7th CreTech 2019

7th CreTech International conference 2019

Research proceeding for 7th International conference at Loft Mania Boutique Hotel Chumphon Thailand.

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CreTech 2019

7th International Conference on Creative Technology

3rd National Conference on Creative Technology

June 19-21, 2019

7th International Conference on Creative Technology

Welcoming Message

Dear Excellecies, distinguished guests, ladies and gentlemen,

On behalf of the CreTech 2019 organizing committee, it is my great pleasure and honor to welcome all of you at the opening ceremony of the 7th International Conference on Creative Technology here in Loft Mania Boutique Hotel, Chumphon, Thailand. We are very delighted to see all researchers from many educational institutes to share and exchange your precious experiences as well as valuable studies diverse fields through not only oral presentation but academic posters in creative technologies, and education research. This conference provides a forum for accessing to the most up-to-date and reliable knowledge from both commercial and academic worlds, sharing best practice in the fields as well as learning about case studies of successfully integrated technologies. The meeting provides an opportunity to highlight the recent developments apart from identifying emerging future areas of growth. This deals with recent advances in the field of Engineering, Science and Technology, Creative Technology, Business, Tourism, Economics, Social Science, and Humanity which is divided into 5 parallel oral sessions each day and poster presentation. We also expect to provide technical demonstrations, and numerous opportunities for informal networking.

The success of the conference is ultimately depended on all the people who have worked with us in planning and organizing both the technical program and supporting social arrangements. In particular, we would like to thank to the Program Chairs for their smart advice and brilliant suggestions on organizing the technical program; the Program Committee for their thorough and timely reviewing of the papers, and our sponsors who have helped us to diminish the costs of CreTech 2019 for all participants.

Once again we are very proud to welcome our distinguished keynote speaker, Dr. Pattanachok Sai-ai will share his experience in the topic of "Multidisciplinary for Sustainable Education and Energy". With your continuing contributions, the 7th International CreTech will certainly grow to become a leading annual conference in the field of creative technologies and education.

We would like to say thank you again to precipitate CreTech 2019 conference. I hope that you will enjoy all forums and activities we offer.

Yours sincerely,

Sukit N.

Dr.Sukit Nitinai

President of Rajamangala University of Technology Krungthep

Honorary Chair, CreTech 2019

All accepted papers will be published in the proceeding of CreTech conference.
Selected papers will be published in

UTK Research Journal (TCI 1)
Science & Technology Asia
(TCI 1,ACI ,EZB and Scopus)

Call for Papers

CreTech 2019

Registration http://utkcretech.rmutk.ac.th

7th International Conference on Creative Technology
3rd National Conference on Creative Technology

June 19-21, 2019

Loft mania Boutique Hotel
Chumphon , Thailand

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Food Safety, Product Development, Biotechnology
Agricultural Science, and Related Area

Track 3 Creative technology
Architecture, Product Design, Fashion Design,
Textile Design, Packaging Design, and Related Area

Track 4 Business, Tourism, and Economics
Management, Marketing, Financial and Banking
Tourism and Hospitality, Economics and Related Area

Track 5 Social Sciences and Humanities
Teaching and Education, Languages and Ontologie
and Related Area

Important Dates

Mar 30, 2019 Paper submission (Full paper)

Apr 22, 2019 Notification of full paper acceptance

May 10, 2019 Final full paper submission deadline

May 24, 2019 Early-bird registration deadline

Jun 20, 2019 Standard registration deadline

Jun 19-21, 2019 Conference day

Registration
International Conference

Registration due date	Registration Type	Fee (Thai Baht)
Early-bird Registration (Before May 1, 2019)	Regular Paper	6,500
	Student Paper	3,000
	Additional Paper	3,500
	Participant	3,500
Onsite Registration (From June, 20, 2019)	Regular Paper	8,000
	Student Paper	5,500
	Additional Paper	4,000
	Participant	4,000

Registration
National Conference

Registration due date	Registration Type	Fee (Thai Baht)
Early-bird Registration (Before May 1, 2019)	Regular Paper	3,000
	Student Paper	2,500
	Additional Paper	2,000
	Participant	2,000
Onsite Registration (From June, 20, 2019)	Regular Paper	4,000
	Student Paper	3,000
	Additional Paper	2,500
	Participant	2,500

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Content

Track 1

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Modified Ant Colony Optimization with mutation and Reset Pheromone for Travelling Salesman Problem

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ABSTRACT

Ant Colony Optimization (ACO) algorithm is a stochastic algorithm. It is used for solving combinational optimization problem. The ant colony walks along pheromone density from nest of ant to feeding sources. It leads to create shortest path from nest of ant to feeding sources. Ordinarily, ACO encounters the problem of trapping in local optimum. To solve this problem, the mutation technique is applied with ACO. However, the mutation technique cannot improve searching performance of ACO. This paper proposed improving ACO by the result from mutation technique is applied with pheromone of ants. In addition, when the problem of trapping in local optimum occurs, pheromone of ants is reset to solve this problem. The proposed technique is tested on twenty maps from the Traveling Salesman Problem Library (TSPLIB) and gives more satisfied search results in comparison with ACOs.

Keywords: ant colony optimization, travelling salesman problem, optimization, mutation operator

1. INTRODUCTION

Reference (1) proposed Ant Colony Optimization algorithm (ACO) in 1991. It gets inspired from the foraging behavior of ant colony (2), (3), (4). ACO has been well-known used for solving optimization problems (5) such as job scheduling problem, traveling salesman problem (TSP), network routing and vehicle routing problem etc. ACO endeavor to search for shortest paths from ant's nest to feeding sources. Each ant walks along the pheromone density and releases pheromone among walking. This behavior causes the pheromone density in short path. It is very high. On the other hand, the pheromone density in long path is very low (6), (7).

The benefits of ACO, it can search for the good solution rapidly. Moreover, it is efficient for solving TSP and similar problems (8), (23), (24), (25). For cons of ACO, it has the high opportunity to trap in the local optimum (8), (9), (23), (24). To solve problem of trapping in the local optimum, many algorithms such as Particle Swarm Optimization (PSO) applied with the mutation technique (15), (16). Many researchers (8), (12), (13), (14) enhance diversity of ant colony by adding the mutation technique to the process of ACO. The experiment results of these technique showed that mutation techniques can enhance searching performance of the standard ACO and obtain better solution than the standard ACO.

Reference (8) proposed the mutation technique is similar to mutation strategy of the Genetic Algorithms (GA). The mutation technique can enhance diversity of ant colony. Reference (13) proposed the mutation technique apply with ACO. The concept of this algorithm can summarize as follows. The mutation technique is applied with the best ant. Then, if the result from mutation is better than the result from the best ant, the best ant is replaced by it. This algorithm is called that ant colony optimization algorithm with mutation mechanism (MACO). Reference (14) proposed mutation technique apply with ACO. The

concept of this algorithm can summarize as follows. The mutation is applied with some ants. Then, if the result from mutation is better than the mutated ant, the mutated ant is replaced by it. This algorithm is called that ant colony optimization algorithm with uniform mutation using self-adaptive approach (ACOMS). From the experiment results show the performance of MACO and ACOMS in solving combinatorial optimization problems is better than that of the previous modified ACO.

The cons of ACOMS and MACO, the evaluation calls of these techniques are more than that of the standard ACO per a generation. It means the number of guessing solutions that are more than the standard ACO per a generation. So, it is not fair. If evaluation calls are equal, these techniques may obtain solutions worse than ACO. In addition, the results from the mutation cannot guide searching next generation. So, the mutation technique which is added cannot improve searching of ACO. But, these techniques enhance number of guess solutions. Surely, solutions of these techniques are better than solutions of standard ant colony if the number of generations is equal.

For process of ACO, the pheromone is determinant for creating tours of a solution or ant. Hence, this paper proposes the result from mutation is better than the mutated ant. That uses for improving pheromone. Next generation, process of ACO has the high opportunity to create better solution than the result from mutation. It can enhance searching performance of ACO. However, this technique leads to trap in local optimum. Therefore, the pheromone is updated from the best result only. Ant colony is rarely diversity of population. To handle trapping local optimum problem, this paper proposed a novel pheromone reset technique apply with ACO when ant colony happens to trapping in local optimum. The proposed algorithm can get better solutions when it is compared by standard ACO and other compared ACO algorithms.

A set of maps in the TSPLIB (18), (19) is used to compare the standard ACO (6) by source code from (17), MACO (13), ACOMS (14), and the proposed technique. The results show that the solution quality of the proposed technique is better than other compared ACO algorithms in the TSPLIB.

2. RELATED WORK

2.1 Travelling Salesman Problem

Traveling salesman problem (TSP) (20) is popular combinational discrete optimization problem and NP-hard problem. This problem has been used for many engineering applications such as computer networks and the design of hardware devices (21). As amount of cities are increased, searching the optimal tour becomes very hard. The salesman attempts to travel all cities only once and to create a closed tour of the shortest path. A complete weighted graph G = (V, A) can be used to represent a TSP. Where V is the set of n cities and A is the set of paths fully connecting all cities. Each edge (d_{ij}) is the distance between cities i and j. d_{ij} is as follows:

$$d_{i,j} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (1)$$

V = {1,.., n}, A = {(i, j): i, j ∈ V},
d(i, j) = d(j, i), Edge (i, j) ∈ A

2.2 Ant colony optimization

This paper shows applying ACO with TSP. An ant (A) is the set of paths fully connecting all cities. So, ant is solution of TSP. The fitness function of TSP is as follows:

$$fitness\_of\_ant = \sum_{i=1}^{n-1} d_{i,i+1} + d_{n,1} \quad (2)$$

ACO can be described briefly as follow. Initially, each edge has an initial pheromone $\tau_{ij}(0)$ between two cities. The next step is select city of ant. The first city of each ant is randomly selected, and then each ant selects next city according to probability function as follows:

$$P_{i,j}^{k} = \begin{cases} \dfrac{[\tau_{i,j}(t)]^{\alpha}[n_{i,j}]^{\beta}}{\sum_{t \in allowed}[\tau_{i,j}(t)]^{\alpha}[n_{i,j}]^{\beta}} & , j \in allowed \\ 0 & , otherwise \end{cases} \quad (3)$$

Where β is a parameter which determines the relative importance of pheromone versus distance (β > 0), $\eta_{ij} = 1/d_{ij}$ is the inverse of the distance, τ_{ij} is the pheromone, and $P_{i,j}^{k}$ is the probability of ant k chooses to move from city i to city j.

The result from formula Eq. (3) that causes selecting edges which are shorter and have a greater amount of pheromone. After selection cities of ant has completed, the fitness of ant is calculated by Eq. (2). The fitness of each ant is used to update pheromones according to Eq. (4). This process continues until a stopping criterion is met.

$$\Delta\tau_{i,j}(t+n) = \rho\tau_{i,j} + \Delta\tau_{i,j} \quad (4)$$

$$\Delta\tau_{i,j} = \sum_{k=1}^{m}\tau_{i,j}^{k} \quad (5)$$

$$\Delta\tau_{i,j}^{k} = \begin{cases} \dfrac{Q}{L_k} & , if\_the\_k^{th}\_ant\_uses\_edge(i,j)\_in\_its\_tour \\ 0, & \_otherwise \end{cases} \quad (6)$$

Where is calculated by Eq. (6), $\Delta\tau_{ij}$ is the sum of new enhanced pheromones at this edge is degree of dissipate for pheromones, ρ is a coefficient such that (1 - ρ) represents the evaporation of trail between time t and t+n, $\tau_{i,j}^{k}$ is the amount of pheromones of the k^{th} ant at its edge between t and t+n, and Q is consistent value, L_k is fitness of ant k.

3. MODIFIED ANT COLONY OPTIMIZATION WITH MUTATION AND RESET PHEROMONE

As previously mentioned, the mutation operator can improve solution of ACO. The result from improving pheromone affects to search for solution of ACO next generation. Surely, if the pheromone is updated from good solution, it has the high opportunity to create better solutions. In the same case, if the mutation is applied with good solution, it has the high opportunity to create better solutions. Hence, this research proposed the best ant is selected after ACO step create tours each generation. Then, the best ant is applied with the mutation operation. The best result from the mutation, it is used to update pheromone. The pheromone is only updated by the best result from mutation. The result from improving pheromone, it affects to search for solution next generation. This algorithm can improve searching for solution and get better solution.

However, the result from pheromone is only updated by the best solution. It leads to trap in local optimum. The pheromone is created from only the best solution. It is rarely the diversity of population. It occur the trapping in local optimum problem over the standard ACO.

The trapping in local optimum problem occur with ACO. It cause from pheromone which is stagnation. The pheromone which is stagnation creates the same solution over and over again, that no better solutions can be found anymore (6), (9). Therefore, the unchanged number of consecutive solution can indicate state of ant colony when ant colony traps in local optimum. Generally, resetting should be used when colony trap or trend to trap in local optimum (15), (16) to distribute ant colony to search for other areas. To handle the trapping in local optimum problem, this paper proposed reset pheromone when all ants occur trapping in local optimum. In order that pheromones occur changing, it creates the new tours and can jump out local optimum. The easy techniques to indicate the trapping state of the ant colony is to monitor the unchanged number of the best consecutive solution. Thereby, this paper proposed the reset period (RP) considered from the unchanged number of consecutive solution.

The result from searching both ACO algorithm and the mutation technique can enhance searching performance concurrently. Moreover, the reset pheromone is applied when ant happen trapping in local optimum to solve trapping in local optimum problem. Hence, this paper proposed the mutation technique and reset technique apply with ACO. The proposed technique is called Modified Ant Colony Optimization with mutation Pheromone and Reset Pheromone (ACOMR). Pseudo code of ACOMR is shown below:

```
Initialize edges (i, j) and pheromone (τij)
While termination condition ≠ true do
  For each number of ants
   Random the start city
   Reset the best solution of this generation (BG)
   For until cites in list of an ant is full
      Choose the next city with probability according to formula (3)
      The chose city is not repeat city in list of this ant
      Insert chose city into list of this ant
   End For
   Evaluate fitness of each ant
   If fitness of each ant is better than fitness of BG
      BG = this ant
   End If
   If fitness of each ant is better than fitness of solution
      Update fitness of solution = fitness of this ant
   End If
  End For
  Apply the mutation operation with BG only as follow:
  For city i begin 0 to the number of cities
   Random the city j
   Swap city i and city j (i≠j)
   Evaluate fitness of the result from swap
   If fitness of the result from swap is better than fitness of BG
      BG = the result from swap
   Else
      Swap city i and city j
   End If
  End For
  Update pheromone by BG only according to formula (4)
  Times of BG consecutive unchanged ++
  If the times of BG consecutive unchanged >= reset period
   All pheromones in table are initialized
   Set the times of BG consecutive unchanged to 0
  End If
End While
```

4. EXPERIMENTS AND RESULTS

4.1 Parameters Setting

Parameters are as follows for all experiments: $\rho = 0.05$, $Q = 1$, $\beta = 1$, $\alpha = 1$, as suggested by (17), $\tau_0 = (n \times L_{nn})^{-1}$ where n is the number of cities, and L_{nn} is the length of list of ant that is produced by the nearest neighbor heuristic (22). The number of experiments of each map is set as 20 runs. To guarantee fairness of performance measurement, evaluation calls of all the algorithms are set equation. The number of evaluation of each run in experiments is 1,000,000 evaluations. The number of ants is set as 50. The non-ACO parameters are as follows: The compared algorithm parameters (MACO, ACOMS) are set according to suggested by the original papers. For proposal algorithm, the reset period (RP) is set as 30.

All experimented algorithms are not used by the well-known path improvement heuristics such as 2-opt (10), and Lin–Kernighan (11). This research is conducted by a personal computer of AMD FX-8320 with 3.5 GHz CPU, 8 GB RAM and Visual C++ 2010 as the programming language. All maps are used in experiment are from TSPLIB (18), (19).

4.2 The measures of algorithm performance

The measures of algorithm performance in the experiments are as follows: the average best fitness value (ABF) is the average of best fitness in the final generation from all running. ABF indicates the solution searching efficiency of an algorithm. The closer the ABF to the optimum point of a method, the better the method. SR is the success round. SD is the standard deviation. SR and SD indicate the solution searching reliability of an algorithm. The success percent (SP) is percent of SR.

4.3 Experiment of proposed algorithm

From the experimental results of Table 1 show that the quality solution of ACOMR is better than that of ACO, MACO, and ACOMS because of its lowest ABF all tested maps. The reliability of ACOMR is better than that of ACO, MACO, and ACOMS because of its lowest SD and its

highest SR all tested maps. Hence, ACOMR outperforms ACO, MACO, and ACOMS in case of reliability and quality solution. The experiment can prove that the pheromone very affect to searching performance of ACO. The proposed algorithm only improves the pheromone. The quality solution and the reliability of proposed algorithm are better than that of other compared algorithms (MACO, and ACOMS) which directly improve ants or solution. In some maps, ABF and SD of both MACO and ACOMS are higher than that of ACO, such as BAYG29, In this case show that if number of evaluation call is equal, MACO and ACOMS may obtain worse solutions than ACO in some cases. SP of ACO is 36.32%. SP of MACO is 41.32%. SP of ACOMS is 32.89%. SP of ACOMR is 86.58%. The proposal method can improve SR of ACO by approximating 50.26%.

Table 1. Comparative Results of ACO, MACO, ACOMS, and ACOMR on TSP.

Techniques		ACO		
Problem name	Optimum Point	ABF	SD	SR
burma14	3323	3323.00	0.00	20
ulysses16	6859	6859.00	0.00	20
gr17	2085	2085.00	0.00	20
gr21	2707	2707.00	0.00	20
ulysses22	7013	7023.35	11.44	11
fri26	937	937.00	0.00	20
bayg29	1610	1620.90	10.53	6
bays29	2020	2041.60	10.58	0
Oliver30	420	420.00	0.00	20
dantzig42	699	709.25	5.21	0
swiss42	1273	1308.70	10.86	0
eil51	426	439.30	5.61	1
berlin52	7542	7847.60	71.22	0
brazil58	25395	26516.10	213.24	0
st70	675	722.50	7.24	0
pr76	108159	116410.00	1000.80	0
eil76	538	576.50	8.65	0
rat99	1211	1356.65	15.50	0
kroA100	21282	23220.80	266.32	0

Table 1. (Continued).

Techniques		MACO		
Problem name	Optimum Point	ABF	SD	SR
burma14	3323	3323.00	0.00	20
ulysses16	6859	6859.00	0.00	20
gr17	2085	2085.00	0.00	20
gr21	2707	2707.00	0.00	20
ulysses22	7013	7014.50	2.60	15
fri26	937	937.00	0.00	20
bayg29	1610	1636.65	11.03	1
bays29	2020	2030.75	8.62	2
Oliver30	420	420.00	0.00	20
dantzig42	699	704.35	5.18	3
swiss42	1273	1278.90	7.56	11
eil51	426	433.05	5.23	3
berlin52	7542	7675.90	90.12	0
brazil58	25395	26275.40	186.07	0
st70	675	701.25	14.58	2
pr76	108159	115423.00	1594.01	0
eil76	538	570.65	8.31	0
rat99	1211	1350.05	17.53	0
kroA100	21282	22607.90	314.73	0
burma14	3323	3323.00	0.00	20
ulysses16	6859	6859.00	0.00	20
gr17	2085	2085.00	0.00	20
gr21	2707	2707.00	0.00	20
ulysses22	7013	7031.05	9.15	4
fri26	937	937.00	0.00	20
bayg29	1610	1639.75	11.40	0
bays29	2020	2045.60	10.93	0
Oliver30	420	420.00	0.00	20
dantzig42	699	710.90	7.42	1
swiss42	1273	1311.35	10.00	0
eil51	426	440.45	6.13	0
berlin52	7542	7856.05	106.11	0
brazil58	25395	26614.30	228.03	0
st70	675	722.75	14.84	0
pr76	108159	117107.00	1264.44	0
eil76	538	584.10	7.08	0
rat99	1211	1370.05	18.90	0
kroA100	21282	23169.60	202.73	0
burma14	3323	3323.00	0.00	20
ulysses16	6859	6859.00	0.00	20
gr17	2085	2085.00	0.00	20
gr21	2707	2707.00	0.00	20
ulysses22	7013	7013.00	0.00	20
fri26	937	937.00	0.00	20
bayg29	1610	1610.00	0.00	20
bays29	2020	2020.00	0.00	20
Oliver30	420	420.00	0.00	20
dantzig42	699	699.00	0.00	20

Table 1. (Continued).

Techniques	ACO			
Problem name	Optimum Point	ABF	SD	SR
swiss42	1273	1273.00	0.00	20
eil51	426	426.00	0.00	20
berlin52	7542	7542.00	0.00	20
brazil58	25395	25421.10	47.43	2
st70	675	675.00	0.00	20
pr76	108159	109551.00	708.40	2
eil76	538	538.00	0.00	20
rat99	1211	1216.55	8.21	10
kroA100	21282	21324.10	89.28	15

5. CONCLUSION

The mutation operator is applied with ACO to solve trapping in local optimum. Generally, the mutation operation is applied with ant. These algorithms cause number of evaluation calls that are increased. Moreover, they cannot improve searching of ACO. From these cons, this paper proposed the results from the mutation update pheromone of ants to improve searching of ACO. But, it suffers the trapping in local optimum problem. To solve trapping in local optimum problem, the resetting pheromone is applied with ACO when ant colony trapped in local optimum. The proposed technique is called that ACOMR. ACOMR can solve trapping in local optimum problem and improve searching of ACO. Hence, it can get better solutions. From the experimental results show that the proposed ACOMR outperforms ACO, MACO, and ACOMS with regard to the reliability and quality of solutions in all maps.

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The Development of Website and Animation for Learning about Female Genital Cancer

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ABSTRACT

The purposes of the research were 1) to develop website and animation as media for learning female genital cancer, 2) to compare the learning achievement between pre-test and post-test's learning media, and 3) to study the satisfaction of users using this learning media. This project was evaluated by an animated media expert, two website specialists, a female genital cancer expert, and thirty users. The satisfaction level and the learning achievement were statistically indicated by mean, standard deviation, pair sample t-test. The website was developed with PHP and MySQL programming following Software Development Life Cycle (SDLC) theory as well as the animation was created following Analysis, Design, Development, Implement, and Evaluation (ADDIE) model.

The result showed that the satisfaction rated by experts was found at the highest level (= 4.76, S.D. = 0.44) while the satisfaction evaluated by users was shown at high level (= 4.26, S.D. = 0.64). Moreover, it was revealed that the learning achievement of post-test score was higher than pre-test score with statistical significance at .01 (p-value < .01).

Keywords: leaning media, female genital cancer, animation

1. INTRODUCTION

Cancer refers to any one of a large number of diseases characterized by the development of abnormal cells that divide uncontrollably and have the ability to infiltrate and destroy normal body tissue. Cancer often has the ability to spread throughout body. Cancer is the second-leading cause of death in the world [1]. Statistics shown that the second cancer was cervix cancer of female genital cancer and the age majority was 35-60 years old. The most common type of female genital cancers is cervical, ovarian and endometrial carcinoma [2] [3].

Consequently, learning media for female genital cancer was developed which consisted of practices, website, and animation. The main story and content were general knowledge, types, and preventing of female genital cancer.

The purposes of the research were 1) to develop website and animation as media for learning female genital cancer, 2) to compare the learning achievement of this learning media, and 3) to study the satisfaction of users using this learning media.

The population was females who were interested to learn this animation and the sample was 30 women who were 18-60 years old. 4 specialists: an animated media expert, two website specialists, a female genital cancer expert. This media was online 2D animation and there were pre-test and post-test to compare the scores which were random 10 questions from 15 questions in database which were chosen the best choice. Additionally, users should be enrolled the member and verify by e-mail before login website system.

The pertinent literature was carefully reviewed. Firstly, Preedawon Kadmateekarun and Sunmitra Nuanmeesri (2015) reported that development of animation teaching media on the

topic of the property of the father had the learning achievement with statistical significance at 0.05. The learning achievement was compared between pre-test score and post-test score of 10 switching questions. The satisfaction was evaluated at high level. Both learning achievement and satisfaction were measured from scores of 50 grade 4-5 students of Wat Don Sali School [4]. Secondly, Sumitra Nuanmeesri, Saran Jamornmongkolpilai (2018) concluded that the development of the virtual learning media of the sacred object artwork gave more effective learning process at the statistically significant level of 0.05. The pre-test score and post-test score were calculated the learning achievement from 60 users. The users were satisfied with the virtual learning media at the highest level [5]. Thirdly, Chutipong Punsombut and Pongpipat Saitong (2016) summarized that the developing 3D animation using storytelling method about good eating habit during early childhood had quality at the highest level. The sample group was 30 elementary students at AnubanSakonNakhon School. The 46.67 percentage of students enjoyed big eye cartoon character and the most popular scene was the virtual scene at 63.63 per cent. After watching this animation, the average score was 7.77 out of 10 [6]. Fourthly, Jaruwat Noothong (2017) indicated that development of mini course instructional package on iOS operating system on studio photography for undergraduate student in cinema and digital media production major had satisfaction at the highest level and post-test was significantly higher than pre-test of achievement at statistical level of 0.05. The 32 students were sample group who studied undergraduate student in Cinema and Digital Media Production major at College of Social Communication Innovation Srinakharinwirot University by using purposive sampling. Both pre-test and post-test were used to evaluate the learning achievement [7]. Finally, Uraiwan Srichailard and Soradech Krootjohn (2017) illustrated that development of interactive 2D augmented reality instruction media: earth phenomenon and space technology for grade 6 students had satisfaction at the highest level and the post-test's average score was significantly higher than the pre-test's average score at the statistical level of 0.05. The evaluation was computed from scores of 32 students at Wat Om Noi School [8].

2. MATERIALS AND METHODS

This website was completely developed by the following Software Development Life Cycle model (SDLC) [9]. Firstly, requirement and fesibility were carefully analyzed such as login system, quiz system, and VDO management system. Secondly, graphic user interfact (GUI) was designed such as login form, member form, pre-test form, and post-test form. Database was planed such as member table, questionair table, and score table. Use case diagram, activity diagram, and sequence diagram were drafted. Figure 1 showed use case of website system. Thirdly, website was developed with PHP and MySQL programming. Next, the website was tested and solved some error. Finally, website was evaluated the learning achievement and the satisfaction by 4 experts and 30 users.

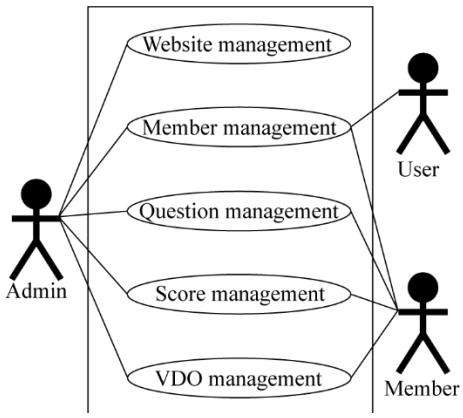

Figure 1. use case of website system.

The ADDIE model was applied to create animation which had 5 steps [10]. 1. Analysis: brandstrom chart, concept chart, and content network chart. Charts consisted of type of

female genital cancer, causes of disease, and protection topics. 2. Design: objective, course flow chart, and module presentation chart. Firstly, pre-test was done. Next, the animation was studied. Finally, post-test was made. 3. Developing: script and story board. 4. Implementation: animation. 5. Evaluation: achievement and satisfaction.

3. RESULTS AND DISCUSSION

The result of this website was shown in the following figure 2, 3, 4, 5, 6, and 7. The main function consisted of management of website, member, score, practice, and animation.

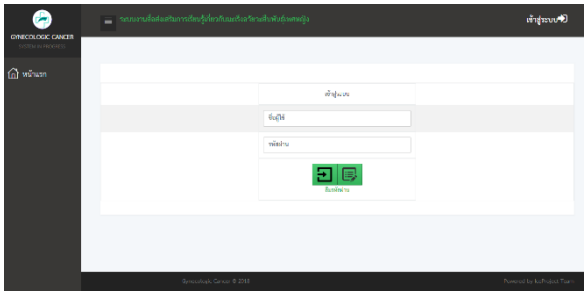

Figure 2. Login page of website.

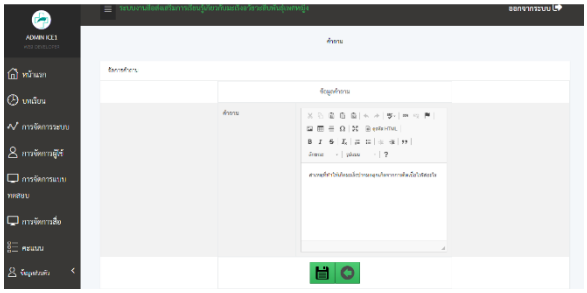

Figure 3. Managing question page of website.

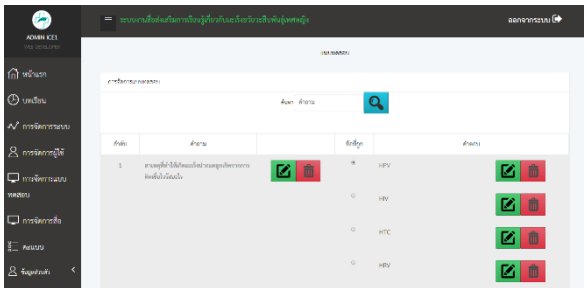

Figure 4. Showing question page of website.

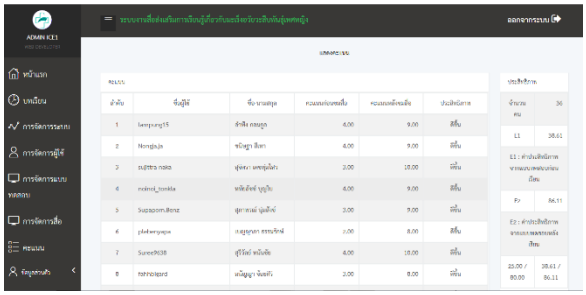

Figure 5. Showing score page of website.

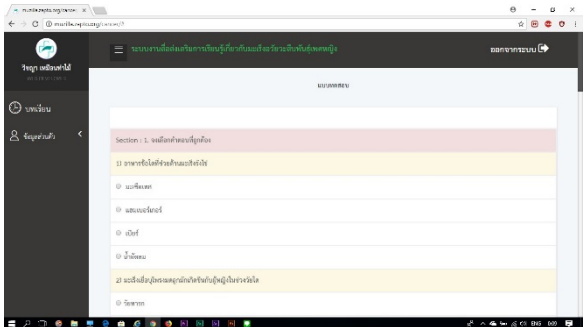

Figure 6. Showing practice page of website.

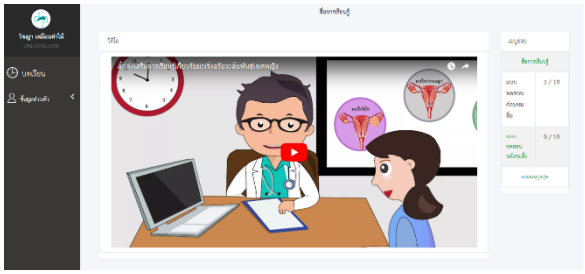

Figure 7. Showing example of animation page of website.

The animation was created in the following figure 8, 9, 10, 11, and 12. The majority story was about a patient painted abdomen. Consequently, she went to see the doctor for consulting. A doctor explicitly described and illustrated about the causes and preventing of female genital cancer. In the end, she was diagnosed as normal pap smear. She said that pap smear neither painful nor dangerous. Therefore, women should be followed up every year.

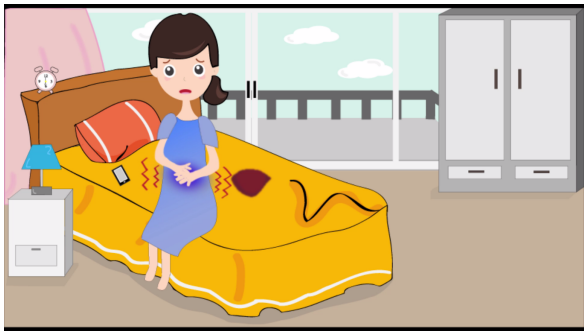

Figure 8. Abdominal pain.

Figure 9. At the hospital.

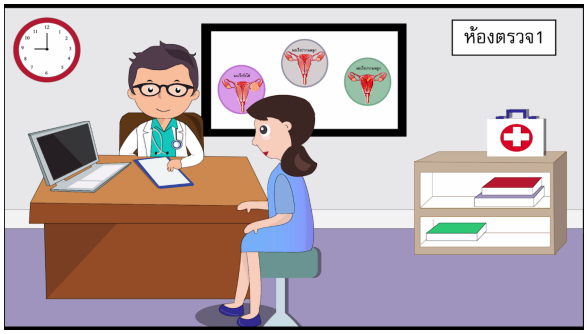

Figure 10. To see doctor.

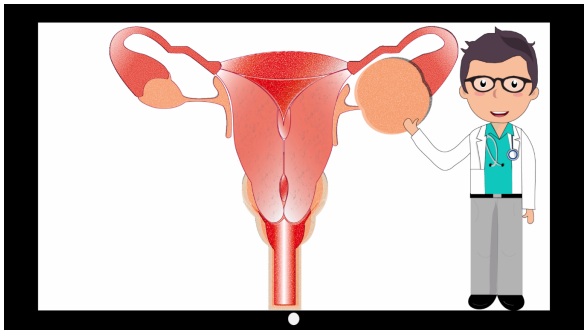

Figure 11. Descripting the cause and preventing of female genital cancer.

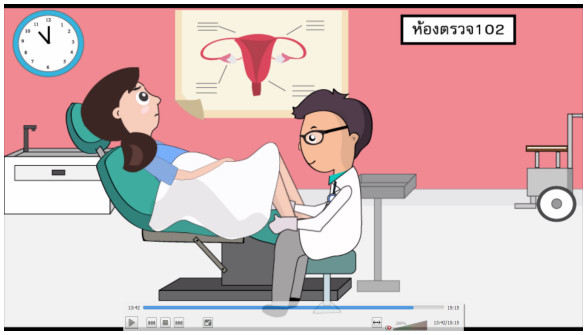

Figure 12. Pap smear.

This website and animation were evaluated by 4 experts and 30 users. The result was found following tables.

Table 1. Satisfaction's experts.

Topic	Mean (S.D.)	Result
1. Contents.	4.67 (0.48)	highest
2. Light, color, and sounds.	4.71 (0.46)	highest
3. Animation.	4.71 (0.46)	highest
4. Website.	4.80 (0.41)	highest
5. Practices.	4.92 (0.29)	highest
Total	4.74 (0.44)	highest

Table 1 show that the overall satisfaction's experts was shown at the highest level (= 4.74, *S.D.* = 0.44). The content part was shown at the highest level (= 4.67, *S.D.* = 0.48). The light, color, and sound part was shown at the highest level (= 4.71, *S.D.* = 0.46). The animation part was shown at the highest level (= 4.71, *S.D.* = 0.46). The website part was shown at the highest level (= 4.80, *S.D.* = 0.41). The practice part was shown at the highest level (= 4.92, *S.D.* = 0.29).

Table 2. Satisfaction's users.

Topic	Mean (S.D.)	Result
1. Contents.	4.18 (0.63)	high
2. Light, color, and sounds.	4.13 (0.67)	high
3. Website.	4.43 (0.59)	high
Total	4.26 (0.64)	high

Table 2 show that the overall satisfaction's users was shown at high level (= 4.26, *S.D.* = 0.64). The content part was shown at high level (= 4.18, *S.D.* = 0.63). The light, color, and sound part was shown at high level (= 4.13, *S.D.* = 0.67). The website part was shown at high level (= 4.43, *S.D.* = 0.59).

The learning achievement of learning media for female genital cancer was measured with pair sample t-test. As a result, it was shown as table 3.

Table 3. Learning achievement of pre-test score and post-test score.

Group (n = 30)	Mean (S.D.)	t (p-value)
pre-test score	3.87 (1.53)	-19.06 (.000) **
post-test score	9.23 (.86)	

** p-value < .01

Table 3 show that the pair sample t-test was conducted to compare learning achievement between pre-test score and post-test score. The average of post-test score was higher than the average of pre-test score. Consequently, it can be shown that the female genital cancer learning media had learning achievement with statistical significance at .01 (p-value < .01). The post-test average score was 9.23 and the pre-test average score was 3.87.

4. CONCLUSIONS

The learning media for female genital cancer was created both website and animation. This learning media was found at the highest level of the overall satisfaction' s experts while the satisfaction' s users was evaluated at high level. Additionally, it was shown that the learning media had the efficiency which related to research of Preedawon Kadmateekarun and Sunmitra Nuanmeesri, Sumitra Nuanmeesri and Saran Jamornmongkolpilai, Jaruwat Noothong, and Uraiwan Srichailard and Soradech Krootjohn.

5. ACKNOWLEDGMENTS

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An application Single Minute Exchange of Die technique to reduce setup time on water pipe extrusion machine

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ABSTRACT

This study aims to reduce the time of change and setup extruding die of 110 millimeters diameter of a water pipe factory. By applying the Single Minute Exchange of Die (SMED) technique to reduce the time of die change and setup. The SMED's principle is to separate internal work into external tasks, change unnecessary die setting work into an external preparation, analyze work processes to reduce internal die setup time, and improve work processes to shorten the time for die setting up. Based on the data collected before the improvement, it was found that the time spent in the die setup was 150 minutes and using 4 staffs in the process. After applying the SMED technique, it can reduce the time to change and set up the extrusion die down to 70 minutes accounted for 53.33%. The productivity value was increased by 414,720 baht.

Keywords: Single Minute Exchange of Die (SMED), internal and external set up

1. INTRODUCTION

At present, various organizations have a lot of business competition. They focus on developing the potential of the organization in many ways and presenting what their organization can perform quickly, accurately, efficiently and less mistake [1,2] to meet the expectations of customers in various aspects such as quality, a flexibility of delivery in a shorter time [2]

The lean production system is a concept developed from the Toyota Production System (TPS) in the 1940s [3] with a focus on 3 principles: 1) continuous improvement 2) creating value by eliminating the 7 wastes [4,5] and 3) customers oriented is produced according to their satisfaction. The philosophy of lean manufacturing is to increase the quality and deliver products at low cost. The basic goals are reducing production time and provide resources to support changing customer orders with the lowest inventory levels possible.

Single Minute Exchange of Die (SMED) was developed by Ono of Toyota Motor Company in the 1950s. [4,6,7] that is a technique used to
reduce the time to change machines or change the workpiece. SMED is an important technique for organizations that implement the principles of lean manufacturing systems. The goal is to change the machine within less than 10 minutes in order to reduce the waste that occurs within tasks of changing the machine for producing the next order that is being produced. In this work, SMED is helping to reduce die change time by 53.33% and productivity value increases by 414,720 THB.

2. SMED APPROACH

2.1 Setup time

Machine Setup Time refers to the time that has been started since the machine has been stopped in order to install, disassemble tools or equipment until the machine is ready to be used to produce a good first product without having to adjust the machine again. [5,8] Machine setup process and time proportion before using SMED as shown in Table 1

2.2 SMED (Single Minute Exchange of Die)

SMED is the concept of reducing the time to setup the machine, Shingo [9] said and recommended about SMED that the production system of Japan, especially in Just in Time (JIT) and Total Quality Control (TQC), it is a very efficient production system.

Table 1 steps to set up the machine and the proportion of adjustment time [9]

Setup steps	Time
1. Arrangements for preparation after the inspection of raw materials and tools	30%
2. Install jig and part tools	5%
3. Measurement, setting, and verification	15%
4. Machine startup and adjustment	50%

In industrial management, JIT is not a method but as a result of using SMED. Many people think that reducing the time to setup machines from 4 hours to 3 minutes is impossible but can actually be achieved by using the SMED system.

SMED [9] was developed by Dr. Shigeo Shingo and has been translated into many languages and spread throughout the world. It has been widely accepted that it can be adapted to all industries, especially the changing of mold and die. There are reports of the effect of this system being used. For example, reports in Japan that show better results in various industries, such as the Presses Dies industry, can be reduced by 1/18, meaning that it is reduced from 18 minutes to 1 minute. Plastics Forming has decreased by 1/20 and Dies-Cast Molding has decreased by 1/10.

The basic principle of SMED is to divide the machine setup into 2 categories [10,11] 1) internal setup means the machine that needs to be stopped only for start changeover work, such as changing mold or adjustment 2) external setup means work that does not need to stop the machine and can be done, such as moving a new mold for installation and moving old molds to storage and etc.

SMED divides the process into 3 steps [4,9,12] i.e.

1. Separating internal and external setup. At this step must be asked an important question "do you have to shut down the machine to perform this task.
2. Converting internal to external setup. Introduce SMED's objective, internal tasks were converted to external tasks.
3. Streamlining all aspects of the setup operation. Applied the specific principle to shorten the setup time.

All of the steps are shown in Figure 1.

3. CASE STUDY APPROACH

3.1 Current situations

The factory is the manufacturer of water pipes and the production section consists of 3 main lines, as shown in Figure 2. The production of water pipe has more sizes of diameter in 3 lines; the largest number of times to change is line no.2

3.2 Steps for selecting and analyzing data

In this step, line no.2 was chosen. It produces 110 mm diameter of the pipe. By applying SMED concept to reduce mold adjustment time based on the analysis of the setup time before the improvement, it was found that the time used for setting up the mold per time was 150 minutes using 4 employees as shown in Table 2.

Based on the process of die set up, it takes a lot of time and the 3rd and 4th operators do not participate in the setup. Therefore, the data analysis is performed with the cause & effect diagram [13] which shows analysis data as shown in Figure 3

4. IMPROVEMENT OF CHANGE AND SETUP PROCESS

Due to problems in the work elements that have been found, the researcher is interested in

reducing the time set up for the extrusion die with the goal set as follows: 1) to manage people to suit the work process 2) reduce internal work procedures to be more than 10 minutes

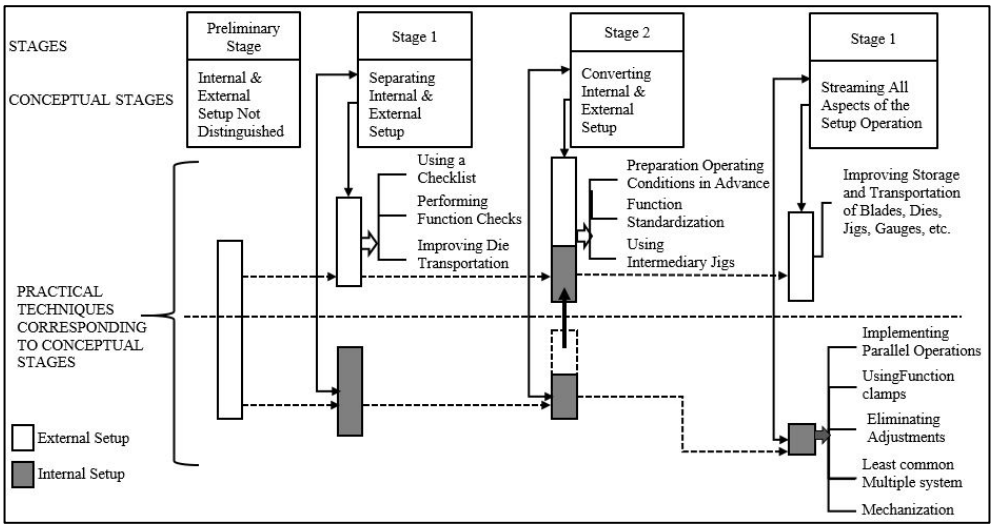

Figure 1. SMED Conceptual stages. [6]

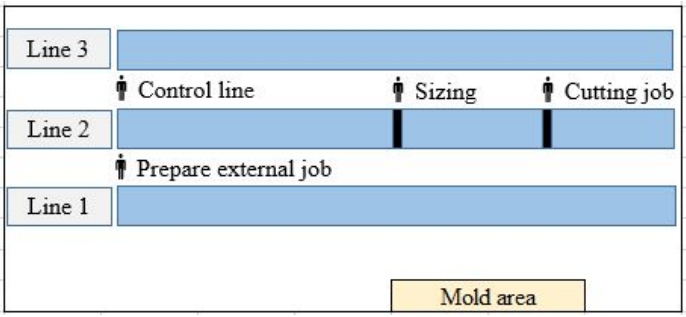

Figure 2. Pipe production line

Table 2. The step of Tasks in the extrusion die setup before improvement

Step of Tasks	Time (minute)			Time (minute)							
	Man	Auto	Walk	20	40	60	80	100	120	140	160
1. Die change	50										
2. Change equipment of Vacuum tank	43		2								
3. Adjust cooling tank (2 tanks)	4		1								
4. Setup puller	4		1								
5. Setup cutter	33		2								
6. Extrude pipe into line	19		1								
7. Adjust die before startup	30										

Operator 1 Setup Operator 3 Prepare die
Operator 2 Setup Operatpr 4 Control Operation
Remark: Operator 3 and 4 are the line leader and supervisor respectively.

3) reduce the overall set up time to 60 Minutes or more than 40%. The researcher has set guidelines for improving the problem of setting up the pipe extrusion die as follows.

1. Change the method of holding the water cooling tube by changing the water tube and installation of the water tube in front of the machine sleeve. Before installing the water tube, this step takes 5 minutes to install and after changing the procedures it can reduce the time by 5 minutes, as shown in Figure 4
2. Change the method of fastening the 2 vacuum plates. Before the improvement, it is found that the time to change the plate 3 minutes per plate, which will take 6 minutes to change in total. After changing the method, a wing nut is used in the fastening plates and can reduce the time to hold the plates by 4 minutes as shown in Figure 5.
3. Reduce the travel path of the operator [14]. Before the improvement, it was found that the cutter storage area is 10 meters away from the setup point, which requires 2 minutes to walk back and forth. Adjustment by moving the clamping cutter storage area to the front of the machine, it can reduce the walk-back time by 2 minutes as shown in Figure 6.
4. Changing the method of clamping the cutter clamp. Before the improvement found that the staff had to loosen the 8 fixing screws to install a new clamp set, which will take 12 minutes. The improvement has slotted the hole for sliding the clamp when removing. After the improvement can reduce the time by 4 minutes as shown in Figure 7.
5. Change the internal tasks into external tasks. From the analysis, it is found that the process of pull the pipe in the line can be moved to external setup that reduces time by 5 minutes and setup procedures before starting production can move to set up outside it reduce time by 10 minutes.
6. Change the way of working for 2 employees who are not continuously working to help set up the process. While the 3rd and 4th employees participate to help in the setup, the total setup time down from 150 minutes to 70 minutes, as shown in Table 3

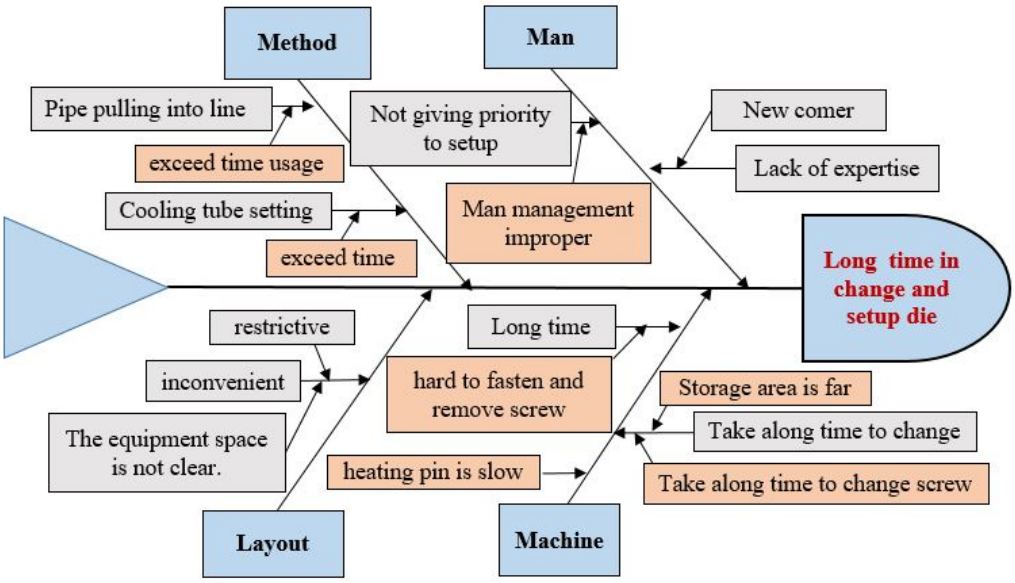

Figure 3. Problem analysis using Cause and Effect diagram

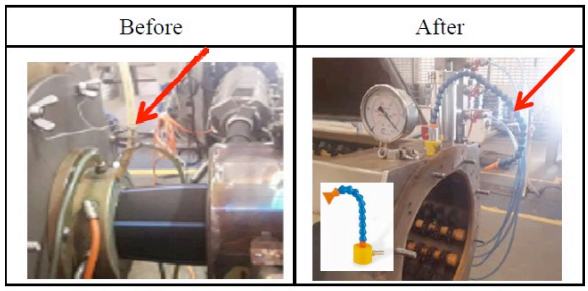

Figure 4. A. Before and B. After change water tube

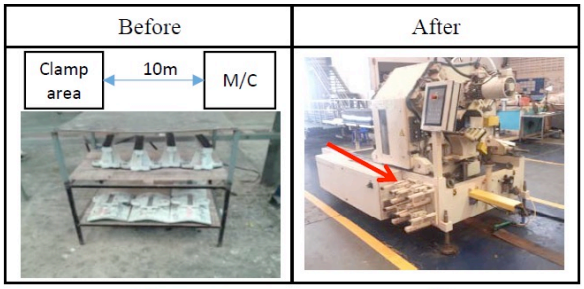

Figure 6. A. Storage area before improvement, and B. Change to preparing in front of the machine

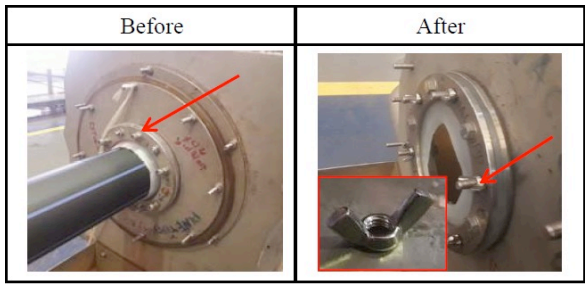

Figure 5. A. Before and B. After a change of nut to fasten vacuum plate

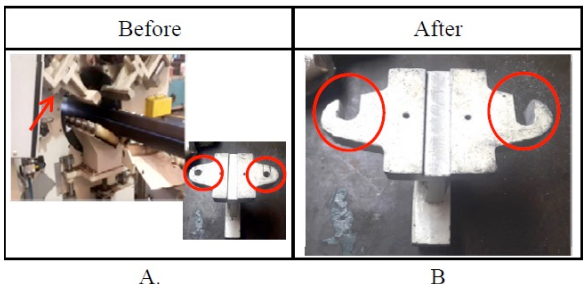

Figure 7. A. hole before improvement and B. Slotted hole after improvement

Table 3. The step of Tasks in the extrusion die setup after improvement

Step of Tasks	Time (minute)			Time (minute)							
	Man	Auto	Walk	20	40	60	80	100	120	140	160
8. Die change	50										
9. Change equipment of Vacuum tank	20										
10. Adjust cooling tank (2 tanks)	34		2								
11. Setup puller	4		1								
12. Setup cutter	4		1								
13. Extrude pipe into line	19										
14. Adjust die before startup	15										

Operator 1 — Setup
Operator 2 — Setup
Operator 3 — Prepare die
Operatpr 4 — Control Operation

5. CONCLUSIONS

After applying SMED to reduce the setup time of the pipe extrusion die, it can be separate 2 tasks of internal work into external work. The work processes are improved by designing and rearrange new work equipment, arrange a new storage area, and managing employees [2,15]. The time to set up die before improvement is at

150 minutes, after improvement the time to set up is reduced to 70 minutes, equivalent to 53.33%, and the productivity value increase by 414,720 baht.

6. ACKNOWLEDGMENTS

Thank you very much for the kindliness people of case study factory. This paper is providing a value that comes from applied the SMED technique only. Some of the data in the work can not reveal since the reasons for the commercial.

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Demonstration system for power braking using wind pressure.

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ABSTRACT

The quality of the air brake system. Evaluation of media experts found that the average rating overall in the demo kit brake system was using air pressure ($\bar{x}$= 4.33, S.D. = 0.50) and the evaluation of expert content Declan showed an average overall rating of the quality of the braking system are demonstrated by using air pressure ($\bar{x}$= 4.47, SD = 0.26) achievement using the lessons demonstrated the braking system was using pressure showed the results of the sample to test before and test after learning of the Committee of 40 . Conclude that the average pretest score was 14.70 percent and 36.75 percent of the average post-test was 29.77 percent, 74.43 is seen that the posttest scores over pretest scores show that students have the knowledge to increase student achievement. By using a set demo braking power using air pressure By t test the values obtained from the calculation is equal to 6.15 when compared to values from the table a critical value (t - distribution) at the significance level of 0.05 is equal to 1.685 when determined to find the critical value (t) the significance of 0.05 (6.15 > 1.685) therefore conclude that series demonstrations braking power using air pressure Created to allow the students to increase academic performance , can make learners have more knowledge is true, as the objective is defined. The evaluation kit demo braking power using air pressure. The evaluation of media experts found that the average rating overall in the medium of demonstration braking power using wind pressure ($\bar{x}$= 4.24, S.D. = 0.55) and the assessment of learners with a set demonstration showed that the overall average rating for satisfaction of the braking system are demonstrated using pressure ($\bar{x}$= 4.63, S.D. = 0.01)..

Keywords: Air Brake system, Demonstration, Achievement.

1. INTRODUCTION

In modern times, automotive technology has been greatly developed. Observed from the exterior appearance of the body, the design technology is used to help increase the performance of the car. Expression car interior accessories and seem designed and built to meet the needs of the driver as well. There are things to facilitate and also taking into account the maximum safety of drivers and passengers causing car manufacturers. To want to produce cars that meet the driving needs of users for safety. There is a break system to help slow down the speed. Therefore, the braking system is necessary and very important for motorists. Must consider life and property. [1]

Therefore, users should have knowledge about the braking system and brake operation. And must promote learning for students with knowledge and understanding of the working principles able to analyze and solve problems that occur in order to effectively enter the manufacturing process in the industry Therefore, teaching and learning management in the study of the subject, the lower car needs to be Have basic knowledge about the car brake system because the braking system is a component of the car There are many mechanical parts. Making it difficult to learn abstract or there is no concrete teaching material to help see the real working mechanism Therefore, has set up a simulation of the brake system to be a demonstration set of the working principle of the

brake system. [2] For students to see the system from the aforementioned problems in order to improve education and quality The producer therefore saw the importance of the problem and thought to create a demonstration kit for power braking systems using wind pressure. [3] To be a teaching and learning media Which will give students more understanding of the content and also have experience from self-experiment as well as analyze various problems Correctly and correctly. [4]

2. MATERIALS AND METHODS

2.1 Study methods used

In the construction of a pneumatic pressure brake demonstration set There are methods of study as follows: There will be a process to create and analyze the following data.

1. Study the content and gather information about power braking systems using wind pressure.
2. Create a test for use as a measurement tool and evaluate learning results in the system demonstration kit Braking force using wind pressure.
3. Create a demonstration set of power braking systems using wind pressure.
4. Create an evaluation form to measure the quality of the teaching demonstration kit. By using the evaluation level of 5 levels, which is very good, good, fair, less, improved.
5. Bring the brake system demonstration kit using wind Go to content experts and evaluation teaching media.
6. Bring the power brake system demonstration kit using wind pressure. Go to test with the sample group.
7. Find the achievement of the learner and apply the results to compare with the hypothesis set.

2.2 Tools and techniques used in education.

To create a demonstration kit for braking systems using wind pressure That has the process of creating and analyzing the following data.

1 The operation of creating a demonstration kit for power braking systems using air pressure with tools and The equipment needed for the operation of the demonstration set is as follows.

A. Data collection and content analysis (Analysis) brainstorming information and Content analysis (Brainstorming Chart).

B. The quality evaluation form of the demonstration kit from media experts Teaching and content.

C. Test for learning achievement of learners.

2. In creating a demonstration set of brake systems using wind, it consists of a demonstration kit for braking systems using Manual pressure for teaching by the learner when learning about the braking system Can use the air pressure to understand the operation of the braking system by using the wind.

3. Creating a demonstration kit for power braking systems using wind pressure is as follows.

The design of the air pressure brake system demonstration kit has various design steps as follows:

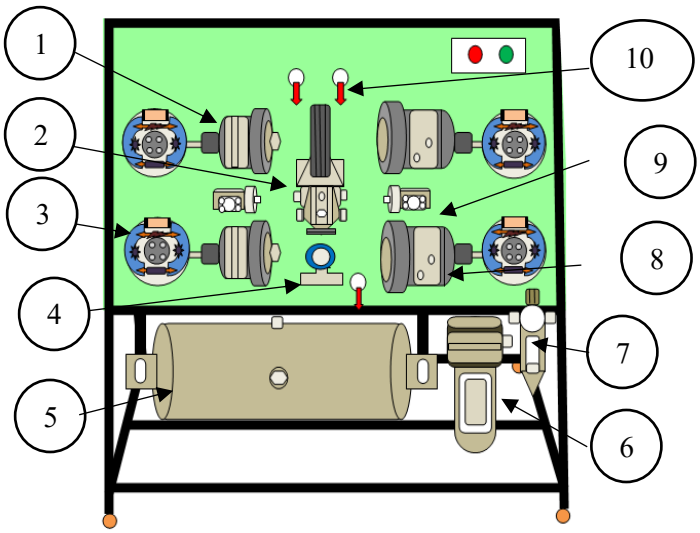

Figure 1. Outline Demonstration Set Demonstration system for power braking using wind pressure.

Power braking using wind pressure system components.

1. Front service brake chambers.
2. Foot valve.
3. Drum brake.
4. Brake hand valve.
5. Reservoir or Tank.
6. Air dryer.
7. Governor
8. Rear service brake chambers.
9. Tractor relay valves
10 Reservoir air pressure gauges.

4. Prepare a manual for the media to assemble the demonstration set, which must be consistent with the demonstration set that has already been created for the expert to verify the accuracy.

5. Create a demonstration set created Going to experiment to find learning achievement from both groups is the group studied by lecture method. And the group that learned by using the demonstration kit, which the two groups will use the same test as 40 items.

6. The results from the study are analyzed and discussed.

2.3 Statistics used in analysis.[5]

1.Item difficulty.

For calculating the difficulty of the exam, can be obtained from the equation.

$$P = \frac{H + L}{N} \qquad (1)$$

When P = The difficulty.

H = The number of people responded correctly in high groups.

L = The number of people responded correctly in low groups.

N = The number of people in the high and low groups.

2. Item Discrimination.

By calculating the power of the discriminant value obtained from the equation.

$$r = \frac{H - L}{N / 2} \qquad (2)$$

When r = Discrimination.

H = The number of people responded correctly in high groups.

L = The number of people responded correctly in low groups.

N = The number of people in the high and low groups.

3. Find learning achievement.

Formula for testing values t – test, Dependent from the equation.

$$t = \frac{\sum D}{\sqrt{\frac{N\sum D^2 - (\sum D)^2}{(N-1)}}} \qquad (3)$$

When D = Differences of grades before and after class.

N = Number of students of the sample group.

= The sum of points difference before and after class.

2.4 Information obtained in the form of weight.

This information is in the evaluation form of the demonstration kit. Which has been brought to experts in teaching media to check and test samples The data will be in the criteria (average) by determining the quality weight as follows. [6]

5 Determine the weight equal to Excellent.
4 Determine the weight equal to good.
3 Determine the weight equal to moderate.
2 Determine the weight equal to little.
1 Determine the weight equal to least.

Inspection or quality assessment uses the criteria as shown in the table.

Table 1. The level of weight, the score used to measure the quality of the instruction set.

