordered them.

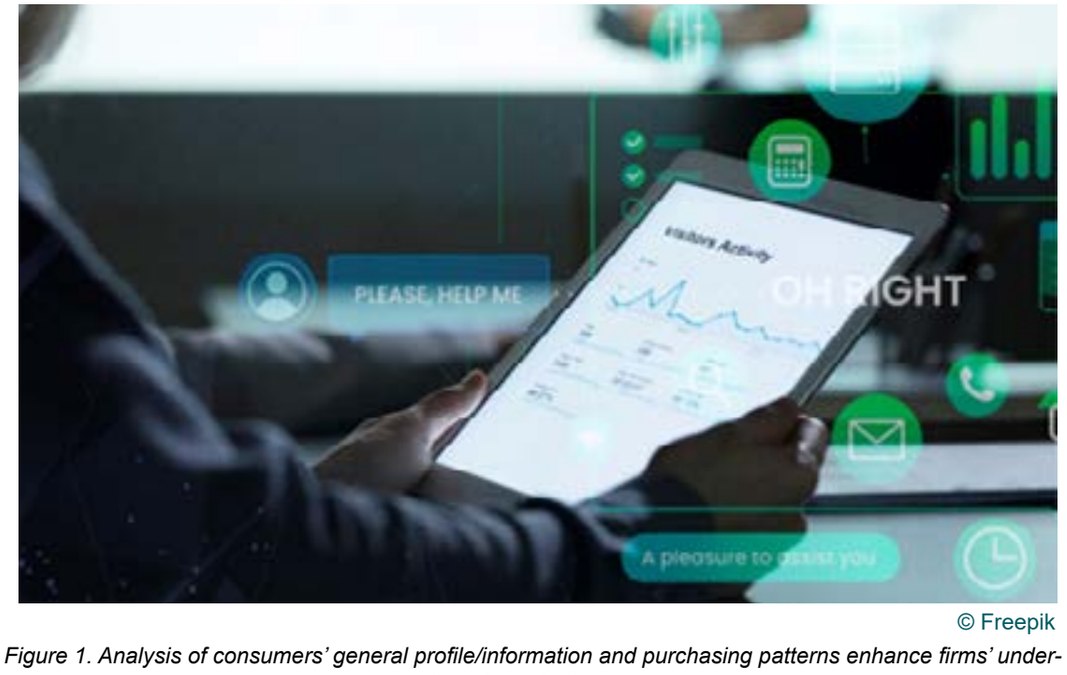

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Figure 1. Analysis of consumers' general profile/information and purchasing patterns enhance firms' understanding about their customers

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Figure 2. The use of BI&A to gather data and generate actionable insights

• Ability to understand the competitors:

Apart from the customers, firms need to also to understand their competitors in the market. And BI&A can provide companies with valuable insight into the size and share of their markets and what their competitors are doing so that they can plan strategic activities to stay ahead of their rivals. As Sun Tzu, a famous Chinese military strategist, once said: "If you know the enemy and know yourself, you need not fear the result of a hundred battles." (Sun Tzu, 2005)

• Better marketing strategies:

As firms understand their customers as well as competitors' strengths and weaknesses better now, they can then design well-planned marketing strategies necessary for a successful marketing campaign that will lead to a more favorable return on investment.

• Generating practical actions:

Being able to make an informed decision is one thing, but a more important thing in leading and managing a firm is being able to generate actionable insight. Simply, now that we know what is going on (and it is good to know), so what? It is imperative to understand why the transportation of the goods has been delayed, yet it is even more essential to know what actions should be taken to deal with such a challenge. And BI&A can do just that. It can provide firms with actionable insight into how to cope with issues.

• Risk mitigation:

While no one can predict what is going to happen in the future, we can use data and BI&A to understand potential risks. Of course, it is not like "no risk, no return". But one may want to understand those risks first before deciding to take the plunge. Even so, one may also want to minimize the

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risks or potentially avoid the unnecessary ones in the first place. For example, a retail company is considering opening a new store in another location. There are a lot of potentials and a great deal of return on investment. After all, the company can reach more customers and what's not. But the decision to do so also comes with a risk; despite the large population in the area, the actual market share for the retail company might not be big enough. Even though the profit that the company can generate will not be sufficient to cover the daily operation cost, let alone the initial investment and the sunk cost.

• Improvement in business operations:

Firms that harness BI&A will have greater control over their business operation. They will have significant empirical insight into how the businesses are doing and what is happening within the firm itself. For example, one might want to know how responsive the firm's service staff is in handling customer complaints or service tickets and what actions related to the ticket are taken. An online retail company like Amazon or Alibaba might want to understand why and where the deliveries are delayed. This kind of insight is constructive in improving business and its services, and BI&A strategy can tell the firms just that.

With the widespread use of technology, big data is being generated constantly in different forms and sources. Big data would be an invaluable asset for firms with BI&A capability as they can obtain practical insights from raw data regarding other aspects of their business operations. With BI&A, firms can achieve better efficiency and profitability by deepening their understanding of the customers and competitors, planning effective marketing strategies, gaining actionable insights, mitigating risks, and enhancing business operations.

Figure 3. Enhancing business operations with the use of BI&A

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ABOUT

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06 A Brief Model of HACCP Plan for the Production of Soy Milk

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HIGHLIGHT

- Hazard: A biological, chemical, or physical agent that is reasonably likely to cause illness or injury without its control.
- Hazard Analysis: The process of collecting and evaluating the information on hazards associated with the food under consideration to decide which are significant and must be addressed in the HACCP plan.
- Critical Control Point: A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

1. What is HACCP?

HACCP is a science-based system to ensure food safety in food production, which includes identifying, evaluating, and controlling hazards (CAC, 2009). It focuses on preventing hazards from the first stage of receiving raw materials rather than depending on end-product testing. It not only improves product safety but also gains consumers' confidence by providing documentation and control as proof and regulatory requirements to food control authorities. HACCP consists of 5 preliminary steps and 7 principles, as shown in Table 1.