Score range	The level
4.51 – 5.00	Excellent
3.51 – 4.50	good
2.51 – 3.50	fair
1.51 – 2.50	poor
1.00 – 1.50	Very poor

3. RESULTS AND DISCUSSION

When evaluating the quality of the brake system demonstration kit by using the pressure of the expert in the demonstration set on the content of the exam consistency And using statistical process to analyze the average quality of the demonstration set after that, make complete corrections and then test with the sample group to test the group before taking the test. And let the sample group understand the demonstration and experiment Then, the sample group will do the test after study. By using the results to calculate statistical values for the achievement of the demonstration set and the satisfaction of the learners with the demonstration set Which shows the analysis results as follows.

3.1 Content analysis of the achievement test from experts.

The results of the straightness analysis of the test and the behavioral objectives The expert can be evaluated by 3 persons. From the analysis, it can be concluded that the tests that are in the range of 0.50 - 1.00 will receive the exam that meets the objectives. Therefore, from the analysis of experts, the examination meets 50 objectives from 60 questions. With items that do not meet the objectives, must be trimmed or modified.

3.2 The results of the difficulty analysis and the classification power of the exam.

The analysis of the test that can be used by the test will be difficult and easy in the range of 0.2 - 0.8 and the power of classification is greater than 0.2. And classification power Not in the period of needing to cut out or make new revisions From the results of the 50 test analysis, statistical analysis and 40 good tests and suitable tests for the demonstration set.

3.3 The results of the quality evaluation form of the demonstration kit.

From the demonstration set to the content and media experts, 3 inspectors from the evaluation of the quality of the demonstration set found that the average quality of the overall teaching package has a good average. In terms of content, the average value is excellent. And the teaching and learning media has a good average.

Table 2. Table showing results of quality assessment form analysis.

Topics for consideration	quality level	S.D.	quality level
Content	4.73	0.26	Excellent
Media	4.33	0.50	good
Overall quality	4.24	0.55	good

3.4 The results of the achievement analysis of the demonstration set using t – test.

The result of the demonstration set was tested with 40 samples, using 40 pre-test forms and 40 post-test tests. After the analysis, it was concluded that the average score before class was 14.70, equivalent to 36.75 percent and the score. The average after school is 29.77, equivalent to 74.43 percent. It can be seen that the pre-school exam score is greater than the post-test score, indicating that the learner has more knowledge.

3.5 Analytical results of the student satisfaction assessment form learned by the demonstration kit.

From the demonstration set for students to learn with the demonstration set, the results of the satisfaction assessment analysis found that the knowledge of the content has a very good average. And the teaching and learning media has a very good level of value Resulting in the overall average being very good.

Table 3. able showing results of content and media satisfaction analysis of students studying with the demonstration set.

Topics for consideration	quality level	S.D.	quality level
Content	4.65	0.13	Excellent
Media	4.62	0.11	Excellent
Overall quality	4.63	0.01	Excellent

4. CONCLUSIONS

The construction of a set of air pressure braking demonstration kits is carried out starting from collecting content and analyzing the content, then presenting to the advisor, issuing the exam, leading the examination to the experts to verify the content of the exam (IOC) after passing the examination from the experts, then take the exam to find the difficulty and power values from the relevant groups and then perform the analysis design and create a demonstration kit for braking systems using wind pressure after that, the completed demonstration kit for experts in teaching and learning media evaluated the quality of the demonstration set. After passing the quality assessment, the demonstration set can be used to measure the student's achievement from the study process and evaluating various aspects, can summarize the results of the quality evaluation of the power braking demonstration system by using wind pressure from the evaluation of the experts. The media expert found that the overall evaluation results in terms of media for power braking demonstration system using wind pressure ($\bar{X}$ = 4.33, SD = 0.50) and from the evaluation of the experts in the demonstration set content showed that the results. The overall average evaluation of the quality of the power braking demonstration system using wind pressure ($\bar{X}$ = 4.47, SD = 0.26). The learning achievement by using the braking system demonstration power set using wind pressure showed that the results show score. The sample group that made the pre-test and post-test test, the total number of test subjects was 40. In conclusion, the average score before the study was 14.70, representing 36.75 percent. After-school examinations are more valuable than the previous test scores, indicating that the learners have more knowledge, learning achievement from using the power braking demonstration system using wind Day with the t-test, the value obtained from the calculation is 6.15 and when compared with the value from the critical value table (t - distribution) at the significance level 0.05 is equal to 1.685. When considered, it was found that the critical value (t) at significance is 0.05 (6.15> 1.685). Therefore, it can be concluded that the demonstration kit for power braking system using wind pressure. That can make learners have more learning results and can make the learner more realistic satisfaction evaluation results of the demonstration system of power brakes using wind pressure based on the evaluation of media experts, it was found that the overall evaluation results in the media aspect of the power braking demonstration system using wind pressure ($\bar{X}$ = 4.24, SD = 0.55) and from the evaluation of the students with the set demonstration showed that the results of the overall average score in the satisfaction of the power brake system demonstration kit using wind pressure ($\bar{X}$ = 4.63, SD = 0.01).

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Energy Consumption of Deep Cycle Lead-Acid Battery and Lithium Battery for Electric Vehicle 2kW

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ABSTRACT

This research aimed to study energy consumption of deep cycle Lead-Acid battery and Lithium Battery for Electric Vehicle with using motor 2kW. EV have been modified from Tuk Tuk that are used in Thailand commercial. The experiment used 2 types of batteries with the same voltage and capacity at 60 V. 48 Ah on no load and load 200 kg condition test. The performance of batteries was finding maximum velocity, energy consumption and maximum distance. A complete experiment of 2 types result is showing an overall good performance of LFP battery. Maximum velocity of LFP batteries better than Lead-Acid batteries in both no load and the load 200 kg testing conditions for 30.74% and 27.25%. EV without weight has energy consumption rate of LFP lower than Lead-Acid for average 23.51%. energy consumption rate during 200 kg conditions of both types of batteries is similar due to the effect from high temperature. The maximum distance of EV when using LFP is better than Lead-Acid for average 38.51 km cause the LFP battery has high specific capacity.

Keywords: electric vehicle, lead-acid battery, lithium battery, energy consumption

1. INTRODUCTION

Fuel crisis Not only affects the economy of the country, which is already exhausted and still has to face with high fuel costs continuously. Burning of fuel in both the transportation sector or in the manufacturing sector also cause environmental impacts and air pollution, for example, PM 2.5 that affects the current human life [1]. Many agencies, both public and private trying to speed up the problem, including the policy of using clean electric cars. Able to car air pollution problems.

Electric cars in the market of Thailand not commercially popular. Because the trains produced and imported from abroad are relatively high There are a few models to choose from. And there is no charging station that is favorable to the actual use [2]. Most people turn to use electric cars that have their own modifications. or use an electric car at a cheap price to save traveling and maintenance costs focus on materials that can be easily purchased in the market. Such as motor driven from the manufacturing sector or even a Lead-Acid battery, which is a battery used for general cars or Deep Cycle Lead-Acid Battery that is used with the solar cell's energy storage system.

However, using Lead-Acid battery still has many disadvantages. Like in the matter of weight Low charge and discharge capability, including a relatively low energy retention rate [3] At present, various types of lithium ion batteries have been modified to be used with electric cars [4]. Lithium Iron Phosphate (LFP) is another type of battery that is commonly used for modified electric vehicles because it is lighter than Lead-Acid as price that is not too high [5]. The results of the survey found that in some suppliers, the price of Lead-Acid and LFP is almost the same price compared to the same load and capacity. Therefore, in this research, there is an idea to study the performance of Lead-Acid batteries and LFP when used with modified electric cars with 2 kW motors. And used as a guideline for the

development of electric cars adapted to meet legal standards Can be used commercially widely.

2. MATERIALS AND METHODS

EV have been modified from tricycle or Tuk Tuk that are used in Thailand for convenience and ease of development into a Tuk-Tuk energy vehicle. 2-wheel drive system and 1-wheel steering system, the overall weight of the car at 500 kg. The back has been designed to installed the distribution system and sound for public relations or used in work related to product advertising.

Figure 1. Tuk Tuk Electric Vehicle.

Electric cars use 2 kW motors at Maximum speed at 4,500 rpm. The experiment used 2 types of batteries with the same load and capacity at 60 V. 48 Ah. The first test uses Deep Cycle Lead-Acid Battery 12 V 48 Ah per cell for 5 pcs and then tested with type 2 batteries as 32650 LFP batteries which is different from the Deep Cycle Lead-Acid battery that is small, lightweight and has a life cycle of up to 60%. The specific properties and point of difference of both is shown in Table 1.

Table 1. Properties of battery [6]

Points of difference	Lead-acid	LFP
Weight	3x weight of li-ion battery	Lightweight
Resilience/discharge	Damages through excessive discharge and extreme temperatures	Less vulnerable to high discharge and climate changes
Initial cost	Low	High , expected to decrease
Life cycle	1750 cycles at 10% discharge 250 cycles at 10% discharge	4000 cycles at 10% discharge 500 cycles at 95% discharge
Efficiency	Low , loss of 15-amp hours	High , no loss of amp hours
Replacement Cycle	2-3 years	7-8 years

LFP has a control unit (Smart BMS) to control the discharge current and voltage of the battery. Change various parameters via smart phone application. Including the ability to measure the temperature to end battery's performance in conditions that have a surface temperature of the battery higher than 70 °C. Both types of batteries are electrically charged from an external supply 220 V /

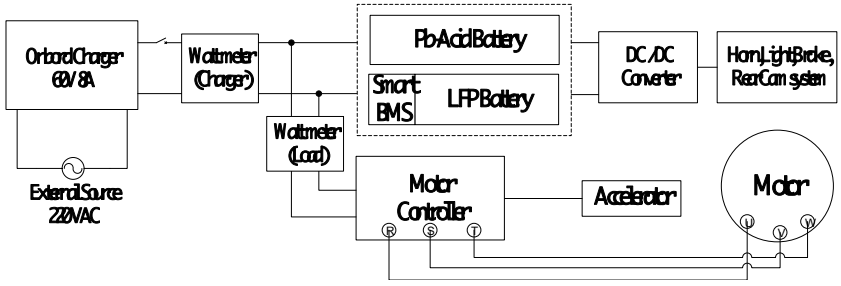


Figure 2. Diagram of driving system

AC with Onboard Charger. It is responsible for changing the voltage of 220 V / AC to 60 V / DC at the output current 8 A. Measure the charge rate with a Watt meter (charge). The driving of an electric tricycle consists of a Blushless DC Motor 2 kW controlled by a motor controller by receiving a signal 0 - 5 V. from the accelerator, the measurement of energy consumption using the watt meter (Load). All driving systems are shown in Figure 2, and the Lead-Acid batteries and LFP that used in this research are shown in Figure 3.

Figure 3. Lead-Acid batteries and LFP batteries.

For research methodology, efficiency of Lead-Acid batteries and LFP when used with modified electric cars with 2 kW motors. The process is as follows:

1. Maximum velocity, using direct distance from start point to end point of 30 meters. Twist the throttle at 100%. Test with both types of batteries in no load and load conditions 200 kg. Timer and take the obtained values calculated in equation 1.[7]

(1)

Where v is velocity in meter/second (m/s), S is distance in meter (m) and t is time in second (s)

2. Energy in watt hours, experimented with both types of batteries maintain constant throttle levels at 50%, 75% and 100% accelerator. Every experiment used the same distance at 6 km. Timer and take the obtained values calculated in equation 2 and 3. [7]

$$P_{(W)} = V \times I \quad (2)$$

$$E_{(Wh)} = P_{(W)} \times t_{(h)} \quad (3)$$

Where $P_{(W)}$ is power in watt (w), V is voltage (V), I is current in amps (A), $E_{(Wh)}$ is Energy in watt hours (Wh) and $t_{(h)}$ is time in hours (h). On the measurement, power datalogger has been used to collect the data and compared with clamp meter.

3. Maximum distance, the EV can refer the experiment standard. The test uses real roads on the route Phran Nok Road - Phutthamonthon Sai 4 Road at 16 km distance. The test starts from the full battery (100%) until the battery runs out (0%) and then measures the distance from the GPS applications. Two type batteries were tested on constant throttle levels at 50%, 75% and 100% accelerator.

3. RESULTS AND DISCUSSION

3.1 Maximum velocity

The maximum velocity indicates the ability of the EV at the starting point to reach a distance of 30 meters. The maximum velocity can show the release of the battery energy shown in figure 4.

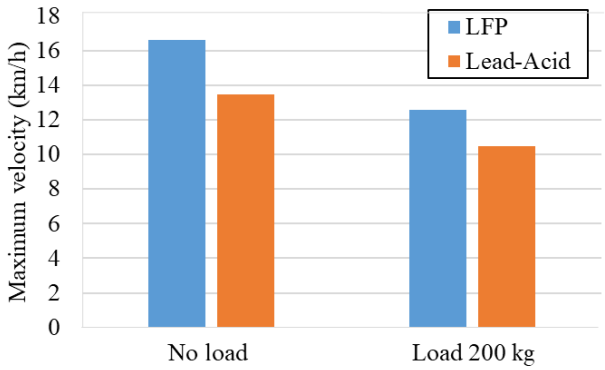


Figure 4. Maximum velocity of vehicle on difference batteries at no load and load 200 kg.

The maximum velocity of vehicle shown in Figure 4. According to the experiment, the velocity of vehicle while used LFP battery and Lead-Acid battery in the distance of 30 meters found that the maximum velocity of LFP and Lead-Acid battery is 16.61 km/h and 12.75 km/h respectively. LFP has the velocity more than Lead-acid for 30.74% When the mass was loaded 200 kg the velocity decreased. The maximum velocity of LFP and Lead-acid battery is 16.61 km/h and 12.75 km/h respectively. Therefore, LFP has the velocity more than Lead-acid for 21.25%.

3.2 Energy consumption

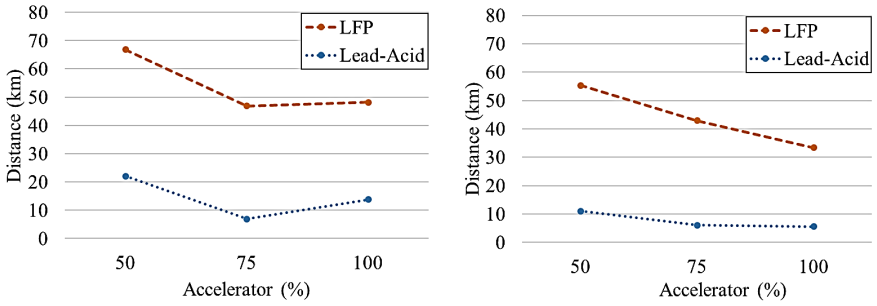
EV experiment was to measure the rate of energy consumption occurs. The energy value indicates the energy consumption rate at different times of change. That is to say, the very energy value represents a lot of energy usage or the amount of energy consumed.

The energy consumption rate of EV is shown in Figure 5. Based on the test results at no load conditions found that. At 50%, 75% and 100% accelerator, Lead-Acid battery has a higher energy consumption rate than the LFP battery at 31.37%, 5.22% and 33.96% respectively.

Considering that the experiment in the condition of carrying a weight of 200 kg found that. At 50% and 75% accelerator, the Lead-Acid battery still has the same energy consumption rate than the LFP, accounting for 8.44% and 4.42%, respectively.

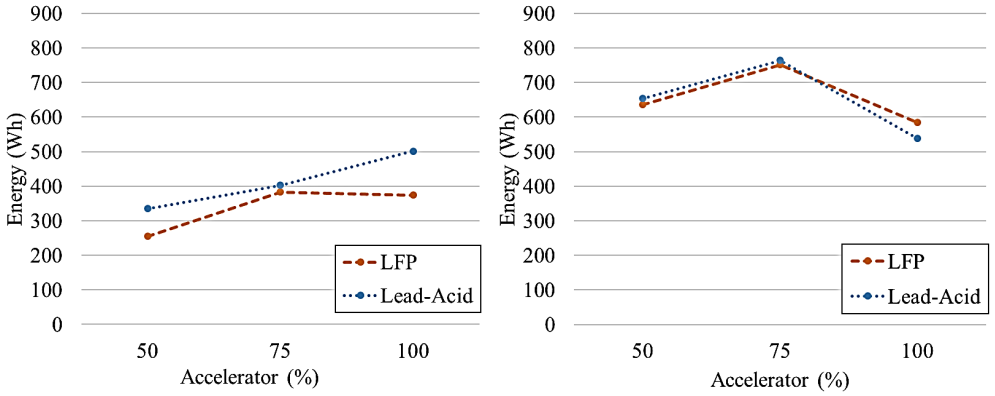
However, at 100% of the throttle, the power consumption rate of the LPF increased more than Lead-Acid. LPF has a higher energy consumption rate than Lead-Acid at 9.98% the data shows that when carrying heavy loads and the energy consumption rate at 100% accelerator. The results in lower LPF capabilities. Due to the release of the highest voltage at 100% accelerator condition, the results in a battery temperature increased. The efficiency of the LFP decreases while the Lead-acid batteries can work well at higher temperatures, Charge and discharge longer. However, the battery may swollen and damaged [8]. Consider on the energy consumption, the energy consumption at 100% accelerator is lower than 75% at two types of batteries cause of the controlling scheme of motor controller. The controller will decrease the supply current when working high-speed, so the energy consumption would be reduced.

From the test results in the load 200 kg conditions. The energy consumption rate of both types of batteries is similar. As a result of mass load effect to LFP battery increased discharge rate to provide current to sufficient the driving system needs [9]. Compare energy consumption rate under condition of no load and load 200 kg. Found that the rate of load 200 kg. increased from no load average for 2 times.



(a) No load (b) Load 200 kg

Figure 5. Energy of EV at no load (a) and energy of EV at load 200 kg (b).



(a) No load (b) Load 200 kg

Figure 6. Distance of EV at no load (a) and distance of EV at load 200 kg (b)

3.3 Distance

Factors that affect users in choosing to buy EV cars. Most users will focus on the maximum distance that the EV can be done. The most important factor is the efficiency of the battery.

The maximum distance of EV when using both types of batteries is shown in Figure 6. From the experiment results at no load conditions found that at 50%, 75% and 100% accelerator, the LFP battery have the maximum distance possible than Lead-acid batteries for 44.85 km, 41.58 km and 35.73 km respectively. But when considering 100% accelerator can go farther than 75% accelerator cause the higher temperature effect on the Lead-acid battery discharge longer [8][10].

Considering that experiment in conditions with a weight increase of 200 kg. found that 50%, 75% and 100% accelerators, the LFP battery have the maximum distance possible than Lead-acid batteries for 44.30 km, 36.90 km and 27.72 km respectively. The result shown demonstrates the ability of LFP batteries can provide maximum distance more clearly than Lead-Acid in no load and 200 kg load conditions. Because the LFP battery has more specific capacity than Lead-Acid which can provide longer power per 1 charge [11].

However, at a 50% accelerator test can reach a maximum distance of 66.89 km and 55.36 km respectively. But the speed in a 50% accelerator test is not very high (average at 10-12 km/h) may not be suitable for actual use.

4. CONCLUSIONS

The target of his research is study the performance of Lead-Acid batteries and LFP when used with modified electric cars with 2 kW motors warrants yielded the following results:

4.1 LFP batteries can make maximum velocity better than Lead-Acid batteries in both no load and the load 200 kg testing conditions. Accounted for 30.74% and 27.25%, respectively. The physical characteristics of the LFP will try to maintain the voltage and try to compensate the current during the discharge period, causing the lead acid battery lacks of ability to response at high current load, the voltage will drop immediately and make the vehicle's maximum velocity cannot reach the same level of the LFP.

4.2 EV Without weight has energy consumption rate of LFP lower than Lead-Acid for average 23.51%. energy consumption rate during 200 kg conditions of both types of batteries is similar due to the effect from high temperature.

4.3 The maximum distance of EV when using LFP is better than Lead-Acid for average

38.51 km cause the LFP battery has high specific capacity.

5. ACKNOWLEDGMENTS

The authors would like to thank the students of the EV laboratory at the Automotive Technology Department, Siam Technology College for their assistance with the research project: Mr. Phuripakorn Ouanngam, Mr. Chaksachon Khamwilai, Mr. Natthaphum Mabutda, Mr. Surachit Phaenpha and Mr. Suchat Sapkhong.

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Simulation of Edge Effect in High Voltage Composite Insulators

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ABSTRACT

In high voltage measurement system, fringing field effect is related to the degradation mechanism in composite insulators. The field stress can lead the insulator failure faster and cause the further deteriorate. This work first analyzes the edge electric field of composite insulator. Secondly, to simulate the electric field around the defects which adjacent near the electrode. The two-dimension (2D) model of the HV insulation test is built in the COMSOL Multiphysics program. Finally, the failure possibility at edge electrode is exactly compared with the experimental test. The test structure consists of two brass electrode radius 37.5 mm as parallel plate with the composite insulator in between. The results revealed that the edge electric field is higher than other spots, and the cavity increases the electric field intensity by 54.6%.

Keywords: composite insulators, edge electric field, COMSOL Multiphysics program

1. INTRODUCTION

Electrical insulation is widely used in various high voltage equipment. The most commonly used insulator in high voltage is a composite insulator. It is due to their better electrical, chemical, and physical characteristics when compared with glass and porcelain insulators [1]. After the manufacturing process, quality checks are provided according to the specific standards from organizations such as IEC, IEEE or ASTM to ensure the safe operation of the insulator. The quality check comes with many requirements and procedures to follow [2]. And, also the test conditions are optimized to get the required output which saves time and money during manufacturing [3].

On the other hand, modeling simulation has been proposed to analyze electric field distribution in the insulators. According to a suitable experimental design, the appro-ximate geometry model build must follow the test structure. E-field distortion at the edge of the conductor, where corona discharges begin, is a prime reason for studying. Therefore, the approach simulation model is able to describe all phenomenon [4,5]. The edge effect could not be avoided in most measuring methods based on the electro-magnetic field theory. However, there are many methods for reducing the edge effect such as curving the electrode edge or utilizing the removal function compensation.

It is well known that a cavity is the cause of insulation degradation [6]. The internal ionization will start from the cavity because of the lower dielectric constant inside it [7]. The electric field between the two electrodes is a uniform field, except for the edge field effect. When a defect occurs in this area, the initial discharge is developing [8].

The work in this paper emphasizes the design and simulation of edge effect in the high voltage insulator test. The composite insulation is adopted with the formation of cavities. For this consumption, the high electric field stress at the edge electrode leads to degradation of the insulator and easily leads the cavities to break irresistibly. First, the simulation model in COMSOL Multiphysics software and the influence of these cavities were analyzed, and then compared with the insulation experimental test.

2. MATERIALS AND METHODS

The composite insulator was procured from natural rubber and nano-composite fillers. The fillers have significant effect to enhance the mechanical or electrical properties of the base material. But during the vulcanization process, the cavity percolation can be filled unexpectedly. However, both effects of edge E-field and cavity are also investigated by modeling prolate and oblate cavities inclusions. The capacitance (C) between the two electrodes by neglecting electrode thickness is

$$C = \varepsilon \frac{w}{d} \qquad (1)$$

Where w is the width and d is the gap between the electrode. However, the fringing field effect is derived by the approximate analytical formula [9]

$$C = \varepsilon \frac{w}{d}\left[1 + \frac{d}{\pi w}\ln\left(\frac{\pi w}{d}\right)\right]. \qquad (2)$$

In this study, the COMSOL Multiphysics program was provided and simulated the electrical phenomena in this insulator. Especially, the edge electric field and voltage stress level nearby the edge. The 20kV composite insulator is considered whereas the modeling setup was listed as in Table 1.

The test structure consists of two brass radius 37.5 mm as parallel plate electrodes with the composite insulator in between. Many shapes of the cavity were adjacent near the ground as illustrated in figure 1.

Table 1. Experimental setup.

Materials	Brass	SF6	Rubber composite
Relative permittivity	1	1.02	4
Electrode (+)	20 kV Pk-k		
Electrode (ground)	Ground		

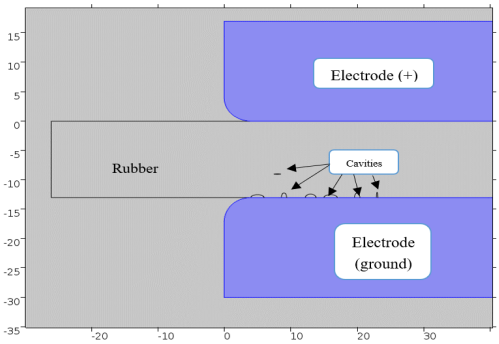

Figure 1. Simulation Geometry of the cavities when adjacent near the electrode.

3. RESULTS AND DISCUSSION

The methodology for 2D simulations is presented. The 2D models followed a possible approach about the cavity near the high electric field stress area. Figure 2 shows the plot of the electrical phenomena which the top electrode was set at operation voltage (20kV). Moreover, the voltage level at the bottom of the insulator was set at zero whereas the medium insulator was SF6 gas. The electric field intensity is defined by the color intensity.

The simulation results indicated that electric field distribution is affected by potential values, positions, and morphology shapes as in figure 3. The equi-potential lines (grey lines) densely cover at the small gap and decrease with the distance. All the figures are considered between electrical amplitude and distance x-axis. This can be seen clearer from the line plot (red line) across the cavities throughout the composite as in figure 4.

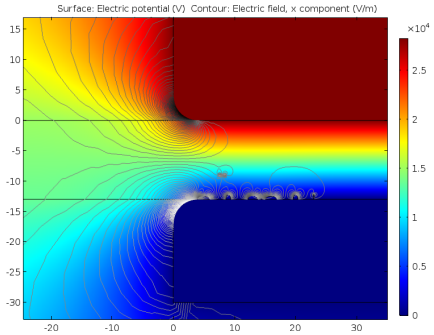

Figure 2. A potential profile at the edge electrode.

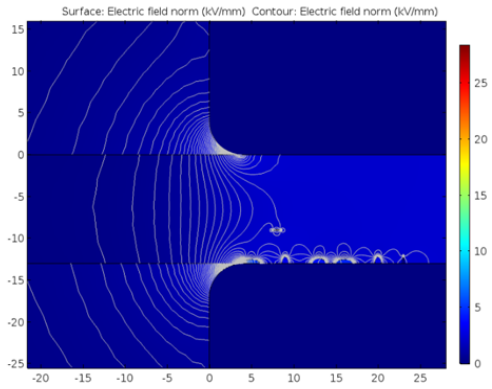

Figure 3. Electric field strength (kV/mm) at the edge electrode.

In figure 5, the line plot of the electric field has been revealed. The electric field strength at the edge electrode is higher than the inside. As well as the cavity near this area can increase the electric field stress. From this result, it has been emphasized that the lower permittivity in the cavity leads to the higher electric field stress.

Table 2. Summary of the permittivity and electric field strength of composite insulator.

Permittivity	4	1.0204
EF strength (kV/mm)	6.4 @cavities	28 @edge

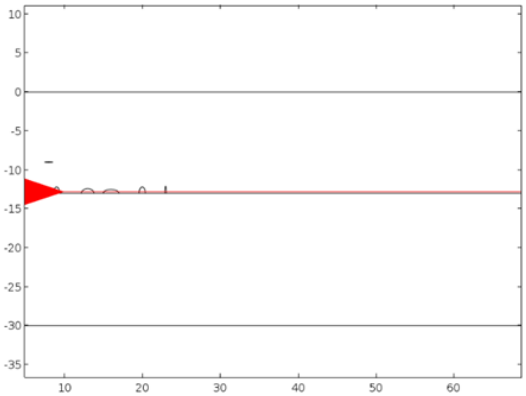

Figure 4. Cutline 2D at y=-12 that cuts pass all the cavities in the composite matrix.

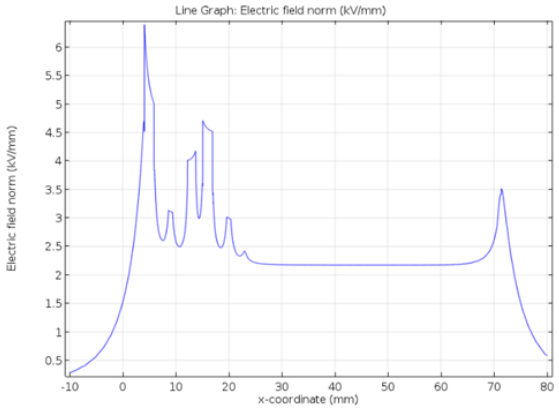

Figure 5. Line plot of the electric field magnitude that cuts pass all the cavities in the composite matrix.

Table 2 shows the electric field observed at edge electrode and cavity conditions at the peak points identified along the insulator. From the simulation result, it indicates that high electric field at the edge electrode can cause insulation damage. The edge electric field without cavity is 3.5 kV/mm, and the presence of cavities increase the electric field intensity by 54.6%. Therefore, the cavity gives more failure possibility for materials at those points. This phenomenon is clearly explained by the test setup which is obtained using high voltage insulation test.

In figure 6, the parallel plate electrodes setup was adopted. The parallel electrodes radius were 37.5 mm. The insulator was energized with high voltage transformer until its breakdown.

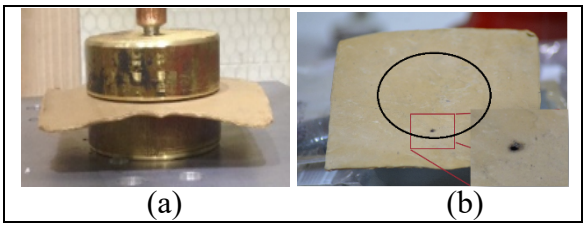

Figure 6. The experiment HV breakdown in composite insulator when (a) the test structure (b) breakdown point near the edge electrode.

The position of the burnt spot was supported by the simulation result in this study. This failure spot near edge electrode burnt faster than other points. Therefore, if there is an insulators failure, it is originated from this effect or cavity.

4. CONCLUSIONS

In this paper, the edge effect was reviewed and considered. Investigations are carried out to reveal the edge effect via FE simulation and experiment. In addition, the voltage and electric field profiles at the highest risk because of the edge effect have been shown. In this study the cavities were assumed adjacent near the edge electrode to exceed the failure. It was found that the edge electric field is normally higher than the uniform field area. This stress can accelerate the insulation failure, by causing the cavities quickly extinguish or degrade itself under the HV test.

5. ACKNOWLEDGMENTS

The author would like to thank Mississippi State University for the COMSOL program support and insulation characterization.

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Evaluation on Aluminum Laminate Wall Under Fixed-Heat Input of DP-GMAW Base WAAM

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ABSTRACT

Wire and arc additive manufacturing (WAAM) is the process that creates or build up the metal layer, usually, layer upon layer by using wire feed with arc technique. The study focuses on the double pulse gas metal arc welding (DP-GMAW) to build-up aluminum alloy 5000 series (ER5356 diameter 1.2 millimeters as a build-up material). The build-up used the fixed heat input (single-condition) of DP-GMAW for all of 10 layers and was shielded by industrial-grade argon gas (Purity >99%). The objective was to study the effect of heat condition on macro appearance and dimension moreover, micro-hardness (Vickers's hardness) investigated the layer hardness under heat condition effect. The results found that the heat condition 0.15 kJ/mm/layer has a better dimension than another sample. The hardness testing found the low heat cumulative conducted the higher hardness on the laminate layer. However, the hardness does not affect significantly heat condition. Furthermore, the effect of heat condition and uncertainty of dimension determined the use as a base data to develop the WAAM procedure.

Keywords: WAAM, DP-GMAW, Aluminum Build-up, Laminate Macro Feature, Aluminum Laminate Hardness

1. INTRODUCTION

The additive manufacturing (AM) has been developed the build-up process of creating or repairing the metal part of producing the complex geometry and saving the cost of the material and investment. The AM is the official industry standard term (ASTM F2792) for all applications of the technology. It is defined as the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies. To build-up material layer, the thermal process as welding and laser melting processes is compatible because the process forms melt the material and continuously form the layer upon layer. [1-2, 4-5]

The GMAW Process has high flexibility. The process could select the many characteristics of the current signal to match with a working material. The aluminum alloy is more compatible with the double pulse current (DP).

To create the weld bead by the advantage of large dimension on width and height when compared with the traditional direct current (DC) that represented by Figure 1. [3]

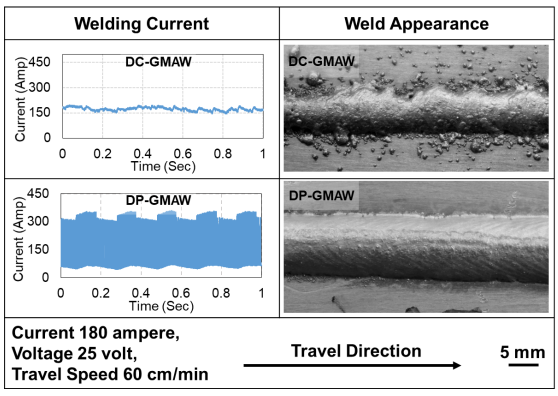

Figure 1 Single bead appearance comparison of current characteristic [3].

This article aims to evaluate the macro appearance/dimension and hardness of aluminum laminate layer under the effect of DP-GMAW heat condition.
Moreover, to determine the effect of heat condition and shape variation in order to develop the WAAM procedure.

2. MATERIALS AND METHODS

2.1 Experiment Procedure

Aluminum alloy wire ER5356 with a diameter of 1.2 millimeters was used as the build-up material, and industrial argon gas (99% purifier) has shielded during the process.

The aluminum 5083 with a thickness of 15 millimeters has been a substrate material.

The build-up geometry was laminated wall by continuous weld layer upon layer.

For the welding process, the experiment set-up consisted of double pulse GMAW power supply of The OTC WB-P500L. Figure 2 shows the mapping setup of the experimental. In this case the machine-parameters were compared by heat input concept to determine the same heat condition of welding parameters. Welding robotic OTC FD-V8 was employed for controlling a precision build-up path for the single-pass and multi-layer experiment.

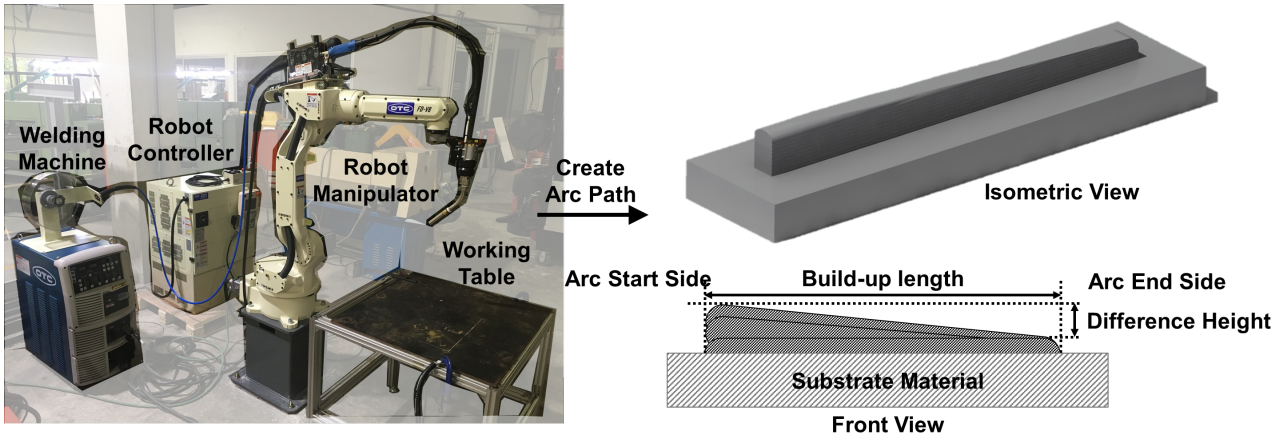

Figure 2 Experimental setup.

A process was continually built from the base layer upon layer with increasing constant distance or constant layer height. The starting the first layer with used 15 millimeters of contact tip to work distance (CTWD). Figure 3 and Table 1 represented the experiment schematic and experiment conditions.

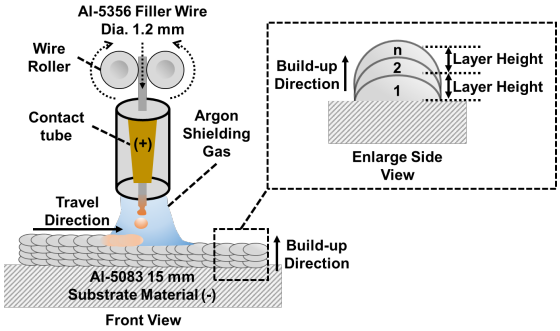

Figure 3 Schematic of the build-up experiment.

For determine effect of heat on dimension, the study selected heat input concept follow by the equation 1.

(1)

Table 1 Condition of the study.

Multi-layer Study Parameters			
Parameters	Condition 1	Condition 2	Condition 3
Current (Ampere)	120	140	140
Voltage (volt)	17.8	18.6	18.6
Travel Speed (cm/min)	100	100	60
Heat Condition (kJ/mm/layer)	0.1068	0.15624	0.2604
Fixed Welding Parameters			
Frequency (Hz)	5		
Duty Cycle (%)	50		
Delta Current (ampere)	30		
Start CTWD (mm)	15		
Layer Height (mm)	1.5		
Argon Shielding Gas Flow (LPM)	15		

2.2 Metallurgical Investigation Procedure

Preparation

The specimen was investigated on the middle length by cross-section then grinding and polishing. For aluminum etching was used 0.5 % hydrofluoric acid (HF) per distilled water 100 ml, the duration for etching had soaked the example about 45 seconds. In addition this etching could be observe the Fe_3SiAl_{12} (gray) and Mg_2Si (black) clearly [6].

Macro Evaluation

To study the effect of heat condition on laminate wall shape, the macro features were consist of

1. Wall angle (maximum wall angle)
2. Effective area (effective section area)
3. Aspect ratio (height and width ratio)

All of the dimensions are represented in Figure 4. The image processing was applied for accuracy measure in each dimension

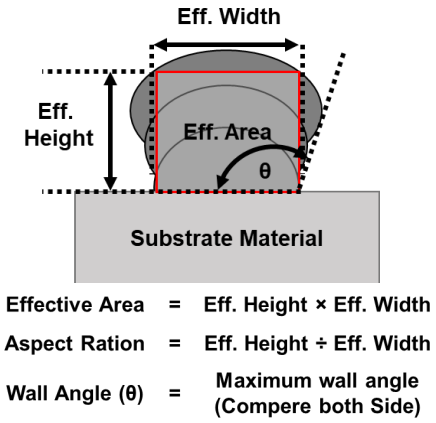

Figure 4 Macro feature.

Hardness Testing

In addition, the hardness properties were investigated. The study used the Vicker's micro-hardness testing under the setting of press load 500 gram-force with 10 seconds of dwell time. The testing was done on all areas of the sample and on each layer. Figure 5 shows region on hardness testing. To present hardness behavior the study used the average hardness and plot on the relationship of distance from fusion line and hardness.

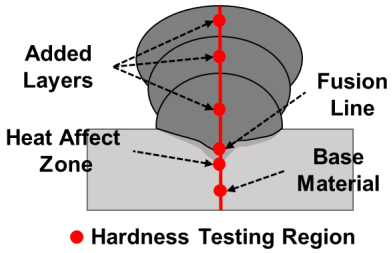

Figure 5 Region on hardness testing.

3. RESULTS AND DISCUSSION

3.1 Macro-evaluation Result

The macro cross-section specimen is shown in Figure 6. The shape of the cross-section looked like fan shape clearly due to cumulative heat effect. The penetration and

formation pattern has changed by using the single condition of DP-GMAW

The dimension result in Figure 7 was found under increasing heat condition. The effective height and width increased in the case of the wall angle in Figure 8. The heat condition caused an increase in the wall angle. The condition 0.26 kJ/mm/layer caused the most significant angle because the formation of molten metal on a high deposition rate has more cumulative heat that occurred width expand on the next bead layer.

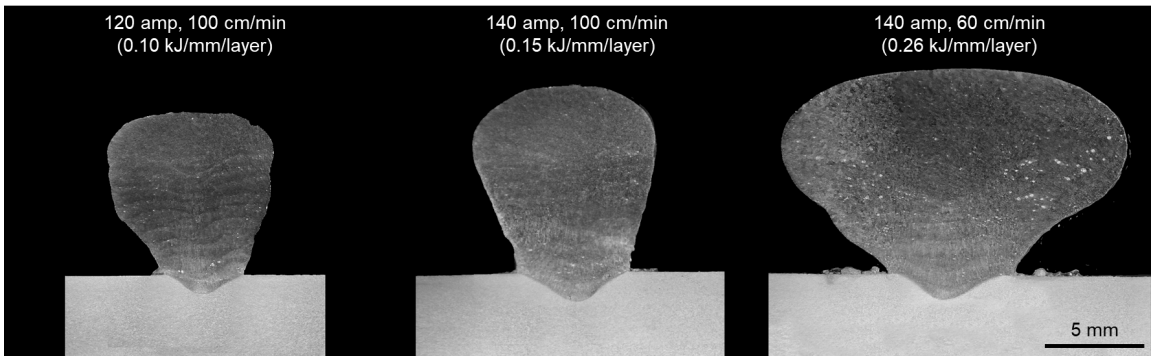

Figure 6 Macro appearance of laminate layer.

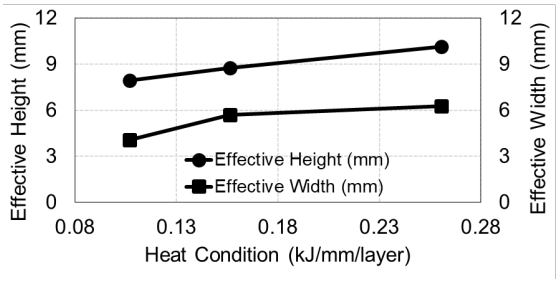

Figure 7 Effect of heat condition on effective height and width.

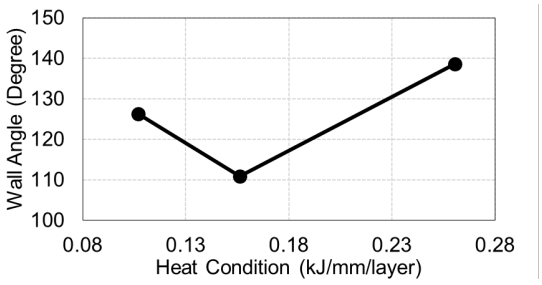

Figure 8 Effect of heat condition on wall angle.

The low condition (0.10 kJ/mm/layer), the wall angle could be observed the uncontrollable of wall structure when 5th layer was preferred. Those layers obtained irregularity of bead layer formation or another the cumulative heat has increased significantly that caused an effect to the wall angle. The study discovered the proper condition that could remain the bead uniformly and obtain the minimum of wall angle and acceptable dimension (height and width) as the 0.15 kJ/mm/layer

The result of the effective area and aspect ratio shown in Figure 9. The effect of heat condition on the effective area increased when the heat increase.

On the other hand, the aspect ratio result was found increase the heat condition has decreased the ratio. It means the new layer under the higher heat condition has not added to the height, but more efficient on extending the width.

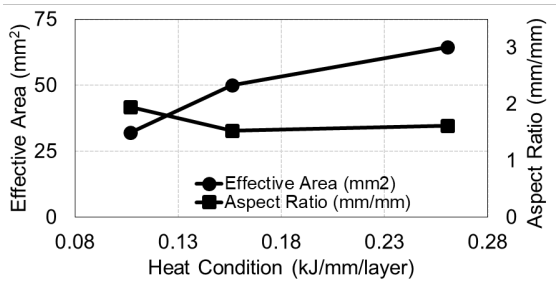

Figure 9 Effect of heat condition on effective area and aspect ratio.

3.2 Hardness Result

The hardness was evaluated on each layer including the base metal, heat affected zone (HAZ, estimate 50 micron from fusion line), and fusion line the hardness result is shown in Figure 10. The hardness is decreasing from the substrate (78 - 79 HV) to the top layer added (63.9 - 64.5 HV). The bottom layer (71.5 - 74 HV) was harder than the top layer (63.9 - 64.5 HV). The t-testing was conducted and the data was found under a confidence level at 95% two sides the result of three group does not significantly mean the heat condition does not effect on hardness.

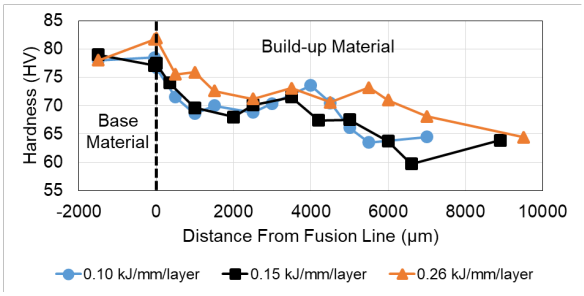

Figure 10 Hardness result in each location and heat condition.

Moreover, Figure 11 shows the microstructure on the fusion line, first layer, mid layer, and top layer. In the Figure could detect the size of Fe_3SiAl_{12} (gray) and Mg_2Si (black) has increased when layer increase.

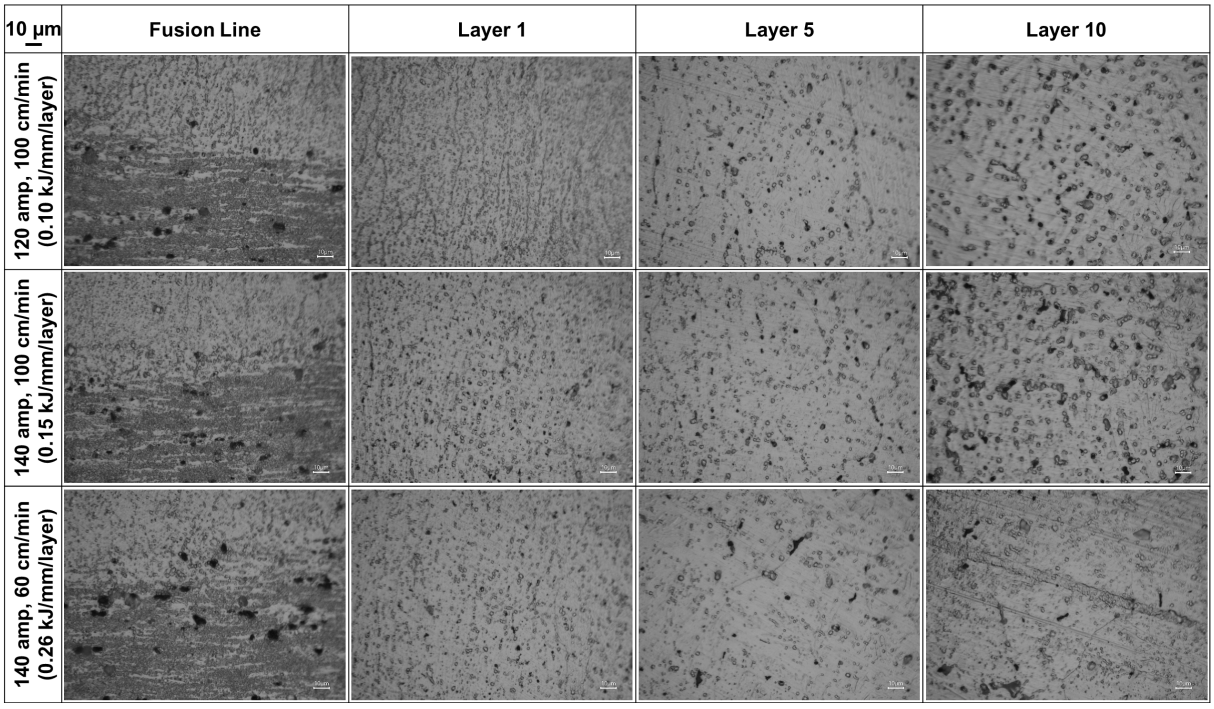

Figure 11 Microstructure on laminate layer.

4. CONCLUSIONS

The effect of heat conditions on laminate layer build-up was investigated. It can be concluded that:

1. The single condition of DP-GMAW on build-up laminate wall has occurred the fan appearance in every heat condition.
2. The increasing heat condition affects increasing effective height, width, and area.

3. The suitable wall angle did not always occur by low heat condition but could be obtained under the uniform build condition as 0.15 kJ/mm/layer as in the study.
4. The heat condition increase added on width more than height.
5. The hardness has a trend to decrease when more cumulative heat increase, but the heat condition was not affected significantly on hardness

The conclusion has indicated the limitation of DP-GMAW single-condition for building-up the aluminum laminate layer. However, the future will study consist of

1. Develop the technique on DP-GMAW multi-condition for Aluminum laminate additive
2. Investigate the mechanical properties on tensile and fatigue to determine the effect of heat condition and suitable application.

5. ACKNOWLEDGMENTS

The study could accomplish under the supporting. The study would like to acknowledgment Flexible Manufacturing Laboratory (FLEX Lab), Industrial Engineering Department, Mahidol University for providing the machine and consumable for this research. Moreover The Thailand Institute of Scientific and Technological Research for funding support.

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Synthesized and characterization of WO_3-doped TiO_2 thin films with visible light antibacterial activity

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ABSTRACT

TiO_2 has been widely studied due to low cost, good catalytic activities and chemical stability. However, the large band gap energy (3.2 eV) of TiO_2 restricts its application within the only of UV irradiation. Therefore, an important challenge about research of TiO_2 is to develop new TiO_2 materials that are active under visible light irradiation, such as doping TiO_2 with non-metal and metal elements. WO_3 was used to the dopant agent in TiO_2 due to several properties. This work, WO_3-doped TiO_2 thin films developed on glass substrates by microwave-assisted sol-gel and dip coating technique. Synthesized thin films were refluxed at 180 W for 1 h by conventional microwave oven and obtained after calcining at a temperature of 500 °C for 2 h by electrical oven. The 1-5 mol% WO_3-doped TiO_2 thin films were tested for its antibacterial activities by using *E. coli* under visible light. It was found that 1 mol% WO_3-doped TiO_2 thin films had the highest antibacterial activity against *E. coli*, about 99.33% under visible light irradiation, for 120 min.

Keywords: WO_3-doped TiO_2, Thin films, Visible light, Antibacterial activity

1. Introduction

In daily life, human beings are often infected by microorganisms like bacteria, mold, viruses, etc. To impart sterility and avoid infection, the using of antimicrobial agents is important. Research has been intensively carried out in antibacterial materials containing various natural and inorganic substrates [1]. At present, a novel antibacterial technique of photocatalytic activity of semiconductor materials. Several semiconductor materials are utilized in photocatalytic oxidation such as TiO_2, ZnO, CdS, ZnS etc. Among of them, titanium dioxide (TiO_2) has the most effective for photocatalytic processes due to its high radicals production, suitable flat band potential, photo stability, chemical stability, low energy consumption [2]. TiO_2 possesses antibacterial properties due to its strong oxidation activity in the presence of light; the generation of reactive oxygen species such as hydroxyl radicals ($\bullet OH$), hydrogen peroxide (H_2O_2) and superoxide ions ($O_2^{\bullet -}$) from photocatalytic reaction [3-4]. The photocatalytic activity of TiO_2 nanoparticles/ thin films depends not only on the properties of the TiO_2 material itself, but also on the modification of TiO_2 with metal or metal oxide. Previous studies reported that the addition of WO_3 in TiO_2 enhances its photocatalytic efficiency. However, WO_3 nanoparticles have prospective applications including biosensing, biodiagnostics, optical fibers, and antimicrobial and photocatalytic uses. WO_3 ions are known to cause denaturation of proteins present in bacterial cell walls and slow down bacterial growth [3-5].

The main objective of this study is focused on synthesis of WO_3-doped TiO_2 thin films coated on glass substrates by microwave-assisted sol-gel and dip coating technique. The structural properties of the thin films were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and atomic force microscopy (AFM). For its antibacterial activities by using *Escherichia coli*

(*E. coli*) under visible light irradiation for a certain time.

2. Materials and method

2.1 Materials

The titanium (IV) isopropoxide ($C_{12}H_{28}O_4Ti$, TTIP) and sodium tungstate dihydrate ($Na_2WO_4.2H_2O$) were obtained from Aldrich Chemistry Co., Ltd and Chem-Supply, respectively. The other reagents, such as ethanol (C_2H_5OH) 36.5-38.0% and hydrochloric acid (HCl) 69-70% were all analytical grade.

2.2 Preparation thin films

Based on our previous studies [1-2, 6], WO_3-doped TiO_2 thin films were prepared via microwave-assisted sol-gel method. Firstly, $Na_2WO_4.2H_2O$ with fixed at 0, 1, 3 and 5 mol% of TiO_2 and TTIP, C_2H_2OH with fixed at 10 and 150 ml and with were mixed into 250 ml of water, and the mixture was vigorously stirred (1,000 rpm) at room temperature for 15 min. The solution was acidified to pH = 3 by adding few droplets of 3 M HCl into the solution and stirred for 45 min. Finally, the treated solution was refluxed at 180 W for 1 h using a domestic microwave oven to produce a milky solution. To fabricate thin films were deposited on glass substrates by dip-coating process at room temperature with the drawing speed of about 1.25 mm/s. The coated samples were dried at room temperature for 24 h and calcined at the temperature of 500 °C for 2 h with a heating rate of 10 °C/min. All samples were designated as TP, T1W, T3W and T5W of various mol ratios of WO_3 to TiO_2 were 0, 1, 3 and 5 mol%, respectively.

2.3 Characterization

Microstructures of WO_3-doped TiO_2 thin films were determined from XRD (Phillips X'pert MPD, Cu-K). Samples were scanned from 10 to 70 at a rate of 2°/mim (in 2Θ) at room temperature, operating at 40 kV and 30 mA, Cu (1.54060 A). The average crystallite size was determined from the XRD pattern using Scherrer's equation [7]. The morphological changes of the synthesized thin films at different mol ratios of WO_3 were characterized by a SEM (Quanta400, FEI, Czech Republic). The surface roughness of thin films was observed by using AFM (Digital Instrument's Nanoscope IIIa MultiMode)

2.4 Antibacterial activity test

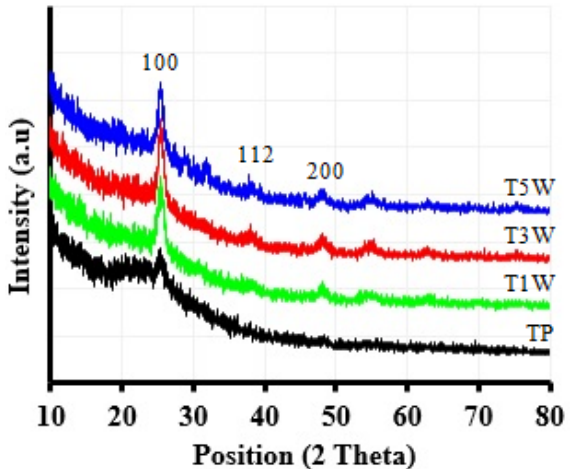
The antibacterial activity of WO_3-doped TiO_2 thin films were prepared by Disc Diffusion Method. It is suggested by Sangchay (2017) [3]. Bare thin films were sterilized in autoclave for 15 min at 121 °C before used. The test was carried out against *E. coli* as gram negative bacterial grow on nutrient broth and agar media at 37 °C for 24 h. Bacterial counts was adjusted according to McFarland tube (0.5) by normal saline. The thin films were examined under visible light as in follow: Aliquots of 10 ml *E. coli* conidial suspension (10^3 CFU/ml) was mixed with 2.5x2.5 cm of the sample. The mixture was then exposed to visible light irradiation (eleven 50 W of fluorescent (F) lamps) for 0, 30, 60, 90 and 120 min. After that, 0.1 ml of the mixture suspension was sampled and spread on nutrient agar (NA) plate and incubated at 37 °C for 24 h. After incubation, the number of viable colonies of *E. coli* on each NA plate was observed and disinfection efficiency of each test was calculated in comparison with that of the control as $100(N_0-N)/N_0$, where N_0 and N are the average number of live bacterial cells per milliliter in the flask of the initial or control and thin films finishing agent or treated fabrics, respectively. The antibacterial activities of three samples were tested.

3. RESULTS AND DISCUSSION

3.1 Characterization

XRD patterns (Figure 1) shown for WO_3-doped TiO_2 thin films confirmed the presence of anatase crystal structure with high intensity peak in (100) orientation. Furthermore, other orientations observed at (112) and (200) for all samples with low intensities, which agree with

JCPDS file no. 21-1272. Rutile phase, didn't confirm, which can be explain for two reasons: first, assuming that annealing temperature of the thin films fabrication process was not enough to transform the crystal phase from anatase to rutile. Second, it seems that WO_3 in the doped sample is distributed homogenous on the anatase crystal without forming another phase [8]. Figure 1 shows that by increasing WO_3 dopant levels, the anatase peaks increased in width and decreased in height and that due to decreased degree of crystallinity [8]. From XRD data the average crystallite sizes of the thin films determined from FWHM by using Scherrer's formula were estimated to be 11.5, 8.3, 10.3 and 10.8 nm for 0, 1, 3 and 5 mol% WO_3-doped TiO_2 thin films, respectively. It was apparent that WO_3 added in TiO_2 has significant effect on crystallite size. The crystallite size of the anatase phase decreased with an increased WO_3 doping which matches with the results of other authors [9] and the smallest crystallite size was observed from 1 mol% WO_3-doped TiO_2 thin films.



Figuer 1. XRD patterns of WO_3-doped TiO_2 thin films

The SEM images (top and cross-section views) of WO_3-doped TiO_2 thin films exemplified in Figure 2. The top-viewed SEM image (Figure 2a) reveals that the uniform-size nanoparticles of the WO_3-doped TiO_2 photocatalyst are in the form of aggregated nanoparticle clusters. The nanoparticle aggregation may be considered to the cause of the WO_3 structure formation in the synthesized TiO_2 photocatalyst. The cross-sectional view of the SEM image of the WO_3-doped TiO_2 thin films layer on the glass substrates (Figure 2b) reveals that the coated smooth TiO_2 thin films adhered on the glass substrates very well. The thickness of the WO_3- doped TiO_2 thin films exhibited of about 0.25-0.5 nm.

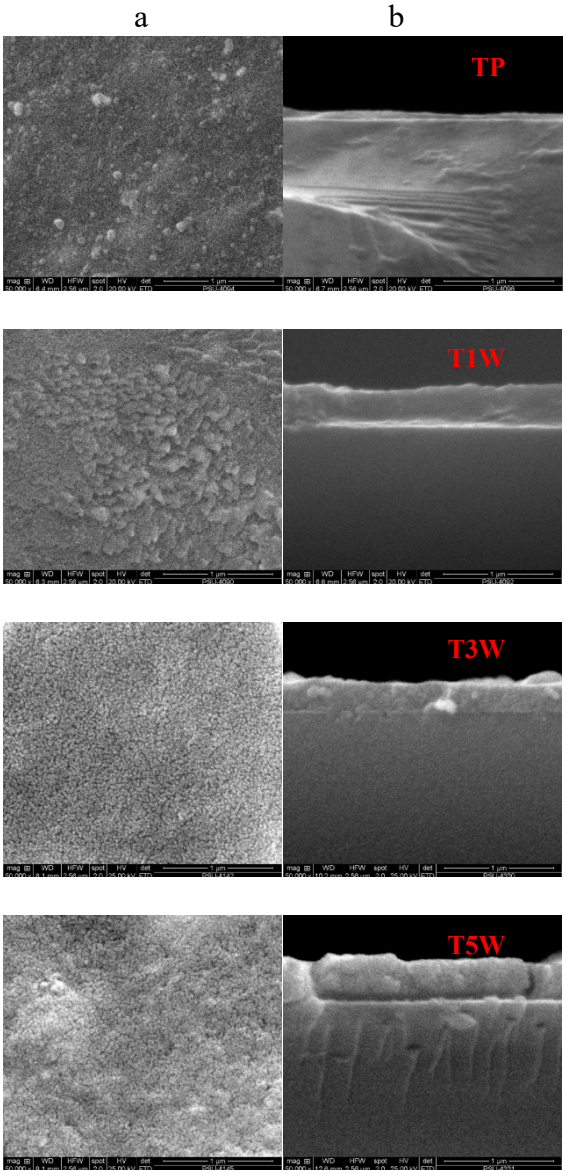
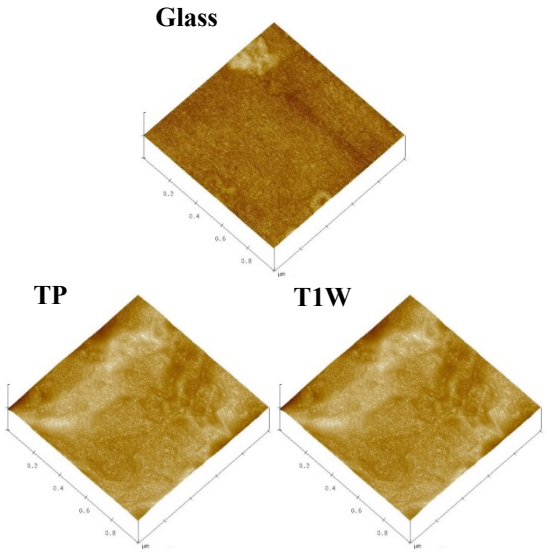


Figure 2. SEM images of WO_3-doped TiO_2 thin films (50,000x): (a) top view and (b) cross-section view

The surface morphology and roughness of the glass substrates and WO_3-doped TiO_2 thin films were characterized using amplitude modulation AFM imaging (Tapping mode). The Figure 3 shows the representative top view images of the surface morphology of various WO_3-doped TiO_2 thin films on glass substrates for once cycles deposited by dipped-coating method. Statistical analysis was performed on all AFM images using Gwyddion software. The surface roughness (RM) was found to increase with WO_3 content from RM = 2.3 nm for low concentration (<1 mol%) to RM = 5.6-7.2 nm for intermediate concentration (1-3 mol%). The surface of WO_3-doped TiO_2 thin films with higher WO_3 content (>3 mol%) was characterized with the existence of flat region with roughness of 4. 9 nm, the effective roughness on those thin films when including the large aggregates should be at least few tens of nanometer. The increased roughness with WO_3 doping should have a great influence on the active surface area and thus on the photocatalytic activities process [8]. It was found that the surface roughness of glass substrates and WO_3-doped TiO_2 thin films on glass substrates are 0.926, 2.262, 7.198, 5.565 and 4.883 nm for glass substrates, 0, 1, 3 and 5 mol% of WO_3 doping, respectively.



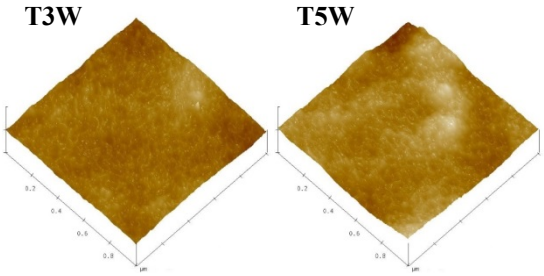


Figure 3. AFM images of glass substrates and WO_3-doped TiO_2 thin films

3.2 Antibacterial activity

The survival rate and percent kill of *E.coli* for WO_3-doped TiO_2 thin films by visible light are summarized in Figure 4 and Figure 5, respectively. The WO_3 doping revealed higher antibacterial activity than un-doped WO_3 used as Figure 6. The results of visible light reaction show good antibacterial activity about of 93. 33% against *E.coli* kill when 1%WO_3-doped TiO_2 thin films was observed. On the other hand, the antibacterial activity of pure and WO_3-doped TiO_2 thin films significantly improved under visible light for 120 min at room temperature. The presence of the WO_3-doped TiO_2 structure enhanced the antibacterial activity up to 93.33, 90.00 and 80.00% against *E.coli* at 1, 3 and 5 mol% of WO_3 doping, respectively, which matches with the results of other authors [3]. The ability of WO_3 to produce free radicals and the oxidative stress of TiO_2 that enhanced by the existence of WO_3 reactions, all lead to increase in the antibacterial activity of thin films. Moreover, the WO_3 makes the thin films uses more radiant energy, which increase the efficiency of antibacterial activity. The TiO_2 illumination forms surface hydroxyl and superoxide radicals on the surface of the photocatalyst lead to oxidize the thin films and increase the species at thin films surfaces, might causes damage in bacterial proteins and DNA after visible light irradiation reference [8]. Also, with the smallest crystallite size of anatase phase and larger surface area or roughness, more reactants can be adsorbed onto the inner and outer TiO_2 thin films surfaces and thus result in higher antibacterial activity of *E.coli*.

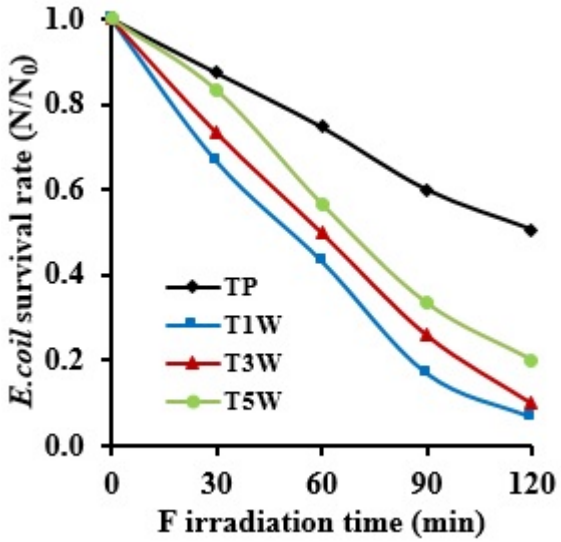


Figure 4. The antibacterial activity of WO_3-doped TiO_2 thin films

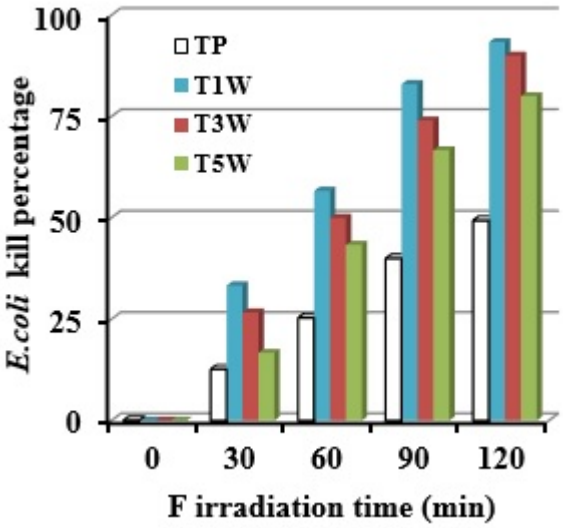


Figure 5. The *E. coli* kill percentage of WO_3-doped TiO_2 thin films

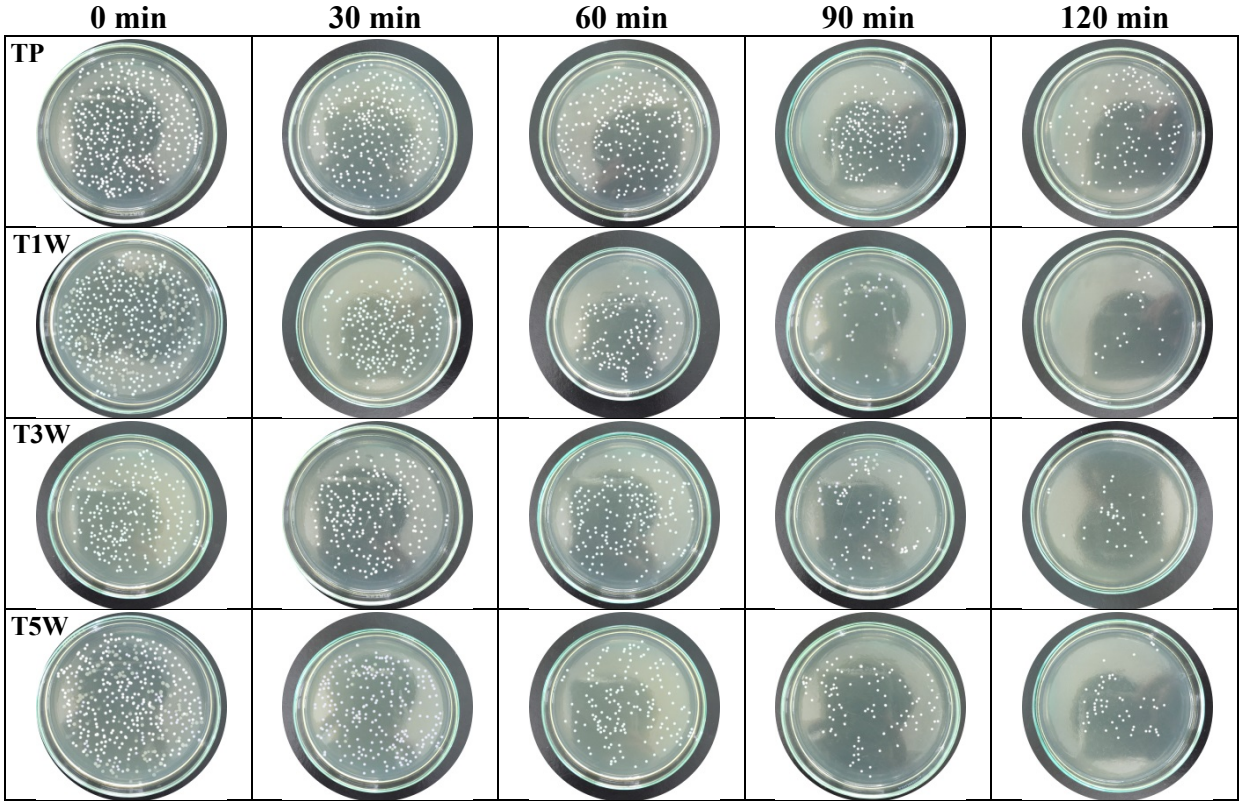


Figure 6. The *E. coli* surviving colonies of WO_3-doped TiO_2 thin films under visible light for 0, 30, 60, 90 and 120 min

4. CONCLUSION

In this study, WO_3- doped TiO_2 thin films have been prepared on glass substrate by microwave- assisted sol- gel and dip coating technology. WO_3- doped TiO_2 thin films were refluxed at 180 W for 1 h by conventional microwave oven and obtained after calcining at a temperature of 500 °C for 2 h for antibacterial activity. The prepared all thin films have anatase phase. However, the concentration of WO_3 doping up to 5 mol% did not transform the anatase crystal phase of TiO_2 thin films to be rutile yet. The XRD data; show that the crystal size of the WO_3- doped TiO_2 thin films was decreased with an increased WO_3 dopant and in the range 8.3-10.8 nm. The antibacterial activity for all thin films against *E. coli* under visible light irradiation has been developed in this work. WO_3 plays a major role in influencing the antibacterial efficiency. The optimum concentration of WO_3 under visible light is 1 mol% , and the antibacterial efficiency at this concentration reaches 93. 33% against *E. coli* under irradiation with visible light for 120 min.

5. ACKNOWLEDGEMENTS

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Detection of Dynamic Physical Data for Welder Skill Evaluation in GTAW process

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ABSTRACT

The purpose of this study is to detect the dynamic physical data for welder skill evaluation in GTAW process by using the data of accelerometer and gyroscope from the hand motion sensor. To access the sensitivity of the hand motion sensor with the commercial sampling rate, the movement of robotic was implemented. The result showed that the accelerometer and gyroscope were correlated to the speed of the robotic movement. For obtaining the correlation between cup-walking pattern and dynamic physical data detection from myo hand motion sensor, twos types of cup-walking pattern have been simulated (Triangle cup-walking and convex cup-walking). In the result showed that the data of accelerometer and gyroscope are enabled to detect the normal and abnormal of cup-walking pattern by using euclidean norm to determine the value in three axes of accelerometer and gyroscope data. Hence, the data of accelerometer and gyroscope from the hand motion sensor could be used for detecting the dynamic physical data for digitalized welder skill evaluation in GTAW process.

Keywords: Gas tungsten arc welding (GTAW), Accelerometer, Gyroscope.

1. INTRODUCTION

Gas tungsten arc welding (GTAW) is a process which commonly used in many industries, especially manufacturing of food beverage pressure vessel which subject to high temperature and pressure that requiring high welding quality [1]. This process is indispensable due to its flexible working process which can make a good quality weld in critical and complicated of welding position in pressure vessel [2].

However, the welds quality produce in the GTAW process is critically effected by the skill of the welder to maintain the torch in order to create the weld bead. Moreover, cup-walking is the welding technique which is commonly use in this welding process [3]. Hence, the dynamic physical data of cup-walking during welding process is critically importance for welder skill evaluation. Many researchers tried to find many methods to evaluated the skill of the welder [4]. In their study, they obtain welder's performance in in manual metal arc welding (MMAW) welding process by using probability density distribution and neural network of the voltage signal during the welding process. Another research, they evaluated the skill of the welder in GTAW process by using the 3D weld pool and current signal and made by the welder to evaluate the skilled of the welder in GTAW process [3].

This research aim to propose a new method for detecting the dynamic physical data of the welder by using the signal of accelerometer and gyroscope which contain in the myo hand motion sensor. This sensor will be attached the hand of the welder that hold the torch during welding process. The signal of the accelerometer and gyroscope are analyzed then developed the pattern of the cup-walking motion

to detect the normal and abnormal of the cup-walking by using the euclidean norm.

2. MATERIALS AND METHODS

Myo hand motion sensor

Myo hand motion sensor consists of an inertial measurement unit (IMU) with a three-axis accelerometer, and a three-axis gyroscope. The capability to measure the accelerometer data and gyroscope data in the sampling rate of 50 data per second [5]. This sensor is the first example of an integrated sensor which is comfortable to use for determining the relative of the arm and easy to set up. Moreover, the data is transmitted by wireless (Bluetooth) to be the excel file which easy for keeping the data and also analysis [6, 7].

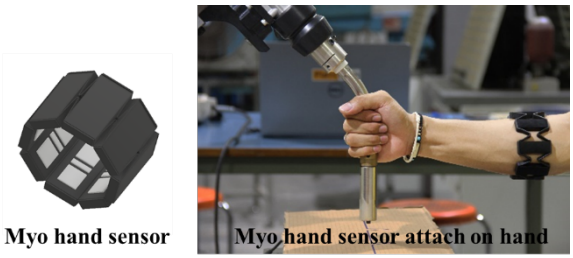

Figure 12. Myo hand sensor

The accelerometer is a device used to measure the linear acceleration of the movement in three axes in the unit of gravity (g) according to the weight provide by the earth gravity [8].The three outputs of the accelerometer are labelled A_x, A_y, and A_z which are the projection of accelerometer on X, Y, and Z axes respectively. The gyroscope is a device used to measure the angle velocity (Rotation angle) in the unit of degree per second (deg/sec) [9]. The three outputs of the gyroscope are labelled G_x, G_y, and G_z which are the angle velocity of X, Y, and Z axes respectively.

To understand motion reading of the accelerometer and gyroscope of the myo hand sensor, the three type's movement were implemented (Moving up-down, moving right-left, and moving back-front) as shown in figure 2. The results showed that for accelerometer movement of up-down, moving of right-left and moving of back-front are sensitive on Z, Y and X axis respectively as showed in figure 2. For instance, the moving up, the data will show as an upward signal which is a positive direction of the Z-axis while the signal will be appeared as a downward signal when moving down. Similar to the Z-axis, the hand moving (Right-Left and back-front) is correspond with the directions in Y and X-axis. For gyroscope, the movement of up-down is sensitive to X and Y axes. Because of moving straight on Z axis (Up-down), so the angle of Z axis is less than another axes. The movement of right-left is sensitive to X and Z axes, because of moving straight on Y axis. The movement of back-front is sensitive to Y and Z axes, because of moving straight on X axis. This result showed that the gyroscope is measure the angle velocity of the movement due to the effect of the movement. For instance, if the movement of up-down, the Z axes doesn't have much angle velocity as same as the axes X and Y.

Euclidean norm formula

By the data of accelerometer and gyroscope in three axes is tell clear about the information. However, to get easier for detecting the motion of the movement the euclidean norm is used for this study. The euclidean norm is used to calculate the value of vector in space which suitable to n-dimensional of the vector [10]. Hence, based on three dimensional accelerometer and gyroscope data from myo hand sensor, euclidean norm was suitable for the calculation. The following is the formula of euclidean norm for combining the output of tri-axes of the accelerometer and gyroscope from the hand motion sensor to detect the hand weaving motion of triangle cup-walking and convex cup-walking.

Euclidean norm formula for combination the accelerometer data:

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2} \quad (1)$$

A: Value of three axes accelerometer (gravity, 'g').
A_x, , : projection of accelerometer on axes X, Y, and Z in (g), respectively.

Euclidean norm formula for combination the gyroscope data:

$$G = \sqrt{G_x^2 + G_y^2 + G_z^2} \quad (2)$$

G: Value of three axes gyroscope (deg/sec).
G_x, , : Angle velocity on axes X, Y, and Z in (deg/sec), respectively.

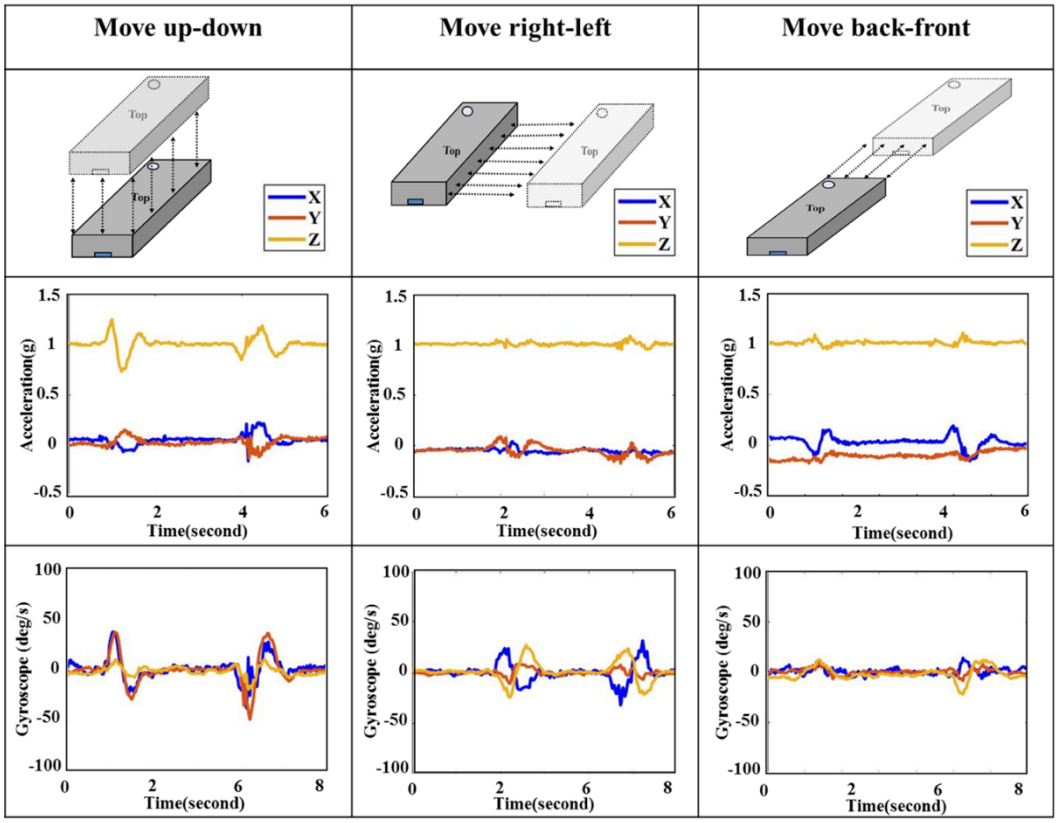

Figure 13. Motion reading of accelerometer and gyroscope from myo hand sensor

The results of three axes accelerometer (A), and gyroscope (G) were significantly affected by the speed of movement which were varied depending on how the operator maintains the movement. The value (A) and (G) were calculated by euclidean norm and were then used for analyzing in the time domain to define normal and abnormal of hand weaving.

Experiment setup

For system collecting data of accelerometer and gyroscope is showed in figure 3. The hand motion sensor was attached to hand in order to collect the data of accelerometer and gyroscope of myo hand motion sensor. Then connect it to the computer via bluetooth. After that run the myo data capture app to collect the data in the process. Finally, the myo data capture was run to collect the hand motion from the sensor. The set data will be transmitted to the PC computer as an excel file.

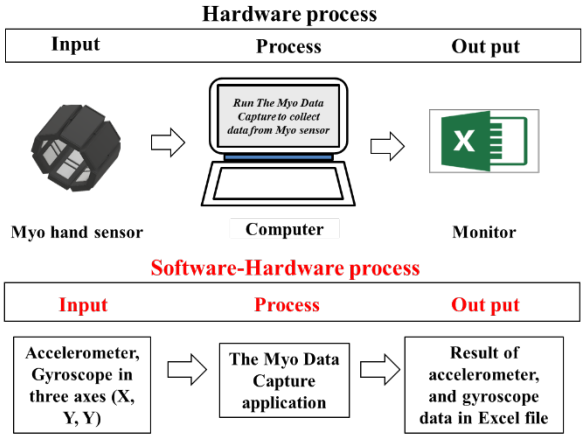

Figure 14. Experiment setup

.

3. RESULTS AND DISCUSSION

Figure 4 showed the result of motion reading of accelerometer in the simulation with the different speed of the robotic movement. By these results showed that the value of accelerometer were effected by the speed of the robotic movement. When the speed was increase, the accelerometer detection value was increased too in the function of linear increased as shown in figure 4. Same to accelerometer, gyroscope also effected by the speed of the robotic moment by the function of linear as showed in figure 5. Moreover, for the lower speed than 100 cm/min, the sensor cannot detect the signal.

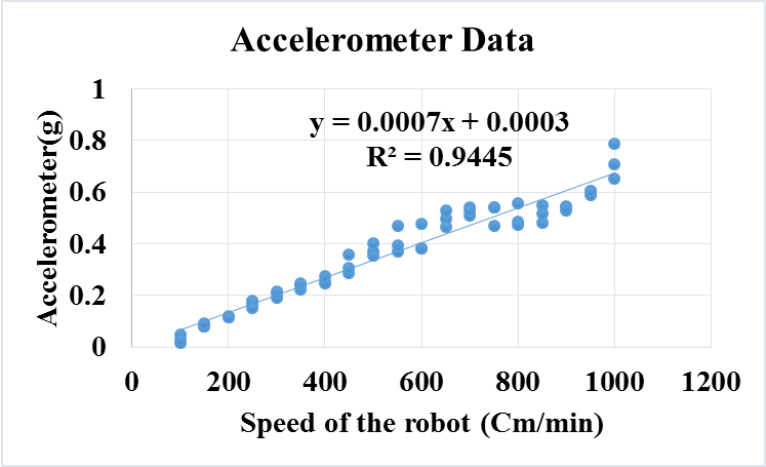

Figure 15. Acceleration data detection of dynamic physical movement from robotic

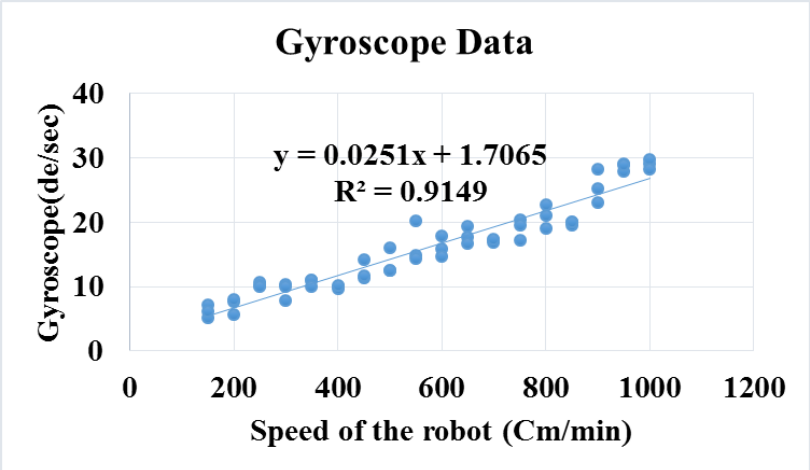

Figure 16. Gyroscope data detection of dynamic

physical movement from robotic

Figure 6 showed the correlation between cup-walking pattern and dynamic physical data detection from myo hand motion sensor. Based on the result, acceleration and gyroscope from the hand motion sensor enable to detect the signal of normal and abnormal of triangle cup-walking and convex cup-walking. Both accelerometer and gyroscope data can distinguish the three defects of the dynamic physical (Speed increased, uncontrolled the hand, and speed decreased).

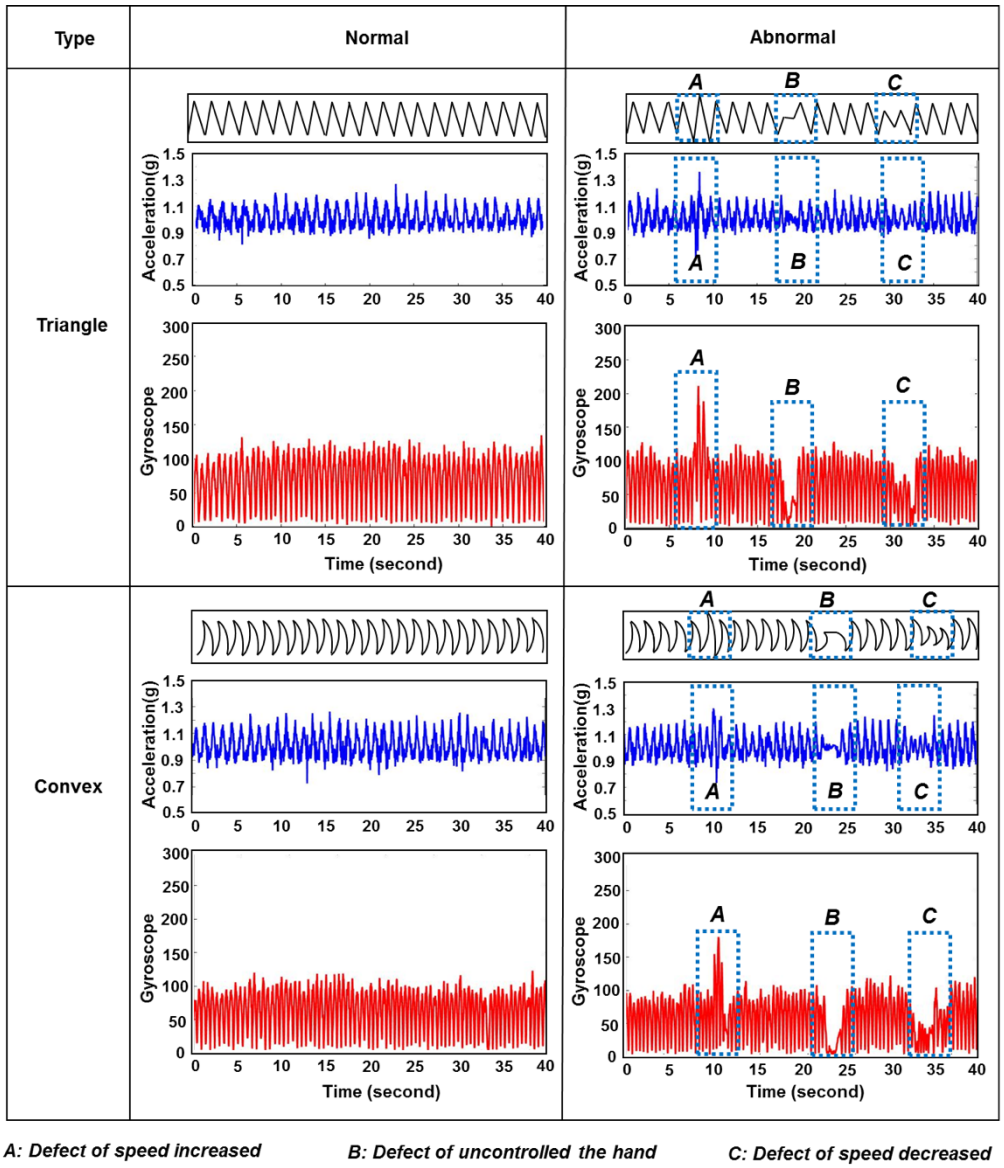

Figure 17. Data of acceleration and gyroscope detection the normal and abnormal of triangle cup-walking and convex cup-walking

4. CONCLUSIONS

In this research, a new method for detect the dynamic physical data for welder skill evaluation has been developed. The finding are describe as following:

- The value of accelerometer and gyroscope detection is depending on the speed of the movement. These value increase when the speed of the welder increased.
- The data of accelerometer and gyroscope has correlated to the cup-walking pattern. The results indicated that these data can make the difference between the normal and abnormal of cup-walking pattern.

5. ACKNOWLEDGMENTS

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Optimal Conditions for Controlling a CNC Turning Machine for Metal Turning Operation

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ABSTRACT

This research presents a study into factors that affect surface roughness of cold drawn bars while being turned using a carbide cutting tool. The aim of this was to ascertain factors as well as their conditions suitable for controlling a CNC turning machine (SIEG brand and KC6S model) to produce surface smoothness and high quality workpieces, with 2 factors in consideration, being: spindle speed at 850, 1625, 2400 rpm (80% of maximum spindle speed) and feed rate at 0.050, 0.075, 0.100 mm/rev. The experiments were conducted on a set of cold drawn bars with 5 different diameters: 10, 15, 20, 25, 30 mm.

According to the experiments and the analysis with engineering statistics through the design of experiments (DOE) with full factorial design, the optimal conditions for controlling the machine provide a confidence level of 95%. Also, the best results for surface smoothness can be summarized as follows: the spindle speed at 1625 rpm and the feed rate at 0.050 mm/rev for a cold drawn bar with 10-mm diameter; the spindle speed at 2400 rpm and the feed rate at 0.066 mm/rev for a cold drawn bar with 15 mm diameter; the spindle speed at 2400 rpm and the feed rate at 0.050 mm/rev for a cold drawn bar with 20 mm diameter; the spindle speed at 2400 rpm and the feed rate at 0.084 mm/rev for a cold drawn bar with 25 mm diameter and the spindle speed at 2400 rpm and the feed rate at 0.072 mm/rev for a cold drawn bar with 30 mm diameter. This reported data can, as a result, be employed as a guideline for operations or controlling a CNC turning machine, to produce high quality workpieces and to minimize defects.

Keywords: Surface Roughness, Spindle Speed, Feed Rate, Full Factorial Design

1. INTRODUCTION

Metal materials are, at present, used for numerous purposes, for example: structure and machinery designs. This also extends to a field of engineering which sometimes demands metal-working for the purpose of part assembling, such as the making of metal axles to affix between shafts and bearings for a mechanical system of engines or agricultural machines [1]. With this regard, CNC technology has been increasingly employed in industries for high-volume production as the technology contributes to production with accurate sizes, less production time, and a fewer number of operators, as compared to that required for manual machine types [3, 4].

In general, however, CNC turning machine type has limitations as each model has, to some extent, different specifications and capacity for production, such as maximum spindle speed, maximum feed rate, size, and machine's structural strength. Small-sized ones or models with less strength, in particular, generate a certain degree of vibration which, in turn, causes inaccuracy in production and problems concerning the quality of finished products.

In light of this, this study was conducted to ascertain factors suitable for controlling a CNC lathe machine (SIEG brand and KC6 S model), with a focus on 2 factors which impact surface roughness of turned pieces, being: spindle speed and feed rate. An analysis employed engineering statistics through the design of experiments (DOE) to determine a suitable spindle speed and a suitable feed rate [2]. The results obtained were then employed as a guideline for controlling CNC turning machine to produce workpieces with the highest quality under limitations of the machine being studied.

2. MATERIALS AND METHODS

For the methods of study and property testing, a CNC turning machine (SIEG brand and KC6S model) was operated on a sets of cold drawn bars with diameter of 10, 15, 20, 25, and 30 mm to determine a level of the factors most suitable for turning operations of metal shafts to produce the highest quality, and to obtain the data to be used as a guideline, for machine operators, for the turning operations. The methods are described as below.

2.1 Design of experiments

The design of experiments (DOE) with full factorial design was conducted with 2 factors in consideration: spindle speed at 3 levels: 850, 1625, 2400 rpm and the feed rate at 3 levels: 0.050, 0.075, 0.100 mm/rev. Also, the depth of cut was set at 0.2 mm per layer. To assess the quality, the workpieces turned according to the experimental conditions were measured for (surface) roughness average (R_a) using a surface roughness tester. The experiments were carried out with 3 repetitions; or a total of 135 workpieces were tested, as shown in Table 1.

2.2 Turning operation with a CNC turning machine

For the testing of turning operation, cold drawn bars with diameter of 10±0.2, 15±0.2, 20±0.2, 25±0.2, and 30±0.2 mm (tolerance value at ± 0.2 mm) were selected because these 5 sizes are within the range most used in design and production of machinery.

Table 1. The design of experiments with full factorial design

Diameter (mm)	Feed rate (mm/rev)	Spindle Speed (rpm)								
		850			1625			2400		
10	0.050	A01	A02	A03	B01	B02	B03	C01	C02	C03
	0.075	A04	A05	A06	B04	B05	B06	C04	C05	C06
	0.100	A07	A08	A09	B07	B08	B09	C07	C08	C09
15	0.050	A01	A02	A03	B01	B02	B03	C01	C02	C03
	0.075	A04	A05	A06	B04	B05	B06	C04	C05	C06
	0.100	A07	A08	A09	B07	B08	B09	C07	C08	C09
20	0.050	A01	A02	A03	B01	B02	B03	C01	C02	C03
	0.075	A04	A05	A06	B04	B05	B06	C04	C05	C06
	0.100	A07	A08	A09	B07	B08	B09	C07	C08	C09
25	0.050	A01	A02	A03	B01	B02	B03	C01	C02	C03
	0.075	A04	A05	A06	B04	B05	B06	C04	C05	C06
	0.100	A07	A08	A09	B07	B08	B09	C07	C08	C09
30	0.050	A01	A02	A03	B01	B02	B03	C01	C02	C03
	0.075	A04	A05	A06	B04	B05	B06	C04	C05	C06
	0.100	A07	A08	A09	B07	B08	B09	C07	C08	C09

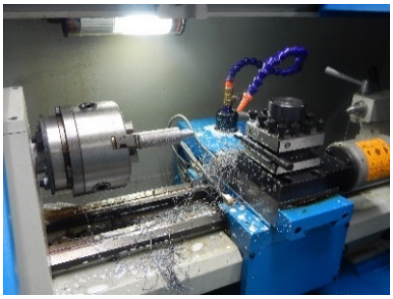
Note: The depth of cut was set at 0.2 mm

To prepare the workpieces for testing with a manual turning machine, all bars were turned to acquire a size approximately 2 mm greater than what was needed, shown in Figure 1.

Figure 1. Turning operation for workpiece preparation.

Then, the machine was operated to form workpieces employing G-code, a set of instructions which controls the machine to perform the turning operation automatically in each step, shown in Figure 2.

(a)



(b)

Figure 2. (a) G-code, (b) Controlling of the CNC turning machine.

2.3 Measurement of surface quality

An assessment of surface quality was carried out to ascertain the roughness average (R_a) using a surface roughness tester (Mahe brand and MarSurf PS1 model). All individual workpieces turned with the machine were measured at 5 different locations; each workpiece was measured for the area within a length of 35 mm, as shown in Figure 3. The use of the instrument is illustrated in Figure 4.

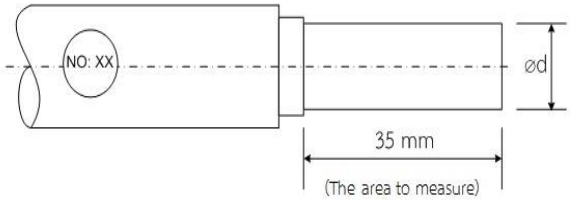
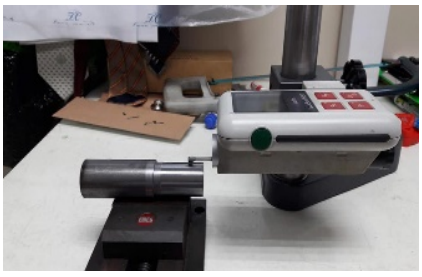


Figure 3. The length positioning of turning operation and measurement

(a)



(b)

Figure 4. Measurement of roughness average (a) Front view, (b) Side view

3. RESULTS AND DISCUSSION

From the testing and the surface roughness measurement of workpieces turned according to the design of experiments, shown in Table 1, results were expressed in roughness average (Ra) of workpieces. The data were, then, determined for an arithematic mean (an average from 3 repeats). The datas are shown in Table 2.

Table 2 The experimental results of roughness average (µm)

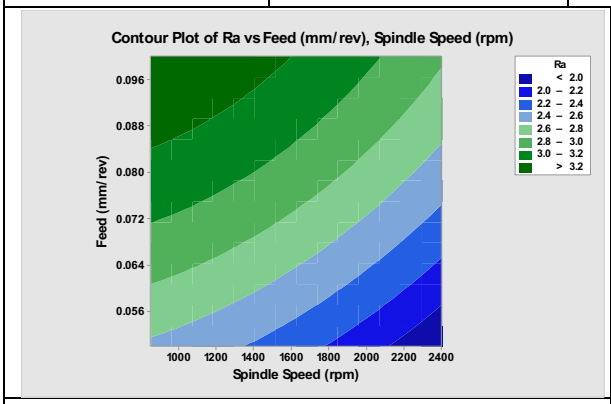
Diameter (mm)	Feed rate (mm/rev)	Spindle Speed (rpm)		
		850	1625	2400
10	0.050	2.713	1.933	2.001
	0.075	3.059	2.913	2.324
	0.100	3.230	3.444	1.718
15	0.050	2.814	2.781	1.919
	0.075	2.872	2.142	2.279
	0.100	2.957	3.058	2.154
20	0.050	2.311	2.034	1.621
	0.075	3.229	2.570	2.443
	0.100	2.432	2.376	1.732
25	0.050	3.547	2.568	1.859
	0.075	2.956	2.639	1.153
	0.100	2.771	3.197	1.023
30	0.050	3.279	2.653	1.923
	0.075	3.082	2.580	1.356
	0.100	3.736	2.488	1.308

In addition, the experimental results were analyzed for engineering statistics with Response Surface Methodology method (RSM) using statistical software : Minitab, to determine the optimized factors to be employed for controlling the CNC turning machine (SIEG brand and KC6S model). The contour plots (2D) and surface plot (3D) show a relationship between a spindle speed and a feed rate which affect the quality of workpieces assessed from roughness average (Ra). These statistical analysis results were shown in Table 3-7. According to the experiments, the optimized factors for controlling the machine can be summarized as below.

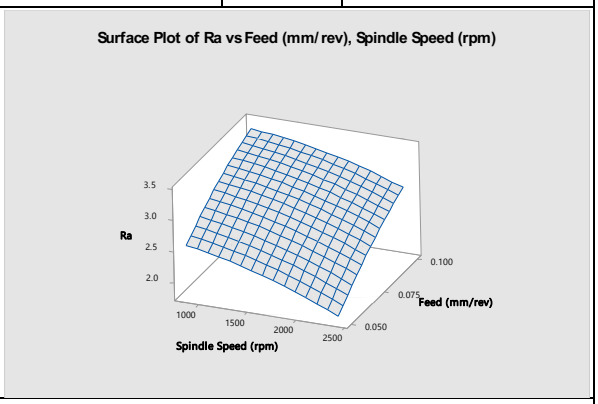
- The optimized factor for turning cold drawn bars with 10 mm diameter is the spindle speed at 1625 rpm and the feed rate at 0.050 mm/rev, which results in the minimum Ra-value of 1.8094 µm and desirability (D) of 88.62%.
- The optimized factor for turning cold drawn bars with 15 mm diameter is the spindle speed at 2400 rpm and the feed rate at 0.066 mm/rev, which results in the minimum Ra-value of 1.9647 µm and desirability (D) of 81.89%.
- The optimized factor for turning cold drawn bars with 20 mm diameter is the spindle speed at 2400 rpm and the feed rate at 0.050 mm/rev, which results in the minimum Ra-value of 1.5905 µm and desirability (D) of 89.32%.
- The optimized factor for turning cold drawn bars with 25 mm diameter is the spindle speed at 2400 rpm and the feed rate at 0.084 mm/rev, which results in the minimum Ra-value of 1.1490 µm and desirability (D) of 93.09%.
- The optimized factor for turning cold drawn bars with 30 mm diameter is the spindle speed at 2,400 rpm and the feed rate at 0.072 mm/rev, which results in the minimum Ra-value of 1.5958 µm and desirability (D) of 87.13%.

Table 3. An analysis of an optimized factor for turning cold drawn bars with 10-mm diameter

Diameter (DIA) ; mm	Spindle Speed (A) ; rpm	Feed rate (B) ; mm/rev	Ra (µm)	Desirability (D) ; %
10	1625	0.050	1.8094	88.62



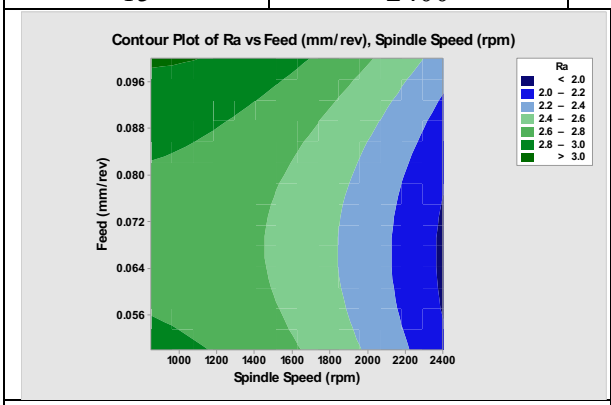
Contour Plot (2D)



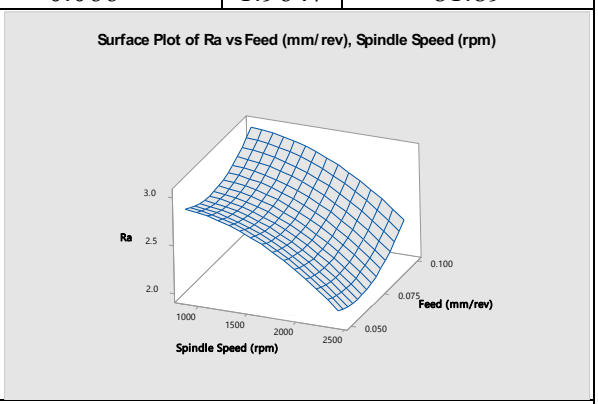
Surface Plot (3D)

Table 4. An analysis of an optimized factor for turning cold drawn bars with 15-mm diameter

Diameter (DIA) ; mm	Spindle Speed (A) ; rpm	Feed rate (B) ; mm/rev	Ra (µm)	Desirability (D) ; %
15	2400	0.066	1.9647	81.89



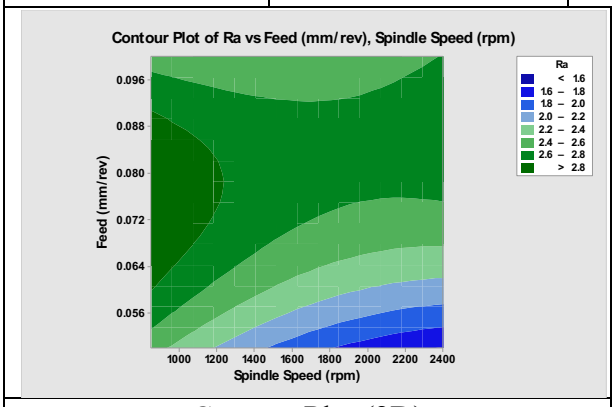
Contour Plot (2D)



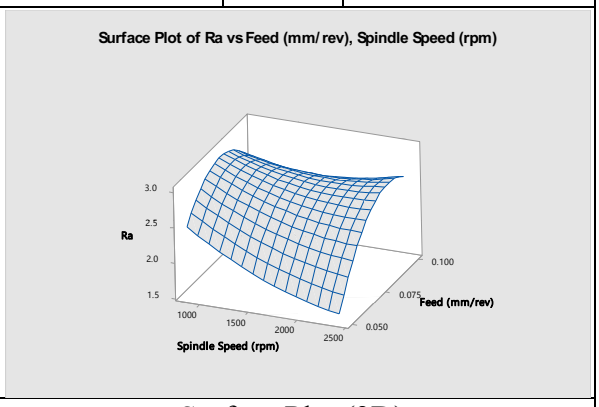
Surface Plot (3D)

Table 5. An analysis of an optimized factor for turning cold drawn bars with 20-mm diameter

Diameter (DIA) ; mm	Spindle Speed (A) ; rpm	Feed rate (B) ; mm/rev	Ra (μm)	Desirability (D) ; %
20	2400	0.050	1.5905	89.32



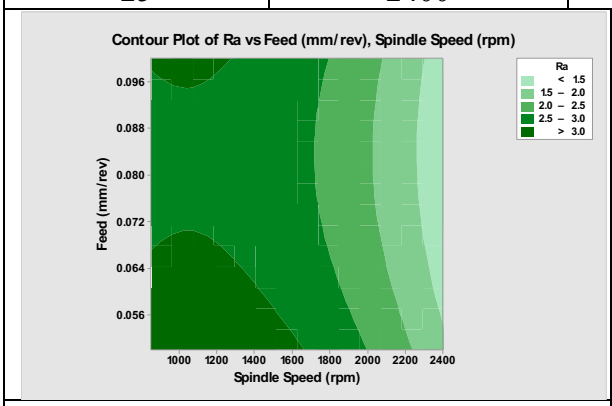
Contour Plot (2D)



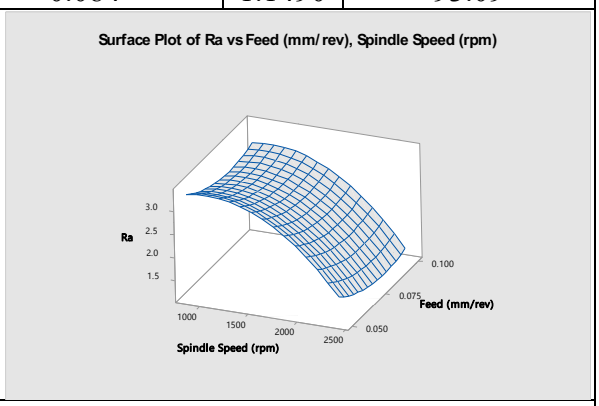
Surface Plot (3D)

Table 6. An analysis of an optimized factor for turning cold drawn bars with 25-mm diameter

Diameter (DIA) ; mm	Spindle Speed (A) ; rpm	Feed rate (B) ; mm/rev	Ra (μm)	Desirability (D) ; %
25	2400	0.084	1.1490	93.09



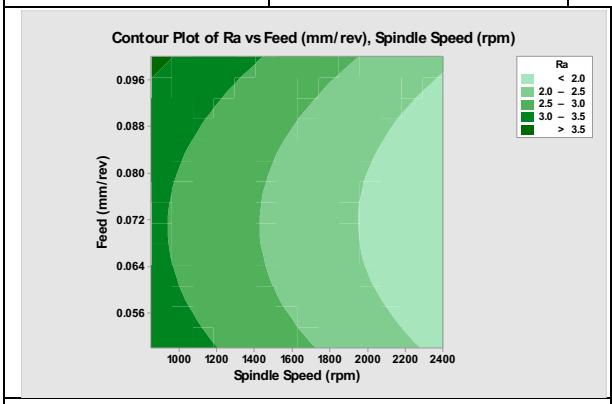
Contour Plot (2D)



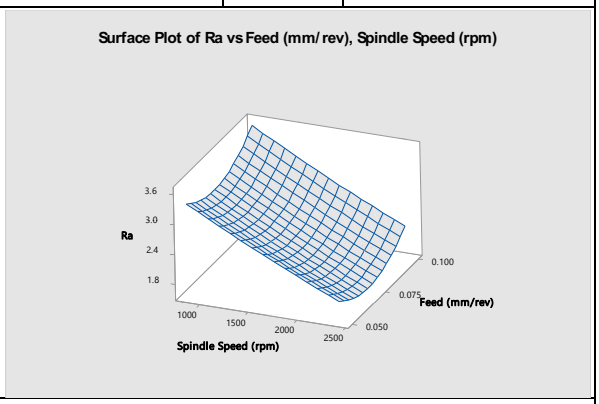
Surface Plot (3D)

Table 7. An analysis of an optimized factor for turning cold drawn bars with 30-mm diameter

Diameter (DIA) ; mm	Spindle Speed (A) ; rpm	Feed rate (B) ; mm/rev	Ra (μm)	Desirability (D) ; %
30	2400	0.072	1.5958	87.13



Contour Plot (2D)



Surface Plot (3D)

4. CONCLUSIONS

This research aimed to learn of the properties of a CNC turning machine (SIEG brand and KC6S model) through the experiments of metal turning operation with a carbine cutting tool. In the study, a set of cold drawn bars with 5 different diameters: 10, 15, 20, 25, and 30 mm was used, with the focus on 2 factors which affect surface smoothness from the turning operation: spindle speed at 3 levels: 850, 1625, 2400 rpm and the feed rate at 3 levels: 0.05, 0.075, 0.100 mm/rev. Also, the depth of cut was set at 0.2 mm per layer. By using the design of experiments with full factorial design, the results provided the minimum roughness average (R_a) of the workpieces turned and maximum desirability (D) under the experimental conditions. Therefore, the reported data can be used as a guideline for controlling the machine in the study, to produce high quality products and to decrease a number of defects.

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The Half Bridge Inverter using Asymmetrical Duty Cycle Control for Battery charger

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ABSTRACT

Half Bridge Inverter using Asymmetrical Duty Control (ADC) for Battery charger is proposes in this paper. Switches devices operate in zero-voltage soft switching mode. The output power is controlled using Asymmetrical Duty Control (ADC) method. A half bridge hardware prototype is constructed and the control algorithm is implemented using an STM32F4 microcontroller. Simulation and experimental results are provided to verify the ability of the proposed method where an operating frequency range and the output power regulation are 44-48 kHz and 300 W, respectively.

1. INTRODUCTION

This is due to the limited availability of natural energy sources and the ever increasing demand for energy. There is a need for renewable energy sources to reduce energy costs in the country. The use of solar energy as a source of renewable energy is increasingly popular. But the relatively low efficiency of solar cells, energy storage should be maximized where the energy transfer system should have the least loss. There are two losses of switch in the converter circuit that has the loss of conduction and switching. The both losses depend on the current that through the switch and the turned on characteristics of switches. In practical we can reduce the switching loss by using the LC resonant circuit [1],[2]. Resonant converters are used in power electronic applications because they offer better than the non-resonant converters, including soft-switching in all switches, low EMI, high frequency operation for reducing the filter and high efficiency.

Recent developments in several ultrasonic applications require the output power control due to a load-parameter variation. The full-bridge VSI using the varying switching frequency method to drive the ultrasonic cleaner have been proposed in [2000]. However, the inverter cannot achieve a non-ZVS condition if the switching frequency is operated lower the resonant frequency or over the anti-resonant frequency.

The zero voltage switching (ZVS) [3] is the soft switching method making the zero voltage across the switch when the switches are turn on. The ZVS eliminates capacitive turn-on losses, and decreases turn-off switching losses by slowing down the rise in voltage, reducing the crossing between the current through switch and the voltage across it. The bidirectional resonant converter [4] is the new adopted for high efficiency of power energy conversion in applications such as DC power system or UPS off grid inverter. The soft switched should have ZVS in two transferring buck and boost modes.

In other applications like induction heating where similar systems with series resonant inverters are used, several switching techniques have been proposed the output power control capability under ZVS operations such as the pulse-frequency modulation (PFM) [3], asymmetrical duty-cycle (ADC) [12], [15], phase-shift (PS) [4], and asymmetrical voltage-cancellation (AVC) [7]-[15].

Half Bridge Inverter using Asymmetrical Duty Control (ADC) for Battery charger is proposes in this paper. Switches devices operate in zero-voltage soft switching mode. The output power is controlled using asymmetrical voltage-cancellation method. A half-bridge hardware prototype is constructed and the control algorithm is implemented using an STM32F4 microcontroller. Simulation and experimental results are provided to verify the ability of the proposed method where an operating frequency range and the output power regulation are 44-48 kHz and 300 W, respectively.

HALF BRIDGE INVERTER

In this test, the switching frequency in the test range is 44-48 kHz. The test parameters are as follows. 8 panels and in the test were tested by adjusting the angle α (α) at every switch at the same angle at 20, 30, and 50 percentage of duty cycle while charging 12 volt batteries of inverters & voltage switches

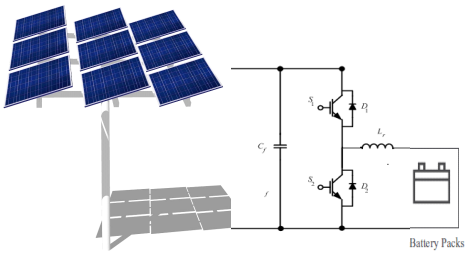

Figure 1. Half bridge inverter charger

2. RESULTS AND DISCUSSION

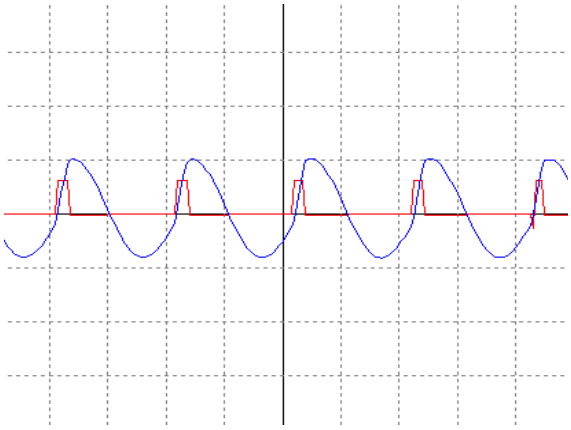

Figure 2. Simulation result

The results and discussion of the work should be explicitely described and illustrated.

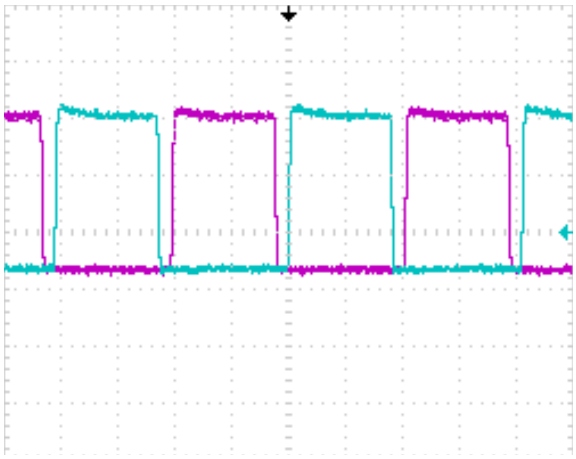

Figure 3 Experimental gate drive signal at 48 kHz

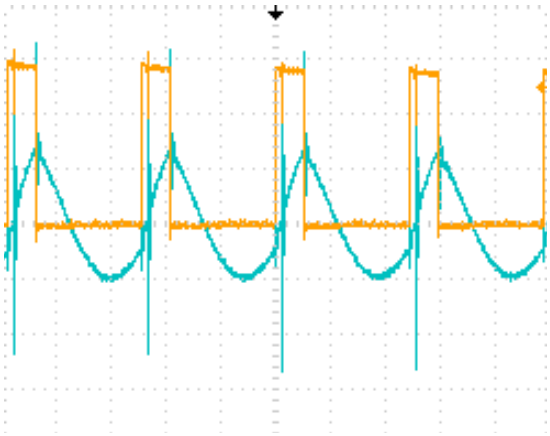

Figure 4 Experimental current and voltage waveform of inverter output at 44 kHz and 20% of duty cycle

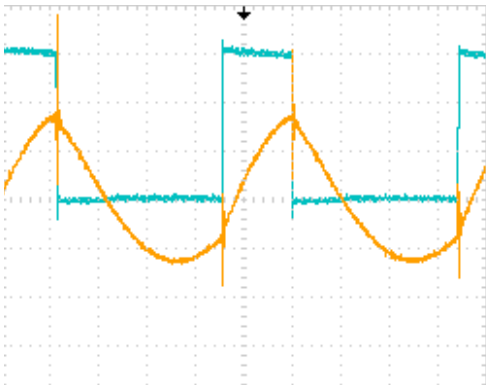

Figure 5 Experimental current and voltage waveform of inverter output at 44 kHz and 30% of duty cycle

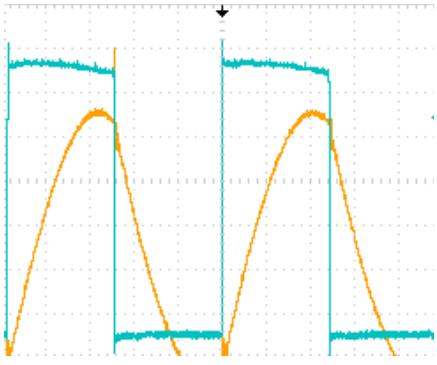

Figure 6 Experimental current and voltage waveform of inverter output at 44 kHz and 50% of duty cycle

3. CONCLUSIONS

This paper has proposed an asymmetrical duty cycle control with the resonant frequency tracking under parameter variation for battery charger application. The output power regulation at high efficiency of the load with an additional series inductor can be controlled under the wide ZVS condition. The additional series inductor can amplify the voltage across the load to increase the output power as well. The merits of the proposed control method can be verified by the simulation and experimental results with the comparative efficiency.

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An Efficient Influence Analysis for Main Economical crop yields in Central Area of Thailand Using Mathematical Models

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ABSTRACT

The objectives of this research are to propose an appropriate and efficient model for analyzing rice, sugarcane, and corn yields data. A linear mixed model (LMM) with spatial correlations following the conditional autoregressive model (CAR) was adopted. The results show that, for rice yields, if the amount of rainfall in the harvest season increases 1 mm, the yields will decrease by 25.74 tons. If the temperature in the harvest season increases 1 Celsius, the yields will decrease by 212.60 tons, and according to the trend, the yield will increase by 15.80 tons each year. For sugar cane yields, if the amount of rainfall in the harvest season increases 1 mm, the yields will decrease by 51.35 tons. If the temperature in the harvest season increase 1 Celsius, the yields will increase by 121.30 tons, and according to the trend, the yield will increase by 29.93.80 tons each year. For corn yields, if the amount of rainfall in the harvest season increases 1 mm, the yields will increase by 73.45 tons. If the temperature in the harvest season increases 1 Celsius, the yields will decrease by 40.44 tons, and according to the trend, the yield will increase by 1.74 tons each year.

Keywords: Linear mixed model (LMM), Rice yields, Conditional autoregressive model (CAR), Spatial data analysis

1. INTRODUCTION

Economic crops such as rice, sugar, corn and cassava bring substantial income to Thailand. Rice is human food, sugar cane is a raw material for sugar production, corn is the raw material for animal feed production, cassava is a raw material for the production of starch and animal feed. Rice is one of the most important economic crops in the world. Thailand is the top rice producer and continuously exports the world's most rice. Rice is an agricultural product that is traded in advance in the Agricultural Futures Exchange of Thailand (AFET), starting from 26 August 2004 to the present (Agricultural Futures Trading Commission).

World rice production increased by 2.0 percent from the previous year. Thai rice production decreased by 3.1 percent from the previous year. Thai rice, both quantity and export value, increased by 65.9% and 30.6% respectively. Sugarcane is very important. For Thai sugarcane production, there were 103.7 million tons, an increase of 3.6 percent from the previous year in accordance with the Zoning policy that motivated farmers to grow sugarcane. The sugar production increased by 13.0 percent from the previous year. For the export of Thai sugar, the volume and value increased by 12.2 percent and 7.1 percent respectively.

This research is an in-depth analysis with mathematical and statistical models. For the data that has been repeatedly collected, Generalized Estimating Equation (GEE) model is very commonly used for data analysis.

GEE was presented by [5] as a model that shows the relationship between more than one independent variables and the dependent variable. There is no assumption that data must be independent. The values of variables that are related to each other can occur when repeating data in the same sample unit. The equation shows the relationship between the independent variables and the dependent variable of each sample unit.

The GEE model has the same regression coefficient; therefore, it is an explanation of the size,

influence of factors in the overall picture of the population, so-called Population-averaged model.

[6] applied the GEE model to determine factors affecting road traffic accidents. [1] adopted the GEE model to predict the efficiency of the wind chill flow cooling tower. [4] apply the GEE model to analyze the risk of malaria. For another model that analyzes this type of data, it is appropriate to take a spatial relationship. The model for spatial data analysis which is widely used based on linear mixed model (LMM).