2. Why is HACCP Important?

The HACCP process might be a bit complex and require many methods, yet it will give numerous benefits to the food producers as follows:

- Prevent food safety hazards along the production line, which either occur naturally in food or are caused by the environment or a production error.
- Major food concerns including biological hazards (bacteria such as *Salmonella* spp.), chemical hazards (pesticide residues), and physical hazards (metals/ glass) must be controlled.
- Reduce an economic loss due to product recall.
- Easily apply for other food safety standards.
- Several consumers in the food chain, especially those outside the country, want a verified HACCP system from their suppliers.

3. HACCP Activity Flow

There are 12 steps and 7 principles of HACCP in Figure 2. (Ozturkoglu-Budak, 2017). The hazards will be controlled and prevented through the following steps, as described in Table 1.

Table 1. 12 steps of HACCP

Clause Name	Requirements
1. Team	- A HACCP team (food safety team) shall be assembled by competent staff.
2. Product description	- Product specifications shall be described in writing. - Product category, all raw materials and ingredients (including packaging materials), and requirements for storage and distribution shall be described in the product specifications.
3. Identification of intended use	- The intended use of the product and target consumers shall be clearly described in the written document.
4. Construction of flow diagram	The flow diagram that covers all steps in the operation shall be constructed.
5. On-site confirmation of flow diagram	- The flow diagram shall be reviewed to ensure it correctly reflects the existing process steps of the operation.
6. (Principle 1) Hazard factor analysis	- All available means of identifying, analyzing, and managing potential hazards in each process shall be considered. - Hazard factors shall include allergens, as necessary.
7. (Principle 2) Establishment of Critical Control Points (CCP)	- Critical control points (CCP) shall be determined.
8. (Principle 3) Establishment of critical limits	- Limits shall be established for critical control points.
9. (Principle 4) Monitoring system	- A monitoring method shall be established for each critical control point.
10. (Principle 5) Corrective actions	- Methods for corrective action (correction, investigation of the cause of occurrence, and elimination of the cause) must be established for deviations from the allowable CL range.
11. (Principle 6) Establishment of verification procedures	- Verification procedures shall be established to confirm whether the established handling (HACCP plan) is being performed as planned and whether it needs to be modified. - Verification shall be performed to adapt to the changes in equipment design and processing methods and technological development in the manufacturing process.
12. (Principle 7) Documentation and recordkeeping	- The necessary documents shall be created, recorded, and maintained.

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Figure 1. Hazard Analysis Critical Control Points (HACCP)

Figure 2. Seven Principle of HACCP © Freepik

4. HACCP Plan for Soy Milk Production

Some parts of HACCP model were reported (Gandhi, 2009) as below:

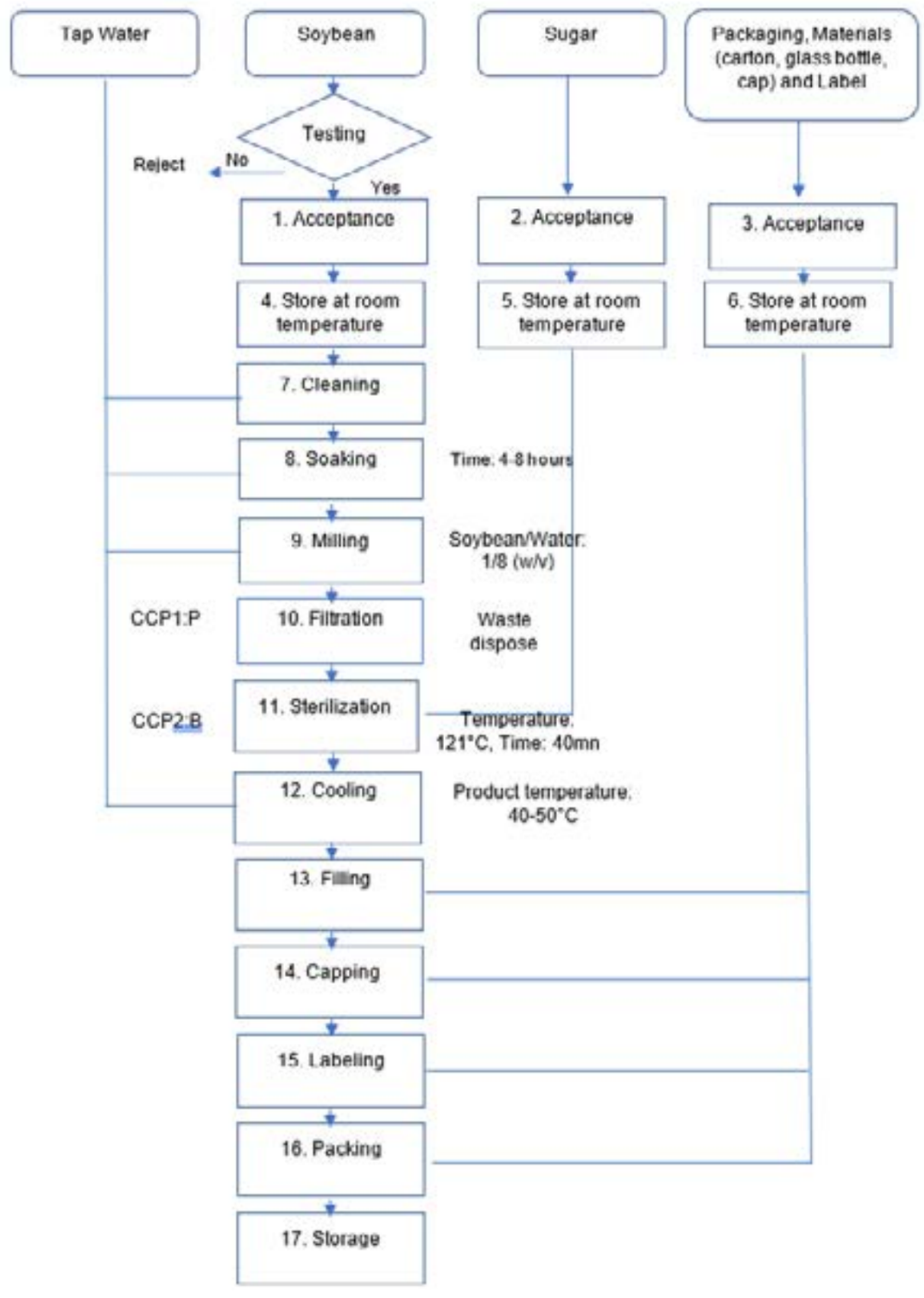
4.1 Product Description

Table 2. Production description of the soy milk product

Product name	Soy milk	
Category	final product	
Type	Ready to drink	
Important product characteristics	Sensory test	Color: creamy to yellow Odor: less beany Taste: nutty
	Physical	Foreign matters: Total absence
	Chemical parameters	Protein:4.3% Fat: 2.0% Carbohydrate: 3.0% Crude fiber:3.7% Ash:3.3% Moisture content:80% Pesticide residues: Not detected Heavy metal: Not detected
	Biological limits	Coliforms: <10 MPN/100mL *Salmonella*: Negative per 100mL *E. coli*: Negative per 100mL *Staphylococcus*: Negative per 100mL *Clostridium perfringens*: Negative per 100mL Yeast: <10 CFU/mL Mold: <10 CFU/mL
Key processing steps	Sorting, cleaning, soaking, washing, milling, filtration, sterilization, cooling, filling, labeling, storage.	
Present of allergens	Soybean	
List of raw materials	Soybean, sugar, water	
Packaging (primary packaging) and labeling	Glass bottle Labeled as required by national regulations, imported country regulations, and customer requirements	
Secondary packaging	Carton (24 bottles/carton)	
Preservatives	None	
Distribution and store condition	25°C in a clean place	
Shipping distribution and storage condition	Room Temperature, clean place	
Self-life	Duration: maximum 12 months	
Instruction for use by consumers	Ready to drink	
Reasonable expected mishandling and misuse	Not to be stored in a dirty place and high temperature	
Intended use	To be chilled or not based on consumers, preference	
Target group of users, and special consumer consideration	For drinking, general consumers especially those who lack protein, pregnant and elderly	

4.2 Flow Diagram of Soy Milk Production

P=Physical hazard, C=Chemical hazard, B=Biological hazard



4.3 HACCP Plan for Soy Milk Production

CCP1: step #10-Filtration

Physical Hazards: residual foreign material (metal pieces, glass pieces, hard foreign matters) in the product.

Root cause: decanter centrifuge failure may not work well to separate foreign material. Management means: Ensure the centrifuge drum is working properly and sufficiently.

Critical Limit (CL): The speed of the centrifuge or drums should be adjusted to get maximum residue separated.

Monitoring procedure (what, how to, frequencies, the person in charge): Control and inspect the condition of the centrifuge drum system following the work instruction by operation staff/maintenance staff. Check and record the time before products pass and at the ending time in the monitoring record every batch by operation staff.

Corrective action (action, person in charge): when the foreign matters cannot be separated well, operation staff shall stop the line and report it to the production manager in order of manufacturing. The production manager shall define the batches manufactured after the last time when it was confirmed that they were normal, and hold these. Then the production manager shall instruct inspection and adjustment of the centrifuge drum, and allow the stored products to pass after ensuring that it operates normally. In the meantime, the production manager and person in charge of quality control shall investigate the possible contamination and strengthen the implementation. The operator staff shall check the heating system before use and repair in case required; otherwise, replace them. Also, the maintenance program shall be implemented correctly to ensure the heating systems are working well.

CCP2: step #11-Sterilization

Biological Hazards: remaining pathogenic microorganisms (*Salmonella*, *Staphylococcus aureus*, *Vibrio parahaemolyticus*, pathogenic *Escherichia coli*, *Listeria*).

Root cause: heating system failure may not work well or Insufficient heating temperature and time, defective heating equipment.

Management means: To reach the product temperature of 121°C during the primary heating, check that the temperature inside the heating device is 121°C or higher and the heating time is 40 minutes or longer. There are at least two thermometers should be installed and calibrated correctly to avoid any errors.

Critical Limit (CL): pressure heating 1.2kg/cm^2: Temperature inside the heating device 121°C or higher, and heating time 40 minutes or more.

Corrective action (action, person in charge): In case of deviation, operation staff will stop the heating device and inform the production manager immediately to identify batches that have not been properly heated and measure the product core temperature and evaluate it (reheats, diverts or discards). Then production manager will instruct the inspection and adjustment of the heating equipment, confirm that the heating conditions are achievable, and then resume production.

5. Conclusion

Implementation of the HACCP technique should be applied strictly at the determined CL and CCPs, namely cleaning, soaking, milling, filtration, heating, cooling, filling, capping, storage, and packaging. For the production of soymilk with the highest quality and safety, HACCP methods were created to control the risks throughout the soymilk production supply chain, and the CCPs were controlled and prevented properly to ensure the safety and quality of the product. The suggested HACCP program offers more flexibility in addressing identified risks, allowing soymilk manufacturers to choose suitable and practical means of control to choose the raw materials that meet the standard. However, to reach achievement in applying the HACCP standard, prerequisite programs are necessary.

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ABOUT

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07 Uot App: A Startup Technology for Promoting Cambodia Digital Tourism

Pech Soveadhh, Master's Degree, Industrial Engineering, Mahido University, Thailand

HIGHLIGHT

- Uot App is a digital community for trip lovers which is built by Cambodians is providing the value of having a nice trip with enjoyment, saving, and the feeling of being local traveling around Cambodia.
- Uot App has special features with innovation and creativity by designing technology with impressive user experience.
- Uot App has been selected to be the Awardee of Creative Star in the China-ASEAN Innovation and Entrepreneurship Competition 2022 and received rewards and recognition of Cambodia.

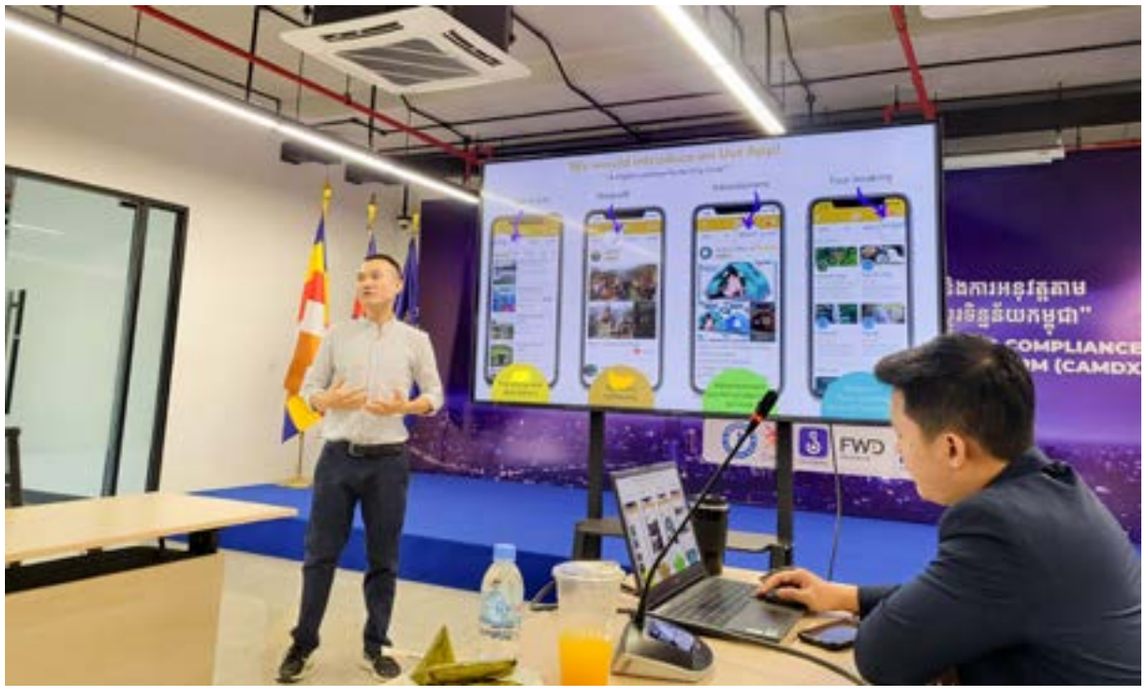
I. History

Uot App is founded by four Cambodian co-founders. Among these co-founders, Mr. Soveaddh Pech is CEO and Co-founder and is recognized as an enthusiastic entrepreneur with passion, energy, and commitment. He graduated with a Master's Degree in Engineering in Industrial Engineering from Mahidol University in Thailand in 2016. His fields of interest are entrepreneurship, engineering, technology, and innovation. Interestingly, Mr. Soveaddh really loves traveling within Cambodia and across the countries. That's why he created the Uot App, which aims to bring the local trip taste experiences of Cambodia to the globe and attract international tourists to visit Cambodia.

II. Introduction

Founded in 2019, Uot App is a digital community for trip lovers built by Cambodians. Using Uot App, users will get the actual value of having a nice trip with enjoyment, saving, and the feeling of being local traveling around Cambodia. Our vision is to connect trip lovers in Cambodia to Asia and to the globe. Our mission is to build a digital platform for trip lovers to promote Cambodian tourism and enhance human well-being.

In January 2023, Uot App is excited to release a new function called "Nat Knea Der or Tour Booking" which is a trip-lovers-dating function, meaning individual trip lovers can book listed tours in Uot App which is organized through our partnership with Cambodian tour operators in our platform. Via this function, "Tour Booking", trip lovers across the countries could connect and have friends with local trip lovers in Cambodia.



Therefore, we are excited and ready to introduce Uot App to go-to-market worldwide. Imagine, tourists all around the global have Cambodian as their friends; then, they will feel very warm and miss Cambodia. Then tourists will repeatedly visit Cambodia, which help to improve the economy of Cambodia.

III. Overview of Uot App

The Uot App, users will be able to explore new attractive tourism sites with joyfulness and get the method to go to each destination where other trip lovers/ adventurers share their real adventure experiences with beautiful pictures or video content and mapping. Because Uot App has all flavors and all styles of the trip such as camping, trekking to mountains, foresting, waterfall, exploring, sea, island, cycling, off-road, temple, agri-tourism, destinations near Phnom Penh, etc. Trip lovers can either enjoy a solo trip, with friends or with their family. Uot App has 4 main functions such as "Trip Article(អ្នតតគ្នា)", "Trip Lover community (អ្នត)", Advertisement (ផ្សព្វផ្សាយ) and Tour Booking (ណាត់គ្នាដើរ)". Users be able to download Uot App in AppStore and Google Play Store by search "Uot". Then users can enjoy the best value of Uot App.

IV. Special Features of the App

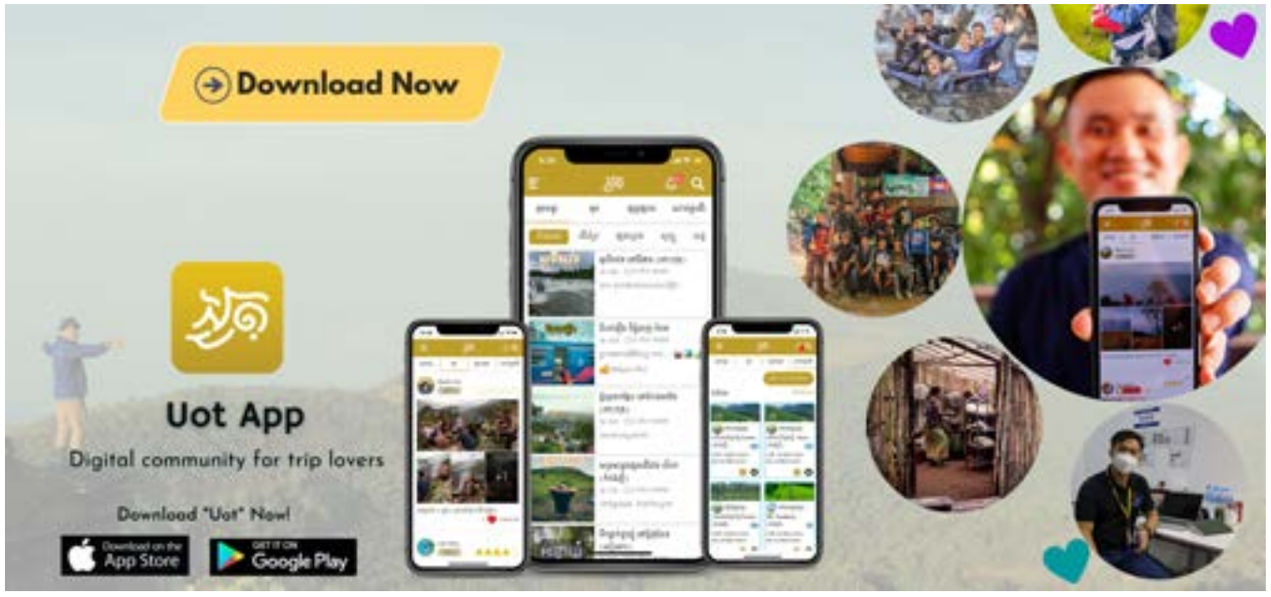
Innovation and Creativity: Newest function, "Nat Knea Der or Tour