The LMM model is a model that shows the relationship of the dependent variable. LMM can add some variables into the model easily. LMM can be used to analyze data with spatial relationships, from the principle of the fact that things that are close together are more related than things that are far apart.

There are many ways to estimate the parameters in the GLM model. The most widely used method when the model is complex is using the Bayesian method. As mentioned above, the researcher is interested in applying the GEE and LMM to rice and sugarcane data for planning in Thailand. The primary factors to be considered are rainfall, average temperature, region (middle, north, northeast, south, east and west).

2. MATERIALS AND METHODS

Data used in this study were collected from the provinces in central area of Thailand from 2005 to 2016. The annual rice, sugarcane and corn production yields were extracted from the data base of the Office of Agricultural Economics Ministry of Agriculture and Cooperatives [9]. The rainfall and temperature were collected from the Meteorological Department Ministry of Information and Communication Technology [7]. The research hypothesis is that the amount of rainfall, average temperature and region have an influence on rice, corn and sugar cane production yields. The analysis of factors related to rice, sugarcane and corn production yields used LMM models with spatial influence. Bayesian method was used for estimating the parameters u. Details of the model are shown below : [3,10]

$$y_{ij} \mid \mathbf{b} \sim N(\mu_{ij}, \sigma^2), i = 1,...,22$$
$$j = 1,...,13,$$

$$\mu_{ij} = \beta_1 + \beta_2 * rain_{ij} + \beta_3 * temp_{ij} + \beta_4 * k + b_{1i} + b_{2ij} + v_i. \quad (1)$$

v_i is the spatial influence, having a CAR distribution which has the following format :

$$v_i \mid \mathbf{v}_{(-i)} \sim \mathrm{N}\left(\sum_{k=1}^{m} \frac{w_{ik} v_k}{w_{i+}}, \frac{\tau_v^2}{w_{i+}}\right) \quad \text{and}$$

$$\mathbf{v} \sim \mathrm{N}\left(\mathbf{0}, \tau_v^2 (\mathbf{D}_w - \mathbf{W})^{-1}\right) \quad \text{or}$$

$$\mathrm{p}(\mathbf{v}) \propto \exp\left\{-\frac{1}{2\tau_v^2} \mathbf{v}^T (\mathbf{D}_w - \mathbf{W}) \mathbf{v}\right\}$$

$\mathbf{W} = (w_{ik})$ is the matrix showing the weight of each area defined as follows, $w_{ij} = 1$ if area i and k are adjacent, where $i \neq k$. $w_{ij} = 0$ if area i and k are not adjacent. $\mathbf{D}_w = \mathrm{diag}(w_{i+})$ is a diagonal matrix that has a diagonal member, the main angle (i,i) is equal to $w_{i+} = \sum_k w_{ik}$. Under the Bayesian method, non-informative distributions for priors which do not affect the posterior were assigned as follows:

$$\beta_1, \beta, \beta_3, \beta_4 \sim N(0, 10000), b_{1i} \sim N(0, \tau_{b1}^2)$$
$$b_{2it} \sim N(0, \tau_{b2}^2),$$
$$\tau_{b1}^2, \tau_{b2}^2, \tau_v^2 \sim InvGamma(0.1, 0.1).$$

For the general characteristics of the data used to study, the mean, standard deviation were used. For parameter estimation, the Bayesian method was used via programing in OpenBugs and R2OpenBugs [2,8].

3. RESULTS AND DISCUSSION

Results

For general characteristics of rice, sugarcane and corn yield data (unit: ton), rice yields are ranked in descending order. The top 10 provinces are Nakhon Sawan (1,224,062.38), Phichit (833,679.46), Suphan Buri (802,910.31), Phitsanulok (709,213.31) Kamphaeng Phet, (658,882.00) Phetchabun (610,625.92), Chai Nat (550,514.62), Phra Nakhon Si Ayutthaya (513,393.46), Sukhothai (462,908.54) and Lopburi (407,947.08), respectively. Sugarcane yields are ranked in descending order. The top 10

provinces are Lop Buri (6,360,560.33), Phichit (5,424,166.17), Nakhon Sawan (4,792,695.33), Saraburi (3,121,571.75), Sukhothai (2,801,949.33), Ang Thong (2,412,315.50), Chai Nat (1,766,494.92), Phitsanulok (1,532,566.50), Uthai Thani (1,316,720.25) and Kamphaeng Phet (947,364.33), respectively. Corn yields are ranked in descending order. The top 9 provinces are Chai Nat (254,125.00), Nakhon Sawan (135,727.92), Suphan Buri (125,782.15), Kamphaeng Phet (124,238.62), Phichit (104,665.46), Lop Buri (71,459.62), Phitsanulok (11,549.15), Saraburi (10,464.15), Sukhothai (6,771.08) respectively.

From table 1, factors influencing the rice production in the central region are the amount of rainfall, average temperature along with the influence of trend. If the amount of rain increases by 1 mm, the average annual rice yield will decrease by 25.74 tons. If the average temperature increases by 1 Celsius, the average annual rice yield will decrease by 212.60 tons. When the time increases for 1 year, rice production tends to increase by 15.80 tons. The spatial influence of each province in the central area of Thailand on the average annual rice yield shows that the top 10 provinces, ranking from the highest to the least values, are Bangkok (0.42), Samut Sakhon (0.40), Nonthaburi (0.30), Nakhon Pathom (0.27),

Table 1. Size estimation, influence of factors affecting rice yield in the central region

Factor	Mean	S.D	95% CI	
β_1	27.01	42.93	-70.17	67.91
β_2	-25.74	0.09	-25.79	-25.51
β_3	-212.60	1.64	-216.60	-211.10
β_4	15.80	5.52	-2.61	19.10

Table 2. Size estimation, influence of factors affecting rice yield in the central region

Factor	Mean	S.D	95% CI	
β_1	50.09	54.04	-92.04	127.30
β_2	-51.35	1.44	-52.59	-49.57
β_3	121.30	84.17	18.37	195.20
β_4	29.93	101.10	-98.63	122.30

Table 3. Size estimation, influence of factors affecting corn yield in the central region

Factor	Mean	S.D	95% CI	
β_1	16.27	63.67	-139.50	143.10
β_2	73.45	3.02	69.33	82.16
β_3	-40.44	44.74	-93.14	98.10
β_4	-1.74	98.40	-164.20	105.40

Pathum Thani (0.20), Saraburi (0.14), Ang Thong (0.12), Samut Prakan (0.10), Phra Nakhon Si Ayutthaya (0.09) and Nakhon Nayok (0.08), respectively. For the average annual rice yield estimates being over 700,000 tons, the first top 10 provinces, ranking from highest to lowest values, are Nakhon Sawan (year 2013; 1,416,000), Nakhon Sawan (year 2012; 1,406,000), Nakhon Sawan (year 2014; 1,355,000), Nakhon Sawan (year 2005; 1,276,000), Nakhon Sawan (year 2008; 1,274,000), Nakhon Sawan (year 2007; 1,258,000), Nakhon Sawan (year 2009; 1,221,000), Nakhon Sawan (Year 2006; 1,195,000), Nakhon Sawan (Year 2015; 1,193,000) and Nakhon Sawan (Year 2003; 1,152,000), respectively From Table 2, factors influencing the sugarcane yields are the amount of rainfall, average temperature along with the influence of trends. If the amount of rain increases by 1 mm, the average annual sugarcane yield will decrease by 51.35 tons. If the average temperature increases 1 Celsius, the average annual sugarcane yield will increase by 121.30 tons, and when the time increases 1 year, the rice yield will increase 29.93 tons. The spatial influence of each province in the central area of Thailand on the average annual sugarcane yield shows that the top 10 provinces, ranking from the highest to the least values, are Sukhothai (32.11), Phichit (23.96), Phitsanulok (23.53), Kamphaeng Phet (21.53), Phetchabun (2.95), Nakhon Sawan (1.47), Uthai Thani (-3.20), Lopburi (-7.11), Ang Thong (-7.75) and Sing Buri (-9.87), respectively. For the average annual sugarcane yield estimates being over 2,000,000 tons, the first top 10 provinces, ranking from highest to lowest values, are Nakhon Sawan (year 2013; 8,546,000), Nakhon Sawan (Year 2015; 8,507,000), Nakhon Sawan (Year 2014 (8,283,000), Nakhon Sawan

(Year 2012; 8,055,000), Suphanburi (Year 2015; 7,259,000), Suphan Buri (Year 2014; 7,125,000), Suphan Buri (Year 2013; 7,094,000), Nakhon Sawan (Year 2011; 6,955,000), Suphan Buri (Year 2004 (6,532,000), Nakhon Sawan (Year 2011; 6,955,000), Suphan Buri (Year 2004; 6,532,000), Nakhonsawan (Year 2011; 6,955,000), Suphan Buri (Year 2004; 6,532,000) and Nakhonsawan (2010; 6,499,000), respectively. From Table 3, the factors that influence corn yields are the amount of rainfall, average temperature along with the influence of the trend. If the amount of rain increases by 1 mm, the average annual corn yield will increase 73.45 tons. If the average temperature increases 1 Celsius, the average corn yield per year will be reduced by 40.44 tons and when the time increases 1 year, the yield of corn will tend to decrease 1.74 tons. The spatial influence of each province in the central area of Thailand on the average annual corn yield shows that the top 9 provinces, ranking from the highest to the least values, are Chainat (109,900), Suphan Buri (79,660), Nakhon Sawan (48,090), Phichit (-2,065), Kamphaeng Phet (-19,060), Lop Buri (-31,260), Saraburi (-37,190), Sukhothai (-71,040) and Phitsanulok (-77,070), respectively. For the average annual corn yield estimates being over 50,000 tons, the first top 10 provinces, ranking from highest to lowest values, are Phichit (Year 2011; 511,200), Phichit (Year 2012; 476,400), Chainat (Year 2012; 449,500), Chai Nat (Year 2011; 444,300), Chai Nat (Year 2010; 427,900), Chai Nat (Year 2009; 398,800), Chai Nat (Year 2003; 296,000), Chainat (Year 2005; 294,300), Chainat (Year 2006; 286,500) and Chainat (Year 2008; 285,200), respectively.

Discussion

Linear Mixed Model (LMM), which contains the spatial effects in this research, is suitable for rice, corn and sugar cane yields because it considers the spatial relationship of the data. Spatial relationships arise from the principle of the fact that things that are close together are more relevant than things that are far apart. Therefore, the quantity of crops in adjacent provinces or nearby inevitably results from spatial relationships. When spatial influences being added into the model, the model becomes more complex. Estimating parameter methods that are commonly used, such as Maximum Likelihood (ML), cannot be used. Therefore, Bayesian method with the Markov Chain Monte Carlo (MCMC) process is a widely popular method that can be used to solve these problems. Bayesian methods have some advantages. One thing is that the answer can be found no matter whether the sample is small or large, unlike ML methods that require large samples. The MCMC process is a computer-based sampling. Although we do not know the form of the probability distribution of the function, we can estimate the parameters such as the mean, standard deviation, by using the real number sampling from many functions. There are saveral random methods such as Gibb sampling, for exampl.

4. CONCLUSIONS

The aims of this research are to propose an appropriate and efficient model for analyzing rice, sugarcane, and corn yields data. A linear mixed model (LMM) with spatial correlations was adopted. Bayesian parameter estimation is used. The results show that, for rice yields, the amount of rainfall in the harvest, the temperature in the harvest and the trend influence on the rice, sugarcane and corn yields. The proposed model can be applied to other crop yields. It is a suitable model because it consider the spatial correlation which usually occurs in the data collected in each area.

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The Feasibility Study for Preventing the Formation of Fouling in The Heat Exchanger by Using Electric Charge Properties

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ABSTRACT

The objective of this study is to find a possible way to prevent fouling in the heat exchanger. Fouling causes the heat exchanger to clog which results in a loss of efficiency. In this study, a prototype of a simulation was designed similar to the water flow conditions of a real heat exchanger. In this prototype, two sets of copper tube with a thickness of 0.5mm and 1.5 mm was used and compared. In each experiment, a generator was used to supply the electricity of 10, 20 and 30 volts respectively into the two copper tubes installed in the simulation system, one side being the positive terminal and the other side being negative. From this study, it was found that in the positive charged copper tube occurred a large amount of fouling whereas the negative side was insignificant. In addition, the study also found high corrosion on the copper tube connected to the positive charge while the negative copper terminal was reluctant to corrosion. Moreover, different thickness of tubing had different rate of corrosion. The copper tube with thin walls (0.5 mm thickness) tend to be less corrosive than a copper tube with thick walls (1.5 mm thickness). Similarly, rate of corrosion was found proportional to the voltage.

Keywords: Heat exchanger, Fouling, Electric charge, Corrosion

1. INTRODUCTION

The hydroelectricity is an open power plant that uses water from the dam to rotate the large turbine axis connected to the generator. When the turbine spins for a long time, it will heat up. It uses oil for cooling and controlling the temperature. The coolant oil is sent to the heat exchanger in order to reduce the temperature of the heat exchanger. While the oil cools the power plant, it gains some temperature. To cool the oil down rapidly, dam water is used. The convection and conduction process of cold water and warm oil set apart by a metal casing is rapid due to the turbulent flow of the oil through a tube. Then, the oil that has been cooled by the water is sent to cooling the turbine again.

The heat exchanger is one of the main equipment in the electricity generation process of hydroelectricity. It is used to cool down the entire plant to operating conditions. The problem here is the water that is used to cool the coolant oil which usually comes from natural sources such as rivers, dams or seas. This often consist of large amount of minerals, debris, and clay. Water is constantly pumped into the heat exchanger and using this water for a long-time, fouling will occur resulting in reduced heat exchange efficiency [6]. Fouling reduces the convection and conduction process resulting ineffective temperature of the coolant oil [9, 10]. In order to fix this, entire plant needs to stop to clean the heat exchanger. This needs to be done frequently. In a hydroelectricity plan, to start a new production process, it requires a lot of fuel and takes longer to enter the equilibrium state. This causes loss in budget and the amount of electricity generated per year. Therefore, in this study, we focus on finding a possible way to reduce the extensity of the problems.

Charge is the basic property of all matter. Each includes protons, neutrons and electrons which are positive, neutral and negative respectively. Positive attracts negative and vice versa and similarly charged repel. Naturally, most matter are found in an equilibrium state unless exposed to certain types of energy. These energies could be in the form of electricity, light, heat etc. In our case, we are using electricity to break down and attract the sediments and minerals in the water to the electric terminals. Understanding the nature of collection of particles in the terminals will help us find the solution for the fouling problem [5].

Usually, the minerals and particle found in the water are negatively charged. When enough electricity is passed, they are attracted to the positive terminal. Therefore, collecting these particles in the proposed system prior will result in lesser fouling in the heat exchanger. The proposed system is cheap and easy to maintain and implement.

2. EXPERIMENTAL

2.1 Material

In this study, copper pipe is a crucial component. Copper in natural state are reluctant to corrosion, similar to gold, silver, aluminum etc. We chose copper as our key material in this experiment because it is cheap, abundant and conducts electricity very well. There are two thickness of copper tube specified in Table 1.

Table 2 Treatments

Treatment	Diameter	Thicknes	Length	Electric charge
T0.5_P	1/2"	0.5 mm	100 mm	Positive
T0.5_N	1/2"	0.5 mm	100 mm	Negative
T1.5_P	1/2"	1.5 mm	100 mm	Positive
T1.5_N	1/2"	1.5 mm	100 mm	Negative

The water flow system model of our prototype is similar to a heat exchanger. The water pump is used for circulate water through a polyvinyl chloride pipe (PVC) designed to allow water to flow back to the starting point. We cut open a section on the top half of the pipe to make the experiment area as shown in Figure 1.

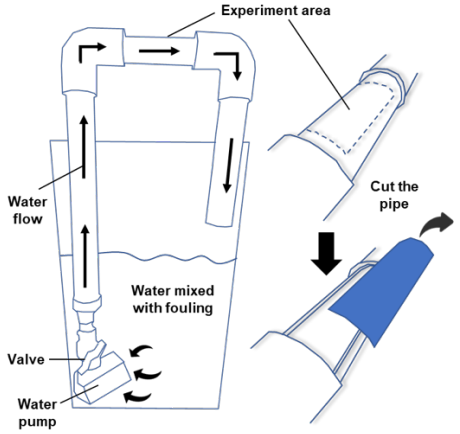

Figure 18 Water flow system model

In order to be able to place the copper tube into the experiment area without copper touching the PVC pipe, a fixture was designed and 3D printed.

2.2 Experiment setup

Two pieces of the same thickness copper tube is placed in the experimental area and held down by the fixture. After this, insulated wires are used to connect the tubes to the power supply's positive and negative terminal as shown in the figure 2.

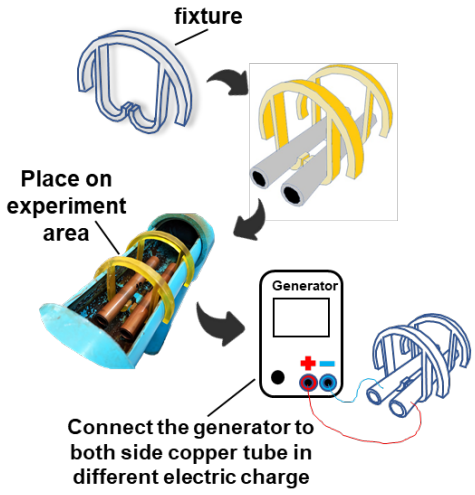

Figure 19 Show the placement of copper tubes with fixture connected to the generator

2.3 Method

Initially the mass of the copper tube is measured(W_1). This copper tubes are placed in the experimental area. Once the tubes are placed correctly, the copper terminals are connected to the positive and negative of the power supply. Then the power supply is turned on. Finally, the water pump is initiated with a similar flow rate of a standard heat exchanger of a hydro-electricity plant.

The experiment is done for an hour, each with a different voltage configuration, i.e. 10, 20 and 30 Volts. Each time an experiment is completed in a voltage setting, the copper tube is then carefully placed in a paper bag. Since, the fouling in copper tube would have significant amount of water observed, we bake the specimen. After the specimen is fully baked, we measure its weight. Later we wash the fouling, re-bake the copper tube and measure its weight again for quality control purposes. We bake each sample at 70 degree C until most of the water is removed.

Therefore, the amount of fouling can be calculated using equation 1

(1)

Where F is the fouling weight; W_2 is the weight of the copper tube after the experiment + the weight of the paper bag W_b is the paper bag weight; W_3 is the weight of the copper tube after washing. All unit are in grams.

The corrosion rate of the copper tube can me calculated from equation 2

(2)

Where CR is the corrosion rate in mils per year (MPY); W is the weight of the missing copper tube (W_1 - W_3) in grams; D is the metal density in units of g / cm^3; A is the surface area of the metal in square inches and T is the time used to test the unit in days [8].

3. RESULT

3.1 Fouling weight

From figure 3 , it can be seen that the positive charge side of the copper tube occurred a large amount of fouling and the negative side had bare minimum.

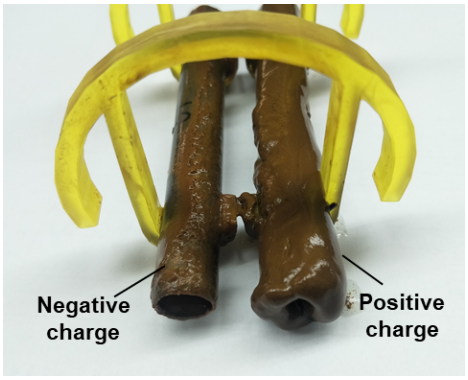

Figure 20 Showing the formation of fouling between negative and positive charges

From the results obtained, it was found that increasing the voltage level would increase the fouling weight on the positive charge of the copper tube. At 30 volts, it was found that the fouling weight was the highest in both pipe thickness i.e. 0.5mm and 1.5mm which were 420 mg and 560 mg fouling in positive terminal and 30mg and 40mg fouling negative terminal respectively. In 10 Volts and 20 Volts the fouling in the negative terminal was insignificant. Figure 4, demonstrates the full result obtained.

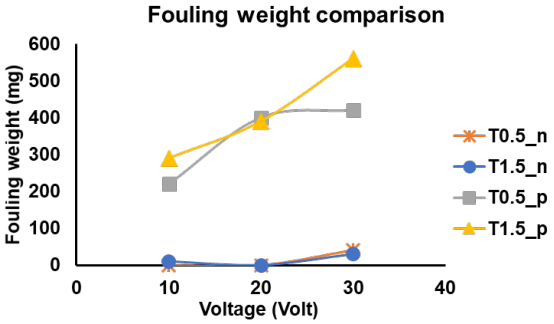

Figure 21 Effect of voltage level on fouling weight

3.2 Corrosion

Figure 5. shows the corrosion on the surface of the copper tube connected to the positive charge causing the mass of the copper tube to decrease. From the results, it was found that when increasing the voltage level, the corrosion is more severe, as shown in Figure 6. At 30 volts the corrosion rate of the positive terminal copper of 0.5 mm thick tube is 1489.84 mils / year and 2210.83 mils / year for 1.5 thick tube. Therefore, the thick copper tube tends to be more corrosive than thin copper tubes when voltage is increased but at the same time more fouling is occurred.

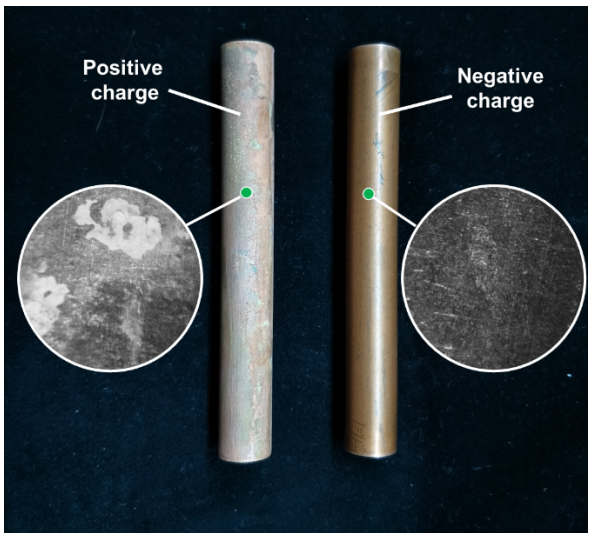

Figure 22 Effect of electricity on copper tube

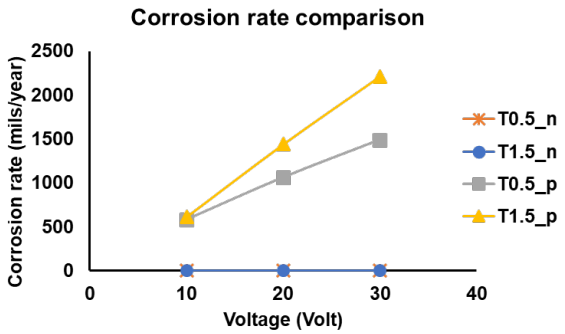

Figure 23 Effect of voltage level on corrosion

4. CONCLUSIONS

Based on the study of possible approach to solve the fouling problem in heat exchanger, the results are summarized as follows:

4.1 Fouling behavior

The particles/debris in water when passed electricity tend to be negatively charged more and get attracted to the positive terminal. These fouling can be composition of clay and minerals.

4.2 Amount of fouling

Increasing the voltage level increases the amount of fouling builds up at the positive terminal of the copper tube. The negative terminal seems to be insignificant with the increase of voltage. It seems that in a larger scale, 10V seems to be sufficient to prevent large fouling happening in the heat exchanger. However, more experiment for longer period with different water sample is required.

4.3 Corrosion rate

The limitation of this approach of preventing fouling form occurring in the heat exchanger is that passing electricity through copper in an uninsulated environment causes oxidation to occur resulting in corrosion. Moreover, different minerals react differently to copper when charged and requires further investigation.

Since, the thin copper wire tend to corrode less than a thick one, using a thin copper tube is seen to be feasible. However, an in-depths analysis is required to find the optimal thickness to fouling ratio and thickness to corrosion ratio.

Based on the above conclusions, it can be concluded that the proposed method is likely to be prevented fouling in the heat exchanger.

5. ACKNOWLEDGMENTS

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A STUDY OF OUTPUT VOLTAGE HARMONIC DECREASING OF GRID TIE CONNECTED INVERTER FOR SOLAR ENERGY SYSTEM USING LLCL FILTER

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ABSTRACT

This paper presents a study of output voltage harmonic decreasing of grid tie connected inverter for solar energy system using LLCL filter using Single Phase AC to AC Converter building Pulse Width Modulation, PWM to control the switching of MOSFET. The microcontroller TMS320F2808 is compatible with MATLAB program using the module generates a pulse width modulated boost converter to drive an AC to AC converter to generate a voltage of 0-220 V, 50 Hz which has the root-mean-square maximum output voltage at 220 volts in sinusoidal waveform. The output voltage can control by adjusting the duty cycle from 10 percent to 95 percent when connected to 300 W of load.

1. INTRODUCTION

In the work needs to control the voltage sine wave frequency of 50 Hz and can be adjusted to the required pressure From the lowest level at 0 volts to the highest level at 220 volts. Can be achieved by applying a sine voltage of 50 Hz through the AC power conversion circuit, as shown in Figure 1, which operates at a switching frequency of 20 kHz with With through the circuit filter circuit In the research, an AC power conversion unit was constructed using the Texas Instruments company TMS320F2808 and used with the program. Matlab / Simulink Creates pulse width modulation signal. In order to adjust the voltage of 0 - 220 volts 50 hertz, and then take the sine wave that is switched with a frequency of 20 kHz to perform mathematical calculations to find various elements And using the data to design the circuit filter circuit. PLC filter circuit that can be obtained [6] but due to the sinusoidal pressure signal obtained, it is necessary to have good quality. Which working at high frequencies may have high frequency. This article presents a test of a single-phase AC to AC converter that has a pulse width modulation signal (Pulse Width Modulation, PWM) to control the switch of the MOSFET With the microcontroller number TMS320F2808 which is compatible with MATLAB program by using the pulse width modulation signal generation module To create an AC voltage of 0-220V 50 Hz that can adjust the voltage With the average square root of the maximum output voltage at 220 volts, with sine wave characteristics Voltage control of the circuit By adjusting the duty cycle from 10 percent to 95 percent while the load is 300 watts

A. AC TO DC HALF BRIDGE INVERTER

The main power circuit features of conventional half bridge inverter as shown in Fig. 1 consists of the two IGBTs with a diode connected in series, filter inductor (L_{filter}), two filter capacitors (C_{filter})

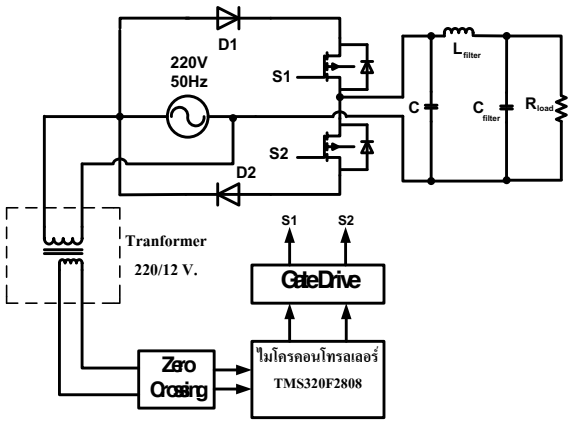

Figure 1. Conventional full bridge inverter

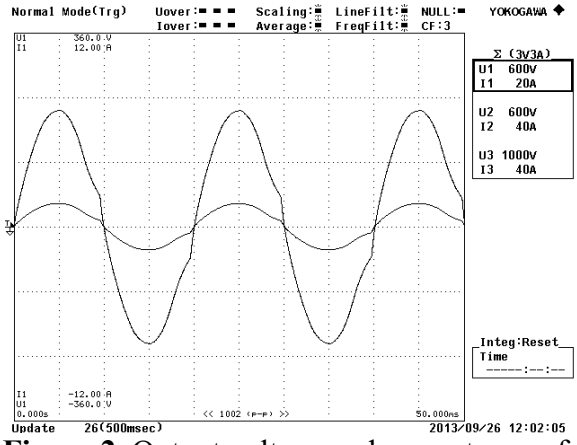

Figure 2. Output voltage and current wave form at 70% of load

DUTY CYCLE & PHASE SHIFT CONTROL INVERTER

The main power circuit features of a full bridge phase shift as shown in Fig. 1 consists of the two IGBTs with a diode connected in anti-parallel, resonant inductor (L_r), two resonant capacitors (C_{r1} and C_{r2}) and two filter capacitors (C_{o1} and C_{o2}), and choke (L).

$$f_r = \frac{1}{2\pi\sqrt{LC_0}} \quad (1)$$

$$L = L_0 + \frac{L_1 \cdot L_2}{L_1 + L_2} \quad (2)$$

$$f_r = \frac{1}{2\pi\sqrt{LC_0}} \quad (3)$$

$$L = L_0 + \frac{L_r}{2} \quad (4)$$

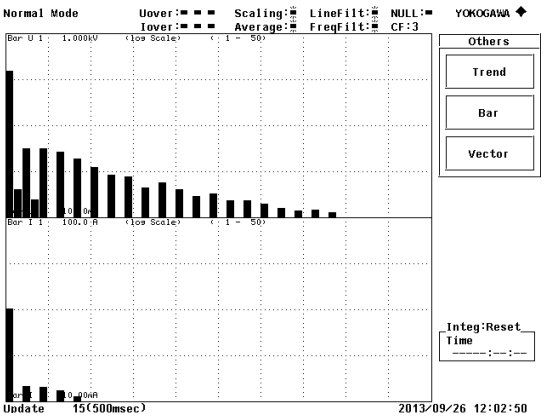

Figure3. Spectrum output voltage and current at 70% of load

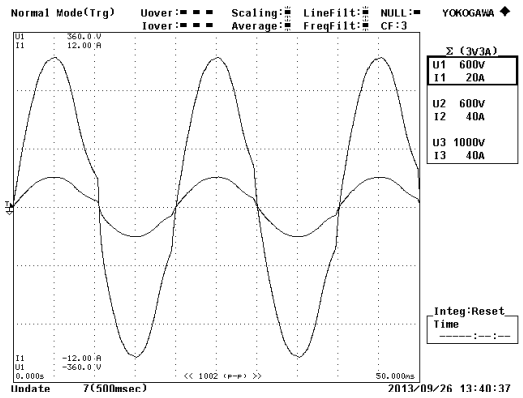

Figure4. Output voltage and current wave form at full load

2. EXPERIMENTAL RESULTS

To verify the validity of the bidirectional converter with asymmetrical duty cycle control, a computer simulation and a hardware experiment are performed. The current and voltage across switches (S_1 and S_2) simulation waveforms of the system are shown in Fig. 3 and 4. Next, the duty cycle is adjusted to 50% for the maximum power.

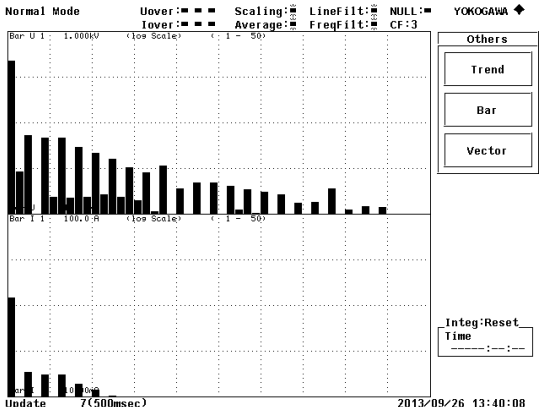

Figure 5. Spectrum output voltage and current at full load.

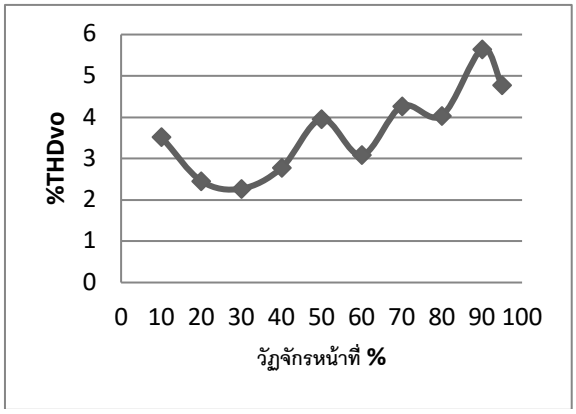

Figure 6. Harmonic distortion and output voltage adjusting the duty cycle at 300 watts load

3. CONCLUSIONS

Harmonic measurement tested by adjusting the duty cycle of 10 - 95 percent. The LC filter circuit can actually filter out high frequencies from the high frequency sine voltage. The load testing is loaded which used a 150 ohm 300-watt resistance because it cannot adjust the duty cycle to 100 percent. Therefore need to increase the input voltage of the AC power converter circuit to be greater than 220 volts, which causes the output voltage while the load is 220 volts at the 95 percent duty cycle in the harmonic distortion value combines the output voltage to be no more than 5 percent. The microcontroller number TMS320F2808 can be used to create one-phase AC converter circuit. And can record data to the EEPROM of the TMS320F2808. Actually, the signal cable that can be connected to the computer can be disconnected without the lost program recorded.

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LOW Q SERIES RESONANT INVERTER FOR COOKING APPLICATIONS

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ABSTRACT

Low Q series resonant inverter for induction cooking applications is proposes in this paper. Switches devices operate in zero-voltage soft switching mode. A control strategy of the resonant inverters with low quality factor loads using a phase-locked loop control to ensure zero-voltage switching (ZVS) operation for optimal power transfer and high reliability is introduced. Simulation and experimental studies have confirmed the validity of the proposed analysis and control method. The benefits of knowing the region of ZVS operation are the insight in the selection of optimal operating condition as a systematic approach while maintaining ZVS operation with high efficiency control method. This greatly facilitates the resonant inverter design process.

1. INTRODUCTION

Recently, there has been an increasing need in the use and research of induction heating (IH) applications based on inductive coupling for contactless energy transfer to the workpiece via magnetic induction couplings where high efficiency, system reliability, convenience, compactness in volumetric physical size, light weight, clean, and safety are required. Induction cooking applications have become increasingly popular in home appliances, implantable biomedical devices, inductive charging systems, space solar power satellites, and others. To address the sizing limitation of the source and optimized power transfer, a resonant compensation is a suitable technique for maximum energy transfer from the power supply to the load. High-frequency resonant inverters have been adopted to provide power to the load. They are commonly found in industrial, automotive, pipeline and consumer applications where compactness in volumetric physical size and light weight are required. The use of a higher switching frequency may result in higher switching losses, resulting in a lowered efficiency. However, resonant inverters are more efficient than comparable PWM inverters because the resonant inverters can be operated under the zero-voltage switching (ZVS) and/or zero-current switching (ZCS), thereby reducing or eliminating some of the switching loss mechanisms for improving the inverter efficiency.

An induction cooking worked at high frequency between 20 kHz and 40 kHz works in the basic of electromagnetic induction to heat bottom of cooking vessels. However, to avoid the acoustic noise (20 Hz to 20 kHz) from the coupling between the induction coil and the cooking vessel, the operating frequency of the inverter must be over 20 kHz. In induction cooker system, the load characteristics depend on many factors including type of material, dimension and coupling of the induction coil and cooking vessel. The quality factor value of the induction coil without the cooking vessel is typically more than 100 whereas the one with the cooking vessel is less than 3 [58].For low-cost vessels, the quality factor value is even lower due to its lower equivalent inductance and higher equivalent resistance. Thus induction cooker is selected to study behaviors and waveforms of resonant inverters under operating conditions of low Q resonant circuit. Low Q

LCR resonant inverter for induction cooking applications is proposes in this paper. Switches devices operate in zero-voltage soft switching mode. A control strategy of the resonant inverters with low and high quality factor loads using frequency control to ensure zero-voltage switching (ZVS) operation for optimal power transfer and high reliability is introduced. Simulation and experimental studies have confirmed the validity of the proposed analysis and control method. The benefits of knowing the region of ZVS operation are the insight in the selection of optimal operating condition as a systematic approach while maintaining ZVS operation with high efficiency control method.

CONVENTIONAL HALF BRIDGE CONVERTER

The conventional half bridge converter shown in Fig. 1 is made to operate with bidirectional power transfer. The converter can operate in boost mode and buck mode by adjusting the duty cycle of switches S_1 and S_2.

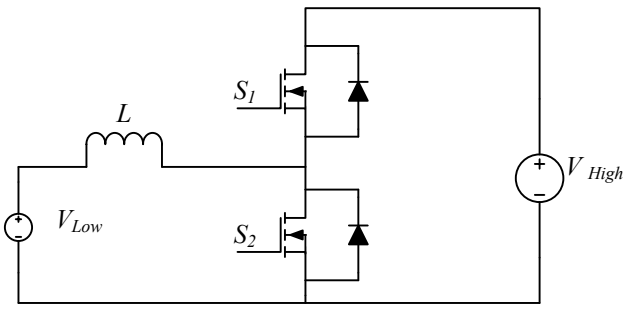

Figure 1. Conventional half bridge converter

But this topology has the loss of switch the turn-on and turn-off loss. In addition, the inductor current has big ripple which is the cause of efficiency reduction in converter using hard switching control

LOW Q HALF BRIDGE RESONANT INVERTER

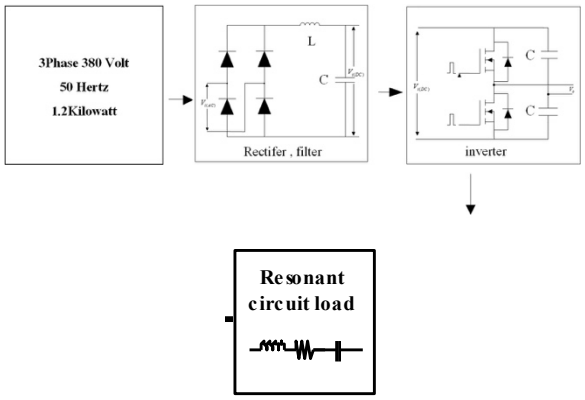

Figure 2. Low Q half bridge resonant inverter

Fig. 1 shows the circuit configuration of the *LCR* resonant inverter, which consists of four parts. In the first part is a full-wave rectifier that converts the ac-input voltage to dc-output voltage. The **electrolytic capacitor C_{DC} is used to filter the** ripple output voltage of a full-wave rectifier. The half bridge inverter using four Insulated-Gate Bipolar Transistors (IGBTs) with anti-parallel diode in second part is generated the ac-output voltage at the high switching frequency for driving the ultrasonic cleaning. The third part is the series inductor L_s. In the fourth part is the ultrasonic cleaning to remove the contaminants on the work-piece.

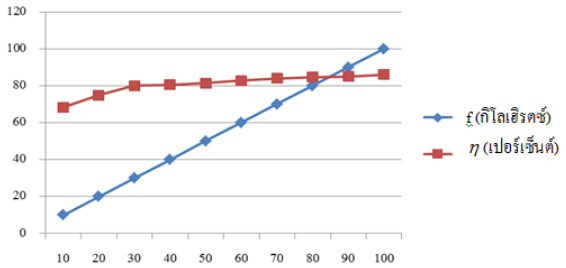

Figure3. Frequency and efficiency of LCR resonant inverter

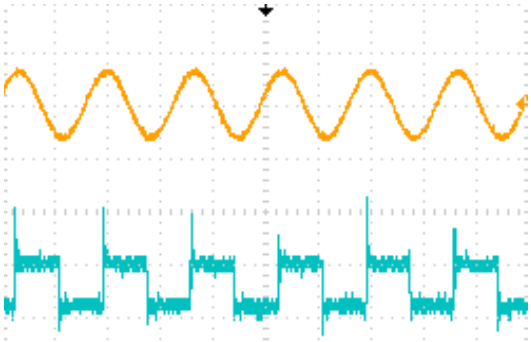

Figure 4. Low Q output current and voltage of LCR resonant inverter

To validate the proposed analysis and control method for the inverter topologies as described in this paper, hardware prototypes are created. The *LCR* resonant inverter for induction heating system is considered first. Then the wireless power transfer system is presented.

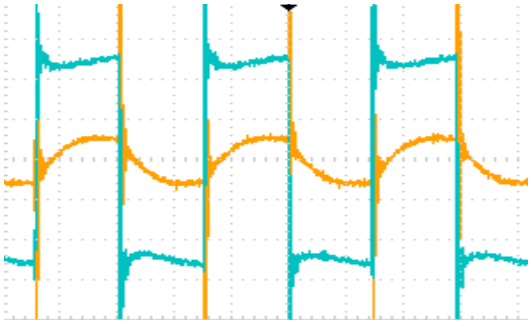

Figure 5. Low Q output current and voltage of LCR resonant inverter

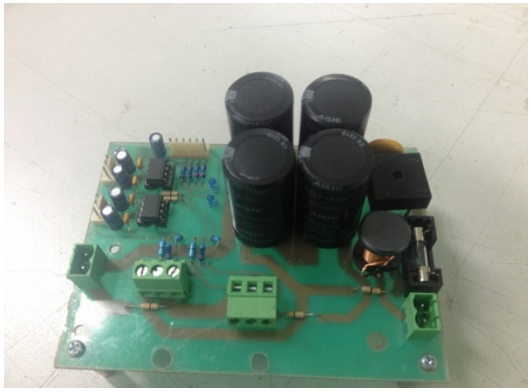

Figure 6. Hardware experiment

2. CONCLUSIONS

This paper has proposed the *LCR* half-bridge resonant inverter using an asymmetrical voltage control with the resonant frequency tracking under parameter variation for ultrasonic cleaning application. The output power regulation of the proposed method can operate under the ZVS operation all parameter variation. Moreover, the wide operating range ZVS of the inverter is improved by a series inductor L_s. Thus, this work has the following advantages. The output power can be adjusted suitably for all operating conditions. The inverter has high efficiency because the switching frequency is located above and closed to the resonant frequency where the zero voltage switching is achieved. The maximum power transfer at the actuator can be improved by the automatic switching frequency.

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TWO OUTPUT COILS DESIGN OF AN INDUCTION COOKER

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ABSTRACT

This paper features two output coil design of power induction cooking that independently adjust the output power of the full bridge circuit, controlled by asymmetric voltage regulator with dsPIC30F2020 IC, total power 1.5kW. AC 220 V single phase power can adjust the power and heat used to cook food independent of each other. Can adjust the power and heat used to cook independently of each other with the IGBT switch generates high-frequency signals and heat-induced coils. Use the induction principle of the magnetic field between the induction cooker. Can adjust the heat level output has five levels.

1. INTRODUCTION

High-frequency resonant inverters for induction heating (IH) technology have widely been used in industrial, automotive, pipeline and consumer applications where high efficiency, system reliability, safety, cleanliness, compactness in volumetric physical size, light weight, and performance are required [1]. The use of higher switching frequency results in higher switching losses, causing a worse efficiency. However, this switching loss can greatly be reduced by the soft-switching technique [2]-[6]. Zero-voltage switching (ZVS) technique is one of soft-switching techniques, which is the representative feature of resonant inverters and is suitable for high-switching frequency operation. The ZVS operation not only avoids switching losses, but it also reduces electromagnetic interference (EMI) and device stresses, and allows the possibility of snubberless operation [4], [7]-[10]. The voltage-source resonant inverter topologies have received much attention because of its output power control capability under ZVS operation. Several switching techniques have been reported in high-frequency IH applications such as the pulse-frequency modulation (PFM) [11], pulse-density modulation (PDM), asymmetrical duty-cycle (ADC), phase-shift (PS) and asymmetrical voltage-cancellation (AVC). The resonant inverters are widely used for medium power induction cooking applications. The topology of inverters has many techniques such as the single switch [2], the half bridge inverter [3], and full bridge inverters [4]. The output power needs to be controlled at the desired level. For the pulse-frequency modulation (PFM) control, the output power can be controlled by varying the switching frequency [5]. However, the drawbacks are the low efficiency and electromagnetic interference (EMI). The phase-shift (PS) control technique controls the power by shifting the phase of the switch conduction sequence [6]. The pulse density modulation (PDM) control proposed in [7] can reduce the power loses on the switches and has the wide power range operation. The asymmetrical voltage-cancellation (AVC) in [4] can achieve higher efficiency than other techniques but the

operation at low power level is limited due to the ZVS requirement.

This paper presents two output power control of induction cooker with full bridge inverter controlled by asymmetrical voltage control for induction cooking appliances. The advantages of proposed control scheme are the wide power range operation at the high efficiency.

2. DUAL OUTPUT FULL BRIDGE INVERTER

The methodology must be clearly stated and described with sufficient detail or references.

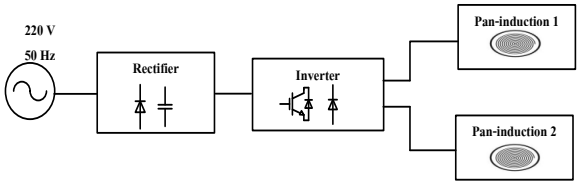

Figure 1. Dual output full bridge inverter system.

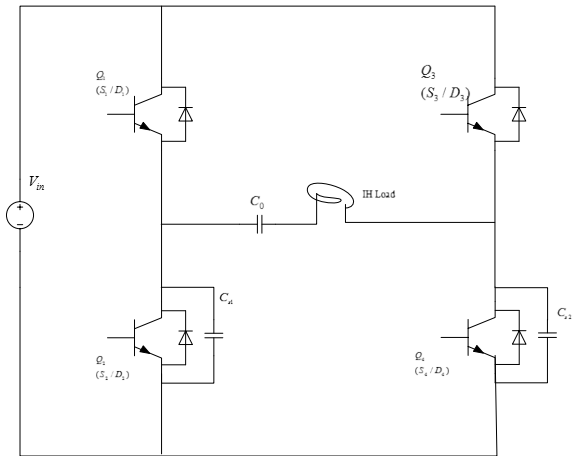

Figure 2. Conventional full bridge series resonant inverter

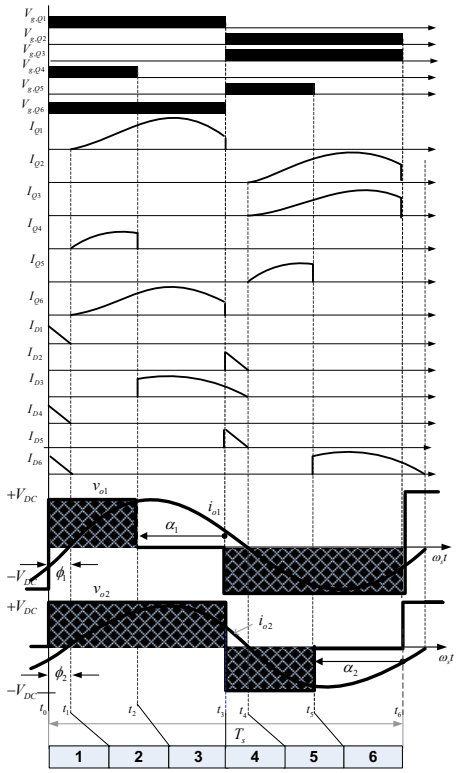

Figure 3. Typical voltage, current and signal gate drives

COIL DESIGN

The methodology must be clearly stated and described with sufficient detail or references.

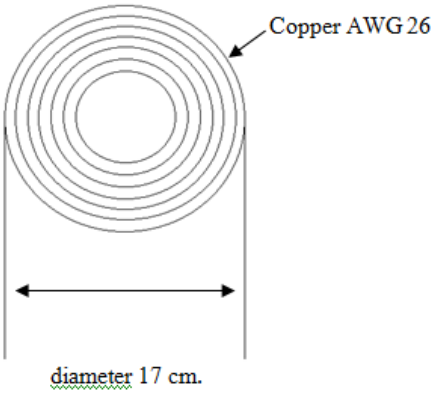

Figure 4. Two output coil design of induction cooker with full bridge inverter

In general, the induction coil is made of copper. This is because copper is a good conductor, resulting in low power loss in the induction coil. It will result in a high efficiency system. However, due to the current density in the induction coil is high. The heat generated by the current flowing in the induction coil is very valuable. Because the current in the coil is high Induction coil designed and built as shown in Figure 3 From the induction coil designed in the previous section, measured with an inductance meter Which the value is estimated In this project, the HIOKI 3532-50 LCR HITESTER was used. The frequency of the instrument was 40 kilohertz. The inductance was estimated to be 58.57 uH. An error from the meter Therefore, choose the size of the capacitor value at 40 kHz resonance frequency as follows:

From $f = \frac{1}{2\pi\sqrt{LC}}$

So $C_r = \frac{1}{4\pi^2 f^2 L}$

$$C_r = \frac{1}{4\pi^2 \left(40\times10^3\right)^2 \left(58.57\times10^{-6}\right)}$$

$$C_r = 0.27\mu F \approx 0.3\mu F$$

Capacitor value is about 0.3 micro Farad, so will use the capacitor size 0.3 micro-farad, 2 pieces. This value is different from the calculated values. Due to the value of the capacitor being used and the installation of the capacitor in the induction coil Therefore, using a capacitor with a value of 0.3 micro Farad

3. EXPERIMENTAL RESULTS

The simulation results of the full-bridge series resonant inverter for AVC control by the PSPICE program have been carried out. The parameters of series resonant load for simulated program are R_{eq} = 5 Ω , L_{eq} = 64.34 μH , and C_o = 330 nF . The dc input voltage V_{DC} is 110 V. The four power switches of Q_1 to Q_4 use the IGBT connect with the D-brake. The switching frequency f_s is 41 kHz. Figure 4 - 6 shows the simulated results of the output voltage v_o and the output current i_o waveforms. Figure 4 (a) shows the result at the output power at the full load (1,158 W). Figure 4 (b) shows the result at the output power at 87 % of full load. Figure 5 (a) shows the result at the output power at 60 % of full load. Figure 5 (b) shows the result at the output power at 40 % of full load. Figure 6 (a) shows the result at the output power at 20 % of full load. Figure 6 (b) shows the result at the output power at 10 % of full load, which is the minimum output power. Figure 7 shows the efficiency comparison between PDM/AVC and AVC control. The wide range of the output power for PDM/AVC is approximately 10% to 100%, but the range of the output power of AVC is approximately 25% to 100%. The high efficiency of the proposed control scheme can be achieved especially at the light load.

Table. 1 Coil Efficiency

f (kHz)	R_c (ohm)	R_{c+w} (ohm)	η (%)
10	4.21	6.16	68.34
20	9.22	12.3	74.95
30	14.75	18.45	79.94
40	19.81	24.59	80.56
50	24.98	30.71	81.34
60	30.53	36.88	82.78
70	36.11	43.02	83.93
80	41.61	49.15	84.65
90	46.82	55.03	85.08
100	52.56	61.14	85.97

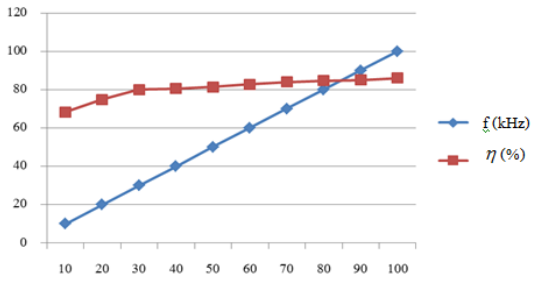

Figure. 5 Coil efficiency and frequency

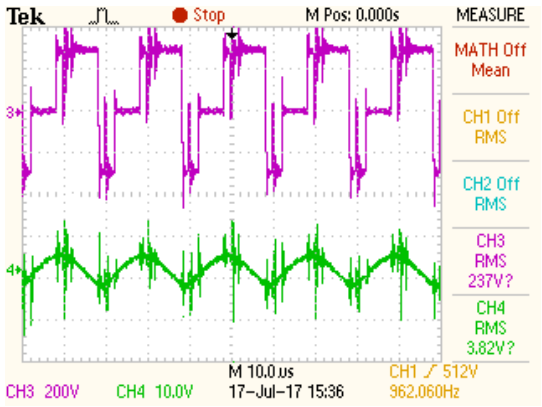

Figure. 6 the voltage and current output results waveform.

This paper proposes the comparison of the average power between old and new topology. The topic consists of three topics such as [1] the simulation [2] the average power and [3] the comparison of the average output power.

4. CONCLUSIONS

In this paper, two independent power induction cooking use an improved asymmetrical voltage-calculation control for induction cooking appliance with the power loss analysis. The experimental results are shown with different output power under operating of ZVS conditions. A performance of improved topology is better than the normal control strategy.

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THE TIME DELAY OF DUAL PHASE LOCK LOOP FOR INDUCTION HEATING IN HIGH TEMPERATURE APPLICATION

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ABSTRACT

In this paper, the time delay of dual phase lock loop and asymmetrical voltage control for induction heating in high temperature application employing with full bridge series resonant inverter built around IGBT as its switching devices suitable for aluminum heating 500 grams with bar type is presented. Heating times of 10 minutes were achieved at a power level of approximately 4 kW. The operating frequency is automatically tracked to maintain a small constant lagging phase angle using dual phase lock loop when brass is melted. The coil voltage is controlled to protect the resonant capacitors. The experimental results are presented

1. INTRODUCTION

The induction heating principles have widely been used in industrial or consumer utilizations such as home induction cookers, induction brazing, forging, melting, and surface hardening, etc., [1] where cleanness, flexibility, reliability, high efficiency and performance are required. Power semiconductor devices are extensively applied in medium to high-power inverter for induction heating applications. The inverter uses zero voltage switching (ZVS) to reduce switching loss, allowing high switching frequency [4], [5]. An overview of characteristics and control methods of the voltage source and the current source topology is illustrated in [1, 13]. Voltage source inverter has various control methods used for improving the efficiency such as variable frequency or pulse frequency modulation (PFM), phase shift (PS), pulse density modulation (PDM) and control rectified dc link. A Current source inverter (CSI) has a limited number of control methods, but it is less affected by input voltage ripples and it has short circuited protection capability [2]–[5]. Voltage-source or Current-source inverter for induction heater has employed many switches such as IGBT, MOSFET, SIT, SCR etc.

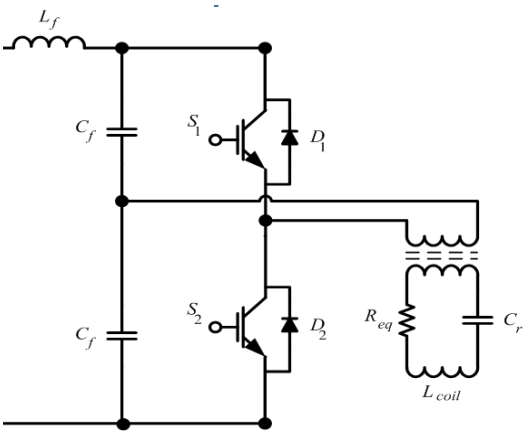
Voltage-source resonant inverters (VSI) are widely used in applications that require output power control ability where a zero-voltage switching (ZVS) condition must be met to ensure a high efficiency [4-7]. Recent developments in switching schemes and control methods have made the voltage-source resonant inverters widely used in applications that require output power control capability. For example, in pulse-frequency modulation (PFM), the output power can be controlled by varying the switching frequency while the inverter operates under zero- voltage switching (ZVS) scheme [3]. This variable frequency control method has several demerits [1, 4] including a wide noise spectrum which makes it difficult to limit electromagnetic interference (EMI), more complex design of filtering out for the output voltage ripple, and poor utilization of magnetic components [5]. The resonant voltage inverter needs an output transformer for matching the output power to the

induction load. Most induction heating applications require accuracy in output power control capability. For example, induction cooker require accurate power control over a wide range of output power for different cooking presents where a ZVS condition must be met to ensure high efficiency [2-4]. The reviews of the induction cooking are on a series resonant load where the load temperature is low and parameters remain constant. For the higher power applications, when work piece is melted, the phase lock loop control will be needed to address the issue of parameter variation. The dual phase lock loop can improve the performance of voltage control oscillator (VCO) such as higher operation bandwidth to minimize the effect of noise disturbance and the variation of power supply.

In this paper, the time delay of dual phase lock loop and asymmetrical voltage control for induction heating in high temperature application employing with full bridge series resonant inverter built around IGBT as its switching devices suitable for aluminum heating 500 grams with bar type is presented. Heating times of 10 minutes were achieved at a power level of approximately 4 kW. The operating frequency is automatically tracked to maintain a small constant lagging phase angle using dual phase lock loop when brass is melted. The coil voltage is controlled to protect the resonant capacitors. The experimental results are presented

2. HALF BRIDGE VOLTAGE SOURCE RESONANT INVERTER

A circuit diagram of the basic system is shown in Fig. 1. The half bridge induction furnace comprises of three phase input 380 v 50 Hz, three-phase diode rectifier, single-phase half-bridge IGBT inverter, an induction heating load (induction coil and graphite crucible with brass in side), resonant capacitor, filtering choke and filtering capacitor. The filtering capacitor is necessary to feed a constant voltage into the inverter, so causing a square wave of voltage to be fed to the load by the half bridge arrangement.



II.

Figure 1. Half bridge voltage source resonant inverter

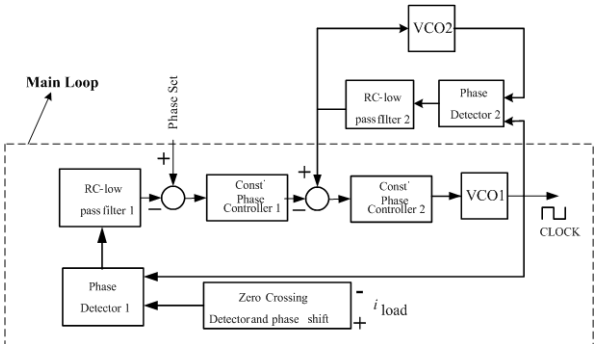


Figure 2. Dual phase lock loop control for induction furnace

The dual phase lock loop control is shown in Figure 3. There are two loops in this control. It comprises main loop which composed of a current sensor at load, zero crossing detector, phase shift circuit, low pass filter 1, phase detector 1, VCO 1 and PI controller 1 and second loop which composed of low pass filter 2, phase detector 2, VCO 2 and PI controller 2. The phase-locked loop integrated circuit is applied for frequency control at a little higher inverter frequency than a resonant frequency. By using exclusive-OR gate and VCO in IC 4046 that are the phase locked IC.

For voltage source resonant inverter, gate drive signal is in phase with signal of load

voltage phase. Hence, we can use VCO 1 output instead of load voltage pulse. Current signal was compared with voltage signal in order to detect the difference of the phase by exclusive-OR gate, which admires to use to be a phase different detector. In close loop by using two IC phase locked loop, we have to convey the voltage signal passes a zero crossing detector to shift 90º of phase origin before bringing it into phase detector 1 and 2. The signal which leaves from phase detector 1 and 2 were filtered by RC low pass filter 1 and 2 to get an average value of voltage. The average voltage conforms to different of phase between voltage and current at load. At that time the voltage is sent into compare with required phase set. The phase error from comparison is the input of constant phase controller 1. The output of phase controller 1 will be compared with the output of the phase lock loop number 2 (VCO2). The parameter of this error is the input of constant phase controller 2 to adjust voltage control oscillation in order to maintain the constant leading phase angle when parameters of heating load are varied.

III. EXPERIMENTAL RESULTS

To validate this proposed control method and circuit configuration, experimental results are performed. The proposed circuit with PLL method is developed. A hardware platform is then created. Computer simulation is discussed in this chapter. The two most important parameters of induction heating power supplies are their frequency and power output [3]. The prototype design required a minimum frequency of 30 kHz and a power rating of approximately 4 kW.

In this section, the results of half bridge resonant inverter with the matching transformer are considered. A half bridge series resonant inverter circuit with dual phase lock loop control technique as shown in Fig. 3-4 is experimented. The resonant frequency is at 32 kHz.

The following parameters are used $V_{in} = 380V$, $L_f = 1.35mH$, $C_f = 220\mu F$, $C_r = 6\mu F$, $L_{coil} \approx 4.5\mu H$ and $R_{eq} = 0.123\Omega$ A prototype induction furnace with half bridge series resonant inverter has successfully been constructed. The 500 grams of brass work piece has been melted in a time of approximately 10 minutes with approximately 4 kW fed to the resonant circuit.