Booking" in Uot App, is innovated to connect trip lovers. Each individual could book and have a trip together as a group safely and happily as having a trip with his/her close friends no matter what nationality you are.

Functionality and Design: All eco-tourism tours are listed in Uot App monthly with trip detail and date. In short, it is a collection of tour monthly that users can conveniently select the term of tour based on their available time. Then users could pay via App, and be ready to go for a trip.

User Experience: It is a straightforward step to book a trip. Select, book, pay, and go are simple processes and convenient for the user experience to book a trip in Uot App via the function "Tour Booking". User is able to select the trip and pay in one platform of the Uot App.

Market Performance: In Cambodia, the new function, "Tour Booking" is the latest collection of tours and an innovative platform to allow trip lovers to book a tour with many various choices to choose include tour organizers and available dates.



Social Responsibility: Uot App is building a digital platform to promote Cambodia tourism and enhance human well-being using technology.

Trip lovers from Asia will benefit from having a happy trip and feeling a very local experience of Cambodian traveling. In addition, we enhance the increasing revenue opportunity for the community. For Cambodia and Asia, we are building a digital platform to trip lovers to support Cambodia tourism.

V. What are the Awards and Recognitions that Uot App has received?

Lately, Uot App has been selected to be the Awardee of Creative Star in the China-ASEAN Innovation and Entrepreneurship Competition 2022 organized by the Ministry of Science and Technology of the People's Republic of China and ASEAN Secretariat and with supportive of the Ministry of Industry, Science, Technology & Innovation of Cambodia. Moreover, Uot App received awards and recognitions such as:

- 2nd Prize of Startup Khmer Enterprise Award 2022, organized by Khmer Enterprise and the Ministry of Economy and Finance
- Bronze Award of Green Industry 2021, organized by the Ministry of Industry, Science, Technology & Innovation of Cambodia
- Awardee in Khmer Tourism for the Future Incubation, organized by IHPP, Ministry of Tourism, and Khmer Enterprise

VI. What is the next plan of Uot App?

Being in the technology sector, it is so competitive for Uot App to add new exciting functions related to booking, community building, payment, and entertainment to deliver value to our users who always support us as a digital community. All of us together could enhance technology to support our Khmer tourism to grow Cambodia's economy.

AUTHOR'S BIOGRAPHY

Pech Soveaddh

ABOUT

Uot App is founded by four Cambodian co-founders. Among these co-founders, Mr. Pech Soveaddh is CEO and Co-founder who is recognized as an enthusiastic entrepreneur with passion, energy, and commitment. He graduate with a Master's Degree in Engineering in Industrial Engineering from Mahidol University in Thailand in 2016. His fields of interest are entrepreneurship, engineering, technology and innovation. Interestingly, Mr. Soveaddh really loves traveling within Cambodia and across the countries. That's a reason he created Uot App which aims to bring the local trip taste experiences of Cambodia to the globe and attract international tourists to visit Cambodia.

08 The Active Presence of IoT Systems in Transforming Agriculture in Cambodia into Smart Agriculture in the Future

Siek Sokan, Master's Degree, Intelligent Mechatronics, Institute of Technology of Cambodia, Cambodia

HIGHLIGHT

- Internet of Things (IoT): the network of physical items or "things" that are implanted with sensors, software, and other technologies for the purpose to communicate and exchange data with other devices and systems through the Internet.
- Artificial Intelligence: the discipline of integrating computer science and robust datasets to facilitate problem-solving.
- Agricultural Robots: these are robots are used to replace human activities in the agriculture sector.
- Sensors: these are the devices are used to collect data by converting physical input from the environment into a signal.

The Internet of things (IoT) plays a crucial role in the agriculture sector. It can transform traditional agriculture into smart agriculture in four steps.

- First step, real-time data gathering is an important step. It is used to collect all the data of crops.
- Second step, after data of the crops is collected, it turns to data analysis, and a decision-making process.
- Third step, before agricultural robots do their tasks, decision-making must be done.
- Fourth step, data monitoring the presence of the display module provides users with many benefits. They can see the live data and the history, remote control via App and Web application, and make the cash payment online.

Keywords: Internet of Things, Artificial Intelligence, Agricultural Robots, Sensors

1. Introduction

1.1 IoT in Industrial Revolution 4.0

The Internet of Things (IoT), which is a special kind of technology in the Industrial Revolution 4.0 (IR 4.0) is an internet-connected device to share data over the cloud as shown in Figure 1 (Singh, 2021) & (Sisinni , 2018). Its application is in agriculture, infrastructure, industrials, health care, energy, financials, and communication services (Elijah, 2018). The key idea behind this technology is to deploy billions or trillions of intelligent devices that can make innovative communication between those devices. In 2027, 41 billion internet-connected devices will be developed. They will produce a significant market size to reach $2.4 trillion annually. These technologies will provide more advantages for the business, such as operation cost minimization, productivity improvement, increased safety in the working environment, better

Figure 1. The connected devices via WIFI (Elenabsl extracted 2022)

client experiences, and the addition of business information (Borgini 2022, Mar).

1.2. Review of Potential of the Agriculture Sector

Among the sectors which are mentioned, agriculture is the particular sector. It is put more consideration because the global population demands are increasing nowadays, so food production needs to improve for satisfy all the sector needs. Using the conventional method in food production does not affect this change. Therefore, using IoT systems in the agriculture sector can give better revolutionary changes. It is known as the revolution of smart/ modern agriculture systems containing smart management systems, smart operation systems, and labor minimization to replace conventional methods in food production systems (Suma, 2021).

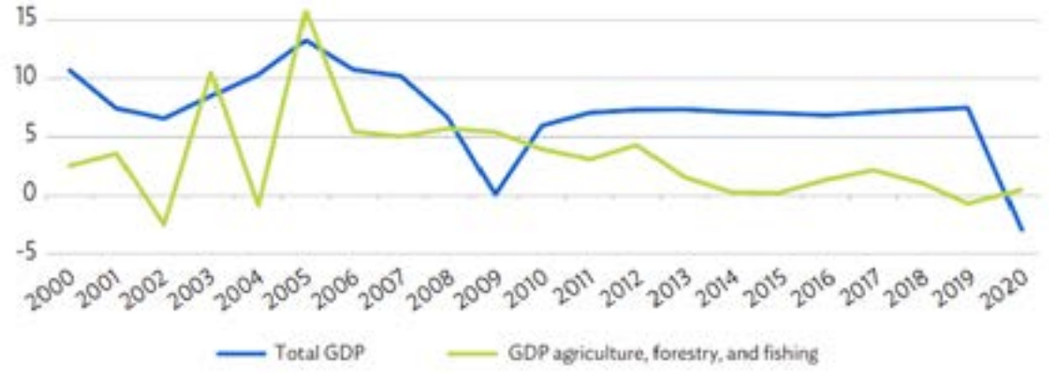


Figure 2: Total Gross Domestic Product (GDP) compared to agriculture GDP of Cambodian people from 2000 to 2020: annual % growth (ADB 2021)

Suma's article mentioned six important steps to get a better method for increasing the quantity of food. They are multi-culture framework, predictive analysis framework, IoT cloud for the proposed method, IoT device and sensors, security management, and Agri robot. The author tends to discuss deeply the result of different sensors like humidity, temperature, moisture sensor, and fetching the information flow via Wi-Fi.

Zhang *et al.* suggested the combination of precise agriculture (PA) and the Internet of things for reaching food demands. There are three main parts to IoT-based PA such as data collection, site-specific operation, and IoT application in PA. This technology can implementation in agriculture irrigation, agriculture fertilization, crop disease and pest management, and precision livestock farming. It is such a green revolution for humans.

1.3 Review of Cambodia's Agriculture Situation

If we look into the agricultural situation in Cambodia, the majority of the Cambodian population's GDP comes from agriculture as shown in Figure 2. From 1994 to 2015, Cambodia maintained an average annual growth rate of 7.6% and became to a lower-middle income economy in 2015 (ADB 2021). However, the Royal Government of Cambodia (RGC) plans to transform the national economy from a lower-middle-income country to a high-middle-income country by 2030 and a high-income country by 2050 (RGC 2015) & (MISTI 2022). Therefore, the presence of IoT systems will be standing an important part to achieve this vision.

2. Objective of This Research

There are four stages to managing agriculture in Cambodia effectively. They are:

1. Real-time data gathering
2. Data analysis, and decision-making
3. Management of agricultural robots
4. Data monitoring

3. The Proposed 4 IoT Stage Procedures

3.1. Real-Time Data Gathering

Different parameters such as temperature, soil, water level, fertilizers, and pesticides are required to detect and record. They really affect a crop's ability to produce more effectively (Kiran, 2021) & (Navulur, 2017). As shown in Figure 3, sensors are used to detect all the parameters needed. They have their own functionalities. Therefore, different parameters need different sensors. In addition, after all those sensors detect the parameters from the field, they transfer the data to the server through the gateway whose functionality is to send data from local to global. Furthermore, if the developers prefer reliable data from sensors, they need to do the calibration at different rang that they satisfy.

3.2. The Data Analysis and Decision-Making Procedure

Furthermore, the server itself has a special function called cloud computing (Zhang, 2018). It can store data (agriculture data and the user's bank account), analyze data, and make decisions. It is also built based artificial intelligence (AI) framework, which consists of machine learning and deep learning. So, it can become a smart decision-maker. Before the data is sent to the monitor and agricultural robots, it is executed and checked with the desired conditions that have been set. For example, if the temperature is set between 21 degrees Celsius to 35 degrees Celsius for the general crop, the farm temperature cannot reach this control limit by the action of agricultural robots, which are managed by the server through the gateway, as well as the fertilizer, and pesticides condition. Moreover, the system can learn from history. So, it can recommend good condition for all parameters through the monitor.

3.3. Activities Flow of Agricultural Robots

Another important part is that the fast response from agricultural robots can stabilize the agriculture condition requirement. All the agricultural robots can be the fan, water pump, agriculture praying drone, picking robotics, and transportation robotics. These devices can be controlled wirelessly via the internet or serial communication directly. To be sure when they should perform their tasks, they must be waiting for the decision-making that is the control signal from the server through the gateway. An example of a robot from agricultural robots, which is used in the apple farm, is a picking robotic or robot arm. It needs to pass several steps before it can perform its tasks. In the first step, the camera which is put in the robot, captures each apple's physical. Then, these images are sent to the server. In step 2, these images are classified, detected, and segmented into labels by the machine learning algorithm (fuzzy c-means (FCM), k-means, or Neural Networks algorithm). Step 3, after the decision-making is done, the signal will be sent to the robot arm through the gateway. Finally, this robot can pick the ripe apple or not based on the decision-making condition.