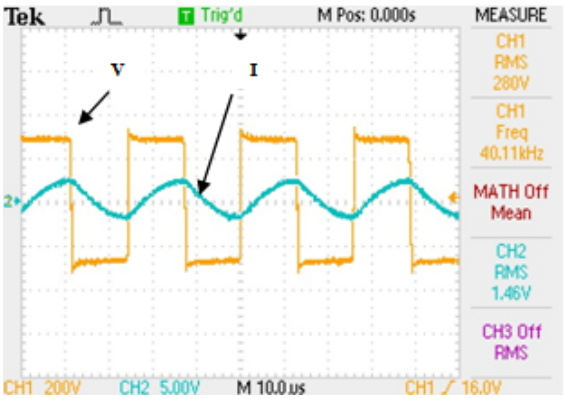


Figure 3. The inverter output voltage and current wave forms at room temperature (I: 20A/div, V: 200V/div and Time: 10 *u*s/div.)

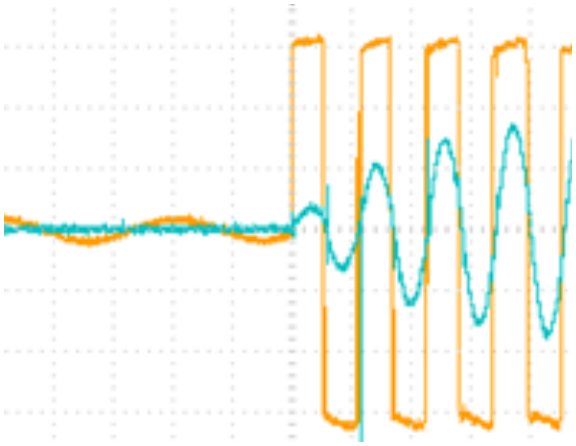


Figure 4. The time delay of inverter output voltage and current wave forms at 1200 º C work piece temperature (I: 20A/div, V: 200V/div and Time: 10 *u*s/div.)

Figure 4 shows the output sinusoidal current and pulse voltage wave forms in repetitive steady state under a full-load condition. The lagging of phase angle is about 32 º and operating frequency is 33.8 kHz. Figure

4 shows the output sinusoidal current and pulse voltage wave forms in repetitive steady state under a full-load condition. The lagging of phase angle is still about 32 º at 35.2 kHz operating frequency. From figure 3-4, it is obvious that zero-voltage soft-switching and no voltage spikes is presented either the need for any snubber circuit or voltage clamping devices was cut, which reduced the number of components needed for the hardware stage.

3. CONCLUSIONS

The dual phase lock loop we proposed can track fast to change and make time delay a little. The purpose of dual phase lock loop can improve the performance of VCO such as higher operation bandwidth and the variation of power supply. Therefore the resonance dual phase locked loop is found to be suitable for the application of the automatic frequency control of the prototype

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CURRENT SOURCE RESONANT INVERTER FOR INDUCTION HEATING APPLICATIONS

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ABSTRACT

A half bridge current source inverter for induction heating with high frequency power supply is proposes in this paper. The two switches are controlled in zero-current soft switching mode. The two IGBTs are driven with common ground that makes it decreasing gate drive supply. The dc choke for filtering the dc current use about 5 mH. The inverter has been operated at 35.7 kHz. The output power transferred to the load is 1200 watts. It can heat the workpiece about 100 grams from room temperature to approximately $800°C$ within 12.30 minutes with unity power factors on the input side.

1. INTRODUCTION

Induction heating principle is a well-known use to make a high temperature of workpiece such as in melting, brazing, surface and hardening. Each application uses different appropriate frequency [1]. Recently, there has been an increasing interest in the study and research of induction heating (IH) based on inductive coupling for contactless energy transfer directly to the work piece via magnetic filed generated by induction coil where high efficiency, system reliability, convenience, compactness in volumetric physical size, light weight, clean, and safety are required. To address the sizing limitation of the source and optimized power transfer, a resonant compensation with capacitor is a suitable technique for transfering maximum power from the power supply to the load. High-frequency resonant inverters have been adopted to supply and adjust the power to the load. They are commonly found in industrial, automotive, pipeline and consumer applications where compactness in volumetric physical size and light weight are required. Recently, the resonant heating is driven by the inverter either the current-source inverter or the voltage-source inverter. Conventional current-source inverters require zero-current switching (ZCS), parallel resonant tank, maintainable output current by series inductor in dc-link, and the output power based on the controlled rectifier in dc link.

Several controls and switching patterns used in VSI have been reported in high-frequency induction heating applications such as variable frequency or pulse frequency modulation (PFM), asymmetrical duty-cycle (ADC), phase shift (PS), pulse density modulation (PDM), asymmetrical voltage-cancellation (AVC), and combination of various strategies. For example, in the pulse-frequency modulation (PFM), the output power can be controlled by varying the switching frequency while the inverter operates under zero-voltage switching (ZVS). This variable-frequency operation has several disadvantages [8] including a wide noise spectrum which makes it difficult to control electromagnetic interference (EMI), more complex filtering of the output-voltage ripple, and poor utilization of magnetic components. The pulse-density modulation (PDM) method can regulate the output power by varying the period in which the inverter supplies high-frequency current to the induction coil [6], [8]. The PDM has the demerit of causing a problem in flicker system regulations and harder

to control the temperature. The asymmetrical duty-cycle (ADC) control technique uses an unequal duty-cycle operation of the switches in the converter. In phase-shift (PS) control technique in [10] the output power is varied by shifting the phase of switch conduction sequences. The asymmetrical voltage-cancellation (AVC) is then proposed in [3], [10]. A combination of PDM and PFM has been used in commercial induction cooking applicances rating up to 12 kW. In [10], the variable-frequency AVC control used in the full-bridge resonant inverter for induction cooker with the low Q resonant circuit, is proposed to identify the condition of ZVS operation by the fundamental harmonic approximation technique. From the review the PFM can use for smoothing and simple to control the precise temperature applications.

Half bridge current source inverter inverter for gear hardening applications is proposes in this paper. Switches devices operate in zero-voltage soft switching mode. A control strategy of the resonant inverters with low and high quality factor loads using a phase-locked loop control to ensure zero-voltage switching (ZVS) operation for optimal power transfer and high reliability is introduced. Simulation and experimental studies have confirmed the validity of the proposed analysis and control method. The benefits of knowing the region of ZVS operation are the insight in the selection of optimal operating condition as a systematic approach while maintaining ZVS operation with high efficiency control method. This greatly facilitates the resonant inverter design process.

2. CONVENTIONAL VOLTAGE SOURCE HALF BRIDGE CONVERTER

The conventional voltage source half bridge converter shown in Fig. 1 is made to operate with bidirectional power transfer. The converter can operate in boost mode and buck mode by adjusting the duty cycle of switches S_1 and S_2.

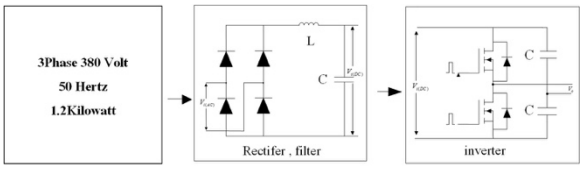

Figure 1. Conventional half bridge inverter

But this topology has the loss of switch the turn-on and turn-off loss. In addition, the inductor current has big ripple which is the cause of efficiency reduction in converter using hard switching control

3. PARALLEL HALF BRIDGE CURRENT RESONANT INVERTER

The parallel resonant inverter or current source inverter needs a switch that can block a bipolar voltage. It can make appropriate switching action by connecting a switch and diode in series. The output voltage of the inverter is sinusoidal, in the case of low Damping Factor and operating frequency is near resonant frequency. The inverter is selected to operate at a little higher inverter frequency than a resonant frequency, in order to achieve zero-current soft-switching which reduces loss at IGBTs switches and protects spike voltage. The voltage across switch has both positive and negative values. The positive voltage is blocked by IGBT and negative voltage is blocked by diodes.

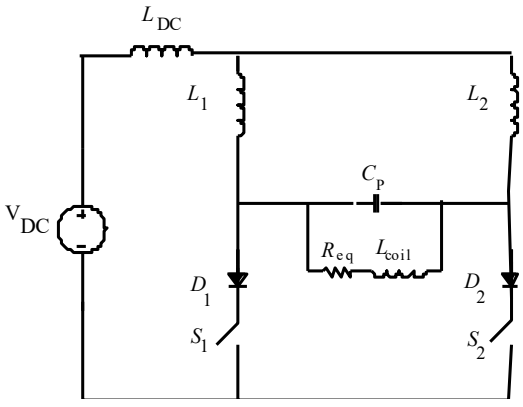

Figure 2 Half bridge resonant current source inverter

Fig. 2 shows the parallel LLCL half bridge current source inverter for induction heating application. The inverter consists of two switches (S_1, S_2) with blocking diodes (D_1,D_2), a resonant capacitor(C_p), a DC inductor (L_{DC}), current source inductor(L_1 and L_2) and an induction coil that comprises of a series combination of resistance (R_{eq}) and coil inductance (L_{coil}).

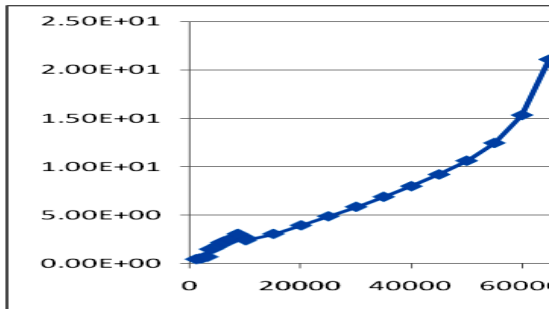

Figure 3 Load Impedance of LLCL resonant inverter

3. LLC HALF BRIDGE RESONANT INVERTER

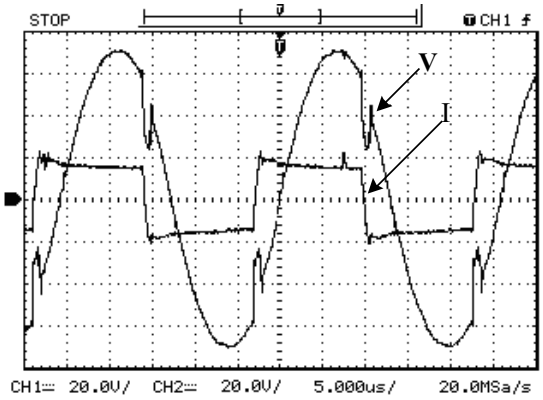

Figure 4 Output current and voltage of LLCL with leading resonant inverter

To validate the proposed analysis and control method for the inverter topologies as described in this paper, hardware prototypes are created. The LLCL resonant inverter for induction heating system is considered first. Then the inductive heating transfer system is presented.

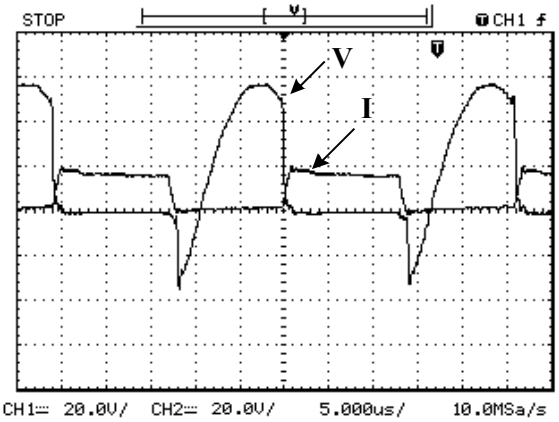

Figure 5 current and voltage across the switch of LLCL resonant inverter

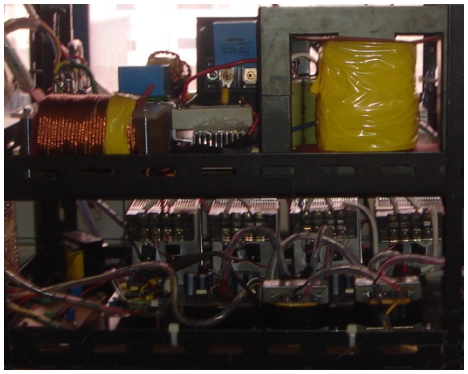

Figure 6 Hardware invertrer

4. CONCLUSIONS

This paper has proposed the LLCL half-bridge resonant inverter using an asymmetrical voltage control with the resonant frequency tracking under parameter variation for ultrasonic cleaning application. The output power regulation of the proposed method can operate under the ZVS operation all parameter variation. Moreover, the wide operating range ZVS of the inverter is improved by a series inductor L_s. Thus, this work has the following advantages. The output power can be adjusted suitably for all operating conditions. The inverter has high efficiency because the switching frequency is located above and closed to the resonant

frequency where the zero voltage switching is achieved. The maximum power transfer at the actuator can be improved by the automatic switching frequency.

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Heuristics for inventory routing problem in two-echelon distribution system

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ABSTRACT

This study aims to implement heuristics for solving the inventory routing problem in two echelon distribution system that composed of single warehouse and multi-retailer. We assume that at each retailer customer demands occur at constant and deterministic. The 1st heuristic is to find time interval and frequency of replenishment as in Abdul-Jalbar et al. [2] and 2nd heuristic we use the Clarke-Wright savings algorithm [16] for solving capacitated vehicle routing problem (CVRP) with VRP solver V1.3 to find the vehicle routing which performance of vehicle routing depends on the truck capacity. For solving real practical problem we use data from Thai brand underwear company to show the performance of these heuristics which determine inventory replenishment and vehicle routing while minimizing long-run average transportation and inventory costs.

Keywords: inventory routing problem; two echelon distribution system; capacitated vehicle routing problem

1. Introduction

The combination of inventory management and transportation is interesting to be expanded with highly growth by increasing of information technology. The inventory routing problem (IRP) consists of determining a vehicle routing and frequency of order replenishment at the relevant facilities, while minimizing the costs from this part of the supply chain**.** One of the goal of the supply chain management is inventory in hand can be served to customer with the minimal total cost. The total cost consists of holding cost, setup cost and transportation cost which the transportation cost depend on the vehicle routing of truck which deliver goods to customer with less distance.

Consider IRP that customers or retailers have been served on the discrete time by the fleet of capacitated vehicle. The problem is to decide, in each time period, how much to deliver to each customer and the routes of the vehicles in such a way that the sum of inventory and transportation costs is minimized [1]. The inventory concerns the replenishment scheduling to support the demand of customers or retailers.

The scope of this paper is combined inventory management and routing problems for solving real practical problems. The rest of the paper is organized as follows. Section 2 addresses Jalbar's heuristic [2] to search the replenishment scheduling. In Section 3-6, we discuss about vehicle routing problems (VRP) and capacitated vehicle routing problem (CVRP). Solving real practical problem in section 7 and analysis and discussion in section 8. Finally, conclusion will be in section 9.

2. The Heuristic to Compute Near-Optimal Integer-Ratio Policies

Abdul-Jalbar et al. (2010) developed a heuristic to compute near-optimal integer-ratio policies for solving the two-echelon distribution system. This heuristic have the advantage of giving more flexible in determining the replenishment intervals because it has no restriction to be powers of two multiples of some

base planning period. This method consists of an iterative procedure to find a balance between the replenishment and the inventory holding costs at each installation which similar to the economic order quantity model (EOQ). The notation and the parameters of the problem are:

d_j demand per unit time at retailer $j = 1,\ldots,N$

k_j fixed replenishment cost per order at retailer $j = 1,\ldots,N$

k_0 fixed replenishment cost per order at the warehouse

h_j inventory holding cost per unit and per unit time at retailer $j = 1,\ldots,N$

h_0 inventory holding cost per unit and per unit time at the warehouse

The variables are the following:

t_j replenishment interval at retailer $j = 1,\ldots,N$

t_0 replenishment interval at the warehouse

f_j number of times that retailer $j = 1,\ldots,N$ places an order during t_0

Notice that if $t_0 \geq t_j, f_j \in \{1,2,3,\ldots\}$. Otherwise, that is, if $t_0 < t_j, f_j \in \left\{\frac{1}{2},\frac{1}{3},\frac{1}{4},\ldots\right\}$.

C_j the average total costs incurred by retailer $j = 1,\ldots,N$,

C_0 the average total costs incurred by warehouse

C_T the average total costs of the total system

Both t_j / t_0 or t_0 / t_j must be a positive integer and notice that when $t_j \geq t_0$, the warehouse does not hold inventory for that retailer but when $t_j < t_0$ the warehouse does hold inventory for that retailer. The average total cost (per time unit) for the system as follows:

$$C_T = C_0 + \sum_{j=1}^{N} C_j = \frac{k_0}{t_0} + h_0 \sum_{j:f_j>1} \frac{(f_j - 1)d_j t_j}{2} + \sum_{j=1}^{N}\left[\frac{k_j}{t_j} + \frac{h_j d_j t_j}{2}\right] \quad (1)$$

Since f_j represents the number of times that retailer j places an order during t_0, it holds that $t_j = t_0 / f_j$. Thus, we can express the total (7) in terms of t_0 and f_j as the following:

$$C_T = \frac{k_0}{t_0} + h_0 \sum_{j:f_j>1} \frac{(f_j - 1)d_j t_0}{2f_j} + \sum_{j=1}^{N}\left[\frac{f_j k_j}{t_0} + \frac{h_j d_j t_0}{2f_j}\right] \quad (2)$$
$$= \frac{1}{t_0}\left[k_0 + \sum_{j=1}^{N} f_j k_j\right] + \frac{t_0}{2}\left[\sum_{j=1}^{N}\frac{h_j d_j}{f_j} + h_0 \sum_{j:f_j>1}\left(1 - \frac{1}{f_j}\right)d_j\right]$$

Thus, the objective function for computing the integer-ratio policy is

$$\min C_T = \frac{1}{t_0}\left[k_0 + \sum_{j=1}^{N} f_j k_j\right] + \frac{t_0}{2}\left[\sum_{j=1}^{N}\frac{h_j d_j}{f_j} + h_0 \sum_{j:f_j>1}\left(1 - \frac{1}{f_j}\right)d_j\right] \quad (3)$$
$$\text{s.t.} f_j \in \left\{\ldots\frac{1}{3},\frac{1}{2},1,2,3,\ldots\right\}$$

This integer-ratio policies computation will base on the formulation in (3). The ratio between the replenishment and the inventory holding costs for retailer j will be denoted by

$$r_j = \frac{2f_j^2 k_j}{h_j d_j t_0^2}, j = 1,\ldots,N \quad (4)$$

The optimal replenishment interval at the warehouse for given values f_j by deriving C_T in (3) with respect to t_0 and set it equal to zero, is

$$t_0^* = \left[\frac{2(k_0 + \sum_{j=1}^{N} f_j k_j)}{\sum_{j=1}^{N}\frac{h_j d_j}{f_j} + h_0 \sum_{j:f_j>1}(1 - \frac{1}{f_j})d_j}\right]^{1/2} \quad (5)$$

Then, substituting (5) into (4), r_j can be rearranged to

$$r_j = \frac{f_j^2 k_j}{h_j d_j}\left[\frac{\sum_{j=1}^{N}\frac{h_j d_j}{f_j} + h_0 \sum_{j:f_j>1}(1 - \frac{1}{f_j})d_j}{(k_0 + \sum_{j=1}^{N} f_j k_j)}\right] \quad (6)$$

Substituting (5) into (3), the cost function C_T can be expressed in terms of the f_j values as follows:

$$C_T(f_1,...,f_N)=\left[2(k_0+\sum_{j=1}^{N}f_j k_j)(\sum_{j=1}^{N}\frac{h_j d_j}{f_j}+h_0\sum_{j:f_j>1}(1-\frac{1}{f_j})d_j)\right]^{1/2} \quad (7)$$

This method consists of an iterative procedure where each of iteration try to adjust r_j values to be closely to one and r_j also have been tested with different values and found that the best solutions are obtained if decreasing the f_j values for all retailers with r_j>1.2 and increasing the f_j values for all retailers with r_j <0.4. Once the f_j values are updated, then compute the cost associated with the new f_j values by using (7). This procedure is repeated until all f_j values ∈ [0.4, 1.2] or until the total cost in some step increases. The procedure of the proposed heuristic for computing integer-ratio policies as follows:

Step 0: Set $f_j=1,\forall j=1,...,N$. $L=N$ and $\Theta_L=\{1,2,...,N\}$. Then, compute $C=C_T(\mathrm{f})$ and go to Step 1.

Step 1: Compute $r_j,\forall j=1,...,N$ using (6). Then $\forall j$ with $r_j>1.2$ decrease value f_j to obtain f_j^* and $\forall j$ with $r_j<0.4$ increase value f_j to obtain f_j^*. Thus, $\forall j$ with $0.4\le r_j\le 1.2 f_j^*\leftarrow f_j$. Then, compute the new cost $C=C_T(\mathrm{f}^*)$.

If $C'<C$ then $C\leftarrow C',\mathrm{f}\leftarrow \mathrm{f}^*$, go to Step 1, otherwise go to Step 2.

Step 2: Set $l=\arg\max_{j\in\Theta_L}\left\{r_j,\frac{1}{r_j}\right\}$. If $r_l>1$, then decrease value f_j similarly to Step 1 to obtain value f_j^*.

If $r_l<1$, then increase value f_j as in Step 1 to obtain value f_j^*. Then, compute the new $C'=C_T(f_1,...,f_j^*,...,f_N)$.

If $C'<C$ then $C\leftarrow C',\mathrm{f}\leftarrow \mathrm{f}^*,L\leftarrow N,$ compute $r_j(j=1,...,N)$ else $\Theta_L\leftarrow\Theta_L/\{l\},L\leftarrow L-1$.

If $L>0$ go to Step 2, otherwise go to Step 3.

Step 3: Stop, The lowest cost, C is found. (see Abdul-Jalbar et al. (2010) for a spreadsheet model) [3]

3.Vehicle Routing Problem

VRP defines a class of combinatorial optimization problems to optimize vehicle travel during round trips. Some researchers have explained to optimize the vehicle routing problem which can lead to significant economic savings [4]. The earliest VRP was proposed by Dantzig et al [5] in 1959, which was the traveling salesman problems (TSPs).It was the routing of a fleet of gasoline delivery trucks between a bulk terminal and a number of service stations supplied by a terminal. In the capacitated VRP (CVRP) (since 1959), the fleet of identical vehicles located at a central depot need to optimize the routing for supporting a set of customers with known demand. Now, it has been extended to many different patterns, such as multiple depots VRP [6], periodic VRP [7], and pickup and delivery VRP [8].

The traditional VRP can be widely extended such as Dynamic Vehicle Routing Problems (DVRP) or On-line Vehicle Routing Problems (since 1976) have recently appeared due to the information technology which can considerate real-time data. In DVRP, some orders are prepared to transport before the starting of the working day; nevertheless, new orders come and the operation must response them into an current schedule. VRP with Time

Windows (VRPTW, since 1985) serves a number of customers within predefined time windows at minimum cost (in term of distance travelled) with a constant capacity and total trip time constraints for each vehicle [9].

The Capacitated Vehicle Routing Problem (CVRP) is one of the fundamental problems in the combinatorial optimization with a number of practical applications in transportation, distribution and logistics. The aim of CVRP is to find a set of minimum total cost routes for a fleet of capacitated vehicles based at a single depot, to serve a set of customers under the following constraints: (1) each route begins and ends at the depot, (2) each customer is visited exactly once, (3) the total demand of each route does not exceed the capacity of the vehicle [10]. Munawar et al (2009) presents a case study to illustrate the design and implementation of cellular Genetic Algorithm (cGA) with Local Search (LS) to solve CVRP[11]

4.Mathematical formulation of the CVRP

The first mathematical formulation and algorithm for the solution of the CVRP was proposed by Dantzig and Ramser [5]. Borˇcinov´a [10] presents that the mathematical formulation in let $G = (V, H, c)$ be a complete directed graph with $V = \{0, 1, 2, \ldots, n\}$ as the set of nodes and $H = \{(i, j) : i, j \in V, i \neq j\}$ as the set of arcs, where node 0 represents the depot for a fleet of p vehicles with the same capacity Q and remaining n nodes represent geographically dispersed customers. Each customer $i \in V - \{0\}$ has a certain positive demand $d_i \leq Q$. The nonnegative travel cost c_{ij} is associated with each arc $(i, j) \in H$. The cost matrix is symmetric, i.e. $c_{ij} = c_{ij}$ for all $i, j \in V$, $i \neq j$ and satisfies the triangular inequality, $c_{ij} + c_{jk} \geq c_{ik}$ for all $i, j, k \in V$. The minimum number of vehicles needed to serve all customers is $\left\lceil \frac{\sum_{i=1}^{n} d_i}{Q} \right\rceil$.

The binary decision variable x_{rij} is defined to indicate if the vehicle r, $r \in \{1, 2, \ldots, p\}$ traverses an arc (i, j) in an optimal solution. The integer linear programming model of the CVRP can be written as

$$\text{Minimize} \sum_{r=1}^{p} \sum_{i=0}^{n} \sum_{j=0, i \neq j}^{n} c_{ij} x_{rij} \quad (8)$$

Subject to

$$\sum_{r=1}^{p} \sum_{i=0, i \neq j}^{n} x_{rij} = 1 \quad , \forall j \in \{1, 2, \ldots, n\} \quad (9)$$

$$\sum_{j=1}^{n} x_{r0j} = 1, \forall r \in \{1, \ldots, p\} \quad (10)$$

$$\sum_{i=0, i \neq j}^{n} x_{rij} = \sum_{i=0}^{n} x_{rji}, \forall j \in \{0, \ldots, n\}, r \in \{1, \ldots, p\} \quad (11)$$

$$\sum_{i=0}^{n} \sum_{j=1, i \neq j}^{n} d_j x_{rij} \leq Q, \forall r \in \in \{1, \ldots, p\} \quad (12)$$

$$\sum_{r=1}^{p} \sum_{i \in S} \sum_{j \in S, i \neq j} x_{rij} \leq |S| - 1, \forall S \subseteq \{1, \ldots, n\} \quad (13)$$

$$x_{rij} \in \{0, 1\}, \forall r \in \{1, \ldots, p\}, i, j \in \{0, \ldots, n\}, i \neq j \quad (14)$$

The objective function (Eq.8) minimizes the total travel cost. The model constraints make to ensure that each customer is visited by exactly one vehicle (Eq.9). The row constraints (Eq.10) and (Eq.11) promise that each vehicle can go away from the depot only once, and the number of the vehicles arriving at every customer and entering the depot is equal to the number of the vehicles leaving. In the constraints (Eq.12) the capacity constraints are expressed, making sure that the sum of the demands of the customers visited in a route is less than or equal to the capacity of the vehicle performing the service. The sub-tour elimination constraints (Eq.13) ensure that the solution contains no cycles disconnected from the depot. The constraints (Eq.14) state the definition domains of the variables.

5. Solving CVRP algorithm

A CVRP can be solved by formulating an integer programming model or by constructing a graph theory model or other related models. After the CVRP model is set up, the most important step for solving CVRP can be divided into exact, heuristic and meta-heuristic algorithms [12].

1. Exact algorithms : A efficient branch-and-cut algorithm was introduced by Augerat *et al.*(1995) [13].And the best exact method has been proposed by Fukasawa et al. [14] which combines the branch-and-cut and the Set Partitioning (SP) approach [15].

2. Heuristic algorithms: Lawrance B. Synder (Leigh University) presented the VRP solver using the Clarke-Wright savings algorithm [16] . Yeh et al (2016) proposed a two-stage iterated local search strategy [17].

3. Meta-heuristic algorithms: Leung et al (2013) proposed a simulated annealing with heuristic local search [18].

This study presents a Clarke-Wright savings algorithm [16] for solving CVRP with VRP solver. This solver can solve when knows demand of each customer and location of warehouse /customers/retailers in term of latitude and longitude.

6. How to solve CVRP

The demand and location of each customer will be provided from the replenishment scheduling. VRP solver V.13 which was been created by Lawrance B. Synder (Leigh University) [16] has been used to solve CVRP. Procedure of this operation is explained by flowchart (Fig. 1) as follows:

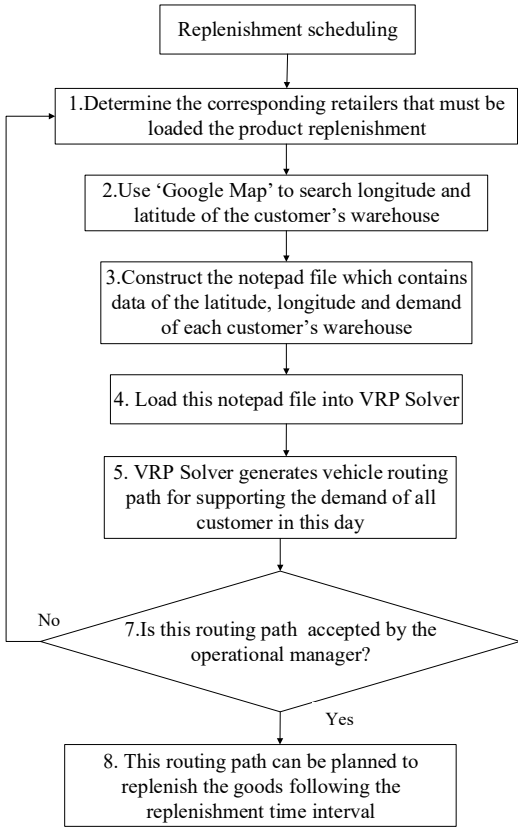


Figure 1. Flow chart of searching the routing path

7. Solving real practical problem

This study uses the data Thai brand underwear company to find the replenishment scheduling with the minimum total cost by Jalbar's heuristic and the Clarke-Wright saving method in this following.

Table 1 Data of Thai brand underwear company

	Warehouse j=0	Retailer1 j=1	Retailer2 j=2	Retailer3 j=3	Retailer4 j=4
Holding cost (h_j) [baht/unit]	60	60	60	60	60
Replenishment cost (k_j) [baht]	200	200	200	200	200
Demand (d_j)	541	324	158	31	28

Table 2 Starting the initial solution in a spreadsheet

$t_o = 0.201$	j=0	$j = 1$	$j = 2$	j=3	j=4	Total
f_j	1.00	1.00	1.00	0.33	0.50	
$(1-\frac{1}{f_j})d_j$	0	0	0	0	0	
$f_j k_j$		200	200	66.67	100	566.67
$\frac{h_j d_j}{f_j}$		19,414	9,474	5,634	3,336	37,858
$\frac{f_j k_j}{t_j^*}$	993.78	993.78	993.78	331.26	496.89	3809.49
$\frac{h_j d_j t_j^*}{2 f_j}$		1953.55	953.33	566.93	335.69	3809.49
$h_o \sum_{j:f_j>1} (1-\frac{1}{f_j})\frac{d_j t_o^*}{2}$		0	0	0	0	0
C_T						7,618.99
r_j		0.509	1.042	0.584	1.480	
q_j	112.79≈112	65.12≈65	31.78≈32	18.90≈19	11.19≈11	

Parameters in Table 2 is the initial parameter for step 0 then follow step 1-3 until the current cost is the smallest value. Result of iterative procedure (step 1-3) can be explained as follows.

Table 3 Result of iterative procedure

Iteration	f_o	f_1	f_2	f_3	f_4	C_T	t_o^*
1	1	1	1	1	1	8,054.07	0.248
2	1	2	1	1/2	1/2	8,583.90	0.275
3	1	1	1	1	1/2	7,834.77	0.23
4	1	2	1	1/2	1/2	8,587.97	0.276
5	1	1	1	1/2	1/2	7,587.36	0.211

In Table 3, the total cost C_T of the 5th iteration is the lowest value following the iterative procedure of Jabar's heuristic. The number of time in the 5th iteration that retailer $j = 1,...,N$ places an order during t_0 is $f_{1\text{-}4}$ = 1,1,1/2 and 1/2 can be explained in the real practice that if the working time per day is 8 hr.. The replenishment time interval (RTI) can be determined the replenishment scheduling in this following.

Table 4 The replenishment time interval

	RTI (hr.)	Adjusted RTI(hr.)	Replenishment (q_j)
Warehouse	$=t_0$x 8 x f_o =0.211x8x1= 1.688	1.5	112
Retailer1	= t_0x8xf_1 =0.211x8x1= 1.688	1.5	65
Retailer2	= t_0x8xf_2 =0.211x8x1= 1.688	1.5	32
Retailer3	= t_0x8xf_3 =0.211x8x1/2 = 3.376	3	19
Retailer4	= t_0x8xf_4 =0.211x8x1/2 = 3.376	3	11

RTI can be transferred in term of the replenishment scheduling as follows.

Table 5 Replenishment scheduling

Period Hour	Period 0 0	Period 1 0-1.5	Period 2 1.5-3.0	Period 3 3.0 -4.5	Period 4 4.5-6	Total
Warehouse	112	112	112	112		448
Retailer1		65	65	65	65	260
Retailer2		32	32	32	32	128
Retailer3		0	19	0	19	38
Retailer4		0	11	0	11	22
Inventory at the end of period	112	127	112	127	0	

From Table 5, inventory at the end of period 0 starts on 112 cartons and inventory at the end of period 4 still keep zero.

Replenishment Time Interval (RTI) can be extended in term of transportation by the number of time that retailer j = 1,.., N places an order (f_j) replenishment interval from Table 3. It transfers to a number of time that truck must transport to retailer that places an order. The vehicle routing can effectively search to be explained as follows.

1. From step 1-3 of the searching route path flow chart (Figure 1) and Table 6, the location of each retailer and its quantity (demand) can be determined in Table 6

Table 6 The corresponding retailers

Truck capacity 105 and 150 cartons per fleet	Location		Replenishment scheduling (hour)				Total demand
	Latitude	Longitude	0-1.5	1.5-3	3-4.5	4.5-6	
Warehouse	100.301906	13.751719					
Retailer 1	100.7502	13.58673	65	65	65	65	260
Retailer 2	100.577983	13.577983	32	32	32	32	128
Retailer 3	100.510754	13.726377	0	19	0	19	38
Retailer 4	100.483344	13.765122	0	11	0	11	22

Table 7 Distance between warehouse and all retailers

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Warehouse	72	71	33	27
Retailer 1		7.1	42.9	46.9
Retailer 2			45.6	51.7
Retailer 3				12.5

The corresponding retailers deliver the product replenishments following Table 6.

2. From step 3-5 , all the data of location and the product replenishment including total demand of each retailer are input data of VRP solver. It can effectively solve VRP and its competitive solution is presented in Fig. 2 , Fig. 3 (a),(b) as follows:

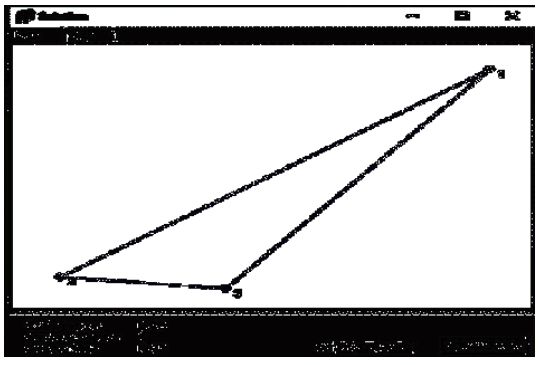
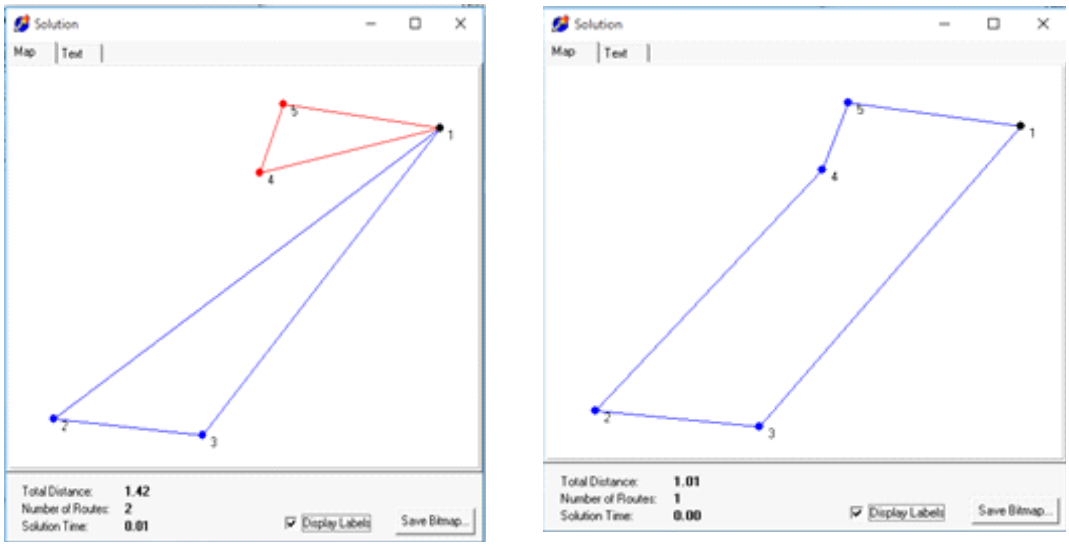


Figure 2 the vehicle routing on replenishment scheduling in 0-1.5 hr,and 3-4.5 h



(a) (b)

Figure 3 (a) the vehicle routing on replenishment scheduling in 1.5-3 hr and 4.5-6 hr. with the truck capacity 105 cartons per fleet
(b) the vehicle routing on replenishment scheduling in 1.5-3 hr and 4.5-6 hr. with the truck capacity 150 cartons per fleet

In Fig.2 (a), the vehicle routing starts from warehouse (0) to retailer 1 and 2 and vice versa. Total distances that truck delivers simultaneously is 72+7.1+71 = 150.1 km. And in Fig. 3(a), the vehicle routing with truck capacity 105 cartons per fleet begins from (loop1) warehouse(0) to retailer 2 to retailer 1 and turn to warehouse (0) and (loop2) warehouse (0) to retailer 3 to retailer 4 and turn to warehouse (0) and vice versa . Total distances is certainly 71 + 7.1 +72 + 33 + 12.5 + 27 = 222.6 km. In Fig. 3(b), while the vehicle routing with truck capacity 150 cartons per fleet begins from warehouse(0) to retailer 2 to retailer 1 to retailer 3 to retailer 4 and turn to warehouse (0) with only one loop . Total distances is certainly 71 + 7.1 +42.9 + 12.5 + 27 = 160.5 km.

In step 6, if the operation manager accepts these routings, the truck can deliver goods to all retailers absolutely. In the contrast, any routing paths may disrupt with the traffic jam or under construction; therefore, the manager must consider the alternative routing for replacing. When considering the transportation cost, it can be known by searching on the website of logistics provider. This study implements the transportation cost between warehouse and all retailers from https://app.giztix.com/ that can be shown in Table 8.

Table 8 Transportation cost

(105–150 cartons/fleet)	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Warehouse	฿1,555-฿1866	฿1,568-฿1,851.6	฿904-฿1084	฿600-฿720
Retailer 1		฿600-฿720	฿973-฿1,167	฿1,147-฿1,376
Retailer 2			฿1,008-฿1,209	฿1,196 -฿1,435
Retailer 3				฿600 -฿720

In Table 8, total transportation cost of the routing path (Fig. 2 (a)) is 1,568+600 + 1,555 = ฿3,723 and total transportation cost of the routing path (Fig.3(a)) is 1,568 + 600 + 1,555+904+600+600 = ฿5,827 . While total transportation cost of the routing path (Fig.3(b)) is 1,851+720+1,167+720+720 =฿5,178. So, truck with high capacity (150 cartons/fleet) can enhance to diminish total transportation cost about 11.14%.

8. Analysis and discussion

This study proposes that the replenishment scheduling and the vehicle routing are the solution of the inventory routing problem. From this practical problem, it can be definitely concluded in the solution as follows.

Table 9 Solution of practical problem

	1st fleet	2nd fleet
Retailer1 (cartons)	65	65
Retailer2	32	32
Retailer3	-	19
Retailer4	-	11
Truck capacity(cartons/fleet)	105	150
Transportation cost (Baht)	3,723	5,178
Replenishment cost (Baht)	7,587.36	
Total cost (Baht)	16,488.36	

The replenishment scheduling enhances the quantity of goods for each retailer with the minimum holding and ordering cost. The possible time interval for the replenishment should be related to delivery time and transportation cost saving for both the warehouse and the retailers. In the solution of CVRP , it can search the vehicle routing with less transportation cost. The truck with high capacity enables to pick up more cartons; although, its transportation cost per fleet must also increase.

9. Conclusion

The inventory routing problem can be served customers/ retailers on the discrete time to deliver goods by the fleet of capacitated vehicle with less total cost. The solution of this practical problem indicates that it can be searched the replenishment scheduling and corresponding vehicle routing with Jalbar's heuristic and the Clarke-Wright saving algorithm.

However, the proposed iterative procedure of Jalbar's heuristic complicates to solve with more customers/retailers. Hence ; it should be written in computer code for solving the large-scale problem conveniently. Using the

meta-heuristic algorithms generate CVRP solution to be better than the Clarke-Wright saving algorithm.

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Development of Spectrophotometric Method for Determination of Gabapentin in Pharmaceutical Formulations by Derivatization with Chromogenic Agent Cresol Red

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ABSTRACT

A spectrophotometric method has been developed for the determination of gabapentin (GBP) in pure form and pharmaceutical preparations. The proposed method is based on the complexation of gabapentin and the chromogenic agent cresol red (CR) obtaining the yellow ion-pair equal-molecular complexes. The extracted complexes showed maxima absorbance at 420 nm and cresol red concentration was 150 mg L^{-1}. A calibration curve was obtained with a linear portion ($R^2 = 0.999$) over the rage of 5 - 50 mgL^{-1} gabapentin. The detection limit (3σ) and the quantification limit (LOQ) were found to be 0.70 mgL^{-1} and 0.90 mgL^{-1}, respectively. The relative standard deviation was 0.42 % for 10 mgL^{-1} gabapentin (n = 10). The proposed method has been successfully applied to the determination of gabapentin in pharmaceutical preparation with percentage recovery range of 96 - 102 %. This method provides rapid, simple and cost-effectiveness.

Keywords : Gabapentin, Cresol red, Spectroscopy, Pharmaceutical preparation

1. INTRODUCTION

The gabapentin (1-(aminomethyl)cyclo-hexaneacetic acid) (Figure 1a) known as an anti-convulsant drug is a structural analogue of γ-aminobutyric acid (GABA). The action of gabapentin is attributed to the irreversible inhibition of the enzyme GABA-transaminase, thus preventing the physiological degradation of GABA in the brain; a secondary mechanism of a blockade for GABA uptake is also suggested [1]. Gabapentin has been approved for treatment of generalized anxiety disorders in Europe. In addition, it has been permitted by FDA for the spinal cord injury treatment and acts as the first drug for the fibromyalgia treatment.

Currently, the standard techniques in some pharmacopeia for analysis of gabapentin and its pharmaceutical dosage forms are not available. Many researchers have attempted to develop the effective methods for gabapentin determination. For examples, HPLC [2], LC-MS [3], GC-MS [4], spectrofluorimetry [5], capillary electrophoresis [6] and spectrophotometry [7, 8]. Particularly, the spectroscopic methods have been widely used for several analytical processes because of its simplicity, convenient, fast and cost-effectiveness. Nevertheless, it has not been extensively developed for gabapentin analysis in pharmaceutical formulations. According to the fact that the gabapentin has significantly low UV-Vis absorption or fluorescence, it is challenged to develop the determination method by derivatization with a chromogenic agent to gain alternative species representing gabapentin which is more effective to the analysis.

There are many analytical techniques developed for gabapentin. Farhan and coworkers have reported the spectrophotometric analysis of gabapentin. It is based on the formation of colored

gabapentin derivatives with the *n*-electron donor from ninhydrin and the π-electron acceptors from *p*-benzoquinone [9]. Although the procedure has successfully applied to determine gabapentin with good recovery, the experiments are difficultly performed as well as ninhydrin has been known as a carcinogenic agent. Additionally, Gouda and coworkers have found that a chromogenic reagent namely quinalizarin can interact to the primary amine group of gabapentin to generate a charge transfer complex which shows the absorption maximum at 571 and 528 nm [10]. The advantage of this development is a highly sensitive method, but the reagents used are quite expensive. Recently, a chromogenic agent typed cresol red or *o*-cresolsulfonephthalein (Figure 1b) has been applied to analyze amlodipine [11]. It involves the formation of the yellow complex from the reaction of amlodipine and cresol red. The primary amine group of amlodipine in Britton-Robinson (BR) buffer reacts with cresol red resulting to generate the ion-pair complex which is quantitatively extractable in chloroform and high absorptivity in the UV-Vis region. These researches point out that cresol red is possible to be an alternative reagent for quantitative analysis of gabapentin. It is due to the consisting of reactive primary amine groups in the structure of gabapentin which is similar to amlodipine (Figure 1c). Moreover, using cresol red as a chromogenic agent has many advantages. Cresol red is a pH indicator and color marker commonly used for laboratory procedures due to simple preparation, and inexpensive.

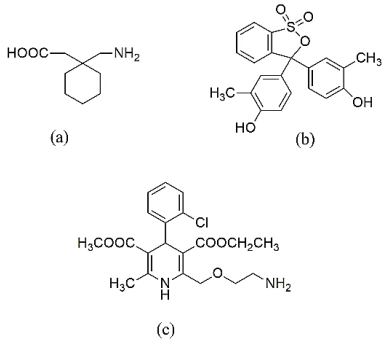


Figure 1. Chemical structure of gabapentin (a), cresol red (b) and amlodipine (c).

This present work aims to develop the spectrophotometric analysis for gabapentin by cresol red to achieve the simple method of application in the pharmaceutical formulation analysis with high degree of accuracy, precision and cheaper. The benefits of this developed technique are possible to be used simply in quantitative control and insurance of the drug in industry.

2. MATERIALS AND METHODS

2.1 Chemicals and instrumentations

Gabapentin used as working standards was pharmaceutical grade and was purchased from Sigma-Aldrich. The gabapentin drug capsules were obtained from commercial sources in the local pharmacy. Cresol red was purchased from Sigma-Aldrich. All other chemicals were of analytical grade and used without further purification. The double distilled water was used to prepare all solutions.

The absorption spectral measurements were performed using a Jasco model V-650 double beam UV-Vis spectrophotometer (Japan) equipped with 10 mm matched quartz cells. The solutions in the extraction process were mixed by a vortex–genie 2 mixer model G560E (Scientific Industries, Inc., New York, U.S.A).

2.2 Standard solutions

The stock solution of gabapentin (1000 mgL^{-1}) was prepared by dissolving the appropriate amount of gabapentin (100 mg) in methanol (50 mL). The final volume was adjusted to 100 mL by distilled water. The corresponding concentrations of the standard solutions of gabapentin (4, 6, 8, 10, 20, 40 and 50 mgL^{-1}) were subsequently prepared by dilution. The stock solution of cresol red (1000 mgL^{-1}) was prepared by dissolving cresol red (100 g) in a mixed solvent containing ethanol and water in a 1:1volume ratio. The total volume was adjusted to 100 mL by distilled water. The Britton-Robinson (BR) buffer (pH 2) was prepared according to the published procedure [12]. Boric acid (0.04 M), phosphoric acid (0.04 M) and acetic acid (0.04 M) were mixed together and adjusted the pH to 2.0 by sodium hydroxide (0.2 M).

2.3 General procedures

The appropriate volumes of the standard solution of gabapentin (0.1–1.0 mL) were pipetted into a series of 10 mL volumetric flasks containing cresol red (3.5 mL) and BR buffer, pH 2 (2 mL). The total volume was adjusted by distilled water. The reaction mixtures were extracted in chloroform (3 mL) by mixing on a vortex mixer for 2 min and consequently allowed to separate the chloroform layer for 2 min. The absorbance of the chloroform phase was measured at 420 nm subtracted by the absorption of the blank solution prepared by the similar procedure as the complex preparation without the addition of the drug substances. The calibration curve was plotted to calculate the amounts of gabapentin in the drug samples.

2.4 Application of this method

Twenty capsules of gabapentin drug were weighed accurately and ground into fine powder. The appropriate amount of the powder containing gabapentin (10 mg) was dissolved by 40 % methanol (25 mL) and transferred into a 100 mL volumetric flask. The solution was shaken thoroughly for 5 min and was adjusted the total volume to 100 mL by distilled water. The final concentration of gabapentin was 100 mgL^{-1}. Subsequently, the various concentrations of gabapentin from 10 to 50 mgL^{-1} were prepared by dilution of the former solution with distilled water.

3. RESULTS AND DISCUSSION

3.1 The Appropriate absorption spectra

According to low absorption intensity of gabapentin, the pharmaceutical analysis of this drug by a conventional UV spectrophotometric method results the very low sensitivity [9].The derivatization of gabapentin by cresol red as the derivatizing agent to form the ion-pair complex exhibiting high absorptivity and high sensitivity is the one of alternative method for determining gabapentin. The reaction was based on the complexation of gabapentin and cresol red in BR buffer, pH 2 to achieve the yellow ion-pair species extractable in chloroform.

Absorbances of the derivatized complex were scanned from 380 to 480 nm by fixing the concentration of cresol red but varying the concentration of gabapentin. Upon increasing the concentration of gabapentin from 4 to10 mg L^{-1}, an enhancement of the absorbance was observed with the absorption maxima (λ_{max}) at 420 nm. It was probably arised from electron transition of the dye molecules formed in the ion-pair complex (Figure 2). The recommended derivatization mechanism of the ion-pair complex formation under the acidic environment was shown in Scheme 1. When solvated in H_2O, the cresol red dye was deprotonated at the hydroxyl group and allowed for rearrangement of the internal bonds resulting to produce the negatively charged SO_3^- group [13]. While gabapentin was protonated at the primary amine group. Consequently, a single unit of the derivatized gabapentin-cresol red complex was stabilized by electrostatic interactions of the positively charged nitrogen atom of gabapentin held together with the negatively charged oxygen atom of cresol red.

3.2 Optimization of experimental conditions

In order to optimize the suitable conditions for the analysis of gabapentin, we have investigated the effect of several parameters including wavelengths, reagent concentrations, solvents and pH. The influences of each parameter were observed by changes in the sensitivity (slope of the standard curve plotted by the absorbances and four concentrations of the standard solutions of gabapentin) and the linearity (R^2). Three replicated measurements were performed for all experiments.

Effects of wavelengths. The consequence of wavelength on the sensitivity of the presented spectroscopic method was investigated in the range of 380 to 450 nm with an interval of 10 nm. The correlation of wavelengths versus the sensitivity was shown in Figure 3a. When the wavelengths enhanced, the sensitivity is changed in which it was increased in the range of 380 to 420 nm and was then decreased in the range of 420 to 450 nm. The

highest point was clearly observed at 420 nm indicating to the optimum wavelength which was chosen for further experiments.

Effects of the concentrations of cresol red. The concentration of the derivatizing agent is one of the important parameters since the maximum conversion of the gabapentin available in the solution to be the ion-pair complex depends on the concentration of derivatizing agent. The effects of varying concentrations of cresol red on the formation of the ion-pair complex extracted in chloroform were studied. Upon increasing the concentrations of cresol red, the sensitivity was gradually increased until reached to the concentration of 150 mgL^{-1}. After that, the sensitivity was decreased from the concentrations of 150 to 200 mgL^{-1} and almost constant from the concentrations of 200 to 300 mgL^{-1} (Figure 3b). It was possible to be reached to the saturated point. As the evidence, the concentration of cresol red of 150 mgL^{-1} provided the maximum sensitivity value of 0.0443 absorbance unit/mgL^{-1} (R^2 = 0.9966) suggesting suitable concentration to form the derivatized ion-pair complex in this analytical method.

Effects of pH. The effects of pH were further examined because pH of the solution provided acidic or basic environments resulting in highly effective complexation of gabapentin and cresol red. The derivatization reaction of gabapentin was taken place under the acidic conditions with varying the pH from 1 to 5. The relation of the pH and the sensitivity was displayed in Figure 3c. An enhancement of pH from 1 to 2 caused an increase of the sensitivity. On the other hand, the sensitivity was gradually decreased upon increasing pH from 2 to 5. According to the highest sensitivity (0.044 absorbance unit/mgL^{-1}) and linearity (R^2 = 0.994) for pH 2, it was selected as the optimal pH to form the ion-pair complex of gabapentin and cresol red.

Effect of solvents. The polarity of the solvents impacts to both extraction efficiency and absorptivity of the gabapentin-cresol red ion-pair

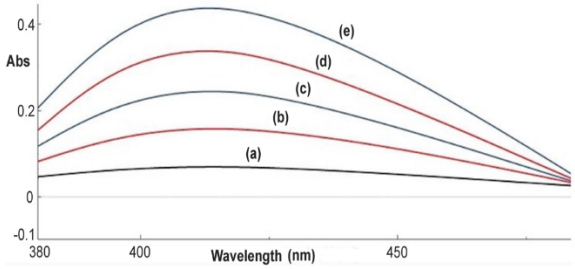


Figure 2. Absorption spectra of the derivatized gabapentin-cresol red complex generated by the reactions of cresol red (150 mgL^{-1}) and gabapentin (a) 0 mgL^{-1}, (b) 4.0 mgL^{-1}, (c) 6.0 mgL^{-1}, (d) 8.0 mgL^{-1} and (e) 10.0 mgL^{-1} in Britton-Robinson buffer, pH 2 (2 mL), total volume of 10 mL.

complex. Several water-immiscible organic solvents including hexane, formaldehyde, diethyl ether and chloroform were studied. The most convenient solvents have been found to produce the highest absorbance, extraction power and color stability of the formed ion-pair complex [8]. Figure 4 shows the effect of solvent used for the extraction to the sensitivity. In a comparison, the sensitivity of the complex extracted by each solvent has a tendency of chloroform > diethyl ether > hexane > formaldehyde. Chloroform gives the significantly higher amount of the ion-pair complex with greater sensitivity (0.045 absorbance unit/mgL^{-1}, R^2 = 0.993) than those of other solvents. It suggests that chloroform can dissolve more derivatized ion-pair complex into its layer suitable to be the extraction solvent for the derivatized gabapentin.

Effects of extraction time. The investigation of the appropriate extraction time for the gabapentin-cresol complex in chloroform layer was additionally done. The extraction time is significant to obtain a large amount of the product exhibiting intense absorbance which is beneficial for the analysis. The results showed that low absorption intensity was detected at 1 min possible due to unsaturation of the compound in the chloroform layer. When increasing the extraction time to 2 min, the absorbance and sensitivity were moderately enhanced because the ion-pair complex could more enter into the extraction solvent layer. After 2 min,

the absorption intensities were slightly changed and constant. The evidence points that the extraction time for 2 min is suitable to apply in the analytical method for gabapentin. Furthermore, it is an advantage of this method which saves the analysis time.

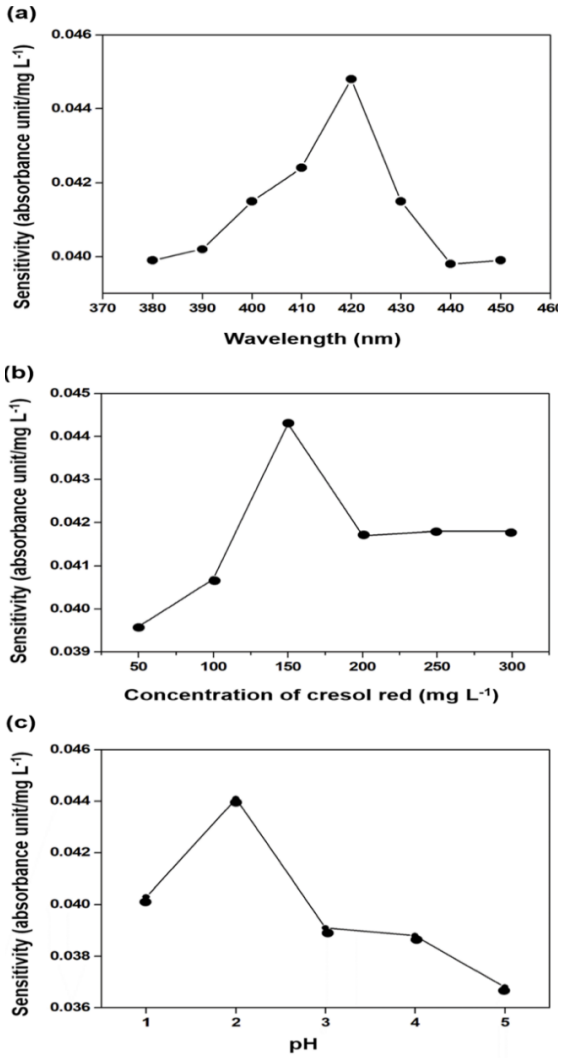
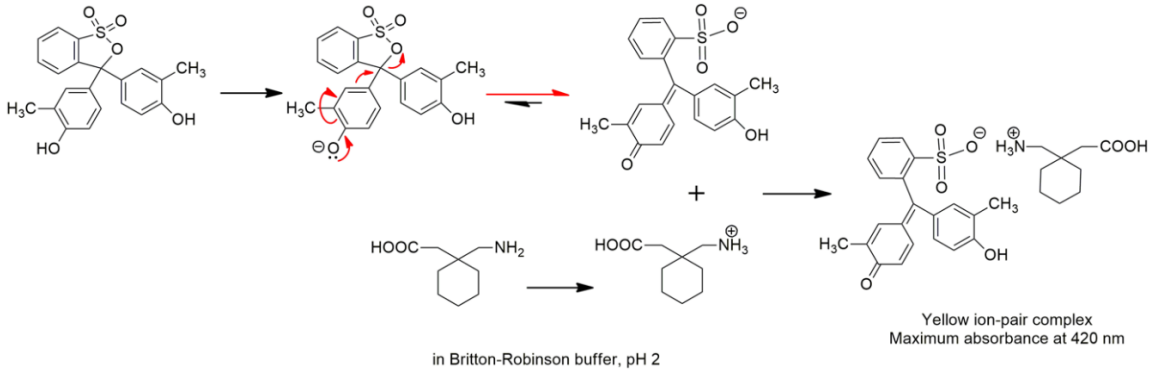


Figure 3. The plots of the sensitivity versus the several parameters to optimize the determination of gabapentin. All parameters were determined with the similarly varied concentrations of gabapentin of 4, 6, 8 and 10 mgL^{-1} in BR buffer, pH 2 (2 mL). Experimental conditions: (a) cresol red (150 mgL^{-1}); extraction in chloroform for 2 min; varied wavelength from 380 to 450 nm; (b) varied concentrations of cresol red from 50 to 300 mgL^{-1}; extraction in chloroform for 2 min; wavelength at 420 nm; (c) cresol red (150 mgL^{-1}); varied pH from 1 to 5; extraction in chloroform for 2 min; wavelength at 420 nm.



Scheme 1. The possible mechanism of the derivatization of gabapentin by cresol red producing the yellow ion-pair complex (adapted from [19]).

The stabilization of ion-pair complex. The stability of the complex obtained by the derivatization reaction of gabapentin and cresol red in chloroform was further explored. It was performed by measuring the absorption intensity of the ion-pair complex formed by gabapentin (10 mgL^{-1}) and cresol red (150 mgL^{-1}) and extracted in chloroform layer. The measurement was carried out after the reaction finished at different times (0 – 20 min). As the observation, the absorption intensity of the gabapentin-cresol red complex was most likely to be constant indicating that the complex can stabilize itself up to 20 min.

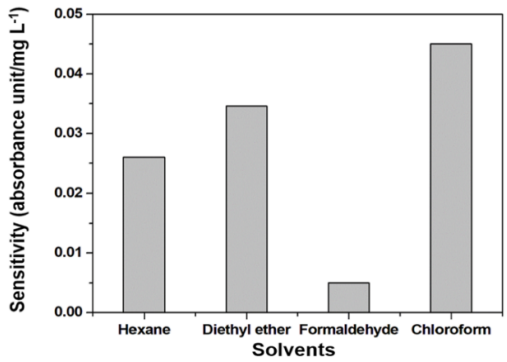


Figure 4. The change of the sensitivity when the ion-pair complex was extracted in hexane, diethyl ether, formaldehyde and chloroform for 2 min and measured at 420 nm.

Therefore, the absorbance can be measured immediately after extraction with chloroform within 20 min in which that time does not affect to the absorption of the ion-pair complex.