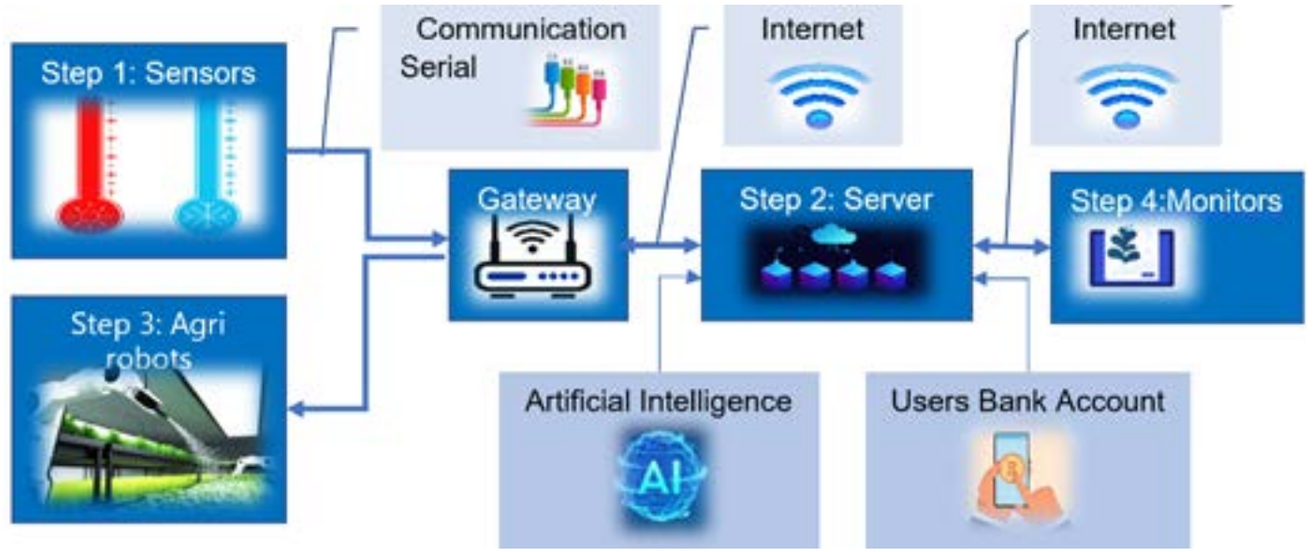


Figure 3. IoT diagram in agriculture sector

3.4. Data Monitoring and Remote-Control Process

Besides the three conditions that have been described, monitoring also provides fruitful functionalities. When the server has done an execution, it sends data to the display for data monitoring. Hence, the users can see all the live agriculture parameters, see the notification of the maintenance schedule, and know the damage's location in the systems. From this scenario, the users can remotely control the agricultural robots via the App and Web application for maintenance or fixing purposes or solve these purposes directly in the fields if there is any point that cannot be controlled automatically. Another important thing is that users can also pay online for the cost of the power consumption, and the raw materials cost of their crop by following the reference data in the interface and the guideline in the monitor.

4. Expected Result and Discussion

As a result, the four components of the IoT system will provide the farmers in Cambodia with fruitful results if they install this system entirely and correctly. They can earn more from labor costs, and transportation costs, and get a precise application to every stage of the crop process. Therefore, they can get higher productivity. However, they need to spend more on devices and power consumption. To operate every machine, they need electrical power that is charged into the devices' batteries or direct energy into the machines.

If we look into Suma and Zhang *et al.* article, we see that they mentioned many steps in terms of IoT in agriculture sectors. Suma focused on improving the quantity of agricultural products to meet all sector needs by applying six important keys of IoT. However, Zhang proposed three main steps to get precise agriculture and used IoT as the fundamental network infrastructures of the systems. Based on Cambodia's situation and the methods which are raised, we can extract four primary points for adopting IoT systems into the agriculture sector in Cambodia

5. Conclusion

This IoT presence can provide more benefits to all the farmers in Cambodia through smart activities of data collection, data analysis and decision-making, agricultural robot performances, and monitoring. Thus, agriculture technology in Cambodia will change from manual methods to automatic and smart methods. As a consequence, Cambodia's GDP will grow to reach the RGC's vision.

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09 A Journey of a Food Scientist

and STEM Educator with some tips to Pursue STI Careers

Ek Pichmony, Ph.D., Food Science, Washington State University, United States

I. Brief Self-Introduction

My name is Ek Pichmony (ឯក ពេជ្រមុនី). I was born in Battambang province, Cambodia. I graduated from the Institute of Technology of Cambodia, in 2013, with an Engineer's degree in Chemical engineering and Food Technology. In the same year, I also received my Bachelor of Arts in English literature from University of Cambodia.

In 2015, I received the master's degree in Sustainable Management of Food quality from University of Montpellier (France) and University of Basilicata (Italy), with the support of Erasmus Mundus program. In 2021, I obtained my doctoral degree in Food Science from Washington State University (United States), with the support of Fulbright for Foreign Students program.

I am currently working as a lecturer and researcher in the Faculty of Chemical and Food Engineering, Institute of Technology of Cambodia (ITC). I am also the deputy director of the Graduate School of ITC, and I am in charge of the doctoral programs.

In addition to teaching, I am working on research projects as well as R & D projects with food companies. My current research projects include the surveillance of aflatoxin contamination in peanuts, rice-based product development using extrusion technology, the development of healthy and nutrient-dense snacks for kids, and the application of solar drying technology for dried fish. I like sightseeing and walking in the park or nature as much as I can. I also like reading books and cooking new recipes from YouTube videos.

II. Brief Education Life

Why do you think education is important, especially STI education?

Personally, education is essential for every human being. It doesn't matter if it is a formal education (going to school/classes) or an informal one. We are learning every day and from everything around us. Knowledge and experiences crucially lead us to have better thinking, make decisions, create new ideas, solve problems, invent new things, and so forth. STI education is a vital part of our personal development and living, especially in this digital era. The world is moving faster than ever. STI is around us; for instance, we are using mathematics for everyday business, and we are using laptops or smartphones to communicate and to work. Interestingly, learning science makes us curious, and once we understand the principles, we can invent/create/do many things from the basis of science. For example, we can choose what to eat once we understand what essentials for our body are and how they work in our body.

What motivates you to choose STI education?