3.3 Analytical figures of merit

The calibration curve was generated by plotting the correlation of absorbance of the product and the concentrations of gabapentin (5.00 – 50.00 mgL^{-1}). The reactions of the corresponding gabapentin with cresol red (150 mg L^{-1}) in BR buffer, pH 2 were taken place under the suitable conditions. The obtained product was extracted by chloroform and measured the absorption intensities at 420 nm. The calibration curve was fitted linearly and gave the sensitivity (slope) of 0.039 absorbance unit/mg L^{-1} with the intercept value of 0.03 mgL^{-1}. The correlation coefficient (R^2) was 0.9990 (Figure 5). The limit of detection (3σ) and limit of quantification were found to be 0.70 mgL^{-1} and 0.90 mgL^{-1}, respectively. Moreover, the precision of this method was investigated by gabapentin standard solution (10 mgL^{-1}). Ten measurements were made resulting in a good precision with the signal variability of 0.42%.

3.4 Interference test.

To mimic the analytical environment for determination of gabapentin in pharmaceutical formulas, the several additives including starch, glucose, sucrose, iron, and sodium chloride were added to the standard solutions of gabapentin. The absorbances of the solution (10 mg L^{-1}) in the presence of excess amount of the different additives with the concentration ratios ([gabapentin]/ [additives]) of 1:1, 1:5 and1:10, were detected. If

the absorbances of mixed gabapentin-additives differ from those of free gabapentin at least 5 %, it will be indicative of interference. The result showed that there was no significant interference in the spectra at the maximum [gabapentin]/[additives] ratio. It suggests that the proposed method is capable to use for the pharmaceutical preparations.

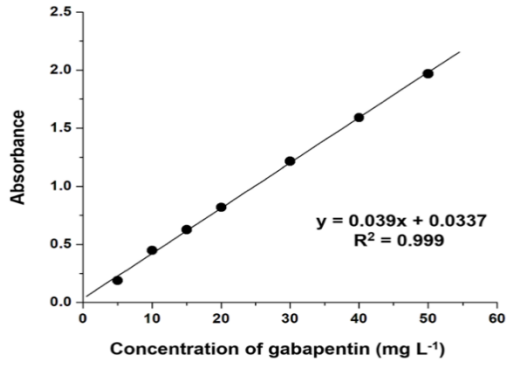


Figure 5. The calibration curve plotted by the absorbances and the concentrations of the gabapentin standard solutions from 5 to 50 mgL^{-1}.

3.5 Application of the proposed method

This method was applied to quantitatively analyze gabapentin in three types of commercial drug capsules. The labeled amounts of gabapentin of 100 mg, 300 mg and 400 mg per drug capsules were determined using the calibration curve in Figure 5. As a result, the extents of gabapentin of 102.4, 290.80 and 400.60 mg per capsule, respectively, were found in the drug capsules. It is indicative of good accuracy and precision of the method. In addition, the recovery percentage was further investigated to obtain the accuracy of the methods. Three concentrations of the standard solutions of gabapentin were added into each initial concentration as listed in Table 1. The calculated percent recovery was in the range of 96 – 102 suggesting high efficiency and acceptable to employ this method to the analysis of gabapentin in the pharmaceutical applications.

4. CONCLUSIONS

The proposed method involves the development of spectrophotometric technique for the determination of gabapentin using cresol red (CR) as a derivatizing agent. It shows more advantages than the previous methods due to high accuracy and precision, rapid, use of the simple reagent in the ordinary analytical laboratory. The high recovery percentage and low relative standard deviation reflect the high accuracy and precision of the proposed method. Moreover, this method is simple to apply in wide ranges of concentrations. These benefits can be available to apply in a commercial and acceptable as a routine method for the determination of gabapentin drug in pure samples and in pharmaceutical formulations.

Table 1. The recovery percentage of the determination gabapentin by the proposed method

Sample	The concentrations of gabapentin (mg L^{-1})				
	Initial	Added	Total	Found [a]	Recovery (%)
A	10.24	5.00	15.24	14.64	96.06
		10.00	20.24	20.53	101.43
		15.00	25.24	25.13	99.56
B	29.08	5.00	34.08	34.88	102.35
		10.00	39.08	39.86	101.99
		15.00	44.08	44.81	101.66
C	40.06	5.00	45.06	43.85	97.31
		10.00	50.06	48.82	97.53
		15.00	55.06	54.80	99.53

[a]Average of three replications.

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Emotion Detection System for Student during Studying in the Laboratory using Kinect Sensor V2

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ABSTRACT

This paper proposes an emotion detection system for student in the laboratory using data mining classification methods on streamed video. There are two parts: emotion detection and report. Firstly, we are interested in a specific 2D stream of face-joint positions which are representative of the human face captured by Kinect sensor. The twenty-three face-joint positions such as eyes, mouth, eyebrows, and nose were chosen to compute distance between face-joint positions. The recognized emotion patterns of the study are normal, happy, sleepy, and confused. Classification method uses Multilayer Perceptron. Lastly, report support is sent to the teacher as a reference to student's emotion, so that the teacher could make well-informed decisions to improve teaching techniques. Experimental result has shown that system can detect emotion with 91% accuracy.

Keywords: Kinect, Face recognition, Emotion detection, Classification method, Video streaming

1. INTRODUCTION

Emotion is related to moods and feelings used to communicate and interact by facial expressions [1]. Thus, facial expressions can provide proper information about the emotion of a person, especially, in case of student. Facial expressions convey the emotions and feelings of the student about content and teaching methods. If students are in doubt, the confusion may induce tiresomeness and affect learning. Charles Darwin [2] defines the type of the facial expressions of emotions such as happiness, anger, fear, surprise, disgust, sadness, etc. An effective emotion detection system should be able to monitor a student's facial expression to help the teacher to improve feedback during the learning, especially, in case of studying in the laboratory settings.

There are many research studies on emotion detection system using camera captured facial expressions [3, 4]. Nevertheless, most of them are too complex, expensive, and involved low level image processing. So, Kinect sensor is used to detect emotion because of affordability and ease of development [5, 6].

In this paper, we propose emotion detection system for student in the laboratory using Kinect sensor. Our research focuses on a set of four emotions: normal, happy, sleepy, and confused, to be a knowledge base for teacher. Kinect is used to detect face-joint positions. This study uses Multilayer Perceptron for emotion recognition. Then, emotion is reported to the teacher to have information for access emotion of student and making a well-informed decisions to improve teaching techniques.

This paper is organized as follows: Section 2 presents related works; Section 3 describes the methodology of our proposed system; Section 4 presents the experimental results and discussions; finally, Section 5 presents the conclusion.

2. RELATED WORK

There are several researches, which use Kinect sensor to detect emotion. Yu et al. [6] proposed a method to detect behavior and learning process in a classroom situation. The system can detect several gestures such as sitting, raising hand, standing, sleeping, and breathing. The result shows that the system can detect with high performance.

Fan et al. [7] proposed abnormal behavior detection in online examination using Kinect sensor. Abnormal behavior is detected using duration and frequency of activities. The result shows that the system can detect with high accuracy in classification of abnormal behavior and normal activities.

In addition, Vermun et al. [8] presented a method to detect gesture using Kinect sensor. The detection method involves by comparing processed images stored in the database to develop feedback during the learning process.

Szwoch et al. [9] presented a method to detect emotion using depth image. The recognized emotion patterns of the study are neutral, joy, neutral surprise, positive surprise, euphoria, fear, fright, anger, and rage. The result shows that the system can detect emotion, even though it suffers lighting.

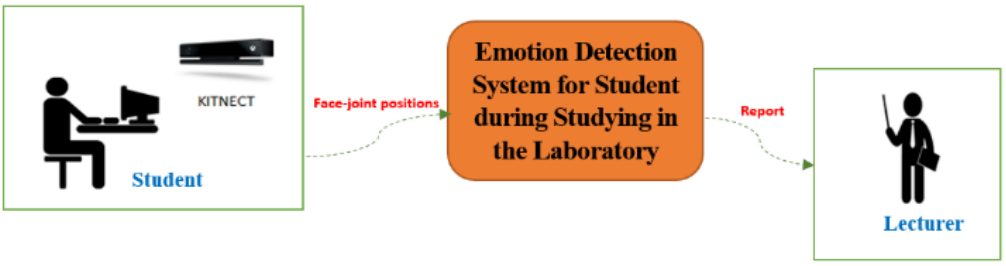


Figure 1. Overview of the proposed system.

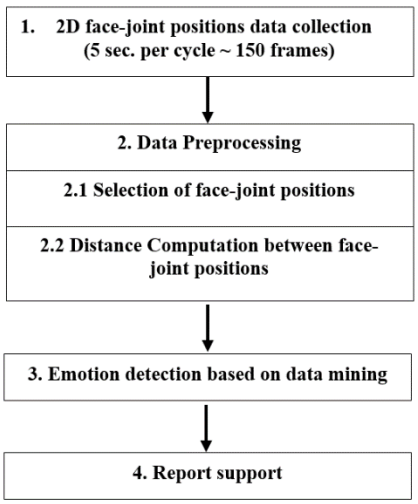


Figure 2. Model of the proposed system.

3.1 Real-time Detection of Face-Joint Positions

In the view of real-time detection of face-joint positions in 2-dimensional space (X and Y), there are over 1,000 face-joint positions [10] as seen in Figure 3.

Figure 3. All face-joint positions [10].

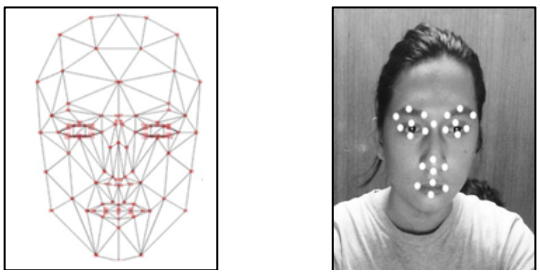
3.2 Data Preprocessing

In this section, there are two phases: selection of face-joint positions and distance computation between face-joint positions.

3.2.1 Selection of face-joint positions

We implemented pilot experiments to select instance of face-joint positions which could possibly optimize processing time of the emotion detection with three choices:

1. all face-joint positions as seen in Figure 3
2. 121 face-joint positions [5] as seen in Figure 4(a.)
3. 23 face-joint positions as seen in Figure 4(b.)



(a.) 121 face-joint positions [5] (b.) 23 face-joint positions

Figure 4. Face-joint positions.

From the pilot experiment results (Table 1), choice (3) (detailed in Table 2) was selected as it provides a significantly faster run time when compared to the other choices.

Table 1. Comparative performances of emotion detection using three choices.

Face-joint positions	Emotion detection accuracy	Processing time (seconds)
All face-joint positions	95%*	10
121 face-joint positions [5]	94.28%	6
23 face-joint positions	91%	2*

Table 2. Detail of 23 face-joint positions.

Face-joint positions	Detail
Eye (right and left)	eye joint positions (left, right, top, and down)
Mouth	mouth joint positions (left, right, top, and down)
Eyebrow (right and left)	eyebrow joint positions (left, center, and right,)
nose	nose joint positions (left, right, top, and down)
Eyebrow center	Center of Eyebrow

3.2.2 Distance computation between face-joint positions

Based on 23 face-joint positions, we compute distance between face-joint positions in Equation 1.

$$\sum_{i=1}^{n} \left\| C_i - T_j \right\| = \sum_{i=1}^{n} \sqrt{(C_i.x - T_j.x)^2 + (C_i.y - T_j.y)^2} \quad (1)$$

1. Emotion Detection Based on Data Mining

Relying on distance computation between face-joint positions as explained in section 3.2.2., emotion can be detected using Multilayer Perceptron (MLP) [11]. MLP is a neural network, which contains multiple layers of nodes in a directed graph. MLP is developed through back propagation for training the network as seen in Figure 5.

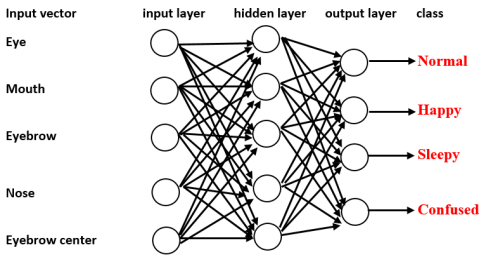


Figure 5. Architecture of MLP for emotion detection.

From Figure 5, there are 3 layers (input layer, hidden layer, and output layer) with 5, 5, and 4 nodes, respectively. We set the learning rate at 0.3 and momentum at 0.2. The input layer consists of 5 features (Eyes, Mouth, Eyebrows, Nose, and Eyebrow center). The hidden layer is with 5 nodes. The output node consists of 4 possible values: normal, happy, sleepy, or confused.

3.4 Report Support for Teacher

After an emotion is detected, recorded emotion is reported to the teacher on the report web interface when finishes a class. The report consists of detail of emotion per duration and emotion summary

4. RESULTS AND DISCUSSION

In this section, we describe the experimental setup and provide an evaluation of performance of emotion detection.

4.1. Experiment Setup and Dataset

In our experiment, there were 80 student subjects (16 female, 64 male) with various facial features as seen in Figure 6. Each situation was repeated 5 times per subject of each emotion such as normal, happy, sleepy, and confused. There are a total of 1,600 (80x4x5) video clips. 1,200 video clips were used in a training data set, while the remaining data were used to test using 5-fold cross-validation.

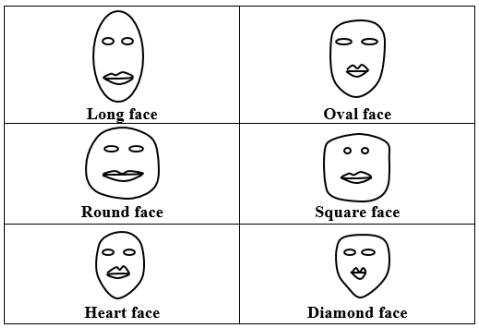


Figure 6. Characteristic of sample subjects for emotion detection [12, 13, 14].

In our experiment, we established in the laboratory setting with a Kinect sensor [15] to monitor facial movement of the student during studying. The Kinect sensor is set up at approximately 55-100 centimeter from subject as seen in Figure 7.

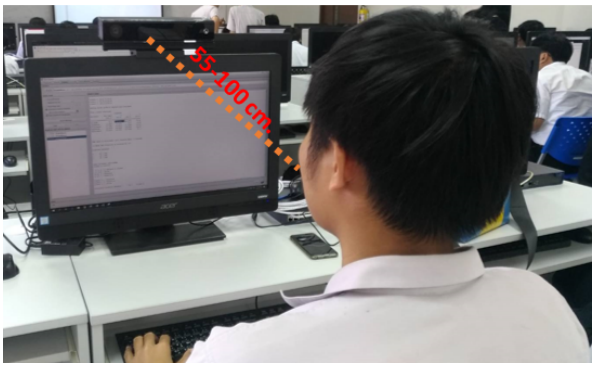


Figure 7. Experiment setup for emotion detection system.

We use SDK [16] in our research because it is a library of Microsoft's Kinect Face API, which is implemented with C# [10]. Thus, the environment is readily setup for developers. The advantage of Kinect sensor is its unobtrusiveness and ability to detect in all environments, even though it has illumination conditions. It also has the limitation of occlusion using a single Kinect camera.

4.2. Discussion of Performance of Emotion Detection

We showed an experiment evaluating performance of the emotion detection algorithm. The results of evaluating 400 video clips are shown in the confusion matrix as shown in Table 3.

Table 3. Results of evaluating our emotion detection approaches.

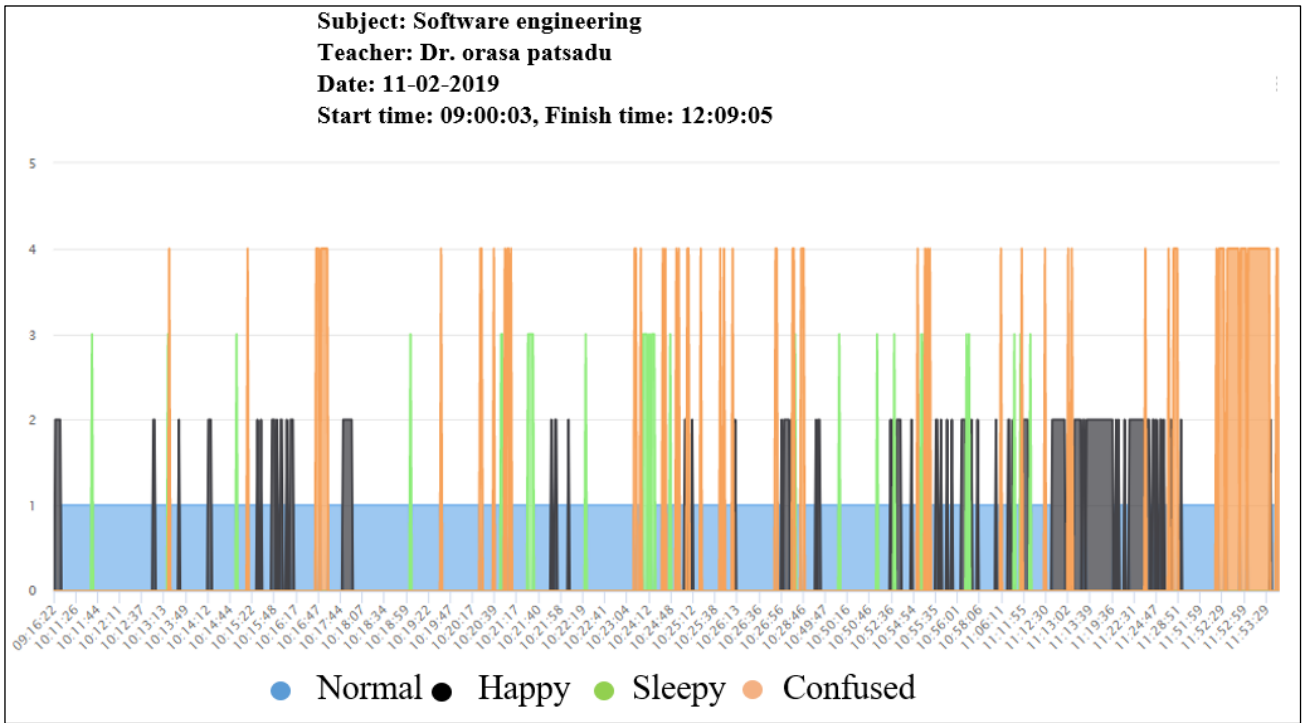
		True value			
		normal	happy	sleepy	confused
Prediction	normal	98	0	0	2
	happy	1	97	0	2
	sleepy	14	3	76	7
	confused	5	1	1	93

Table 3 reports that two motions (normal and happy) can be detected with high performance classification. Moreover, we compare the performance with three performance measures such as accuracy, recall, and precision as shown in Table 4.

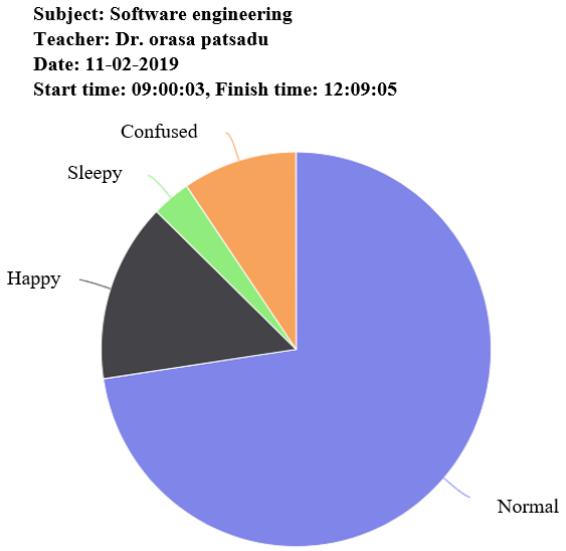
Table 4. Measures for evaluating our emotion detection approaches.

	MLP
Accuracy	91.00%
Precision	91.00%
Recall	91.80%

From Table 3 and 4, most errors are cases of detection of two emotions, namely sleepy and confused. The cause of inaccuracy is the size of the eyes and eyebrows, which produces ambiguity of emotion detection. In part of report support is shown in Figure 8.



1. Emotion per duration



2. Emotion summary

Figure 8. Result of emotion detection report.

5. CONCLUSIONS

In this paper, we propose emotion detection system for student in the laboratory using data mining classification methods. We are interested in a specific stream of 2D of face-joint positions which are representative of the human face captured by Kinect sensor. The 23 face-joint positions such as eyes, mouth, eyebrows, and nose were chosen to compute distance between face-joint positions. The recognized emotion patterns of the study are normal, happy, sleepy, and confused using Multilayer Perceptron. After finishing a class, report support is sent to the teacher. Experimental result has shown that system can detect emotion with 91% accuracy.

For future work, we will extend the system by combining several emotion detection methods. Moreover, we plan to set up our prototype system in real situations.

6. ACKNOWLEDGMENTS

This research was supported by Rajamangala University of Technology Krungthep. We thank the volunteers for their invaluable assistance in setting up the experimental environment for the capturing sessions.

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Effect of silver yarn on mechanical and antibacterial properties of polyester woven fabric

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ABSTRACT

In this research, mechanical properties and antibacterial properties of woven fabric containing polyester and silver yarns were determined. The results found that the amount of silver yarns per square inch affected tensile and tearing strength of the fabric. Adding silver yarn in fabric increased the tensile strength of fabric but tearing strength got decreased compared to normal fabric. In addition, the antibacterial properties of fabrics were also investigated by using *Staphylococcus aureus* and *Klebsiella pneumoniae*. The antibacterial results showed that the polyester fabrics containing silver yarns exhibited excellent activities against both bacterial species which are more than 99.93 and 99.94% reductions of *Staphylococcus aureus* and *Klebsiella pneumonia*, respectively when compared to the normal fabric. This developed fabric can be used as guideline that silver yarn is compatible with common textile processing, which are weaving, dyeing and finishing processes. In addition, it can help to develop the fabric for medical textile, which is one of the interesting segments in technical textile.

Keywords: silver yarn, mechanical property, antibacterial property, polyester, tensile strength, tearing strength, medical textile

1.INTRODUCTION

As the increasing and developing of bacteria and virus, many businesses launch the products to satisfy this market. In addition, it is known that health related business is highly concerned in the global market. People have more awareness and concern on their health and it tends to get more and more popularity in market.

Silver is considered as the first antibiotic. Silver generally has low toxicity and minimal risk is expected when silver is used in approved medical applications [1]. Silver ions have long been used in biomedical field due to their dynamic inhibitory and bactericidal effects against a broad spectrum of gram-positive and gram-negative bacteria and superbugs [2]. Feng *et al*. [3] have reported that the silver ions penetrate into the cell wall of the microorganism, turn the DNA into a condensed form and react with the thiol groups of the proteins, which lead to the damage and further the death of the bacterium.

To create antibacterial fabric, there are various chemical and physical possibilities that can be considered. Different types of yarn provide the different effect to bacteria but it is not widely use due to the cost. On the other hand, using antibacterial chemical finishing on fabric is not durable. So, this study would like to study the effectiveness of antibacterial fabric by using silver yarns and find the optimal point of the amount of silver yarn per inch in order to develop the antibacterial fabric in the future.

2.MATERIALS AND METHODS

2.1 Materials

Polyester yarn was obtained from Kanwal Textile Co., Ltd., Thailand. Silver yarn was purchased from Maw Chawg Enterprise Co., Ltd., Taiwan.

2.2 Yarns and fabric

Table 1. The specification of fabrics

Fabric	Weave	Polyester yarn	Silver yarn 72/36/2	Warp density	Weft density
Normal fabric	2/2 twill	300 denier	no	69	64
Sample A	2/2 twill	300 denier	5% of silver yarn	69	64
Sample B	2/2 twill	300 denier	4% of silver yarn	69	64

All kinds of fabric in the study are weaved by water jet LW551 210 weaving machine. The yarns used in this study are similar denier sizes. A 2/2 twill weave woven fabric can be varied by altering warp yarns. The 4 and 5% of silver yarn in the fabric show 5 and 6% silver yarn per square inch, respectively.

2.3 Mechanical properties

Tensile strength of woven fabric is determined according to ISO 13934-1:1999(E) Briefly, tensile strength was investigated using an Intron Model 5566 Universal Testing Machine with 100 mm/min crosshead speed with a 200 mm gauge length. The tear resistance measured according to ISO 13937-2: 2000(E). The woven fabrics were carefully cut into a rectangular shape of 50 mm width and 100 mm length. The test speed and gauge length were 100 mm/min and 100 mm, respectively.

2.4 Antibacterial test

The woven fabrics were tested according to AATCC TM 100: 2004. This test method provides a quantitative procedure for the evaluation of the degree of antibacterial activity. The test organisms are *Staphylococcus aureus*, which is gram positive organism, and *Klebsiella pneumoniae*, which is gram negative organism. The test specimens were sterilized before testing by using the autoclave at 121 ºC with 15 psi for 15 minutes.

Briefly, the fabrics were introduced in the 100 ml nutrient broth inoculated with the *S. aureus* or *K. pneumoniae* microbe and incubated at 37°C for 24 h. Microbial inhibition was determined by the reduction in number of bacterial colonies formed with respect to the control sample using the following equations:

$$R = \frac{B - A}{B} \times 100$$

where

R = Percent reduction in bacteria

A = CFU for treated test specimen swatches in the jar incubated for 24 h contact period

B = CFU for untreated control test specimen swatches in the jar immediately after inoculation (at "0" contact time)

3.RESULTS AND DISCUSSION

3.1 Tensile strength

The tensile strength of both warp and weft direction of all kinds of the fabric, which are normal fabric, sample A, and sample B are exhibited in Table 2.

Table 2. Tensile strength of fabric

	Normal fabric	Sample A (5% of silver yarn)	Sample B (4% of silver yarn)
Warp direction	1,843.01	1,888.58	1,844.23
Weft direction	1,747.88	1,678.48	1,708.92

From the Table 2, the results show that in warp direction, the tensile strengths of sample A and sample B have increased while the tensile strengths of weft direction have decreased when comparing with normal fabric. It implies that the increasing of tensile strength in both sample A and sample B is the result of adding some silver yarns in warp direction at the different percentage (Figure 1). It shows the positive relationship that if there is the increasing in

silver yarn, the tensile strength will increase. On the other hand, the weft direction shows negative relationship that adding more silver yarn, the tensile strength decreases.

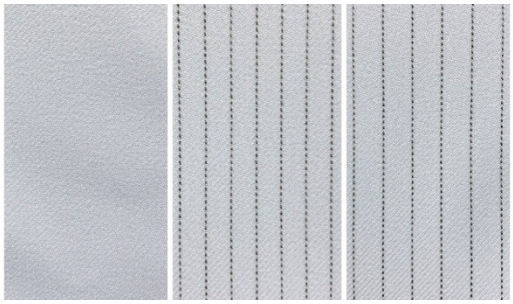

Figure 1. Samples of all fabrics in the study

All the sample fabrics, as shown in Figure 1, have the same construction. Since, the core component's mechanical/tensile properties in any hybrid yarn structure dominates the yarn's mechanical/tensile properties [4]. Therefore, incorporating the metallic filaments as core deteriorate the mechanical/tensile properties of textile yarns and ultimately the fabrics.

3.2 Tearing strength

Table 3 shows the tearing strength in both warp and weft direction of all kinds of the fabric that are normal fabric, sample A and sample B.

Table 3. Tearing strength of fabric

	Normal fabric	Sample A (5% of silver yarn)	Sample B (4% of silver yarn)
Warp direction	76.05	70.00	72.10
Weft direction	82.83	63.44	64.51

Refer to Table 3, the results present tearing strength of sample A and sample B in both warp and weft directions have decreased when comparing with normal fabric. It reveals that silver yarn has negative relationship with tearing strength. The increasing in silver yarn obviously decreases the tearing strength of the fabric.

Adding silver yarn into the fabric leads to the differences of yarn breaking strength, breaking elongation and crimp. These significant differences are the example of the primary factors that influencing a great many fabric properties especially in tensile and tearing strength. The integral yarn strength is a major contributing factor to both tensile and tearing strength of the fabric.

In the discussion an attempt has been made to relate yarn properties to fabric properties. However, it must be emphasized that a certain amount of conflict exists as far as the tensile and tearing strengths of fabric are concerned. It showed that the cloth assistance factor increases with the increase in crossing threads per inch, but an increase in threads per inch would reduce the tear strength. Therefore, the end-use requirement plays an important role in the choice of parameters in design modification of fabrics.

Tearing strength can be improved by reducing threads per inch in the opposite direction and by increasing the yarn strength in the direction of the test [5].

3.3 Antibacterial efficiency

The prepared fabrics were evaluated for antibacterial activity against *S. aureus* and *K. pneumoniae* according AATCC 100: 2004 standard. The percentage reduction in the antibacterial activity of fabrics is revealed in Table 4.

Table 4. The percentage reduction of antibacterial finishes on textile materials

	Normal fabric	Sample A (5% of silver yarn)	Sample B (4% of silver yarn)
S. aureus	0	> 99.93	> 99.93
K. pneumoniae	0	> 99.94	> 99.94

The antibacterial property of normal fabric did not show any reduction, while silver yarn has strongly provided the high percentage reduction of antibacterial (Table 3). There are various mechanisms about how silver kills bacteria. Most of the proposed mechanisms involve silver entering the cell in order to cause damage [6]. Our results are also in line with those reported by Hipler *et al.*[7] that found that silver-loaded

cellulosic fiber is found to be effective against *S. aureus*. Furthermore, the cotton fabrics impregnated with silver and silver/copper nanoparticles were prepared by Eremenko *et al*.[8] The results show high antimicrobial properties of materials with low concentration of silver and silver/copper nanoparticles is confirmed with a wide range of multidrug-resistant bacteria and fungi: Escherichia coli**,** Enterobacter aerogenes**,** Proteus mirabilis**,** Klebsiella pneumoniae**,** Candida albicans yeasts, and micromycetes**.**

4.CONCLUSION

Silver yarn obviously has antibacterial property in both gram-positive bacteria and gram-negative bacteria. The different amount of using silver yarn in the fabric, which is 5 and 6 silver yarns per square inch, is not affect to the percentage reduction of antibacterial within 24 h. For further study, the speed of antibacterial by increasing in different amount of silver yarn should be concerned in order to find the appropriate amount of silver yarn that should be used in the proper fabric.

In term of mechanical property, silver yarn directly affects strength of fabric in both tensile strength and tearing strength. From the results, it implies that if the developer needs to maintain or increase tensile strength of the fabric, the increasing in silver yarn in both warp and weft direction will be concerned to reach the objective. It is because the results reveal that the increasing of silver yarn in warp direction increases tensile strength of the fabric. Moreover, the optimal point of antibacterial effectiveness in term of percentage reduction or timing of prevention of the growth should be considered as the significant factor in order to develop fabric that compatible to be produced in textile industry and meet the customer's satisfaction.

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Effect of some yarn types on tensile strength, tearing strength and air permeability of polyester woven fabrics for Uniform

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ABSTRACT

Polyester garments are less comfortable due to hydrophobic in nature. In order to improve the comfort of polyester, six different yarn types were used in this study including polyester yarn 150D/2/96F (standard), Cool quick polyester yarn (specialty yarn with + shape), micro polyester yarn 150D/2/384F, micro polyester yarn 150D/2/576F, ply twisted polyester yarn 300D/288F with 120 TPM, and ply twisted polyester yarn 300D/288F with 200 TPM. In this study, tensile strength, tearing strength and air permeability of polyester woven fabric using the same weaving and dyeing processes were investigated. Changing the weft yarn types influenced the warp and weft directional tensile and tearing properties due to different physical characteristic of each yarn. For example, higher fabric breaking tensile strength results can be observed for finer filament in fabric structure. The standard fabric displayed the highest value of air permeability which various factors involving fiber cross-section, fiber count, and yarn twist affect air permeability.

Keywords: mechanical properties, tensile strength, tearing strength, air permeability, uniform

1.INTRODUCTION

Clothing is one of the basic needs for human being. It protects human body from weather and environment. The role of clothing is not only to protect the body from the element but also to serve as adornment and symbolize someone's functions, characteristics and mentality. Uniform is a type of clothing worn by members of an organization. Government officer is a huge uniform market. The most generally use uniform fabric in Thailand is polyester.

Nowadays, some manufacturers are diversifying into specialty market by creating a series of new products using the same machinery with minor modifications in the process or equipment. The technology of polyester yarn spinning was developed for a decade creating various yarn types. Changing the shape of yarn, it can change properties of yarn. These specialty fibers are focus on high value products that are new and improved over current materials, in both existing and new applications. Non circular cross-section fiber is developed such as hollow, trilobal, hexagonal and other shapes in order to improve physical properties and applications. Micro denier fiber is popular in functional wear and sport wear. The future of specialty yarn is growing.

To improve government uniform fabric, the effect of 6 different yarn types on mechanical properties and air permeability were determined.

2.MATERIALS AND METHODS

In this research, twill 2/2 fabric construction was applied for all types of six different weft yarns. In order to keep other factors stable, only weft yarns were changed.

The six different yarn counts were the same denier and all types of weft yarn were weaved in the same set of warp yarn using Nissan 210 Model 551 weaving machine. The yarns count in both warp and weft direction was 150D/2/96F which D stands for denier and F stands for filament. The density per inch of warp and weft direction was 88 and 76, respectively. Then, the 6 different types of yarn in one piece 2 meters each were produced. After that, the standard dyeing and finishing process were applied to all fabrics.

The 6 different yarn types are polyester yarn 150D/2/96F (standard), Cool quick polyester yarn 150D/2/192F, micro polyester yarn 150D/2/384F, micro polyester yarn 150D/2/576F, ply twist polyester yarn 300D/288F with 120 TPM, and ply twist polyester yarn 300D/288F with 200 TPM.

Cool quick is a specialty fiber that have cross shape (+) cross-sectional fiber [1]. Micro polyester is the fiber that has denier less than one [1]. Ply twist is the practice to twist several yarns together and this call plying [2]. TPM stands for twit per meter.

Methodology

Every specimen must be test under standard atmosphere: a relative humidity of 65 ± 4 % and a temperature of 20 ± 2 °C.

Fiber cross-section: Optical microscope of the fibers was carried out under visible light using Olympus Bx41 optical microscope.

Tensile strength: Tensile strength is a determination of maximum force and elongation at maximum force. The testing strip method of ISO 13934-1: 1999(E) is used with Instron 5566 universal testing machine. Sample size for the experiment was 50 mm in width and 300 mm in length. The gauge length was 200 mm and rate of extension was 100 mm/min.

Tearing strength: Tearing strength is a determination of tear force of trouser-shaped test specimens (Single tear method). Tearing strength is determined according to ISO 13937-2: 2000(E) with Instron 5566 universal testing machine. Sample size for the experiment was 50 mm. × 200 mm.

Air permeability: air permeability means the velocity of air flow passing through a known area under a prescribed air pressure. This processes tests according to ISO 9237:1995(E) by using M021A air permeability tester machine. The pressure differential between the fabric surface and testing surface area were 100 Pascal and 20 cm^2, respectively.

3.RESULTS AND DISCUSSION

Tensile strength

Tensile strength of developed fabrics is shown in Table 1 and Figure 1.

Table 1. Tensile strength of fabric

Yarn types	Warp	Weft
Standard yarn 150D/2/96F	1,843.01 N	1,747.88 N
Cool quick yarn Micro yarn 150D/2/384F	1,820.85 N	1,453.86 N
Micro yarn 150D//2/576F	1,908.16 N	1,783.66 N
Ply twisted 300D/288F 120TPM	1,785.77 N	1,808.63 N
Ply twisted 300D/288F 200TPM	1,911.50 N	1,951.33 N
	1,813.98 N	1,899.81 N

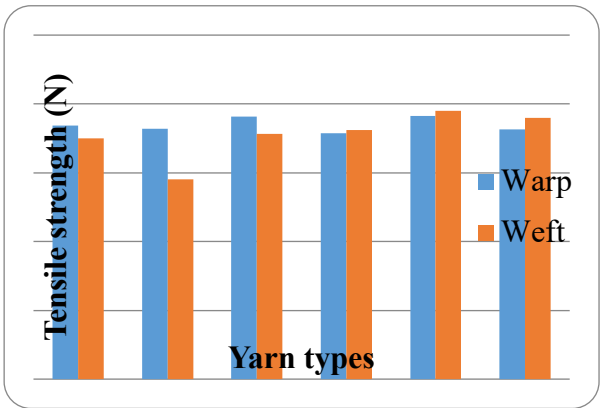


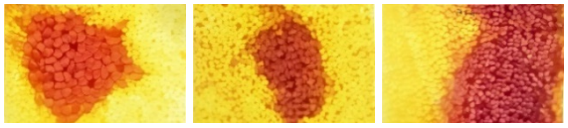
Figure 1. Tensile strength of fabrics

From Table 1 and Figure 1, changing the weft yarn types influences the warp and weft directional tensile properties of fabrics. The warp directional tensile strength of fabric containing micro yarn 150D/2/384F and ply twisted yarn 300D/288F 120TPM are higher than the fabric using standard yarn. In other hand, the warp directional tensile strength of Cool quick yarn, micro yarn 150D/2/576F and ply twisted yarn 300D/288F 200TPM are lower than the standard one. For the weft directional tensile strength, fabrics made from other yarns in weft direction give the higher tensile strength than standard fabric except Cool quick yarn.

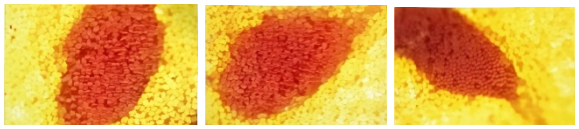
By changing weft yarn, it affects the tensile strength in warp and weft direction. The physical construction of fabrics is changed causing the strength transfer efficiency of warp and weft yarn in woven fabric. According to Taylor [3], strength of woven fabrics of common constructions usually ranges between 85% and 125% of the integral strength of all yarns in the direction tested. It is very important for fabric developer to be able to know that how much of the strength of the individual yarns will translate into the fabric strength in a particular direction after weaving in a specific woven structure.

For weft yarn, it is directly affected from yarn changing. The physical characteristic of each yarn is different. The ply twisted yarn 300D/288F 120 TPM is the strongest yarn. Ply twist help to increase durability and flexibility of yarn. The proper amount of twist has a positive correlation with yarn strength [2]. For micro polyester, the tensile strength shows slightly higher than that of standard yarn and finer filament is stronger than another lower filament (Table 1). The filament fineness has considerable effect on breaking strength. Higher fabric breaking strength results from finer filament in fabric structure [4].

The fiber cross-section in Figure 2 shows the different fineness of yarn that affects to tensile strength of fabric. Yarn count and its filament are identified by number. In this study, two types of micro polyester yarn with different amount of filament were used. For example, the number 150 refers to yarn count in denier; 192 means number of filaments; and 2 is the result of twisting two yarns together. Therefore, the output of 150D/2/384F is 300 denier polyester yarn with 384 filaments (192F+192F). The lowest weft directional tensile strength is Cool quick yarn. According to the fiber cross-sectional shape of fiber in Figure 2, Cool quick yarn exhibits low inter-fiber contact potential around 27% while circular cross-sectional shape has 100% inter-fiber contact potential. Fiber friction is affected by the surface structure of fibers and lower friction leads to lower yarn strength [5].



Standard:150D/2/96F Cool quick 150D/2/384F



150D/2/576F 150D/288F 120TPM 150D/288F 200TPM

Figure 2. Fiber cross-section of 6 yarn types of yarn (200× magnification)

Tearing strength

The numerical test results are shown in Table 2 and graphically presented in Figure 3.

Table 2. Tearing strength of fabric

Yarn types	Warp	Weft
Standard yarn 150D/2/96F	76.05 N	82.83 N
Cool quick yarn	71.10 N	52.10 N
Micro yarn 150D/2/384F	71.93 N	62.28 N
Micro yarn 150D/2/576F	67.44 N	59.03 N
Twisted yarn 300D/288F 120TPM	74.12 N	69.11 N
Twisted yarn 300D/288F 200TPM	68.35 N	58.43 N

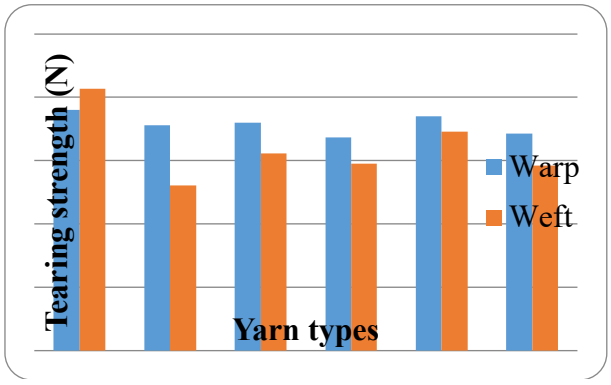


Figure 3. Tearing strength of fabric

The tearing strength is affected by changes in weft yarn types (Table 2 and Figure 3). The standard yarn has higher tearing strength properties than other weft yarn types. Even though the change in weft yarns with the same fabric construction, it is affected to total strength transfer efficiency of warp and weft yarn. The movement of the yarns will be restricted in tight constructions and results in a low tearing strength. Loose and open constructions allow yarns to move and group together, thus result in a high tearing strength [6].

Air permeability

The air permeability of woven fabric depends on many parameters of fabric. Thus, the determination of air permeability of woven fabric is highly complex. The results are shown in Table 3 and Figure 4.

Table 3. Air permeability of fabric

Yarn types	Air permeability ($cm^3/cm^2/s$)
Standard yarn 150D/2/96F	7.27
Cool quick yarn	4.41
Micro yarn 150D/2/384F	7.00
Micro yarn 150D/2/576F	5.61
Twisted yarn 300D/288F 120TPM	5.01
Twisted yarn 300D/288F 200TPM	6.13

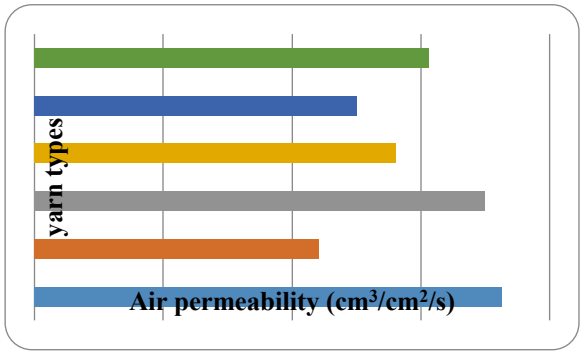


Figure 4. Air permeability of fabric

As shown in Table 3 and Figure 4, the standard fabric displays the highest value of air permeability followed by micro polyester 150D/2/384F, polyester 300D/288F 200 TPM, micro polyester 150D/2/576F, polyester 300D/288F 120 TPM, and Cool quick yarn, respectively.

It has been found that there are many factors that can affect the air permeability of a fabric. Several early studies of air permeability of different materials showed the following factors to affect air permeability: porosity, fabric thickness, fiber count, yarn twist, yarn crimp, and size of pores [7].

From the above factors, the characteristics of yarn itself directly affects to air permeability. Air permeability is linked to fabric cover factor that help improve air permeability.

4.CONCLUSION

This study shows that yarn types in the same yarn count affect to fabric tensile strength, tearing strength and air permeability. The maximum tensile strength in warp direction is ply twisted yarn 300D/288F 120TPM yarn, while the maximum weft directional tensile strength is ply twisted yarn 300D/288F 120TPM yarn. The highest tearing strength in warp and weft direction is the standard polyester yarn 150D/2/96F. Other yarn types decrease tearing strength properties. In air permeability testing, the standard yarn still displays the highest air permeability value which is 7.27 $cm^3/cm^2/s$. The application of developed fabrics depends on the

purpose or utility of fabric. For example, ply twisted yarn 300D/288F 120TPM exhibits the highest tensile strength properties with low air permeability rates. By reducing fabric density construction, the air permeability is improved.

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Hybrid finite difference for solving differential equations

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ABSTRACT

A finite difference is widely used for solving numerical solution of differential equations. Some restriction of traditional finite difference affect to increasing an error of numerical solution. This paper presents a hybrid finite difference, upwind scheme and central finite difference for solving ordinary differential equations and partial differential equations which could have stability more than the traditional method. We found that the numerical solution by hybrid scheme get rid of maximum error more than central finite difference method and level of gamma parameter lead to decreasing of root mean square error.

1. INTRODUCTION

The finite difference method is used for solving ordinary differential equations and partial differential equations. Approximation of d(f(x))/dx is defined by forward difference approximation (FDA), backward difference approximation (BDA) or central difference approximation (CDA) in finite difference. The differentiable function of x can be expanded in a Taylor series about x. The idea of finite difference extend to a function of two variables for partial differential equation. BDA,FDA and CDA are replaced by u_x, u_y [1].

The upwind scheme is combination of backward finite difference and forward finite difference. The hybrid scheme is blended between upwind scheme and central finite difference. Configuration of gamma parameter will affect to level of upwind scheme and central finite difference in hybrid scheme. The upwind scheme is modified for convective-diffusion equations. A second order upwind scheme is applied for multidimensional magnetohydrodynamics in 1998 [2]. The Linear hyperbolic systems are discrete by second order upwind method [3]. The upwind scheme is represented to first order derivative and central finite difference is applied to second order derivative for change to elliptic problem [4]. The upwind compact scheme is solved with the Euler equation for the incompressible flow [5]. The OUCS2 upwind compact scheme is applied to calculation of first derivative in the Euler and Navier-Stokes equations [6]. Semi-Discrete Central scheme is constructed and analyzed by the total variation(TV) of approximation solution [7]. Central difference, upwind and hybrid scheme are solved in different grid system for general transport equation [8]. Triangular discretization of the domain is purposed with central upwind scheme for variable density shallow water flow equations [9]. The well-balanced positivity preserving second-order "triangular" central-upwind scheme is improved for the two-dimensional Saint-Venant system of shallow water equation [10].

In this paper, we propose a hybrid scheme for solving ordinary differential equations and partial differential equations.

Numerical solutions are compared with analytic solutions in the different gamma parameter.

2. MATERIALS AND METHODS

This research use hybrid method for first derivative and central finite difference for second derivative. Blending of upwind scheme and central finite difference depend on gamma parameter. Configuration of gamma parameter in hybrid method is set as 0.1,0.5 and 0.9 respectively. Maximum norm and root mean square error (RMSE) are purposed for comparison numerical solution.

2.1 Ordinary differential equation.

We consider the ordinary differential equation as following

$$-\frac{d^2u}{dx^2}+k\frac{du}{dx}=\sin x. \qquad (1)$$

Boundary condition is $u(1)=2, u(3)=5.$

Analytic solution is

$$u(x)=c_1+c_2e^{kx}+\frac{\sin x-k\cos x}{1+k^2},$$
$$c_1=2-c_2e^{k}-\frac{\sin 1-k\cos 1}{1+k^2},$$
$$c_2=\left[3-\frac{(\sin 3-k\cos 3-\sin 1+k\cos 1)}{1+k^2}\right]\times\frac{1}{e^{3k}-e^{k}}.$$

The Eq.(1) is demonstrated for comparision numerical solution between the central finite difference method and hybrid upwind scheme.

2.1.1 Central finite difference method for ODE

The Eq.(1) is discreted by central finite difference method as following

$$-\left.\frac{d^2u}{dx^2}\right|_{x_i}+k\left.\frac{du}{dx}\right|_{x_i}=f(x_i) \qquad (2)$$

$$-\left(\frac{u_{i-1}-2u_i+u_{i+1}}{(\Delta x)^2}\right)+k\left(\frac{u_{i+1}-u_{i-1}}{2\Delta x}\right)=f(x_i) \qquad (3)$$

$$-(k\Delta x+2)u_{i-1}+4u_i+(k\Delta x-2)u_{i+1}=2(\Delta x)^2 f(x_i) \qquad (4)$$

$$Let \quad L=-(k\Delta x+2).$$
$$Let \quad R=(k\Delta x-2).$$

Eq.(4) can be written in the matrix form as following

$$\begin{bmatrix} 4 & R & & & \\ L & 4 & R & & \\ & \ddots & \ddots & \ddots & \\ & & L & 4 & R \\ & & & L & 4 \end{bmatrix}\begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_{n-1} \end{bmatrix}=\begin{bmatrix} 2(\Delta x)^2 f(x_1)-Lu_0 \\ 2(\Delta x)^2 f(x_2) \\ \vdots \\ 2(\Delta x)^2 f(x_{n-1})-Ru_n \end{bmatrix} \qquad (5)$$

Let $$A=\begin{bmatrix} 4 & R & & & \\ L & 4 & R & & \\ & \ddots & \ddots & \ddots & \\ & & L & 4 & R \\ & & & L & 4 \end{bmatrix}$$

and $$U=\begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_{n-1} \end{bmatrix}$$ Let $$F=\begin{bmatrix} 2(\Delta x)^2 f(x_1)-Lu_0 \\ 2(\Delta x)^2 f(x_2) \\ \vdots \\ \vdots \\ 2(\Delta x)^2 f(x_{n-1})-Ru_n \end{bmatrix}$$

We rearrange (5) yields the following result $AU=F.$ Matrix U is solved by computer programming.

2.1.2 Hybrid upwind scheme for ODE

The Eq.(1) is discreted by hybrid upwind scheme as following

$$-\left.\frac{d^2u}{dx^2}\right|_{x_i}+k\left.\frac{du}{dx}\right|_{x_i}=f(x_i) \qquad (6)$$

$$\frac{d^2u}{dx^2}=\left(\frac{u_{i-1}-2u_i+u_{i+1}}{(\Delta x)^2}\right) \tag{7}$$

$$\frac{du}{dx}=\frac{\gamma}{2\Delta x}\left((1+\varepsilon)(u_i-u_{i-1})+(1-\varepsilon)(u_{i+1}-u_i)\right)+\frac{(1-\gamma)}{2\Delta x}(u_{i+1}-u_{i-1}) \tag{8}$$

Eq.(6) can be substitued by Eq.(7)-(8), the result as following

$$\begin{aligned}&\left(-2-k\Delta x(\gamma\varepsilon+1)\right)u_{i-1}\\&\quad+\left(4+2k\Delta x\gamma\varepsilon\right)u_i\\&+\left(-2-k\Delta x(\gamma\varepsilon-1)\right)u_{i+1}=2(\Delta x)^2 f(x_i)\end{aligned} \tag{9}$$

Let $L=-2-k\Delta x(\gamma\varepsilon+1).$

Let $C=4+2k\Delta x\gamma\varepsilon.$

Let $R=-2-k\Delta x(\gamma\varepsilon-1).$

Eq.(9) can be written in the matrix form as following

$$\begin{bmatrix} C & R & & & \\ L & C & R & & \\ & \ddots & \ddots & \ddots & \\ & & L & C & R \\ & & & L & C \end{bmatrix}\begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ \\ u_{n-1} \end{bmatrix}=\begin{bmatrix} 2(\Delta x)^2 f(x_1)-Lu_0 \\ 2(\Delta x)^2 f(x_2) \\ \vdots \\ \\ 2(\Delta x)^2 f(x_{n-1})-Ru_n \end{bmatrix}$$

2.2 Partial differential equation.

We consider the partial differential equation as following

$$\frac{\partial u}{\partial t}-\frac{\partial^2 u}{\partial x^2}=-2,\ 0<x<1,\ t>0. \tag{10}$$

Boundary condition is

Initial condition is $u(x,0)=x^2+1 \quad ,0<x<1.$

Analytic solution is $u(0,t)=3, u(1,t)=5, t>0.$

$$u(x,t)=x^2+x+3+\sum_{n=1}^{\infty}b_n\sin n\pi x e^{-n^2\pi^2 t}.$$

where $b_n=\begin{cases}\dfrac{2}{n\pi}, & n \text{ is even.}\\[2ex] \dfrac{-10}{n\pi}, & n \text{ is odd.}\end{cases}$

The analytic solution is an infinite series as

$$\begin{aligned}u(x,t)=x^2+x+3&-\frac{10}{\pi}\sin\pi x e^{-\pi^2 t}+\frac{1}{\pi}\sin 2\pi x e^{-4\pi^2 t}\\&-\frac{10}{3\pi}\sin\pi x e^{-9\pi^2 t}+\frac{1}{2\pi}\sin 2\pi x e^{-16\pi^2 t}\\&-\frac{2}{\pi}\sin\pi x e^{-25\pi^2 t}+\frac{1}{3\pi}\sin 2\pi x e^{-36\pi^2 t}-\ldots\end{aligned}$$

2.2.1 Central finite difference method for PDE

The Eq.(10) is discreted by central finite difference method as following

$$\frac{\partial^2 u}{\partial x^2}=\left(\frac{u_{i-1}-2u_i+u_{i+1}}{\Delta x^2}\right) \tag{11}$$

$$\frac{\partial u}{\partial t}=\frac{1}{2\Delta t}(u_{i+1}-u_{i-1}) \tag{12}$$

Eq.(10) can be substitued by Eq.(11)-(12), the result as following

$$\begin{aligned}&\left(-2(\Delta t)-(\Delta x)^2\right)u_{i-1}\\&+\left(4(\Delta t)\right)u_i\\&+\left(-2(\Delta t)+(\Delta x)^2\right)u_{i+1}=2(\Delta t)(\Delta x)^2 f(x_i)\end{aligned} \tag{13}$$

Let $L=-2(\Delta t)-(\Delta x)^2$ is an coefficient of u_{i-1}.

Let $C=4(\Delta t)\gamma\varepsilon$ is an coefficient of u_i.

Let $R=-2(\Delta t)+(\Delta x)^2$ is an coefficient of u_{i+1}.

We substitute L,C and R in the matrix form for solving numerical solution.

2.2.2 Hybrid upwind scheme for PDE

The Eq.(10) is discreted by hybrid upwind scheme as following

$$\frac{\partial^2 u}{\partial x^2}=\left(\frac{u_{i-1}-2u_i+u_{i+1}}{\Delta x^2}\right) \tag{14}$$

$$\frac{\partial u}{\partial t}=\frac{\gamma}{2\Delta t}\left((1+\varepsilon)(u_i-u_{i-1})+(1-\varepsilon)(u_{i+1}-u_i)\right) + \frac{(1-\gamma)}{2\Delta t}(u_{i+1}-u_{i-1}) \tag{15}$$

Eq.(10) can be substitued by Eq.(14)-(15), the result as following

$$\begin{aligned}&\left(-2(\Delta t)-(\Delta x)^2(\gamma\varepsilon+1)\right)u_{i-1}\\&+\left(4(\Delta t)+2(\Delta x)^2\gamma\varepsilon\right)u_i\\&+\left(-2(\Delta t)-(\Delta x)^2(\varepsilon-\gamma+2)\right)u_{i+1}=2(\Delta t)(\Delta x)^2 f(x_i)\end{aligned} \tag{16}$$

Let $L=-2(\Delta t)-(\Delta x)^2(\gamma\varepsilon+1)$ is an coefficient of u_{i-1}.

Let $C=4(\Delta t)+(\Delta x)^2\gamma\varepsilon$ is an coefficient of u_i.

Let $R=-2(\Delta t)+(\Delta x)^2(\varepsilon-\gamma+2)$ is an coefficient of u_{i+1}.

We substitute L,C and R in the matrix form for solving numerical solution.

3. RESULTS AND DISCUSSION

This research will compare numerical solution of differential equation with central finite differential, hybrid upwind scheme and analytic solution.

Accuracy is measured in the discrete maximum norm and root mean square error (RMSE). The discrete maximum norm and maximum of root mean square error was given in Table 1-Table 3. that is estimated for difference gamma in hybrid scheme. The analytical and numerical solution profiles are given in Fig. 1- Fig. 11.

$$\text{Maximum Norm} = max\left|\hat{\boldsymbol{u}}_i-\boldsymbol{u}_i\right|$$

$$\text{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\hat{\boldsymbol{u}}_i-\boldsymbol{u}_i)^2}$$

$\hat{\boldsymbol{u}}_i$ where is an approximate solution of differential equation and u_i is the analytic solution .

Example 1. We consider the ordinary differential equation $-\frac{d^2u}{dx^2}+k\frac{du}{dx}=0$.

The analytic solution is $u(x)=c_1+c_2e^{kx}$ where $c_1=-c_2e^k$, $c_2=\frac{1}{1-e^k}$.

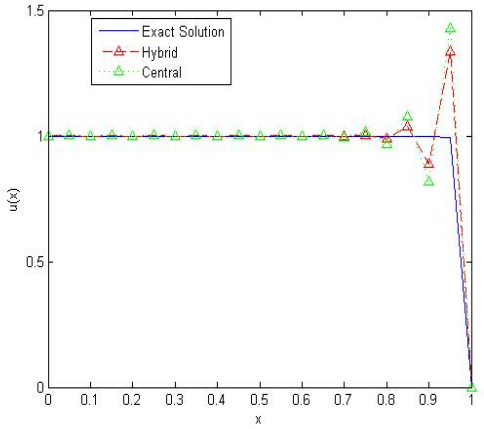

Figure 1. Numerical solutions with parameter $\gamma=0.1$ of hybrid method.

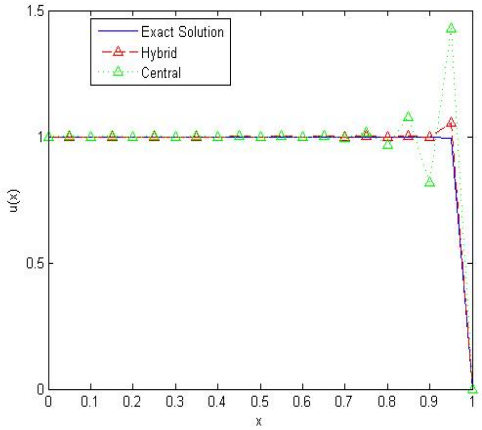

Figure 2. Numerical solutions with parameter $\gamma = 0.5$ of hybrid method.

Table 1. The numerical solutions by difference gamma in Example 1.

Method	Central	Hybrid	
Error [a]		$\gamma = 0.1$	$\gamma = 0.5$
MaxNorm	0.435309	0.340071	0.059370
RMSE	0.151922	0.113810	0.018794

Example 2. We consider the ordinary differential equation $-\frac{d^2u}{dx^2} + k\frac{du}{dx} = \sin x$.

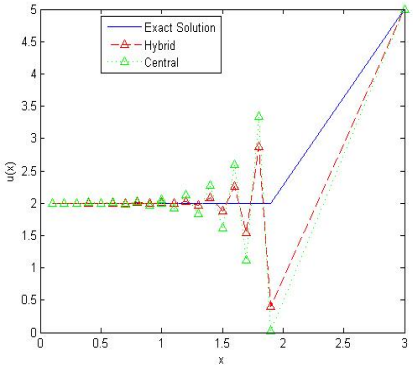

Figure 3. Numerical solutions with parameter $\gamma = 0.1$ of hybrid method.

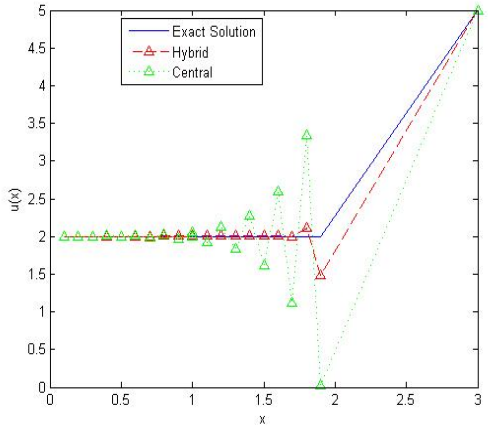

Figure 4. Numerical solutions with parameter $\gamma = 0.5$ of hybrid method.

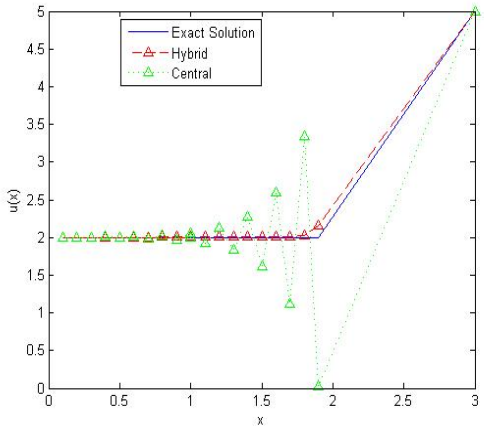

Figure 5. Numerical solutions with parameter $\gamma = 0.9$ of hybrid method.