I love observing the nature around us, and I'm always curious how nature works and how scientists have discovered things which make us as we are today. STI fascinates me a lot; so I pursue my education and career in STI.

III. Experiences & Achievement

What inspire you to become who you are now?

First of all, my family, especially my late grandfather, has inspired me to love education by showing me how powerful education is in changing one's life and society. Secondly, my curiosity about nature has made me interested in physics and chemistry. Then, I met many inspiring teachers and people on different paths of life who have made me discover myself along the way. Thus, I become who I am today.

What are your great achievements/ accomplishments?

One of my great accomplishments was when I was awarded the Young Scientists and Engineers award (Y-E-S award) from the Honda Foundation in 2011. It was one of the turning points for me to go further in STI education, and to connect Science to our everyday life.

Another achievement is my Ph.D. degree because I encountered countless failures during my research, which made me stronger academically, mentally, and professionally. It was the most rewarding moment once I received my Ph.D. degree.

IV. Personal Development

How did you start your personal development?

I honestly cannot remember how I started to develop myself. I think it's the on-going process of wanting to be the better version of yourself every day. I keep learning and exploring from everyone and everything around me and reflecting on what makes me better in my life and career. One mindset is that "one cannot know everything, and learning is a life-long mission."

How to cope with fear of failure?

To cope with fear of failure, one should train their mental well-being to be stronger. I, personally, started meditation to improve my mental health in general. Meditation has also helped me to accept the unknown future, and what we can do is to do our best today.

One phrase that I have reminded myself if I'm anxious about failure is "If I cannot succeed or get it done successfully, so what!!, It's not the end of the world. I'll try my best now and be better next time."

What is your life mission?

My life mission is to make food and food products to be safe, accessible, affordable, and nutritious for everyone in Cambodia and beyond.

V. Advices to Next Generation

What is your message to the next generation in STI education and careers opportunity?

Science and Technology are always around us, so keep being curious and explore yourself in STI education. It is fascinating.

To get a good career in STI, you need real hard skills and soft skills. To learn a really hard skill, put your mind to learning it until you can perform the work. For instance, if you want to learn how to code in MATLAB, set a milestone and then learn to code until you reach that milestone. For soft skills such as teamwork, leadership, interpersonal communication, etc., you need to keep learning them by exposing yourself to different teams, people, and environments, and practicing your soft skills. It is a never-ending learning that you need to keep constant improvement and get out of your comfort zone.

10 A Journey to Become a Digital Transformer—

Kam Pisal, Master's Degree, Royal University of Phnom Penh, Cambodia

I. Brief Self-Introduction

I'm KAM Pisal, the President of Modernize Tech Insights Co., Ltd and Founder & Chairman of YELLOWSOFT and PHZARLAN. I'm an expert in project management, system analysis and solution design, strategic planning, strategic marketing, software development, computer network infrastructure architecture, and cybersecurity. My educational background is in Information Technology (IT) Engineering. In 2013, I graduated with an Bachelor's degree in IT at the University of Battambang and a master's degree of Master IT Engineering at the Royal University of Phnom Penh in 2019. I like to explore new technologies to keep up with the fast-moving technology trend.

II. Brief Education Life

Why do you think education is important, especially STI education?

Industry 4.0 revolution is the new trend while everything is moving and running digitally. Education in Science, Technology and Innovation (STI) is very essential for the new generation to understand the trend which will help prepare themselves to catch up with the career opportunities for our nation's development.

What motivates you to choose STI education?

STI is the key to my life; I, have loved them since I was young. I had wished to be a scientist. Unfortunately, I've not become a scientist but I can use one part of STI education to be who I am and become a Digital Transformer.

What are your oversea education experience?

I got professional training in Shanghai, China, which was conducted by NEC Japan. During this professional

training program, I received an additional Exchange Scholarship Program of ERASMUS to study at Pual Sabatier University in France. Most of the oversea training courses are High Availability of hardware and software solutions with all platforms, Hyper-Converge Infrastructure, and efficiency to manage, analyze, and monitor file servers.

How does your education advance your career?

Without these oversea education experiences, I would not be myself today. I'm a President of Modernize Tech

Insights Co., Ltd., Founder & Chairman of YELLOWSOFT and at PHZARLAN, and National Consultant at the Ministry of Public Works and Transportation and National Consultant at the Ministry of Agriculture, Forestry and Fisheries. Perhaps, I may still be a farmer in the field today.

III. Experiences & Achievement

What inspire you to become who you are now?

STI brought me a way that I can simply do anything, fast, low cost, and with high benefits. Additionally, experiences in real practice with entrepreneurs and teamwork is inspired me to keep growing, learning, and sharing.

What are your great achievements/accomplishments?

Help and develop our new generation, along the way of running a business, and I, have helped a lot of new generations through internship programs, scholarships offer, jobs, etc., and honored, that I got the opportunity to develop a system for the Ministry Agriculture, Forestry and Fisheries, Ministry of Public Works and Transportation, and Ministry of Women Affairs. I also have developed our own ERP System to help SMEs use digital systems to manage their business.

How you build the network or make a good collaboration with your partner?

Honesty, virtue, and credits are my inner power key to connecting and collaborating with my partners and building a strong network.

How can you extend your skills into a professional setting?

Being well-prepared (Checklist of execution) with a strategy before activation is how I apply to extend my skills into a professional setting.

IV. Personal Development

How did you start your personal development?

In my personal experiences, I believe that honesty, virtue, and credits combined with hard skills from day to day and open-mine to learning from everywhere and everyone around, not only from school, are the best self-development.

How to cope with fear of failure?

Failure is not bad, but people feel disappointed when they fail something. I think funding, regulation, and opportunity can cure the fear of failure.

What is your life mission?

Develop new generations through STI and join the government's mission to develop our nation.

V. Advices to Next Generation

What is your message to the next generation in STI education and careers opportunity?

- You are the one result-oriented person.
- One chance is your last credit.
- Communication is a powerful key to breaking the challenges of development.
- One Life is enough if you do your best today.

Thank you for your reading our publication. For an improvement of our next publicaton, we would like to request for your feedback. Please scan the QR Code below.

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