Table 2. The numerical solutions by difference gamma in Example 2.

Method	Central	Hybrid		
Error [a]		$\gamma = 0.1$	$\gamma = 0.5$	$\gamma = 0.9$
MaxNorm	1.978637	1.594305	0.513291	0.155889
RMSE	0.842973	0.601025	0.165887	0.050337

Example 3. We consider the partial differential equation $\frac{\partial u}{\partial t}-\frac{\partial^2 u}{\partial x^2}=-2, 0<x<1, t>0.$

Boundary Condition is $u(0,t)=3, u(1,t)=5 \quad , t>0.$

Initial Condition is $u(x,0)=x^2+1 \quad , 0<x<1.$

The analytic solution is

$$u(x,t)=x^2+x+3-\frac{10}{\pi}\sin\pi x e^{-\pi^2 t}+\frac{1}{\pi}\sin 2\pi x e^{-4\pi^2 t}+\ldots$$

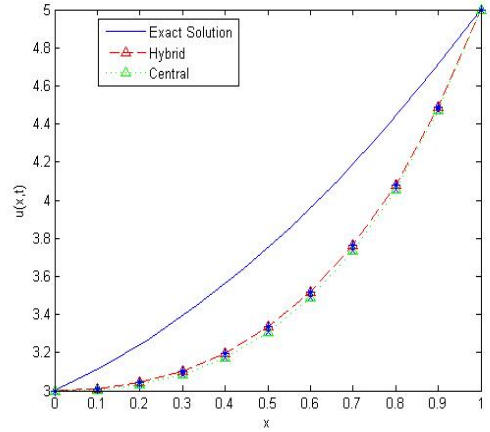

Figure 6. Numerical solutions with parameter $\gamma=0.5$ of hybrid method.

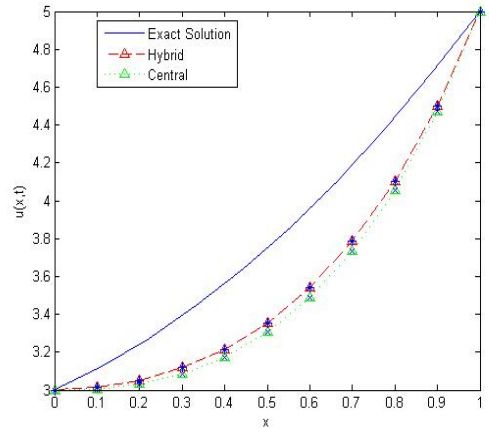

Figure 7. Numerical solutions with parameter $\gamma=0.9$ of hybrid method.

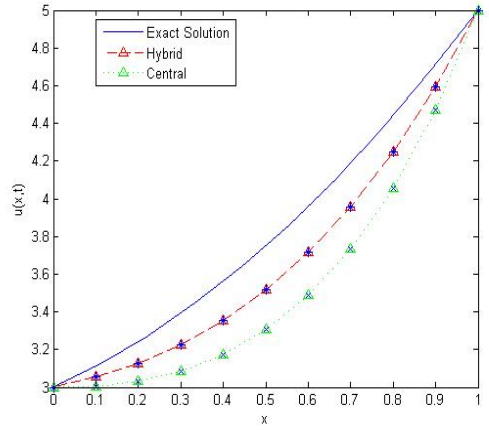

Figure 8. Numerical solutions with parameter $\gamma=5$ of hybrid method.

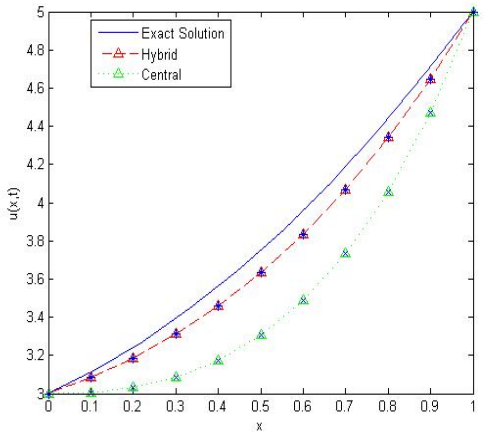

Figure 9. Numerical solutions with parameter $\gamma=10$ of hybrid method.

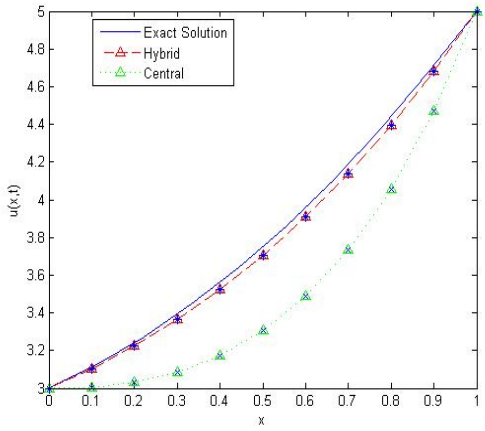

Figure 10. Numerical solutions with parameter $\gamma=15$ of hybrid method.

Table 3. The numerical solutions by difference gamma in Example 3.

Method	Central	Hybrid		
Error [a]		$\gamma = 0.1$	$\gamma = 0.5$	$\gamma = 0.9$
MaxNorm	0.410521	0.379110	0.182407	0.064411
RMSE	0.286993	0.264867	0.126159	0.024845

4. CONCLUSIONS

The hybrid scheme has maximum norm and root mean square error less than central finite difference method in addition to the most of maximum gamma will have lower error for same hybrid scheme. Increasing of gamma parameter in partial differential equation will decrease maximum norm and root mean square error. Moreover, convergence rate will correspond with gamma parameter in hybrid scheme.

5. ACKNOWLEDGMENTS

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Optimization of free fatty acid reduction in coconut oil via sulfamic acid-catalyzed esterification

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ABSTRACT

This study presents the two-step esterification process for the reduction of free fatty acid (FFA) content in coconut oil to less than 1% w/w. The initial value of FFA content in coconut oil was 25.22% w/w. The esterification reaction in the presence of sulfamic acid as a catalyst was carried out to investigate the optimum conditions and to study the effects of variables on the reaction. These variables included methanol contents of 20-50% v/v, catalyst amounts of 0-15% w/v of oil, reaction temperatures of 25-60 ºC, and reaction times of 1-4 h. The FFA content in oil was determined by AOAC Official Method 940.28 (AOAC 2012). After the two-step process, the FFA content was reduced to 0.91% w/w. The optimum conditions for the first step were a methanol content of 50% v/v, catalyst amount of 10% w/v of oil, a reaction temperature of 60 °C, and a reaction time of 2 h. The optimum conditions for the second step were a methanol content of 40% v/v, catalyst amount of 5% w/v of oil, a reaction temperature of 60 °C, and a reaction time of 2 h. In addition, the results demonstrate that all of the reaction variables had the positive effects on the reaction.

Keywords: Free fatty acid, Esterification, Sulfamic acid, Coconut oil

1. INTRODUCTION

The fact that nowadays petroleum is very important in human life and it is the major world energy resource. It is used as fuel in transportation, industry, household, electricity generation, and agriculture. Besides, petroleum is comprised of a mixture of various hydrocarbons which can be used as feedstock in petrochemical industry. However, petroleum resource is limited and non-renewable and the global petroleum use as fuel has had a negative impact on the environment such as global warming and air pollution. In the present day, Thailand strongly relies on crude oil import and it resulted in the costs huge expenditure of the country. Therefore, in order to relieve these problems, the alternative fuel must be used. One of the interested alternative fuels was biodiesel which is renewable, environmental friendly, and available locally. Biodiesel is the fatty acid methyl ester which is produced currently from plant oils and animal fats. In many countries, biodiesel is produced from plant oils such as soybeans, canola oil, palm oil, corn oil, coconut oil, and jatropha oil. In addition, the used cooking oil is the high potential commercial source for biodiesel production.

In general, the crude and waste vegetable oils are more viscous than petroleum diesel for many times. For example, the viscosity of Stone fruit kernel oil and waste coffee oil are 34.82 and 26.74 mm^2/s at 40 ºC, respectively [1,2] while the viscosity of Thai petroleum diesel is 1.8-4.1 mm^2/s at 40 ºC (ASTM D 445). Therefore, the use of vegetable oil in an unmodified diesel fuel system will cause the negative effects to the engine and fuel system such as poor fuel atomization, incomplete combusion, and coking of the fuel injectors. In order to solve these problems, the vegetable oil must be transesterified to acquire a viscosity close to that of petroleum diesel. Nowadays, the commercial process for biodiesel production is alkali-catalyzed transesterification in which triglyceride in oil and fat are converted to methyl ester (biodiesel) and glycerol. The feedstocks for this process are vegetable oils and

animal fats containing free fatty acid (FFA) less than 1% w/w [3]. However, these feedstocks are expensive. Thus, the low price feedstocks such as oils and fats having FFA content more than 1% w/w should be used instead to reduce the biodiesel production cost. However, the high FFA content is the obstacle in the alkali-catalyzed transesterification because FFAs react with alkaline catalyst to form soap. Soap increases the viscosity of the reaction mixture resulting in the lower yield of biodiesel. In addition, soap inhibits the separation of biodiesel from glycerol and washing water. Therefore, to solve this problem, the two-step process for biodiesel production was used. The first step is the pretreatment step in which the FFAs in oil are esterified to methyl esters by using acid catalyst and the FFA content is reduced to less than 1% w/w after the reaction. In the second step, triglycerides in oil are transesterified to biodiesel by using alkaline catalyst. In esterification step, sulfuric acid is the most commonly preferred homogeneous catalyst. Although sulfuric acid has high efficiency to catalyze esterification, it has some disadvantages such as corrosivity, a large amount of water is used to wash the product, and a large amount of waste water needs to be treated. With these reasons, many researchers currently aim at the use of heterogeneous catalysts such as Lignin-based solid acid catalyst manufactured from olive cake [4], Montmorillonite Clay K-30 [5], and Zirconia-supported tungstophosphoric heteropolyacid [6] in biodiesel production. In addition, some researchers reported the success of use sulfamic acid as eco-friendly catalyst to convert FFAs in oil to alkyl esters via esterification [7].

Sulfamic acid (SA, NH_2SO_3H) is a white crystalline solid, odorless, and relatively stable. It is moderately soluble in water and slightly soluble in methanol. In recent year, reports in the literatures revealed the several advantages of using sulfamic acid as catalyst in organic synthesis, including non-hygroscopicity, non-corrosivity, non-volatility, easy separation from the reaction mixture and reusable, and low cost [8,9]. Hence, in this study the researchers focus on the reduction of FFA content in coconut oil containing high FFA via acid-esterification. The coconut oil is one of the high potential feedstocks for biodiesel production in Thailand. The objectives of this study were: (a) To investigate the optimum reaction conditions for the reduction of FFA in coconut oil to less than 1% w/w by using sulfamic acid-catalyzed esterification, and (b) To study the effects of the important variables on the reaction.

2. MATERIALS AND METHODS

The coconut oil feedstock was obtained from Sangsook Industry Company Limited as unrefined types. Absolute ethanol was purchased from Merck. Potassium hydrogen phthalate, sulfamic acid, phenolphthalein, and sodium hydroxide were purchased from Ajax Finechem Pty Ltd. All chemicals used in this study, such as absolute ethanol, phenolphthalein, sulfamic acid, sodium hydroxide, and potassium hydrogen phthalate were analytical grade.

Preparation of coconut oil

The coconut oil was viscous, amber color and had suspended solid particles. The oil was heated at 60 °C and subsequently filtered to remove impurities with Whatman filter paper No.93. After that, the free fatty acid in coconut oil was determine by AOAC Official Method 940.28 (AOAC 2012). Besides, some physical properties of coconut oil such as viscosity, density, and water content were also tested by standard test methods.

Apparatuses

The apparatuses used for acid-catalyzed esterification of FFA in coconut oil consisted of a 250 mL three-necked flat-bottom flask as reactor and hotplate with a magnetic stirrer. The two necks of the reactor were equipped with a reflux condenser and thermometer while the other neck was used for sulfamic acid feeding. The reflux condenser was used to condense the evaporated methanol back to the reaction mixture.

Experimental conditions

In this study, the sulfamic acid-catalyzed esterification was performed with the aim of investigating the optimum conditions for the reduction of FFA content in coconut oil to less than 1% w/w and to study the effects of dominant variables on the reaction. The reduction process composed of two steps and it was carried out at the atmospheric pressure in a laboratory-scale experiment. In the first step, the dominant variables affecting the esterification such as methanol amounts (20, 30, 40, and 50% v/v), catalyst amounts (0, 5, 10, and 15% w/v of oil), reaction temperatures (25, 40, 50, and 60 °C) and reaction times (1, 2, 3, and 4 h) were optimized. In the second step, methanol amounts of 30 and 40% v/v were used to investigate the optimum condition to reduce the FFA content in coconut oil to less than 1% w/w.

Experiment

The coconut oil feedstock, methanol, and sulfamic acid were used in amounts of established for each experiment. The coconut oil was first charged into the reactor and heated to the desired temperature. Then, methanol and sulfamic acid was added to the preheated oil. After the completion of the addition, the time was considered as the beginning of the experiment. The reaction mixture was heated and stirred at constant stirring speed until the end of the reaction time. After the reaction, the reaction mixture was poured into separatory funnel and allowed to settle overnight under gravity to separate methanol, spent catalyst and water produced during the reaction. The reaction mixture was separated into two layers. The top layer consisted of coconut oil, trace unreacted methanol and water whereas the lower layer contained a mixture of an excess of unreacted methanol, catalyst, and water. The oil layer was separated and then subjected to remove water and residual methanol by heating at 110 °C. After that, the impurities in oil was removed by filtration with Whatman filter paper No.93 and the clear oil product was obtained. Finally, the content of unreacted FFA which remained in oil product was determined by AOAC Official Method 940.28 (AOAC 2012).

3. RESULTS AND DISCUSSION

Characterization of the coconut oil

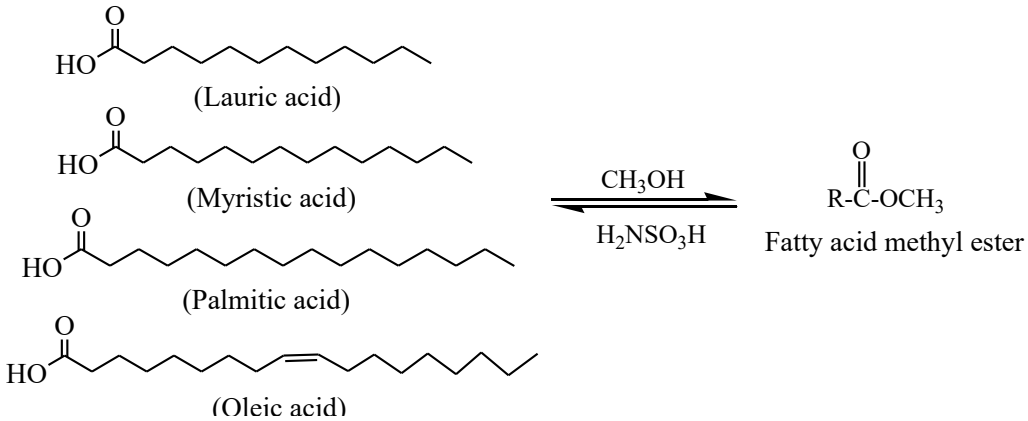
The coconut oil used in this study was clear, viscous and amber color after filtration. Its some important properties are shown in Table 1.

Table 1. Properties of coconut oil feedstock

Property	Method	Oil
FFA content, % w/w	AOAC 940.28 (AOAC 2012)	25.22
Kinematic viscosity at 40 °C, mm^2/s	ASTM D 445	29.23
Density at 15 °C, kg/m^3	ASTM D 4052	0.9256
Water content, % w/w	ASTM E 1064	0.666

Coconut oil is more viscous than Thai petrodiesel about ten times and it has low volatility. Therefore, it is not suitable for direct use in a unmodified diesel engine because it causes the difficulty in fuel atomization and in mixing of fuel and air. To improve the coconut oil performance in diesel engine, its viscosity must be reduced to a level close to petrodiesel. The best way to achieve this purpose is converting coconut oil to biodiesel. The initial FFA content of coconut oil was 25.22% w/w and this value is beyond the limited value (1% w/w) of oil used as feedstock for biodiesel production. Therefore, it is difficult to convert this oil to biodiesel by commercial alkali-catalyzed transesterification process due to the soap formation. From this reason, the researchers used the two-step esterification process to reduce the FFA content in coconut oil to less than 1% w/w. The coconut oil contained trace of water so it was not a obstacle for the esterification reaction.

Coconut oil is the mixture of saturated, monounsaturated and polyunsaturated fats. The saturated fat in coconut oil is made up of six different types of fatty acids, including caprylic, capric, lauric, myristic, palmitic, and stearic acid. Of the six types of fatty acid, the most predominant is lauric acid. The monounsaturated and polyunsaturated fat in coconut oil are made entirely of



Scheme 1. Esterification reaction of FFAs

oleic acid and linoleic acid, respectively. The fatty acid composition of coconut oil was shown in Table 2.

Table 2. Fatty acid composition of coconut oil [10]

Fatty acid	Fatty acid content (%)
Caprylic acid (C8:0)	3.35
Capric acid (C10:0)	3.21
Lauric acid (C12:0)	32.72
Myristic acid (C14:0)	18.38
Palmitic acid (C16:0)	13.13
Stearic acid (C18:0)	3.60
Oleic acid (C18:1)	12.88
Linoleic acid (C18:2)	4.35

Hence, during sulfamic acid-catalyzed esterification, the FFAs were esterified to form various kinds of methyl esters of fatty acids such as methyl laurate, methyl myristate, methyl palmitate, and methyl oleate as shown in Scheme 1.

Acid-catalyzed esterification : Step 1

The effect of methanol amount

Esterification requires 1 mole of methanol for each mole of fatty acid to produce 1 mole of methyl ester and 1 mole of water. The reaction is an equilibrium and the using of large excess of methanol ensures that the reaction is driven to methyl esters direction. Therefore, one important variable affecting the esterification is the methanol amount. In this study, the effect of methanol amounts of 20, 30, 40, and 50% v/v (1:4, 1:7, 1:11, and 1:17 molar ratio of FFA/methanol, respectively) on the esterification was investigated at the conditions of 5% w/v of oil sulfamic acid catalyst, 60 °C, and 2 h of reaction time. The results were shown in Figure 1.

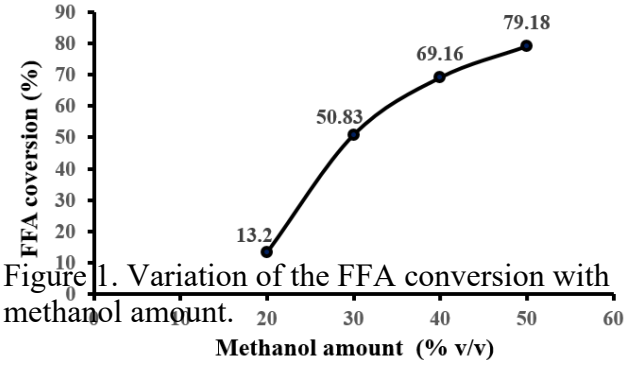


Figure 1. Variation of the FFA conversion with methanol amount.

Figure 1 shows that the methanol amount significantly affects the FFA conversion. When the methanol amount was 20% v/v (1:4 molar ratio of FFA/ methanol), the FFA conversion was only 13.2%. The FFA conversion increased rapidly from 13.2-79.18% with an increasing of methanol amount from 20%-50% v/v. The same trend was reported by Montes D'Oca, M.G. et al.[8]. A maximum FFA conversion was reached at 50% v/v. (1:17 molar ratio of FFA/methanol) and the FFA content in oil was reduced to 5.25% w/w at this point. The increase in FFA conversion trend

can be explained by Le Chatelier's principle. When methanol amount increased, the equilibrium shifted in the direction of forward reaction. This lead to the increasing of methyl ester and water formation. Furthermore, the viscosity of the reaction system reduced when the large excess of methanol was used. This resulted in the better mixing between oil, methanol, and catalyst which promoted the rate of reaction. Hence, the FFA conversion was increased rapidly in the fixed reaction time. Therefore, the optimum methanol amount was 50% v/v and the investigation of the effect of catalyst amount was conducted by using this methanol amount.

The effect of catalyst amount

Another important variable that affects the acid-catalyzed esterification is the catalyst amount. To investigate the effect of catalyst amounts (0, 5, 10, and 15% w/v of oil) on esterification, the experiments were carried out at the condition of methanol amount of 50% v/v, 60 °C, and 2 h. The results were shown in Figure 2.

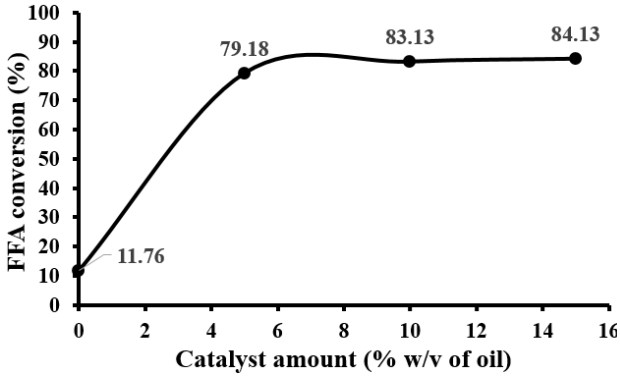


Figure 2. Variation of the FFA conversion with catalyst amount.

It can be seen clearly from Figure 2 that the minimal FFA conversion of 11.76% was obtained when sulfamic acid was not used as catalyst. The esterification could have occurred from the autocatalysis whereby the reaction was catalyzed by the FFA in coconut oil. The rate of reaction was increased considerably in the presence of sulfamic acid and resulting in the high FFA conversion. These results indicated that sulfamic acid had the important role as catalyst for the esterification of FFA in coconut oil with methanol. Increasing the catalyst amount increased the reaction rate. Hence, at catalyst amount of 5% w/v of oil provide FFA conversion of 79.18% (FFA content 5.25% w/w) within 2 h, whereas 10% w/v of oil provide FFA conversion 83.13% (FFA content 4.25% w/w) in the same reaction time. The same results were observed by Montes D'Oca, M.G. et al. who studied the efficiency of sulfamic acid as catalyst for the esterification of oleic acid and the results showed that an increase in catalyst amount from 5 to 10% increased methyl oleate yield from 71 to 80% under the condition of molar ratio of methanol/ oleic acid of 6:1 and 120 °C [8]. However, the gradual decrease in esterification rate was observed when the catalyst amount beyond 5% w/v of oil was used and the reaction slowly reached its equilibrium after methanol amount of 10% w/v of oil. From an economical point of view, 5% w/v of oil was selected as the optimum catalyst amount and this value was used to investigate the effect of reaction temperature. In the industrial scale, sulfamic acid in the methanol-water layer can be recovered and recycled.

The effect of reaction temperature

In this study, the effect of reaction temperatures (25, 40, 50, and 60 °C) on sulfamic acid-catalyzed esterification were investigated at the conditions of methanol amount of 50% v/v, catalyst amount of 5% w/v of oil and the reaction time of 2 h. The results were shown in Figure 3.

Esterification is the endothermic reaction so heat is needed to drive the reaction to the product side [11]. Figure 3 reveals that sulfamic acid-catalyzed esterification of FFA in coconut oil with methanol could occur at different temperatures, even though at room temperature (25 °C) but the reaction is incomplete. Rate of sulfamic acid-catalyzed esterification increased with increasing reaction temperature. This resulted in the increasing of FFA conversion consecutively. It can be explained by the four reasons. First, esterification is the endothermic reaction. Thus, when the temperature

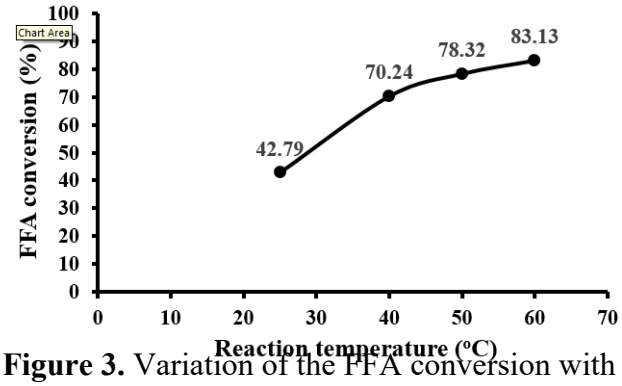


Figure 3. Variation of the FFA conversion with reaction temperature.

increased, the rate of reaction increased. Second, as the temperature increased, the reactant particles had higher energy. They moved more quickly and more of the collisions which resulting in the increasing rate of reaction. Third, from the mass transfer perspective, coconut oil was not soluble in methanol but the solubility of oil increased when the reaction temperature increased. This lead to the lesser resistance to mass transfer which resulted in more completion of the reaction. The last reason, by increasing of reaction temperature, the viscosity of coconut oil decreased resulting in the better mixing between oil, methanol and catalyst. This lead to the more conversion of FFA to methyl ester. This trend was also observed by Montes D'Oca, M.G. et al. who studied the effect of reaction temperature on the esterification of oleic acid. They reported that when the reaction temperature of 80, 100 , and 120 °C were used, the yields of methyl oleate were 62%, 76%, and 80% respectively [8].

The FFA conversion reached the maximum value of 83.13% at 60 °C and the FFA content was reduced to 4.25% at this point. In this study, in order to avoid an excessive loss methanol, the effect of reaction temperatures beyond 60 °C were not investigated due to the boiling point of methanol was 64 °C. Therefore, 60 °C was selected as the optimum reaction temperature and it was used to investigate the effect of reaction time.

The effect of reaction time

To investigate the effect of reaction times (1, 2, 3, and 4 h) on sulfamic acid-catalyzed esterification, the experiments were carried out at methanol amount of 50% v/v, catalyst amount of 5% w/v of oil, and reaction temperature was 60 °C. The results were shown in Figure 4.

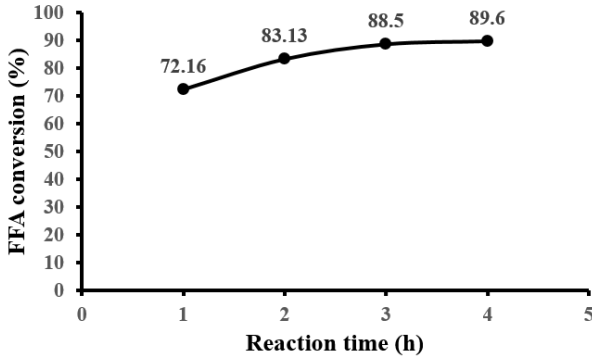


Figure 4. Variation of the FFA conversion with reaction time.

The results indicated that the conversion rate was so high in the first one hour. This is due to the water content was minimal in that period of time. As the esterification proceed, the formation of water increased resulting in the hydrolysis of methyl ester back to FFA. Therefore, the rate of reactions were reduced consecutively when the reaction times increased from 2 to 4 h. The esterification reached it equilibrium after 3 h and in these periods of time, the rate of methyl ester formation equaled the rate of hydrolysis of methyl ester. Hence, from an economical point of view, 2 h was selected as the optimum reaction time.

Therefore, the optimum conditions obtained from the step 1 were methanol amount of 50% v/v, catalyst amount of 5% w/v of oil, reaction temperature of 60 °C and reaction time of 2 h. At this condition, FFA conversion was 83.13% and the FFA content was reduced from initial value to 4.25% w/w.

Acid-catalyzed esterification : Step 2

In order to investigate the optimum condition for the reduction of FFA in coconut oil to less than 1% w/w, the coconut oil having FFA content

4.25% w/w was produced by using the optimum condition in Step 1. After that, the produced oil was used to further investigate. The investigation was conducted by variation of methanol amount (30 and 40% v/v) under the conditions of catalyst amount of 5% w/v of oil, reaction temperature of 60 °C, and reaction time of 2 h. The results were shown in Table 3.

Table 3. Esterification of FFA in step 2

Methanol amount (% v/v)	FFA content in oil (% w/w)
30	1.58
40	0.91

From Table 3., it indicated that the FFA content in coconut oil was reduced to less than 1 %w/w at the methanol amount of 40% v/v. Therefore the optimum condition for step 2 was methanol amount of 40% v/v, catalyst amount of 5% w/v of oil, reaction temperature of 60 °C, and reaction time of 2 h. At this point, the FFA was reduced from initial value to 0.91% w/w.

Properties of oil product

The oil product having FFA content 0.91% w/w was produced by the two-step acid-catalyzed esterification process and it was sent to the Bangchak Petroleum Public Company Limited for the properties testing. The results were shown in Table 4.

Table 4. Properties of oil product

Property	Method	Oil product
Kinematic viscosity at 40 °C, mm^2/s	ASTM D 445	15.62
Density at 15°C, kg/m^3	ASTM D 4052	0.9159
Water content, % w/w	ASTM E 1064	0.097

The results showed a significant viscosity reduction from 29.23 to 15.62 mm^2/s after the two-step acid-catalyzed esterification. This obviously indicated that sulfamic acid catalyzed both esterification and transesterification in the same time. The sulfamic acid-esterification converted FFA to methyl ester and water while sulfamic acid-transesterification converted triglyceride to methyl ester and glycerol. However, the acid-catalyzed transesterification of triglyceride occurs slowly and it is slower than alkali-catalyzed transesterification of triglyceride about 4,000 times [12]. The oil viscosity was reduced by a half after the reaction because the high molecular weight triglyceride was transesterified to the low molecular weight fatty acid methyl ester. The oil product contained minute traces of water and this confirmed that the water removing process in this study was efficient.

4. CONCLUSIONS

This study reveals that the FFA content in coconut oil can be reduced to less than 1% w/w by the two-step process sulfamic acid-catalyzed esterification with methanol. In the first step, the optimum conditions were methanol amount of 50% v/v, catalyst amount of 10% w/v of oil, reaction temperature and reaction time of 60 °C and 2 h respectively. At this condition, the FFA content was reduced from the initial value of 25.22 to 4.25% w/w (83.15% FFA conversion). In the second step, the FFA content was reduce to 0.91 % w/w by using methanol amount of 40% v/v, catalyst amount of 5% w/v of oil, reaction temperature of 60 °C, and reaction time of 2 h. All of the variables such as methanol amount, catalyst amount, reaction temperature, and reaction time had the positive effect on the sulfamic acid-catalyzed esterification. The information obtained from this study will be useful to biodiesel producer for produce biodiesel from low cost coconut oil containing significant amounts of free fatty acid. It is the suitable process as a pretreatment step for coconut oil having free fatty acid content between 1-25.22% w/w).

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Recent logistic contentment of technological Grab taxi service against normal taxi service: the case study from the new generation university students in Bangkok

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Abstract

The purpose of this research is to study the customer satisfaction by using nonparametric 1 sample sign test comparing between the technological service of Grab taxi and normal taxi meter. Apparently, the technological of Grab Taxi Application is the revolution of technology of transportation by the assistance of the internet and their advanced connections. With the high competitive businesses of transportation that already have the old transportations service (normal taxi meter) for many years, technological Grab taxi service is now ready to take the market share. This research has compared and measured the customer satisfaction for both types of service specifically in term of *politeness of the driver, cleanliness of the car, price, service reliability, safety and continuation of the service*. To collect the useful data, questionnaires were distributed to the respondents with verbal explanations. The research findings are customers were highly satisfied with Grab taxi service because of the politer driver, cleaner car, more safety and have high tendency to continue the service. However, price and service reliability for Grab taxi service is doubtful in customer's mind.

Keywords: Technological Grab taxi service, Grab taxi service, Normal taxi meter service, Customer Satisfaction, logistics

1. INTRODUCTION

In the 21st century, technology connects people from all communities, provide new jobs and make the business more complex to both owners and the customers than the past. One of the great examples of company that is currently taking advantage of technology is Grab Taxi Holding Limited. They basically offer ride sharing which can be define as a newly invented service that arranges one way transportation on short notice (Murray and Chase, 2012).The multinational ridesharing companies are Uber, Grab and so on. They charge customers the price of ridesharing based on how far customers are going, the time of day, and the type of car. Furthermore, the ease of developed mobile applications apparently assists both customers and drivers by connecting one another which provides available research samples and reachable information (Chen, 2014), Despite their current ongoing success in Bangkok when comparing with normal taxi meter, their services are not preferable to some group of people. Because there have already had many complaints about horrible service quality of normal taxi meter service in Bangkok, ride sharing multinational companies see the opportunity to attack the market. Delivering people from place to place is considered as one part of logistics which can be done by ground, air and sea. However, it was the technology again which allows customers to complain about both old and new service. This research is investigating the satisfaction of the students in Rajamangala University of Technology Krungthep (RMUTK) and comparing those

results between normal taxi service and Grab taxi service. Simultaneously, the goal is also to find out if there is any dissatisfactions of the new technological Grab Taxi service.

2. LITERATURE REVIEW

According to Kotler and Keller (2006) customer satisfaction is an individual perception which customers either are satisfied or dissatisfied created by their expectations towards the performance of product or service. Following study by Horsu and Yeboah (2015) research on customer satisfaction towards minicab taxi services in Ghana. They used six variables namely reliability, continuous service, safety, comfort, affordability and drive behavior were tested to examine the relationship with customer satisfaction. Through multiple regressions analysis they found that continuous service, comfort, affordability and reliability have a significantly positive influence on customer satisfaction. In a major city of San Francisco in the business Bay area, application service taxi has significantly gained more business momentum by just short period of time since 2009 by Chang (2017). Since then, there has been many researches in this field attempting to find relationship between different variables and customer satisfaction toward the service of technological ride sharing topic. Balachandran and Hamzah (2017) has done research and found out the positive significant variable associated with customer satisfaction in many cities in Malaysia, one of the major cities Grab Taxi Holding Limited is currently operating. The tangible, price, reliability, promotion and coupon redemption and the level of comfort were statistically significant to their use of ride sharing service. Among those, comfort was the most influence factor on customer satisfaction of ride-sharing services in Malaysia.

Since the financial crisis in the United States of America in 2007, South East Asia has been able to keep going on most of the businesses. However, many economists can argue that the area has not been fully recovered and never gotten back to the full prosperity. With that in customer's mind, they are expecting to receive good service with the lowest price available. According to Mburu et al. (2013) their finding was value of price has relationship and direct impact to the customer satisfaction in the most of the service industries. Yelkur (2000) added that price is the major element of marketing mix and some researchers proved that marketing mix and customer satisfaction has strong relationship. Moreover, the research done by Khairani and Hati (2017) the perceived value of money for both service quality and electronically application service have a positive and weighty impact towards customer satisfaction. However, Chang (2017) argue that in theoretical aspects, the application taxi service in term of high prices may attract more groups of customers and create new market for this industry against the negative aspects.

3. METHODOLOGY

This research choses the quantitative approach rather than qualitative to gain a deep detail understanding of the 6 variables about satisfaction on service quality of technological Grab taxi service against normal taxi service. By calculating the reliability, normality and final statistical tests between 6 variables using a numerical data which is one of the characteristic of quantitative method done by Bryman and Bell (2003). Primary data was collected from 100 students in Rajamangala University of Technology Krungthep, Bangkok, Thailand by passing questionnaire survey. 4 incomplete questionnaires were taken out leaving 96 available for testing. During the process, the student respondents will participate in this study when they are convenience to fill up the questionnaire outside class and the questionnaire was also passed out in random classroom which is easier and faster for student assistants and teacher to proceed.

In total 6 items were categorized into 2 separated boxes to put in score, first is the satisfaction of normal taxi meter and second for technological Grab taxi service. Each column of the questionnaire represents the score of politeness of driver, cleanliness of the car, price, and service reliability, safety of the customers and continuation of the service. To collect up to date data, the time frame of this research was from 3rd to 28th December 2018 within working university days.

The score card in the questionnaire was set based on five Likert scale measurement, for instance, strongly satisfied, satisfied, either satisfied nor unsatisfied, not satisfied and strongly unsatisfied 5, 4, 3, 2 and 1 respectively (Likert, 1932). Generally, it takes only five to ten minutes for respondents to fill up the survey.

The hypothesis for normality test
H_0 : The collected data is normally distributed.
H_1 : The collected data is not normally distributed.

Types of service	Description
Normal taxi meter (Before)	Satisfaction level when respondents are using the normal taxi meter service
Grab Taxi service (After)	Satisfaction level when respondents are using the Grab Taxi service

Research hypothesis
There are 6 separated variables which will be tested on this research. Those are considered to be 6 alternative hypotheses with one null hypothesis.

Null hypothesis
H_0 : Technological service of Grab taxi does not bring positive effect to the customer than the normal taxi meter service.
6 Alternative hypothesis
H_1: Technological service of Grab taxi provide positive effect in term of *politeness of driver* than the normal taxi meter service.
H_2: Technological service of Grab taxi provide positive effect in term of *cleanliness of the car* than the normal taxi meter service.
H_3: Technological service of Grab taxi provide positive effect in term of *price* than the normal taxi meter service.
H_4: Technological service of Grab taxi provide positive effect in term of *service reliability* to the customers than the normal taxi meter service.
H_5: Technological service of Grab taxi provide positive effect in term of *safety of the customers* than the normal taxi meter service.
H_6: Technological service of Grab taxi provide positive effect in term of *service continuation* of the customers than the normal taxi meter service.

4. RESULRS AND FINDINGS

Table 1. Reliability Statistics by SPSS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
.773	.777	6

The number of Cronbach's Alpha is more reliable when the number is closer to 1 and more than 0.70. By testing the scale and reliability button in SPSS, the score is 0.773 meaning the data is quite reliable.

Table 2. Tests of Normality by SPSS

Dependent Variables	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Politeness of the driver H_1	.253	96	.000	.884	96	.000
Cleanliness of the car H_2	.260	96	.000	.873	96	.000
Price H_3	.172	96	.000	.912	96	.000
Service reliability H_4	.194	96	.000	.923	96	.000
Safety of the customers H_5	.132	96	.000	.965	96	.011
Service continuation H_6	.230	96	.000	.916	96	.000

Lilliefors Significance Correction

To ensure the normality of the collected data, 2 types of Kolmogorov-Smirnov and Shapiro-Wilk test were chosen. If the significant level is more than 0.05, it indicates that the data is normally distributed. In case of the normal distribution, one sample t-test will be used as a statistic calculation tool. If the data do not have normal distribution, 1 sample sign test will be used as a nonparametric calculation tool. By looking at the results on table 2 above, the scores of Kolmogorov-Smirnov are 0.000 for all 6 variables. On the other hand, the scores of Shapiro-Wilk are also 0.000 for most variables, except 0.011 for safety of the customers. However, they are less than the significant level of 0.05. Therefore, the collected data in this research is not normally distributed and are required to use the nonparametric test.

Table 3. Results of mean, standard deviation and standard deviation error mean of difference between Normal taxi meter and Grab Taxi

Dependent Variables	N	Mean	Std. Deviation	Std. Error Mean
H_1	96	1.1875	.86222	.08800
H_2	96	.2813	.81697	.08338
H_3	96	.1458	1.50773	.15388
H_4	96	.3021	1.33077	.13582
H_5	96	.9479	1.86022	.18986
H_6	96	.3333	1.25377	.12796

Table 4. 1 Sample Sign Test by Minitab version 18

Null hypothesis $H_0: \eta = 0$
Alternative hypothesis $H_1: \eta > 0$

Dependent Variables	Number < 0	Number r= 0	Number r> 0	P-Value
H_1	2	16	78	0.000
H_2	14	46	36	0.001
H_3	38	18	40	0.455
H_4	30	28	38	0.198
H_5	19	23	54	0.000
H_6	20	40	36	0.023

The 1 sample sign test on table 4 is based on the direction of the plus and minus sign of the observation. For the dependent variable H_3 and H_4 in the <0 section have the bigger numbers at 38 and 30 respectively more than H_1, H_2, H_5 and H_6, which lead to higher values for significant level.

The results of the nonparametric tests from table 4 above show 4 variables (H_1, H_2, H_5 and H_6) with P-value less than 0.05 and 2 variables (H_3 and H_4) with P-value more than 0.05. For Variable H_1, H_2, H_5, and H_6, the scores are 0.000, 0.001, 0.000 and 0.023 respectively. Since they are less than 0.05, it is considered rejecting the null hypothesis. Therefore, respondents imply Grab taxi service provides politer drivers, cleaner cars and more safety to consumers. More importantly, they are likely to use the service again.

For Variable H_3 and H_4, the scores are 0.455 and 0.198 respectively. They do not have enough evidence to reject the null hypothesis since they are more than 0.05. Therefore, respondents imply they do not have satisfaction in term of price and reliability when comparing with normal taxi meter service.

5. CONCLUSION

With such technological Grab taxi service, outstandingly higher satisfaction levels are revealed in service quality such as polite driver, clean car and safety of customers when being compared to the traditional way of taxi service.

Therefore, they have tendency of continuing to use the service repeatedly again in the last variable tested.

Despite most of the high satisfactions of the Grab taxi service, the findings emphasis the management and policy makers of Grab Taxi Holding Limited show improve certain areas. Based on the significant level, this group of respondents are aware the fact that this technological service is outstandingly more expensive than the normal taxi meter they have been using. It is going to be setback for any share riding companies since price is an important element with direct relationship with customer satisfaction (Yelkur, 2000). In additional, the service reliability is also in doubt for them. This indication show that recent customers do not entirely believe in the reliability of Grab taxi service. The finding is the contrary of previous research paper few years ago which states that Thai customers prefer Grab taxi service because of the high reliability of Ackaradejruangsri (2015). From the result presented in this research, Grab Taxi or other existing companies are forced to improve their services in term of price and reliability since the customers are aware of current setbacks and ready to select new company due to the low switching cost.

5.1 Research limitation

The area of conducting this research was limited inside the university area and excluded from other professions such as university staffs, part-time lecturers, full-time lecturers or higher management level. Those group of people usually prove to be different in consumer purchasing power and maturity which may contribute to the differences in consumer decision-making styles (Fan and Xiao, 2005).

In the Methodology section that mention about they take less than 10 minutes to complete a questionnaire, which may contain data errors. Especially since there were no financial consequences for the respondents participating in the investigation. The problems of nonresponsive are much more serious for surveys that use random population samples than those that use targeted samples (Kennedy and Vargus, 2001).

5.2 future suggestion

According to Robson (2011) the qualitative data can be collected through interviews and written data. The future research should highly consider to include the qualitative data collecting method since it can more find out about the price and reliability as dissatisfactions of the technological Grab taxi service or any other businesses prior to the testing the significant of the quantitative data. Furthermore, different variables from other researches such as comfort ability are advised to include in future research (Litman, 2008).

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Success Factors of Thailand E-Commerce

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ABSTRACT

E-commerce has become the performance tools for not only to an individual company but also country gain and competitive opportunity. Creating successful e-commerce businesses is not an easy task, especially in the extremely competitive market. This study reviews key success factors that are crucial for the success of an e-commerce business. Through this study, the 26 target companies that had succeeded in B2C, B2B, and e-business were charged to distinguish the factors associated with success in utilizing e-commerce and e-business. The thirteen success factors variables were estimated using a ranking scale from one to five. The mean value and the standard deviation were applied to interpret the factors. Factors with the mean value higher than 4.5 were taken to be the potential success factors of e-commerce and e-business. The study disclosed that 5 of 13 proposed factors were selected to be the potential common success factors related to B2C, B2B, and e-business.

Keywords: E-Business, IS strategy, Societal impacts of IS, e-Commerce

1. INTRODUCTION

E-commerce has become the performance tools for not only an individual company but also country gain and competitive opportunity. It is being utilized to expand new demands, communicate with consumers, interact with trading companions, and principally boost economics [2]. From customer and market viewpoints, e-commerce can be categorized into couple views: business-to-consumer (B2C) and business-to-business (B2B) prospect [27]. Though, for each viewpoint of e-commerce, the achievement or defeat of its development and implementation is related to some significant success factors, it is necessary for businesses to recognize these essential success factors strongly affecting the accomplishment or defeat of their development and implementation of e-commerce.

Currently, to improve the performance and powerfulness of their enterprise context, some businesses use e-business to reconstruct their enterprise approaches and conventional trade manners into new applicability which expedites the directions of knowledge with the stakeholders of business [11]. Nowadays in Thailand, e-commerce has been performed by various companies and promoted by the government. E-business has been consequently utilized to conduct their business policies. Nevertheless, the characteristics of their utilizations are altered concerning features and implementation. To design and develop a complete business application which combines B2C e-commerce, B2B e-commerce, and e-business together, businesses should consider some patterns and particular components before performing the method [3]. Because of the appropriate characteristics and employments of B2C, B2B, and e-business, the critical factors that affect the gain or loss of utilization are varied for each kind of usage [4]. These kinds of significant factors should be classified and recognized appreciatively from the utilizer's point of view. Oppositely, gaining prosperity with their implementation will be challenging. Between these significant factors, there is a collection of ordinary and a combination of

particular elements that influence the implementation of B2C, B2B, and e-business practice. To gain highest advantages in the implementation of these methods, the business should understand these fundamental and particular portions so that they can trade with their performances.

The principal purpose of this research is to recognize the general and particular gain factors for the implementation of B2C, B2B, and e-business. Also, the investigation will contribute useful guidelines for performing enterprise gain using the standard and particular success portions for e-commerce and e-business.

2. SUCCESS FACTORS OF E-COMMERCE BUSINESSES

According to various researches intended to study success factors of e-commerce businesses both in Thailand and globally, it is shown that the followings are the vital factors that determine the degree of successfulness of an e-commerce business.

2.1. Credibility of Websites: As stated previously, e-commerce entrepreneurs usually encounter credibility issues for consumers since online channels are the only way to interact with them. All communication, deals, purchases of goods and services are all made online; hence credibility of the website or any supporting channels is considered to be a fundamental and critical success factor of e-commerce businesses. There are many ways to create credibility, one of the easiest way is acquiring a Trustmark issued by accepted institutes such as a DBD Verified of the Department of Business Development [6] to validate the existence of a business and to demonstrate decent practices in running an e-commerce business [13].

Apart from acquiring a Trustmark, a business can also use other approaches to build its credibility, such as presentations of the operation, goods, or services, including any business certificates. For example, www.orderlamp.com [22], whose business is selling lamps via e-commerce channels, presents its certificate issued by Department of Business Development, Ministry of Commerce, along with other certificates received from other international institutes on its website to demonstrate the quality and credibility of its goods and services.

2.2. Customer Relationship Management (CRM): CRM is considered one of the success factor of e-commerce business [24]. The core value of CRM is creating a positive relationship with consumers through activities or works to generate a satisfaction for them to become returning customers. E-Commerce businesses focus on customer relationships such as communication, after sale services, complaints, refunds, etc. These factors are crucial because of the fact that in e-commerce businesses communicating with consumers isn't as convenient as in ordinary businesses. The business can attract a large number of customers and do further businesses with them, provided that it has an impeccable customer relation services.

Some Thai e-commerce businesses like OfficeMate [5] and ReadyPlanet [21] has exceptional after-sale services, such as various available contact channels (24 hours call center, email, live chat) and activities provided for customers (seminar). Such after sale services will create a positive impression for customers and make them return when further needs occur.

2.3. Online Marketing: Online marketing is an approach of using Information Technology tools to familiarize consumers with the business [12], mainly through online marketing channels to enable details and data of goods or services of the entrepreneur to approach the target consumers more effectively. Examples of reaching consumers through online channels are Search Engine Marketing [15], Social Network Marketing [17], Email Marketing [31], Blog Marketing [28], etc. Online marketing tools will help making goods or services being widely

known and increasing numbers of website visitors which leads to an increase in sales [12].

2.4. Demonstration of Credible Personal Information Storage: An entrepreneur must determine policy and inform consumers about approaches of storing their personal information [15], such as credit card information, to strengthen their confidence in performing any good or service transaction via online channels, by assuring them that such personal information will not be disclosed or accessible by other irrelevant and hostile sources which may lead to any further abuses or frauds.

From the above exhibit, www.paysbuy.com [18] has determined and displayed its privacy policy on its website, informing consumers about methods of its information storage, personal information disclosure in case of any enforced government regulations, types of security system technology, accessibility and the right to alter and of users' information.

2.5. Clear Business Directions of Goods and Services: A decent understanding and proficiency in goods or services of one's business [9], including a good understanding of the target market and consumer behaviors, play a vital part in achieving goals of the business. From studying successful e-commerce businesses in Thailand [25] such as www.officemate.cot.th and www.readyplanet.com, including a world-class e-commerce business like www.ebay.com, it is shown that a successful online business demands a decent understanding and proficiency in characteristics of the business from its goods and services to consumer behaviors, also an optimal delivery system and after-sale services.

2.6. Understanding of Consumer Needs on Online Platforms: Online consumers usually have different behaviors compare to ordinary consumers in ways that they seek for goods that are cheaper or easier to acquire on online platforms compare to offline platforms. They, hence, simply want an easier method to compare prices of goods from multiple sellers, or a need of instant use merchandises such as digital goods. An entrepreneur needs to have a good understanding of these behaviors for optimal marketing strategies and market segment [23].

For example on www.ebay.com, [7] there are usually souvenirs such as a Thai Scout Council brooch being sold at a high price, even so customers outside of Thailand are unable to obtain them if not on an online platform.

2.7. Reliable and Credible Hardware and Software System: Doing businesses via e-commerce channels, consumers and customers usually interact with sellers or entrepreneur through the website, in consequences, the front page of the website is consumers' first impression for the e-commerce business. Therefore, constant malfunction or slow processing of the website will discourage consumers from doing further business with the company [8].

2.8. Customers are Informed about Benefits of Purchasing Goods and Services via Online Channels: Typically, consumers will have the incentive to purchase goods or services via online channels [19] when they are aware of the benefits granted to them, such as those goods and services being cheaper, easier to acquire via online channels, or quick delivery. In case that there are no differences between normal channels and online channels, there will be no incentive for consumers to utilize online purchase.

2.9. Have Credible Payment Channels: In an online transaction, an entrepreneur must prioritize safe and convenient payment method for consumers, due to the fact that most of the time in online transactions, payment must be first made by consumers before receiving any goods or services. Having credible payment channels, including after sale services such as refunding, can encourage consumers to do more online transactions [16]. Currently, there are various payment channels such as credit and

debit cards, prompt pay [29], or intermediary money transfers.

2.10. Have Large Enough Variation of Goods and Services for Consumers to Take into Their Consideration: Usually, consumers would choose to purchase from stores that have high enough variation of goods and services to let them compare and consider before doing transactions [14]. Online consumers typically conduct research before actual purchase, accordingly, businesses with well-presented details and significant variation of goods and services will hasten and ease customers' decision.

Amazon.com, Inc. [1] has a massive amount of merchandises. In the early stage of the business, Amazon utilized this strategy of gathering books from multiple sources on its website for consumers with distinct perspective to browse through those books. Presently Amazon expanded its business to cover other numerous types of merchandise, but still retain its original strategy of presenting the massive amount of goods for consumers.

2.11. Website Maintenance Team: An entrepreneur must make use of an advantage of online channels over offline channels, such as the ability to swiftly alter information, images, and price of goods and service. An entrepreneur needs to have a dedicated team to work on website maintenance or else consider using readymade website. [20]

2.12. Convenient and Easy-to-Use System for Customers: This factor is related to the Technology Acceptance Model, which states that a technology that is accepted by users is generally a technology that is convenient and easy to use [10]. When a website is unpleasant to use, causes inconvenience in browsing information and details of merchandises, or has difficult contact channels to reach, it will discourage consumers from further businesses.

2.13. Credible Goods Delivery: Another major issue in e-commerce business is consumers' anxiety of not receiving an exact good as they were informed [20]. Hence the business should have a reliable, credible, and trackable goods delivery systems such as EMS [30] or registered delivery.

3. METHODOLOGY

According to the article reviewed, the gain factors of developing and implementing B2C, B2B, and e-business can be recognized as follows:

1. Website Credibility
2. Customer Relationship Management (CRM)
3. Online Marketing
4. Credible Personal Information Storage.
5. Clear Business Directions of Goods and Services.
6. Understanding of Consumer Needs on Online Platforms.
7. Reliable and Credible Hardware and Software System.
8. In-time Online Product/Service Information
9. Credible Payment Channel.
10. Substantial Enough Variation of Goods and Services.
11. Website Maintenance Team.
12. Convenient and Easy-to-Use System.
13. Credible Goods Delivery.

Accordingly, to obtain a sufficient perception of the gain factors of these methods, the following 13 characters need to be concentrated.

3.1 Target business classification: Businesses that have already performed and succeeded in B2C, B2B, and e-business were targeted to present relevant data for the research. There are four principal groups of target businesses. The first target group involves corporate businesses that deal with the retail store. The second group comprises the online marketplace that provides e-commerce or e-business solutions for their customers. The third group includes the logistic or fulfillment business that provides logistic service, packing, shipping and ERP for their customers. The last group is other kinds of

online business such as fin-tech, market research advisory, mobile application, state enterprise, transportation services, and travel business. The target B2Bs and B2Cs were classified according to their expertise in trading with such demands.

Table 1. The number of e-commerce group

Target business group	Number
B2C	19
B2B	7
Total	**26**

In this study, nineteen companies were selected as the first target business group: five companies implementing B2C in the retail store. Six companies were selected as the second target business group as online marketplace business. Furthermore, eight companies were also selected as the third target business group as logistic or fulfillment business. Finally, seven companies were selected as the other kind online business group. The number of businesses in each target group is shown in table 1 and 2.

Table 2. The number of target business group

Target business group	Number
Retail Store	5
Online Marketplace	6
e-Logistic, Fulfillment	8
ERP	1
Fin Tech	1
Market Research	1
Mobile App	1
State Enterprise	1
Transportation	1
Travel Business	1
Total	**26**

3.2 Survey forms design: Survey forms were created as guidelines for interviews and gathering related information from the target businesses about roles, current status, and gain factors in performing B2C, B2B, and e-business. The 13 different questionnaires were designed for businesses implementing: retail store, an online marketplace, logistic or fulfillment, and other kinds of e-business.

3.3 Data acquisition: In the first group, five retail stores implementing online business included Big-c supercenter, BOW KANYA, TAI GUO PIN, OfficeMate, and beautynista.com. The second group, six online marketplace businesses included takraonline.com, pchome.co.th, shopee.co.th, lazada.co.th, lnwshop.com, and ketshopweb.com consecutively. The third group, eight online logistic or fulfillment businesses included ketshopweb.com, mycloudfulfillment.com, attskybox.com, sokochan.com, dhl.co.th, scgexpress.co.th, facebook.com/akita.wh, and vcanbuy.com consequently. The last group, the other 7 kinds of online businesses included sellsuki.co.th (ERP service provider), treepay.co.th (Fin-Tech), Customerinsight.asia (Market Research), onechat.org (mobile application), mea.or.th (state enterprise), uber.com (transportation service platform), and ThaiGuideGURU (cultural travel business). All of the target businesses mentioned above selected their e-commerce group based on the business successor recommended by Electronic Transactions Development Agency (Public Organization) of Thailand (ETDA) [15] who have organized Thailand e-Commerce Week 2017. They were interviewed using the survey application explicitly created for corporate businesses.

3.4. Data Analysis and Results: Factor analysis was applied to recognize the main factors in the success of B2C, B2B, and e-business. The foundation of the research is to find out the level of significance of each suggested factor.

3.5 Success Factor Variables: The 26 target companies were asked to weight the degree of effect that each factor provided to their

utilization: B2C, B2B, and e-business. Thirteen success factors were obtained based on the related article.

Table 3. The summary of success factors utilized in this research.

Question	Implemented	$\bar{X}$	*SD*
1	100.00%	4.58	0.50
2	96.15%	4.31	1.05
3	100.00%	4.81	0.40
4	100.00%	4.62	0.50
5	100.00%	4.31	0.68
6	100.00%	4.35	0.63
7.1	100.00%	4.08	0.81
7.2	100.00%	4.00	0.82
8	100.00%	4.62	0.50
9	96.15%	4.72	0.54
10	92.31%	4.19	1.06
11	84.62%	4.42	0.76
12	100.00%	4.00	0.80
13	92.31%	3.65	1.26

These factors were weighted from one to five according to the following ranking scale:

1 Represents 'strongly disagree'
2 Represents 'disagree'
3 Represents 'fair'
4 Represents 'agree'
5 Represents 'strongly agree."

4. SUMMARY

In analyzing general success factors of implementing e-commerce and e-business in Thailand, the 26 target companies that had succeeded in B2C, B2B, and e-business were charged to distinguish the factors associated with success in utilizing e-commerce and e-business. The thirteen success factors variables were estimated using a ranking scale from one to five, varying from "strongly disagree" to "strongly agree." The mean value and the standard deviation were applied to interpret the factors. The mean value of each factor represents a level of agreement of the effect of that particular factor to the success of utilizing B2C, B2B, and e-business. Factors with the mean value higher than 4.5 were taken to be the potential success factors of e-commerce and e-business. Through this study, out of thirteen success factors, there are 5 factors being selected to be the potential success factors related to B2C, B2B, and e-business: online marketing (4.81), credible payment channel (4.72), credible personal information storage (4.62), in-time online information (4.62), and website credibility (4.58).

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Formal and Informal Learning and its Role in Developing Entrepreneurial Intention Among Students

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ABSTRACT

Entrepreneurial learning involves theoretical and practical methods which found quite effective in inspiring students for pursuing an entrepreneurship career. This study will discuss the emerging need to teach and promote entrepreneurial learning through reviewing the related literature and use this to identify role of formal and informal learning in developing entrepreneurial intention among students. It also focuses on the role of work experience towards entrepreneurial intention that can be used to study various student groups in an interdisciplinary manner. Data have been collected following survey method conducted among university students (N = 215) of four selected institutions in Chattogram, Bangladesh offering entrepreneurship as a course. Multiple Regression Analysis was used in confirming the hypothesis proposed in the study using the Statistical Package for Social Sciences (SPSS) version 22. The findings show that the variables of formal and informal learning are significantly related to the student's entrepreneurial intention while the another variable work experience is not significant. The research finding will help in further research related to student's entrepreneurial intention.

Keywords: formal learning, informal learning, entrepreneurial intention.

1. INTRODUCTION

Entrepreneurial education has emerged significantly over the last few years and is still in a state of vibrant transformation [1]. Education at all levels is focusing on entrepreneurship because it can play a vital role in developing the entrepreneurial culture and promote the concept that entrepreneurship will be driving force that can run the economy of a country [2]. Now, there is a question of debate whether entrepreneurship learning can be taught and through which method and what kind of entrepreneurial skills and behaviors can be developed through this learning procedure
that may help in shaping an entrepreneurial career.

Bangladesh is an attractive place to conduct this research, as Bangladeshi people have a high entrepreneurial intention and demand for entrepreneurship education at universities. The world largest non-government organization BRAC is a result of entrepreneurial invention that is founded by Sir Fazle Hasan Abed. BRAC, regarded as a social enterprise, which is currently using 73% of its own investments through returns generated from its own social enterprises and microfinancing operates 16 social enterprises in Bangladesh [3]. There are lots of entrepreneurial activities going on among the university level. Again, Grameen Bank, the Nobel winning organization is also famous throughout the world because of his activities related to new and innovative entrepreneurial activities. These two organization with their multiple entities bring a revolution among the young generation to work and think about potential career about entrepreneurship.

The entire study is to rationalize the current role of formal and informal learning along with work experience in developing entrepreneurial intention among students and also to find out whether the concurrent program or the way of learning is helpful in enhancing entrepreneurial intention among the students.

Entrepreneurial intention can be defined as a focused state of mind that guides personal attention and know-how toward planned entrepreneurial behavior [4]. It can be defined as mental positioning such as desire, wish and hope persuading his/her choice of entrepreneurship [5]. According to [6], entrepreneurial intention is the nature of mind that aims and guides the activities of the entrepreneur toward the growth and the execution of new business concepts. As the choice of becoming an entrepreneur is considered unpaid and sensible, it is practical to explore how that decision is taken [7].

Knowledge may be expressed as being either tacit or explicit. Tacit knowledge defines know-how, the often no ordered modules of activity. Know-what means the explicit type of information normally denoted by techniques, procedures, formal written documents and educational bodies. Thus, individuals may be able to improve their understanding through formal learning, such as tertiary learning, informal learning, such as work involvement and nonformal learning, such as adult education [8].

Formal learning is one core element of entrepreneurial learning that may help in gathering of knowledge that may provide skills useful to entrepreneurs. Literature has shown that, there is a close relationship between education, entrepreneurship and success, whereas education commonly producing independent outcome in supporting the possibility of becoming an entrepreneur, or in achieving success [9].

In the literature, it is found that there is a positive association between training and employment growth, specifically if the training represents the wide range of managerial and human relations practices in the organization. Better educated entrepreneurs are more dynamic because they have higher problem-solving capabilities and management skills, leading to greater competence within the firm and advance aspirations.

Entrepreneur's experience is another measurement of entrepreneurial learning. Several studies described a positive association between entrepreneurial experience and firm development [10]. Although it is not clearly found that from the literature that how entrepreneurship's experience grows and is influenced by the overall situation or interactions [11]. But there is evidence that experience in the form of general business skills has a positive effect on growth aspirations [12].

2. MATERIALS AND METHODS

In the study, formal and informal learning have been taken as variables because student acquired different kinds of knowledge during their studies, namely, analytical, practical, financial and marketing skills or tacit and explicit knowledge. Secondly, work experience has been taken as variables to measure the entrepreneurial intention of respondents, because many students worked in various jobs and occupations (such as prior working experience as a freelancer, intern, full-time or part-time employee) besides their study (figure-1)

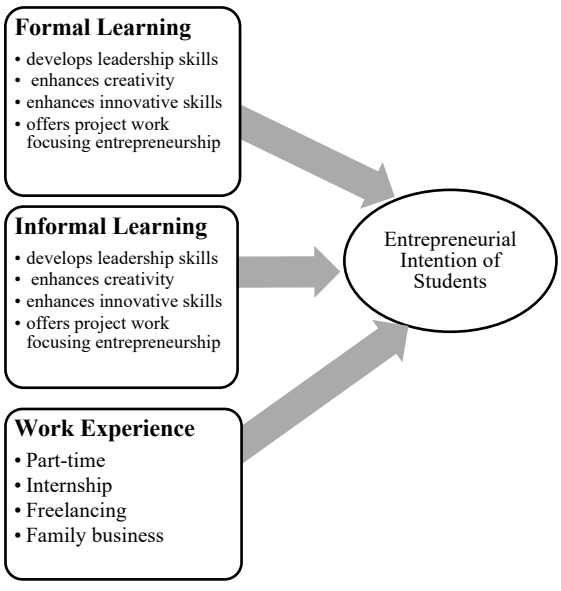

Figure 1.

The focus of this study was to measure the degree to which exposure to formal and informal learning and work experience besides study advances on students' entrepreneurial intention in the university context of Chattogram, Bangladesh. Therefore, the variables employed in this study were formal learning, informal learning, work experience and entrepreneurial intentions. The number of respondents for this study was 215 that has been taken from four public and private universities in Chattogram, the second largest city of Bangladesh. The survey method is used and a questionnaire has been developed based on five Likert-scale starting from strongly disagree to strongly agree was adopted (strongly disagree - 1, disagree - 2, undecided - 3, agree - 4, strongly agree - 5) to analyze the variables. Hierarchical Multiple Regression Analysis was used in confirming the hypothesis proposed in the study using the Statistical Package for Social Sciences (SPSS) version 22. The validity and reliability of the research instruments were analyzed using Cronbach Alpha Reliability Procedure. The test of hypothesis was to examine the effects of formal and informal learning and work experience on students' entrepreneurial intention.

Formal learning has a vital role in developing intention towards entrepreneurship. Specially, the university environment where different courses are offered in relation to entrepreneurship make a vital influence on the attitudes of students and it also create a positive effect on students' entrepreneurial intentions [13]. The successful implementation of an entrepreneurial mind-set among graduates ultimately depends on the abilities of lecturers, as well as on the methods applied in their classrooms, that is, their conceptions of approaches to teaching and learning.

H1: There is a positive relationship between formal learning and student's entrepreneurial intention of different universities in Chattogram.

Informal learning is a terminology normally used to define learning that occurs outside the boundaries of a structured learning arena [14]. Informal learning may include coaching, mentoring, talking and collaborative work, which are commonly practiced in everyday activities [15]. Numerous studies show that before starting their ventures, most entrepreneurs highlighted the challenge of gathering concurrent business knowhow by pursuing informal learning [16, 17]

H2: There is a relationship between informal learning and student's entrepreneurial intention of different universities in Chattogram.

The way of finding out new opportunities depends on the enthusiasm, capability and experience of entrepreneurs [18]. Several studies depict that there is a positive relationship between entrepreneurial experience and firm growth [10]

H3: There is a relationship between work experience and student's entrepreneurial intention of different universities in Chattogram.

From the test, the result of the reliability test for the effectiveness of the overall program was 0.814. This result is more than 0.7, which is considered as high and good reliability, and therefore it is accepted in this study. In case of variables, Formal learning consisted of 6 items of reliability co-efficient and the Cronbach's Alpha is 0.830 while the informal learning consists of 6 items with 0.848 as the Cronbach's Alpha. The last variable is work experience which consists of 5 items and the Cronbach's Alpha was 0.706. From the analysis, it is clearly visible that all of the variables gained more than 0.70 which is in the range good and high reliability.

3. RESULTS AND DISCUSSIONS:

Table-1. Correlations

		entrepreneurial intention	formal learning	informal learning	work experience
entrepreneurial intention	Pearson Correlation	1	.178**	.150*	.084
	Sig. (2-tailed)		.009	.027	.219
	N	217	217	217	215
formal learning	Pearson Correlation	.178**	1	-.082	.192**
	Sig. (2-tailed)	.009		.227	.005
	N	217	217	217	215
informal learning	Pearson Correlation	.150*	-.082	1	.172*
	Sig. (2-tailed)	.027	.227		.012
	N	217	217	217	215
work experience	Pearson Correlation	.084	.192**	.172*	1
	Sig. (2-tailed)	.219	.005	.012	
	N	215	215	215	215

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 1 shows the correlation between relationship among the independent variable (formal learning, informal learning and work experience) and dependent variable which is the entrepreneurial intention. However, work experience has no correlation with entrepreneurial intention. To further examine the relationship between the independent variables and dependent variables, we advanced with the multiple regression analysis.

The result of step-wise multiple regression analysis is shown in Table 2. Only the variable of formal learning and informal learning are found to be significantly related to the entrepreneurial intention. However, the variables of work experience found statistically insignificant.

Table-2: Step-wise Multiple Regression

Model 2		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
	formal learning	.168	.060	.187	2.789	.006
	informal learning	.153	.064	.160	2.388	.018

Table 2 shows that formal learning influences the entrepreneurial intention level where the standardized regression co-efficient is 0.187, $p < 0.05$. Thus, Hypothesis 1 is accepted. Therefore, the result show that the better the way of formal learning provided, the higher the level of entrepreneurial intention will grow among students.

The regression co-efficient for risk thinking is statistically significant at 0.160 ($p<0.05$). The result shows that there is a relationship between informal learning and the level of entrepreneurial intention. Thus, Hypothesis 2 is accepted. The result shows that the offering more informal learning will result in an increase the level of entrepreneurial intention among students.

As for the work experience variable, the result shows that there is no relationship between work experience and the level of entrepreneurial intention. Therefore, Hypothesis 3 is rejected.

Therefore, it can be said that formal and informal learning influences student's entrepreneurial intention in different universities of Chattogram.

4. CONCLUSION

The findings show that the variables of formal and informal learning are significantly related to the student's entrepreneurial intention while the another variable work experience is not significant. These findings reveal the relationship between formal, informal learning and student's entrepreneurial intention.

Although, the research study is based on formal and informal learning and working experience, there are a good opportunity to work with other

variables that may help in creating entrepreneurial intention among the students.

From the study it is found that the requirement of formal and informal learning is very much necessary in order to develop students who wants to pursue career in entrepreneurship. And government and non-government institutions should come forward through offering various courses, training program and creating opportunities for the students. It will not only foster entrepreneurial mindsets among the student but also help the country to produce more young entrepreneurs in the future.

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The influence of reasoning and writer's voice on the overall quality of argumentation

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ABSTRACT

This study investigated the influence of two components of argumentation criteria, that is, reasoning and writer's voice, on the overall quality of argumentation. The two components are important and emphasized in recent knowledge of argumentation. However, they are not taken into account in the general criteria. In this study, the two components were included in an updated argumentation criteria and scale. Five argumentative essays, written by an English student who had trained in argumentation, were collected as research materials. They were evaluated by using the criteria and scale. The findings suggested that the two components would influence the overall quality of argumentation when the argumentation was of poor quality.

Keyword: argumentation, quality, reasoning, writer's voice, English

1. INTRODUCTION

This paper reports on a study which sought to find the influence of reasoning and writer's voice on the overall quality of argumentation. Reasoning and writer's voice are two new components added to an updated criteria and scale for teaching, learning, and evaluating argumentation. The criteria and scale is based on an investigation into the evaluation criteria in two common communication settings of argumentation, that is, English tests and publications on argumentation. It is observable from the two locations that two important elements of argumentation, that is, reasoning and writer's voice, which receive much attention in latest knowledge of argumentation, have not yet been seriously taken into account in the area of evaluation. Therefore, a criteria and scale was created in a study to embrace both the general criteria and the two elements (Kaewpet, 2018a). The updated criteria and scale has been evaluated for its validity, reliability, and practicality, and employed successfully in two studies (Kaewpet, 2018b, 2018c, Kaewpet, 2019). It is further examined in this study to confirm the significance of reasoning and writer's voice. In other words, the study reported in this paper was carried out to find whether reasoning and writer's voice would substantially influence the overall quality of argumentation.

Argumentation skills are recognized as very important for success in daily life, careers and in academic studies. The skills actually reflect the cognitive activity, where a democracy functions (Fulkerson, 1996). Particularly, in the society where social, political, and scientific controversies abound, the ability to make rational choices among competing alternatives is crucial, because skills of argument can help people resolve controversies (Reznitskaya, Anderson & Kuo, 2007).

The first focused component in this study, reasoning, is the nature of argumentation. To win an argument in the process of argumentation, one would need to take six common elements into account. The elements were originally created by Stephen Toulmin in 1958. It is now established to include six elements: *claims*, *data*, *counter-argument claims*, *counter-argument data*, *rebuttal claims*, and *rebuttal data*. A *claim* is a declaration of a writer's position regarding a controversial issue

or situation. A *counter-argument claim* demonstrates an opposing view to the claim. A *rebuttal claim* is against the counter-argument claim; therefore, resides on the same position as the claim. The *data*, *counter-argument data*, and *rebuttal data* are reasons or evidence, which support the claim, counter-argument claim, and rebuttal claim respectively. They can be facts, logical explanations, suppositions, statistics, anecdotes, research studies, expert opinions, definitions and analogies (Qin & Karabakak, 2010; Ramage, Bean & Johnson, 2010; Stapleton & Wu, 2015). Research findings have suggested that argumentation with three of the six elements in particular will result in high quality scores: counter-argument claim, counter-argument data and rebuttal data (Liu & Stapleton, 2014; Stapleton & Wu, 2015).

The second component, writer's voice or authorial voice, has received much attention in recent publications on argumentation. The major function of writer's voice is to demonstrate the writer's authority and confidence. The audience can learn about writer' voice from the lines, or observe it from the language resources built into the argumentation. In one example, Liu (2013) analyzed appraisal resources used in Chinese students' essays. The resources would generally influence writer's voice. They were classified into three categories: attitude, engagement and graduation. Liu found that the appraisal resources foregrounded the writer's voice in the highly-rated essays successfully. In other three studies, features of writer's voice that could influence the writing quality or voice strength were investigated (Helms-Park & Stapleton, 2003; Yoon, 2017, Zhao, 2017). The features included assertiveness, self-identification and reiteration (Helms-Park & Stapleton, 2003). In fact, writer's voice is an important construct in L1 writing, but is not taken into consideration in L2, due to the belief that it does not fit L2 learners who come from collectively-oriented cultural backgrounds (Yoon, 2017). Contrary to the idea, writer's voice should also be taken into account in teaching, learning and evaluating argumentation, because L2 learners will engage in argumentation in L1 settings, and development of their ability should be as near native speakers as possible.

Despite the fact that reasoning is the heart of argumentation, and writer's voice can strengthen argumentation, the two elements are hardly taken as criteria in the general evaluation of argumentation. In one rare example, Stapleton & Wu (2015) employed the six elements to select argumentative essays written by high school students in Hong Kong. The students wrote to argue for or against drug testing. Reasons given in the essays were evaluated in terms of their relevancy to the topic, and three levels of acceptability: not acceptable, weak, and acceptable. Findings revealed five types of quality, i.e., 1. good surface structure or argumentative writing but poor quality of reasoning: failure to rebut all of the counter-arguments, 2. good surface structure but poor quality of reasoning, particularly with non-aligned rebuttal, 3. good surface structure but poor rebutting undermining the overall quality of reasoning, 4. good surface structure but generally weak quality of reasoning, and 5. good surface structure and relatively good quality of reasoning. In this study, the quality of argumentation was not judged on common criteria for evaluating argumentation such as relevancy or language use, which can be unconnected to the teaching and learning situation.

Argumentation is always measured in an influential setting - English standardized tests, where satisfactory test scores are doors to success in academic studies or occupational advancement for the test takers. However, reasoning and writer's voice are not emphasized in the tests. In TOEFL, test takers are asked to write a response to a prompt, which exhibits agreement or disagreement with a given statement. A response at the top score is described as follows: it addresses a given topic

and task effectively, is well organized and developed, displays unity, progression, and coherence, and displays consistent facility in the use of language (ETS–TOEFL, 2015). In IELTS, test takers are asked to write in response to a point of view, argument or problem. The written performance on the highest band is described as fully addresses all parts of the task, presents a fully developed position in answer to the question with relevant, fully extended and well supported ideas, uses cohesion in such a way that it attracts no attention, skillfully manages paragraphing, uses a wide range of vocabulary with very natural and sophisticated control of lexical features, uses a wide range of structures with full flexibility and accuracy (IELTS, 2016). Indeed, the two components – reasoning and writer's voice – have not yet been directly taken into the criteria.

A criteria and scale for evaluating the quality of argumentation has been created to take both common evaluation criteria, and reasoning and writer's voice into account. The other components include relevancy, language use, and organization (Kaewpet, 2018a). It has been evaluated for its effectiveness, in terms of its validity, reliability and practicality, and has been employed to evaluate and compare a number of argumentation models and students' argumentative essays successfully. In a range of *none* to *highest*, the quality of the models fell in the *high* level, and the quality of the essays fell in the *improvement needed* level (Kaewpet, 2018b, c), which were two levels behind the models. That study did not specifically investigate the influence of reasoning and writer's voice on the overall quality of argumentation. However, the influence of reasoning and writer's voice on the overall quality of argumentation was questionable. The influence of each of the five components on the overall quality of argumentation was not significantly different for the argumentation models, but they were significant for the student essays. The influence on the essays was in this order: writer's voice, relevancy, reasoning, organization and language use (Kaewpet, 2018c). While the raw data of that study could be furthered analyzed for a fuller understanding, the research materials, that is, the argumentation models and student essays used in the study were completed when the two components were not yet emphasized. Therefore, they were not the right source for this study. In this study, new student essays were collected from a learner who had learned about the five components. The new essays were employed in the study to find the influence of reasoning and writer's voice on the overall quality of argumentation.

2. METHODS

2.1 Materials and participants

Research materials in this study included 1) student argumentative essays and 2) online evaluation forms. Five essays were written up by a Thai learner of English, who had learned and practiced writing argumentative essays using the criteria. The essays were on five topics or questions including those citing recent publications: 1) should Facebook be allowed to collect information of its users (adapted from Song & Ferretti, 2013), 2) risks vs. careful planning (adapted from Qin &Uccelli, 2016), 3) traffic jams as a tourist destination, 4) GDP or GNH, 5) go for Thainess or go international. The evaluation forms were the updated criteria and scale that was made accessible online by Google Forms. The essays were kept on Google Site pages; and the evaluation forms on Google Drive. Three evaluators accessed the essays and forms through links provided on a Google Web page. All of the evaluators were Thais who had extensive experiences in teaching English to Thai students at the research site. The evaluators were meant to be non-native English speakers, because the criteria and scale was for the teaching and learning situation. The evaluators were asked to choose the degree to which the essays had met the criteria, ranging from 0 (not at all) to 5 (most).

2.2 Analysis

After the evaluation of the argumentative essays by the three evaluators, calculations of the scores were carried out on an online one-way analysis of co-variance (ANOVA) calculator (Stangroom, 2017). The scores were entered into the calculator five times, to find, firstly, the overall quality of the essays taking all five components into account: relevancy, reasoning, language use, organization, and writer's voice; secondly, the quality of them without the reasoning component; thirdly, without writer's voice; fourthly, without both reasoning and writer's voice, and, lastly, the influence of reasoning and writer's voice on the overall quality. In the last round, the mean scores of the first to fourth calculations were compared. The quality of the essays was interpreted from their mean scores as follows: 0.00-1.50: *urgent improvement needed*, 1.51-2.50: *improvement needed*, 2.51-3.50: *fair*, 3.51-4.50: *high*, 4.51-5.00: *highest*.

3. RESULTS AND DISCUSSION

Table 1 shows quality scores of the individual essays, when taking all five components into account. The scores ranged from 3.697 to 4.2727. The mean score of the essays was 4.115, which fell onto a high level.

Table 1. Quality scores of individual essays: five criteria

Summary				
Essay	Mean		Std. Dev.	
1	3.697		1.5709	
2	4.1515		1.0932	
3	4.2727		0.5168	
4	4.2424		1.0009	
5	4.2121		0.7809	
Total	4.115		1.0616	
Result Details				
Source	SS	df	MS	
Between essays	7.4788	4	1.8697	F=1.68695
Within essays	177.3333	160	1.1083	
Total	184.8121	164		

The *f*-ratio value is 1.68695. The *p*-value is .155557. The result is *not* significant at $p < .05$.

Table 2 shows quality scores of the essays when not taking reasoning into account. The scores ranged from 3.9524 to 4.381. The mean score of the essays was 4.181, which fell onto a high level.

Table 2. Quality scores of individual essays without reasoning

Summary				
Essay	Mean		Std. Dev.	
1	3.9524		1.4655	
2	4.1429		1.1084	
3	4.1905		0.5118	
4	4.381		0.4976	
5	4.2381		0.7003	
Total	4.181		0.928	
Result Details				
Source	SS	df	MS	
Between essays	2.0381	4	0.5095	F=0.58216
Within essays	87.5238	100	0.8752	
Total	89.5619	104		

The *f*-ratio value is 0.58216. The *p*-value is .676261. The result is *not* significant at $p < .05$.

Table 3 shows quality scores of the essays when not taking writer's voice into account. The scores ranged from 3.6563 to 4.25. The mean score of the essays was 4.1, which fell onto a high level.

Table 3. Quality scores of individual essays without writer's voice

Summary				
Essay	Mean		Std. Dev.	
1	3.6563		1.5783	
2	4.125		1.0999	
3	4.25		0.508	
4	4.25		1.016	
5	4.2188		0.7925	
Total	4.1		1.0711	
Result Details				
Source	SS	df	MS	
Between essays	8.2125	4	2.0531	*F*=1.82696
Within essays	174.1875	155	1.1238	
Total	182.4	159		

The *f*-ratio value is 1.82696. The *p*-value is 1.26352. The result is *not* significant at $p < .05$.

Table 4 shows quality scores of the essays when not taking reasoning and writer's voice into account. The scores ranged from 3.8889 to 4.3333. The mean score of the essays was 4.133, which fell onto a high level.

Table 4. Quality scores of individual essays without reasoning and writer's voice

Summary				
Essay	Mean		Std. Dev.	
1	3.8889		1.5297	
2	4.1111		1.1318	
3	4.1667		0.5145	
4	4.3333		0.4851	
5	4.1667		0.7071	
Total	4.133		0.9505	
Result Details				
Source	SS	df	MS	
Between essays	1.8444	4	0.461	*F*=0.49894
Within essays	78.5556	85	0.9242	
Total	80.4	89		

The *f*-ratio value is 0.49894. The *p*-value is .736547. The result is *not* significant at $p < .05$.

Table 5 shows comparison of the mean scores of the overal quality of the essays, when taking all components into account., not taking reasoning or writer's voice, or not taking both reasoning and writer's voice respectively. The statistics demonstrated no significant differences between the calculations.

Table 5. Comparison of the treatments

Summary				
Treatment	Mean		Std. Dev.	
1	4.1151		0.238	
2	4.181		0.1558	
3	4.1		0.2533	
4	4.1333		0.16	
Total	4.132		0.1921	
Result Details				
Source	SS	df	MS	
Between treatments	0.0185	3	0.0062	*F*=0.14481
Within treatments	0.6827	16	0.0427	
Total	0.7012	19		

The *f*-ratio value is 0.14481. The *p*-value is .93151. The result is *not* significant at $p < .05$.

This study aimed to investigate the influence of reasoning and writer's voice on the overall quality of argumentation. It was found that the two components did not significantly influence the overall quality of argumentation in the case of the high-quality argumentation. The findings yielded similar results to the previous study in relation to the argumentation models. The models were graded as high quality and the five components of the criteria equally influenced their overall quality. The findings, however, were different in the case of the student essays. The findings suggested that the overall quality of the student essays were influenced by the five components differently. The findings of this study suggested that reasoning and writer's voice, the focus of this study, did not have influences on the overall quality of argumentation. The same reason for the argumentation models applies to the case of the student essays in this study. The essays were of high quality. Therefore, no specific components play role on the overall quality of the argumentation.

This has meant that the five components, including reasoning and writer's voice will possibly have an influential role, when the quality of the overall argumentation falls into a low level. This consideration leads to the need to train beginning or intermediate learners of argumentation in giving reasons, and projecting their voice clearly. Once the students reach a high level, they will most possibly be able to write argumentation well.

4. CONCLUSION

This study has yielded the influence of reasoning and writer's voice on the overall quality of argumentation in the case of beginning or intermediate learners. The findings can be applicable to the teaching and learning situation, as well as future research.

In the teaching and learning situation, the two components, reasoning and writer's voice, should be emphasized when teaching argumentation to beginning or intermediate learners of argumentation. This includes advanced English learners who have no experiences in argumentation. They may perform well in other areas of English, but may not in argumentation. The argumentation models analyzed in the previous study and the essays evaluated in this study were written by writers who were well aware of the elements of argumentation and trained in argumentation. Therefore, their scores were high. Without some training, the evaluation scores may not be satisfactory. It is also understood from this study about the benefit of explicit training in argumentation. The student research participant could write argumentation of the high quality. Furthermore, the updated criteria and scale can be used practically as a guide to teaching and learning. However, it should be used together with a statistical calculator such as that adopted in this study when it comes to evaluation. The effectiveness of the criteria and scale was reported in the previous study in terms of carrying, statistically, equal weights for all of the components (Kaewpet, 2018b). The components in the criteria and scale carry different numbers of items. They will not result in equal weights with the raw scores. Therefore, the raw scores should be calculated with a statistical calculator such as that employed in this study.

For future research, a study should be carried out to evaluate the influence of reasoning, and writer's voice on the quality of argumentation by students who have trained in argumentation and have different levels of ability. The findings of the study can be made useful in the real teaching and learning situation, where a mix of abilities is common.

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A study of Thai hospitality students' self-reported proficiency levels and attitudes towards English

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ABSTRACT

Tourism is one of the largest sectors of the Thai economy and many local people adopt English as a means of conducting business with visiting tourists. Therefore, English has become invaluable to many people. This is true not only for the educated elite but for people from all sorts of backgrounds that try to make a living from foreign travellers. Their requirements may vary greatly; a street seller for example, may need to mainly understand numbers where business people involved in international markets will need greater levels of English skills. In order to maintain and increase tourist numbers the Thai people will need to improve their English skills in all areas. The aims of this study were to obtain information and data on students' proficiency levels and their attitudes towards English. Data was collected from undergraduate students at a Thai public university. The following paper presents data related to undergraduate hotel and hospitality students' self-reported proficiency levels and reasons for learning English. The results of the study provide useful data that can be used to develop and improve existing courses and programs. The results revealed that students require more opportunities for practising English and need to improve all areas of the language.

Keywords: English, hospitality, proficiency, attitudes

1. INTRODUCTION

With the tourism industry being important to the Thai economy it is essential that graduating students meet the needs of visiting tourists. Unfortunately, many Thai students lack behind their counterparts in other Southeast Asian countries when it comes to communicating in English. Thai students often lack confidence in speaking English and find listening skills problematic. Thus, many students resort to using memorisation as a technique to learn the language. Graduates are rarely situated at the hotel front office due to their low English proficiency levels. Many of the students that are enrolled on bachelor degree programs already work part-time in the hospitality and hotel industry. Unfortunately, many Thai hotel and hospitality students lack good English communication skills. In particular, there is a reluctance to engage in speaking activities. Students prefer or feel more comfortable with gap fill or word matching exercises. Speaking tests are often passed through memorisation of vocabulary and phrases. Although students can recite grammar rules, there is little real understanding of the structure of the language. Many students therefore feel that English is difficult. They generally believe that many complicated grammatical rules need to be understood in able to speak English successfully. It is important therefore that the English courses meet the needs of both industry and students. As a result of this, the institute would improve its program and meet the needs of society (2, 5, 8).

Alkaff (2013) studied students' attitudes and perceptions towards learning English as a second language (ESL). The study was

conducted with Foundation Year (FY) students at the English Language Institute (ELI) of King Abdulaziz University (KAU) in Jeddah, Saudi Arabia. The researcher investigated the students' opinions in regard to the importance of English and whether they find it difficult or not. The research objectives were to investigate whether students enjoy English and see it as important, whether they find English difficult and the reasons behind the difficulties and whether students try to improve their English outside of the classroom. A random sample of 47, female science and art students at pre-intermediate and intermediate levels, were chosen for the study. A close relationship between attitude and achievement was found. The study revealed that the majority of students had a positive attitude towards learning English. Some of the students found English difficult but were willing to improve their language. Many of the students questioned found it difficult to find time in their busy schedules to improve their language skills. The study recommended that the institution adopted a less rigorous curriculum that allowed more time for the study of English (1).

Tahaineh and Daana (2013) investigated the social psychological variables of motivation and attitudes towards learning English of female Jordanian undergraduate students. The students were majoring in English as a foreign language at Al Balqa' Applied University-Princess Alia University College-Amman, Jordan. Although Jordanian students can study various foreign languages, English is seen as the most important. The results showed that many students learnt English for academic and career reasons. The students' attitudes towards English speaking cultures was found to be positive but had little impact on their motivation to learn English. The study though found that the students agreed that English was important for communication with other nations. A great majority (96.2%) believe that English will enable them to find a good job. The students showed a strong desire to learn English. Even though the students were majoring in English, time constraints placed limitations on how long they could study. The students indicated that they would like to spend more time learning English and become natural speakers of the language. The study found a need for instruction that assists the students in occupational settings. The students saw English as a key to a successful career and life. The study was limited to female only students that were majoring in the English language. In conclusion, the general overall motivating factor for learning English appeared to be for career opportunities and financial reasons (7).

Despagne (2010) studied the attitudes and perceptions of 300 undergraduate students taking English classes at Universidad Popular Autónoma del Estado de Puebla in Puebla, Mexico. The study was carried out through an on-line questionnaire. Mexico relies on a strong political, cultural, and economical relationship with the United States (U.S). This reliance has increased the spread of English in the country. In Mexico, English has become an essential requirement for many occupations. In general, job advertisements ask for a high level of English proficiency regardless of whether it will be used or not. Forty five percent of the learners perceived English as being a difficult language. However, nearly 90% of the students questioned agreed that the language is extremely important. Ninety nine percent of the students believed that English would help them in their professional growth and 58% of the students believed that English would help them in general life. The results showed that 39.7% of the students believed that English would help them find a better professional situation and would help them to study for a master's degree in a foreign country. Mexicans recognise that English is vitally important for their country's future and economic progression (4).

Chinese students generally learn English in order to pass examinations or to gain employment. It has been shown that Chinese students after many years of study still cannot

speak or understand spoken English. This phenomenon is known as "mute English" in China. Peng (2014) investigated 200 university students in Mainland China to discover which English language skills students perceived to be the most difficult. The study analysed the perceived difficulty rank of five English skills of listening, speaking, reading, writing and translating. The sample was made up of 100 English major students and 100 non-major students. The data showed that Chinese students perceive translating and speaking as the most difficult skills to master. Listening was also perceived as difficult. Reading was perceived to be the least difficult skill. No significant difference was found between translating and speaking between the English majors and non-English major students. Previous studies have noted the difficulties of acquiring these skills in courses with a limited time scale. It has been assumed that Chinese students do not speak English because they are shy. The study showed that oral skills are the most difficult to attain and this may be the main reason that Chinese students do not speak. There is therefore a need to restructure and re-design teaching approaches and course content to improve students' oral English abilities. The problem may lie in the fact that many English teachers in China have a poor level of English proficiency and in particular lack oral skills. Speaking and listening skills though are seen as the most important. The Chinese people need to acquire these skills in order to face future challenges (6).

Cho and Teo (2014) investigated Thai students' motivational orientations and attitudes towards English as a second language. The study used a questionnaire to gauge opinions from 219 Grade 9 students in all six governmental secondary schools in three cities in southern Thailand, namely Pattani, Yala, and Narathiwas. The participants consisted of 138 female students and 81 male students. Eighteen of the students reported that they had been to English speaking countries. The questionnaire looked at the students' integrative and instrumental motivational orientations. The results showed that students had strong instrumental orientation together with moderately high integrative orientation. The students generally showed a favourable attitude towards English. The results showed that students were interested in communicating with foreigners and English speaking culture. English was seen as most important for their future studies (6). The literature shows that students are generally motivated to learn English. This motivation shows a strong relationship to future academic and career prospects. The language is seen as being difficult to acquire and time constraints and opportunities for study can affect student learning. This study aims to collect information and data on Thai hospitality undergraduate students' self-reported proficiency levels and attitudes towards English.

2. METHOD

A sample of 37, 2nd year hospitality students was chosen to participate in the study. The sample was chosen for convenience and because they possessed the necessary characteristics required for this study. The data were collected through a 5 point Likert scale questionnaire. The questions and statements were in both Thai and English to help ensure there was no language barrier. The questionnaire was constructed by the researcher, based on previous research on students' attitudes towards the English language and student proficiency levels (1, 2). The questionnaire was tested for reliability and found to be reliable for data collection. The face validity of the questionnaire statements were assessed by experts at a Thai public university. The collected data was analysed through descriptive statistics.

3. RESULTS AND DISCUSSION

The following section displays the results taken from the questionnaire survey (see Table 1) and discusses the students' responses.

Table 1. Frequency of response for the questionnaire survey statements.

Statement	**Yes**				
Have you ever visited an English speaking country?	11				
Statement	**Always**	**Often**	**Sometimes**	**Rarely**	**Never**
Do you speak English at home?	0	1	12	13	12
Do you use English outside of the classroom?	1	6	19	9	2
Statement	**Very Good**	**Good**	**Average**	**Poor**	**Very Poor**
My English grammar is……	1	7	19	10	0
My English reading is…….	0	12	18	8	0
My English writing is.....	0	10	19	8	0
My English listening is……	1	9	21	6	0
My English speaking is……	0	8	20	9	0

Table 1. Frequency of response for the questionnaire survey statements

Statement	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
I need to practice English every day.	9	20	8	0	0
Knowing English will help me to get a well-paid job.	12	20	5	0	0
Knowing English will help me to live and work in a big city.	13	19	5	0	0
Knowing English helps me speak with foreigners.	15	18	4	0	0
Knowing English will help me work in the front office.	8	20	8	1	0
English is important for my future career.	14	18	5	0	0

In answer to the question: Have you ever visited an English speaking country? Around 70 percent of participants answered no and 30 percent answered yes. The majority of students had therefore not visited an English speaking country. It may therefore be beneficial for students to visit either native speaking countries or those within the region such as Singapore where English is widely spoken and offers opportunities for practice. In response to the question: Do you speak English at home? Over 65 percent of the respondents said they rarely or never spoke English at home. This could be due to the lack of English abilities among family members and thus an opportunity to practice. In addition, only around 19 percent of respondents said they always or often used English outside of the classroom. Around 51 percent said they used English sometimes. Again more opportunities for regular practice are required. This is backed up by the majority of students agreeing or strongly agreeing that they need to practice English every day. The majority of respondents admitted that they had average abilities in all the language skills. All but two of the respondents in the survey said they possessed very good

skills in any area of the English language. It is therefore clear that all areas need to be improved. New approaches to teaching and learning are required to ensure that the students make progress in all areas. Previous focus on grammar and rote learning of context specific dialogues has not produced adequate results. Opportunities for free practice of the language are needed. These opportunities could be provided online or through informal language groups that meet to practice English at set times every week. More interesting classes that do not solely focus on a text book approach are also required. Activities that promote communication are needed. The majority of respondents recognise that strong English skills will enable them to live and work in a big city. These skills have been recognised by the majority of respondents as being useful for communicating with foreigners and for gaining front office or management positions in the hotel. English skills were seen by the majority of respondents as being useful for work situations.

4. CONCLUSION

Students often enter university with inadequate levels of English proficiency. In the curriculum at many universities there is little time for English language classes. Classes may also be over-subscribed and irregular. It is important that students graduate with adequate skills in English for the workplace. In summary, the results of this study have shown that students lack skills in all areas of the English language. Opportunities are needed for practice away from the classroom environment. This may call for more imaginative solutions that utilize technology and approaches where students take more responsibility for their own learning. The study shows students recognise the importance of English in their future careers. Unless graduates improve their English abilities many opportunities will be lost to other ASEAN members.

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The use of social networking applications for learning hospitality related English vocabulary

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ABSTRACT

In order to communicate effectively with foreign visitors, Thai graduates from hospitality and tourism programs need English vocabulary related to their field. Acquiring sufficient vocabulary to converse in a foreign language requires regular practice. In this regard, technology such as social networking applications could be used to assist learners in the vocabulary acquisition process. The purpose of this study was to examine the use of the Line social networking application for learning hospitality specific English. The study aimed to examine students' perceptions of using a social networking application for learning English vocabulary as part of a classroom taught lesson. The results from the study found the participants were positive towards using a social networking application to learn vocabulary. This study discovered that social networking applications could be successfully used for learning English vocabulary as part of a university level course of study.

Keywords: English, vocabulary, hospitality, social networking application

1. INTRODUCTION

Learners of English should possess enough vocabulary to be able to engage in a conversation with an English speaker. This is important when a learner relies on speaking English for business and work. Acquiring enough vocabulary to converse in English requires regular practice and time investment. Additionally, the acquisition of language needs an understanding of how to learn (9). Instructors are often influenced by the teaching methods that they were exposed to as students. It is easy for instructors to become comfortable with familiar teaching methods and develop a fear of change when the method is unsuccessful. Research has shown that a fear of change results in negative consequences for the instructor and students. Change though is not always good. For example, the poor use of technology can often result in wasted time and a lack of overall improvement. It is therefore important that technology is correctly integrated within a course. This requires the collection of data and information so the instructor has a good idea of what works. Results from data can help the instructor feel confident in their approach to teaching through technology (3, 10).

Educators are becoming more interested in the potential of social networking applications for language learning. Currently though, there is a lack of data and information on how social networking applications can be used for teaching and learning the English language. The research that is available suggests that these tools have the potential to aid language learning and teaching. The instructor though should consider the usability of the tool before using it for teaching purposes. The social networking tool should be familiar, easy to use and intuitive (12).

Social networking applications have proven to be useful as instructional tools. During Dehghan, Rezvani and Fazeli's (2017) study, an experimental group received foreign language vocabulary instruction via the WhatsApp social networking application while a control group was taught in a traditional classroom setting. The

results of the study, found no significant differences between the technology-based group and the traditional classroom group (7).

Data were collected from students in China and Hong Kong regarding perceptions and experiences of using applications for learning vocabulary items. The results showed that students value the ability to interact with other users. The findings suggest that personalized learning is essential to learner engagement and learning effectiveness. (17).

Currently, there is a shift from desktop and laptop computers with more people using mobile technologies such as smartphones and tablets. Most students now own a mobile device that can connect to the Internet. Students are therefore well equipped for learning through mobile devices. Research has shown that the use of smartphones and mobile applications can produce positive effects when learning English as a foreign language. Such devices and applications have been beneficial in the development of learners' vocabulary and for increasing the motivation to study (11).

As students are now armed with their own computational tools it is no surprise that educational institutions across the globe are taking advantage of this situation. Many educational institutions are adopting a Bring Your Own Device (BYOD) policy. The (BYOD) policy has various advantages for educational institution. Students that own mobile devices can connect to the World Wide Web and use these devices for learning. No expensive hardware or software is needed by the institution (1).

Instructors should aim to teach in an effective, efficient, and enjoyable manner. In this respect, research has shown that the use of technology for instruction has various benefits. For example, the use of technology can remove the usual restrictions of class based learning and provide the instructor with opportunities to teach in a more unorthodox manner. Technology can also help to motivate students and encourage learning through increased participation (2, 16).

In order to remain relevant in the 21st century, instructors need to constantly evaluate, develop and change their approaches to teaching. This should include the use of the most up-to-date and popular technology available. Technology that is familiar, freely available and can be accessed anytime and anywhere there is an Internet connection (5, 13, 15).

Content design has been shown to be a factor in the success of technology based instruction. In this respect, visual media has been shown to positively influence learning outcomes. In addition, various studies have shown interaction to be a factor in learning success and increased satisfaction levels and improved attitudes towards a subject (6).

This study aims to determine students' perceptions and gain data on using a social networking application for learning English vocabulary as part of a taught lesson. The data could be useful when using social networking applications for instructional purposes.

2. METHOD

A sample of 44, 2nd year hospitality students was chosen to participate in this study. The students were chosen as they possessed the required characteristics required for the study and as they need specialist vocabulary in their future careers. The sample group was also taught by one of the researchers and was therefore conveniently available for this study. During the semester, hospitality related English vocabulary was practiced on a weekly basis through the Line social networking application. The activities related to answering a question based on a visual clue. The media was chosen for viewing on smaller screen devices. The data were collected through a 5 point Likert scale questionnaire that measured agreement. The questions were in both Thai and English to help ensure there was no language barrier. The questionnaire was based on previous studies and checked for reliability

through Cronbach's alpha and checked for validity by 4 suitably qualified lecturers at a Thai public university. The questionnaire data were analysed using a one sample t-test that measured a mean value for each variable against a perceived upper neutral value of 3.40. The neutral value was taken from the following interpretation: 1.00-1.80=Strongly Disagree, 1.81-2.60=Disagree, 2.61-3.40= Neutral, 3.41-4.20=Agree and 4.21-5.00= Strongly Agree. This interpretation has been previously used to analyse data in social science studies. In the case of this study, higher mean values would be viewed as a positive endorsement of the media and the use of the Line application for learning.

3. RESULTS AND DISCUSSION

The questionnaire was checked for reliability and all Alphas were found to be above .70 which is seen as reliable for final data collection (8) (see Table 1).

Table 1. The results for the questionnaire Cronbach's Alpha reliability test.

Variable	Alpha
1) Perception of Learning	.72
2) Satisfaction	.83
3) Ease of Use	.85
4) Media Quality	.76

The results of the study found the use of social networking technology for learning hospitality English to be well received by the students (see Table 2).

Table 2. The results of the questionnaire data analysis showing mean and standard deviation.

Variable	Mean	SD
1) Perception of Learning	4.36	.34
2) Satisfaction	4.31	.38
3) Ease of Use	4.51	.40
4) Media Quality	4.50	.41

The mean averages for perception of learning, satisfaction, ease of use and media quality were all above 4.21. This would suggest a very high level of agreement and a positive endorsement of the Line social networking application as a learning tool. The data was then analysed to establish statistical significance above a neutral value of 3.40. T-tests showed the data to be statistically significant for perception of learning (t=18.62, df=43, p=.00), satisfaction (t=15.74, df=43, p=.00), perceived ease of use (t=18.53, df=43, p=.00), and media quality (t=17.78, df=43, p=.00). The results from the data show very high levels for all 4 variables and thus a positive outcome (see Table 3).

Table 3. The results of the t-test showing mean difference and significance.

Variable	M.D	Sig.
1) Perception of Learning	.96	.00
2) Satisfaction	.91	.00
3) Ease of Use	1.11	.00
4) Media Quality	1.10	.00

In regard to perception of learning, Rott (1999) suggests that six encounters with a word may be enough for recall. In this study, continual review over the length of the course may have strengthened students' full recall of the vocabulary. Previous research has shown that spaced review and practice of vocabulary aids longer term memory retention when compared to mass practice. The ability to recognise words could explain the high values related to perception of learning. The familiarity of social networking applications could explain the results for ease of use. A more familiar learning tool that is easy to use would more likely be adopted by the students. Media was chosen for small screen devices and thus could explain the high values for media quality. The high values for perception of learning, ease of use and media quality would explain students' high satisfaction levels (4, 7, 14).

4. CONCLUSION

Overall, the students were satisfied with the experience and believed it helped them to learn. In the future, technology will become ever more common within education. Instructors should therefore consider integrating technology such as social networking applications into their courses. Policymakers and administrators should ensure that instructors have adequate support and the skills to use and integrate technology into their teaching practices. The findings from this study may be useful for instructors that want to use social networking applications in language learning classes. Further research is required with a larger sample size that employs control and experimental groups. Pre and post-tests could then be used to determine the effectiveness of the Line application as a tool for learning vocabulary.

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A study on student self-responsibility at a Thai public university

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ABSTRACT

In today's society, a bachelor's degree alone may not be enough to secure a well-paying job. It is therefore important that students can work on their own initiative, recognise issues with their behaviour and take responsibility for their own learning. This study aimed to examine whether students at a public university in Thailand recognised problems with their study behaviour. Additionally, the study aimed to determine whether students' projected final grade was in agreement with the researcher's final grade. The participants of the study were 54, 2nd year, English major students of mixed gender taking an essay writing course. During the course, students were given guidance on how to learn independently while being reminded of their responsibilities as learners. Observations were made on a weekly basis regarding attendance levels, punctuality, in class participation, non-academic smartphone use and disruption caused through socialising. Students were then required to complete a questionnaire based on behaviour and award themselves a grade that they believed they deserved. The results of the study found some differences between students' perceptions of their own behaviour and projected final grades and the instructor's opinions based on classroom observations and notes.

Keywords: student responsibility, smartphone use, punctuality, plagiarism

1. INTRODUCTION

In the past, a school leaving certificate or a vocational certificate was deemed sufficient to gain a good, well-paying job. In today's society, "academic inflation" has ensured that even a bachelor's degree may not be enough. A situation now exists where large numbers of degrees are given out every year. Due to this situation, an average to low classification degree in a less sought after subject may have little value in the job market (3). It is therefore important that students gain the skills needed for the workplace. The ability to work without too much guidance is a skill not only valued in the workplace but also the university.

Students' must learn to take responsibility for their own learning and work on their own initiative. This requires the student to take responsibility for their own actions and workload without being continually prompted by the instructor. Students are often given greater levels of autonomy as they progress through university. Students that are capable of working on their own often have more successful learning experiences (5).

When students first attend university, it can be difficult to adapt to the need for higher levels of independence, initiative, and self-regulation. There are several factors that have been linked to student success at university. Factors such as persistence, good time management and organization are among those identified. It has also been found stress, poor academic skills (not attending class and lateness) and distractions from various sources are factors that denied students from achieving their learning and academic goals. In turn, stress and distractions can lead to poor academic skills. Classes may be missed and studying and assignments may be left until to the last minute. In relation to these issues, students often fail to recognise that their own behaviour contributes to their academic failures (9).

Students born in an age of digital media have been seen by some as fundamentally different from past generations of students. These so called 'digital natives' are believed to be proficient in the ability to process multiple sources of information simultaneously (multi-tasking). As a result, instructors and policy makers believe these students require an educational approach far different from that of previous generations. There is strong evidence

though that the ability to multitask within the classroom does not exist (6).

It has been found that the checking of smartphones or tablets for non-academic purposes during lectures can result in lower grades. The division of attention between a lecture and some other activity such as checking social media results in the student remembering less of one of the activities. In addition, students who do not use mobile devices in lectures themselves are often distracted by those that do and thus also do worse in examinations. This suggests that the use of mobile devices damages the group learning environment (4).

In the modern world, smartphones are widely owned and used to connect to an array of services and networks. The use of these devices by students is widespread. High frequency smartphone use though can negatively affect students' health and behaviour. For example, in one study, the use of phones and texting was negatively related to (grade point average) GPA and positively related to anxiety. In addition, GPA was shown to be positively related to (satisfaction with life) SWL and anxiety was negatively related to SWL. Increased phone use has been shown to negatively affect students' academic performance, mental health, and possible wellbeing and happiness levels (7).

The results from various studies have shown that smartphone addiction can have negative effects on mental health and wellbeing. For instance, the results of Samaha and Hawi's (2016) study showed that smartphone addiction risk has a positive relationship to perceived stress. Perceived stress was negatively related to satisfaction with life. Furthermore, smartphone addiction risk was shown to be negatively related to academic performance. Academic performance was shown to be positively related to satisfaction with life (8).

Plagiarism has been seen as a growing problem in academia. The findings from several studies show that the majority of students have an understanding that plagiarism is wrong. However, this has not stopped many students from plagiarizing their work. Various factors such as easy access to online resources, lack of available time, lack of motivation and poor academic writing skills have been shown to influence students' decisions to plagiarize (2).

At the tertiary level, regularly attending class and arriving on time are the responsibilities of the students. Lateness can be a disruptive form of behaviour for the instructor and students already in the classroom. The opening and shutting of doors and loud noises can be distracting and therefore lateness should be viewed as irresponsible behaviour if it occurs on a regular basis. Habitual lateness can be viewed as a sign of contempt for instructors and other students. Furthermore, such behaviour devalues a student's own education. Lateness shortens time in class and may cause the student to miss important activities and opportunities for learning (1). This study aimed to examine whether students at a public university in Thailand recognised problems with their study behaviour. Additionally, the study aimed to determine whether students' projected final grade was in agreement with the researcher's final grade.

2. METHOD

The participants of the study were 54, 2nd year English major students studying at a Thai university in Bangkok, Thailand. The students are of mixed gender and of Thai nationality. The students were taking an essay writing course as part of their degree program. The sample was chosen based on convenience and availability and the students' being less experienced than their peers in years 3 and 4. During the course, students were given guidance on how to learn independently and reminded of their responsibilities. Observations were made on a weekly basis concerning students' attendance levels, punctuality, in class participation, non-academic smartphone use and disruption caused through socialising during class. In addition, assignments were checked for plagiarising through a trusted online application. Data was collected through a questionnaire and short reflection paper. Individual student observations were then checked against students' own perceptions of their behaviour. The instructor agreed, partially agreed or disagreed with the observations taken from the questionnaire and reflection paper. In addition, students were asked to predict their final grade. The results from the grade predictions were then matched with those of the instructor. Again, the instructor agreed, partially agreed or disagreed with the grades. The questionnaire content was based on previous studies related to responsibility (1, 2, 7, 8, 9). The questionnaire was tested for reliability and the Cronbach's Alpha was found to be .76 and thus seen as reliable for data collection. The face validity of the questionnaire statements were assessed by experts at

a Thai public university. Data was analysed through descriptive statistics.

3. RESULTS

The results from the questionnaire produced some interesting data in regard to socialising and phone use in the classroom, punctuality and attendance and plagiarising and effort (see Tables 1 and 2). The results indicate problems with students talking and socialising and playing on their smartphones during activities. On the other hand, a large number of students agreed or strongly agreed the instructor could see the students talking and playing on their smartphones. Fourteen students disagreed or strongly disagree that they rarely or never miss class. Thirty two students agreed or strongly agreed that they did not copy their assignments. Forty four agreed or strongly agreed the instructor would check for plagiarizing and many believed they would be penalized for the offence. Many students believed they had made an effort to learn during the course. Thirty eight students agreed or strongly agreed that they were responsible enough to study at university. Forty nine students believed they should receive at least a C+ for the course.

The study found some differences between students' perceptions of their own behaviour and the instructors' own observations and notes (see Table 3). In many cases, students recognised poor behaviour but awarded themselves a relatively high grade. This resulted in only partial agreement of the students' self-assessment of their behaviour.

Table 1. The following table shows the frequency of response from the questionnaire (Strongly agree=5, Agree=4, Neutral=3, Disagree=2 and Strongly disagree=1).

Statement	5	4	3	2	1
1) I always arrive to the lesson on time.	17	15	21	8	3
2) I rarely or never miss class.	14	15	11	12	2
3) I only leave the class with the instructor's permission.	10	25	10	4	0
4) I never play on my phone during the lesson.	1	8	24	17	4
5) I never talk to my friends during the activities.	0	4	22	20	8
6) I never disrupt the class for other learners by talking.	4	20	19	11	0
7) I think the instructor can see students playing on their phone.	31	16	7	0	0
8) I think the instructor can see students talking to their friends.	31	18	5	0	0
9) I never copy my assignments.	14	18	20	2	0
10) I tried to learn the writing skills.	12	26	13	3	0
11) I tried to learn even when the activity was difficult.	14	27	11	2	0
12) I think the instructor will check my work for copying.	29	15	7	3	0
13) I will get a lower score if I copy.	26	22	5	1	0
14) I will get an F if I copy.	25	17	8	2	2
15) I am responsible enough to study at university.	12	26	15	1	0

My final grade should be……	**A-B+**	**B-C+**	**C-D+**	**D-F**
	24	25	5	0

Table 2. The mean average and standard deviation for each questionnaire item.

Statement	Mean	SD
1) I always arrive to the lesson on time.	3.28	1.05
2) I rarely or never miss class.	3.50	1.21
3) I only leave the class with the instructor's permission.	3.94	.88
4) I never play on my phone during the lesson.	2.72	.88
5) I never talk to my friends during the activities.	2.41	.84
6) I never disrupt the class for other learners by talking.	3.31	.89
7) I think the instructor can see students playing on their phone.	4.44	.72
8) I think the instructor can see students talking to their friends.	4.48	.67
9) I never copy my assignments.	3.81	.87
10) I tried to learn the writing skills.	3.87	.83
11) I tried to learn even when the activity was difficult.	3.98	.79
12) I think the instructor will check my work for copying.	4.30	.90
13) I will get a lower score if I copy.	4.35	.73
14) I will get an F if I copy.	4.31	1.05
15) I am responsible enough to study at university.	3.91	.76

Table 3. The differences in responses between the instructor's opinion and that of the students' in regard to behaviour and self-grading.

Level of Agreement	Number
Agreed	36
Partially Agreed	17
Disagreed	1

4. DISCUSSION AND CONCLUSION

The results of the study found that many students were talking with their friends and using the phone during class time even though they believed the instructor could see them. This mirrors other studies that have shown students to be distracted during lectures at university. This issue may continue unless harsher penalties are introduced. Point deductions may deter many students from talking and using their phone and thus distracting themselves and others during class. An overall ban on phones would seem harsh as they can be a valuable asset for learning in the classroom. During the essay writing class, students used their devices to search for data and information which was necessary to write essays. Although plagiarism does not appear to be a widespread issue among the students, nevertheless the problem exists. Although an anonymous survey, students may be less likely to reveal that they copy their assignments to a course instructor. All students have special needs and should be seen as individuals with individual issues and problems. These could be issues related to family or motivation or even addictions to technology. It is recommended that further research is conducted that employs a larger sample size.

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Using video technology to improve students' English presentation and verbal communication skills

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ABSTRACT

The English language has been adopted as a lingua franca in most countries across the globe. In Thailand, English language skills are vital for conducting business and for providing a quality service in the tourism industry. In addition to the English language, strong presentation and verbal communication skills and confident mannerisms are also required. Unfortunately, students are often shy and lack confidence when speaking and presenting in English. In the past, video technology has been used to help students recognize their own errors and those of their classmates. The following study therefore examined the use of video in enhancing students' verbal communication, presentation and English skills. English major students studying at a Thai university were required to record several videos which introduced themselves. The students were then required to share, review and discuss their own videos and those of their peers. Data was collected through a 5 point Likert scale questionnaire. Students were satisfied with the technology and found it to be useful and easy to use. The use of video technology appears to have benefits as a tool for self-review and peer feedback.

Keywords: English, peer feedback, self-correction, video technology

1. INTRODUCTION

The tourism industry and business sector are valuable to the Thai economy and offer employment for graduates. Both tourism and business require strong English skills. For instance, English language and communication skills are required by hotel staff and tour guides and for business interactions and presentations. English though is viewed as being difficult to learn by Thai students and the levels of language proficiency are often low. Low levels of English proficiency and poor presentation skills can restrict the tasks that new graduates can perform. This can leave them being employed in positions that do not require customer interaction. These positions are often low paid with little possible career progression (6). Interactions in the tourism industry and the business world require strong presentation and verbal communication skills. Students therefore not only need to practise English but they also need to improve their presentation and communication skills.

Cho and Teo (2014) examined Thai students' motivational orientations and attitudes towards the English language. The study used a questionnaire to collect opinions from 219 students in three cities in southern Thailand, namely Pattani, Yala, and Narathiwas. The questionnaire was used to examine students' motivations and attitudes towards learning English. The results from the questionnaire showed that students were generally motivated and had favourable attitudes towards English. English was recognized as being important for their future careers. The study though showed less favourable reactions to their English classes. These received the lowest scores. The results of the study suggest that students are motivated and interested in English but need more creative teaching methods in the classroom. Instructors could use teaching methods that encourage communication and allow the students the opportunity to make presentations. Technology

could also be used to enhance the learning process (2).

Research has shown that instructors are often influenced by the teaching methods that were used by their instructors when they were students. Over the years, instructors can become comfortable using a certain method of instruction. The instructor may have difficulty seeing the benefits of using a new approach or technology and may be unconvinced by the arguments for change. Studies though have shown that rejection of change can result in long term negative consequences for the instructor and students. The instructor should therefore be aware of new teaching methods and technology that can assist the learning process (5).

A lack of time and knowledge can prove to be barriers that restrict the adoption of technology in education. It therefore makes sense to choose technology that will be relatively easy to integrate into instruction. In this respect, technology that is familiar to all users will be easier to integrate than unfamiliar technology. This could include the use of a student's own technology such as a mobile device that contains tools such as video recording capabilities that can be used for learning purposes (1). Video could be used for peer review and feedback..

A study of higher education students in Turkey found various benefits for using peer to peer feedback activities. The results of the study showed that peer feedback had improved critical thinking skills and also improved the quality of the material produced by the students. The students could recognise the benefits of providing peer feedback and receiving peer feedback. The peer feedback process enabled students to reflect critically on the work that they were providing feedback for. In addition, this enabled them to use these skills in order to improve their own work in a similar manner. The process involved students thinking about quality and the manner in which work is evaluated. This can assist students in becoming critical thinkers and reflective learners (3).

In many cases, it has been found that little effort is made during active learning and cooperative learning based projects. Students often just go through the motions of producing work that is quite often low quality. The task of producing a video that will be viewed online by members of a class group can motivate students to produce their best quality work. Previous research in a higher education environment has found that learning effort and motivation is increased through social interaction and from the video report format (10).

The use of video technology can be used in order to allow students to give peer feedback to their classmates. A study of 60 English language students found positive results when using video clips and the peer feedback process. The videos produced in the study contained visual, verbal, and gestural elements. The study found that students generally valued video technology as a platform for feedback production and provision. The feedback process promoted group interaction and helped to foster personalized learning. In addition, the study showed that students cooperated with other group members in order to generate ideas for future improvement (7). The objective of this study is to examine students' perceptions of using video technology to enhance presentation and English language skills.

2. METHOD

A sample of 42, 2nd year English major students, were chosen to participate in the study. The students were chosen for convenience and because they possessed the characteristics required for the study. For example, English major students are likely to communicate with foreigners in their future careers. The data was collected through a 5 point Likert scale questionnaire that measured agreement. The questionnaire was based on a similar previous study and was seen as valid and reliable (9). As

an additional measure, the questionnaire statements were checked for validity by suitably qualified experts at a Thai public university. Reliability was checked through Cronbach's alpha. The statements were in both Thai and English to help ensure there was no language barrier. The questionnaire data was analysed using a one sample t-test. The data was measured against a perceived upper neutral value of 3.40. This has been taken from the following interpretation: 1.00-1.80=Strongly Disagree, 1.81-2.60=Disagree, 2.61-3.40=Neutral, 3.41-4.20=Agree and 4.21-5.00=Strongly Agree. This interpretation has been used successfully to analyse data in previous social science studies and gives meaning to the data. In this study, higher scores would be seen as a positive endorsement of the use of video technology (8). Students were required to record several videos introducing themselves. The students were then required to review and discuss their own and their peers' videos. Lists of errors were made and further videos were produced until the errors were reduced. Common errors were related to body language, gaps in speaking, pace when speaking, content, grammar tenses and pronunciation and clear speech.

3. RESULTS AND DISCUSSION

The questionnaire was checked for reliability and all Alphas were found to be above .60 which is seen as reliable for data collection (Table 1) (4).

Table 1. The results of the reliability test.

Variable	Alpha
1) Perceived Usefulness	.79
2) Ease of Use	.62
2) Satisfaction	.72

The results of the study found the use of video technology in the English language classroom to be generally well received by the students (see Table 2).

Table 2. The results of the questionnaire data analysis showing mean and standard deviation.

Variable	Mean	SD
1) Perceived Usefulness	4.06	.40
2) Ease of Use	4.08	.51
3) Satisfaction	3.89	.40

The data was further analysed to establish statistical significance above a neutral value of 3.4 (see Table 3). T-tests showed the data to be statistically significant for perceived usefulness (t=10.60, df=41, p=.00), perceived ease of use (t=8.72, df=41, p=.00), and satisfaction (t=7.94, df=41, p=.00).

Table 3. T-test analysis showing mean difference (M.D) and significance (Sig).

Variable	M.D	Sig.
1) Perceived Usefulness	.66	.00
2) Ease of Use	.68	.00
3) Satisfaction	.49	.00

The results from the data would suggest positive responses for all 3 variables tested in this study. These results generally agree with those found in previous studies by Demirbilek, 2015, Hung, 2016 and Pickford, 2013.

4. CONCLUSION

Overall, the participants in this study showed positive responses to the use of video technology in the English language classroom. Video technology is familiar to most users and is relatively easy to use. The technology is readily available as a function of the modern smartphone. Taking videos is part of many students' regular activities. Further studies are required to greater understand how video technology could assist students in their learning. Further data could be collected through in depth group interviews alongside the questionnaire survey data.

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Using coloured cards for formative assessment in the physics classroom

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ABSTRACT

During physics lessons, students often become confused and are not able to follow the content. A lack of understanding of the concepts being taught can cause students to fall behind, lose motivation and fail the course. It is the instructor's duty to check that their students have understood the lesson. Asking whether the students have understood is one method for gauging understanding. In many cases though, students will indicate that they have understood when in reality they are unclear on the content of the lesson and what they have to do in the activity or assignment. This study investigates students' perceptions and thoughts on using coloured cards as a form of formative assessment in the physics classroom. Data was collected from general education students studying a physics course at a Thai public university. Green, yellow and red cards were used to indicate different levels of understanding over the course of 1 semester. The results of the study suggest the use of coloured cards for formative assessment is beneficial for both instructor and students.

Keywords: coloured cards, physics, formative assessment

1. INTRODUCTION

During a physics lesson, students can often become confused and are then not able to follow the content. Confusion or lack of understanding of the concepts being taught can cause students to fall behind the rest of the class. This can then result in students losing motivation in the subject. There are various methods for checking understanding during a physics lesson. For example, the instructor could ask whether the students have understood or ask whether the concept is clear. Checking for understanding through asking may prove successful in certain contexts. Older adults or students studying in high level programs may be confident enough to request further explanation from the instructor. In many cases though, students may not want to admit that they have not understood. Students can also feel too embarrassed to ask the instructor to explain again. Other methods such as follow up checking questions have been shown to be useful as a means for gauging understanding. This approach though is more difficult in classes with large student numbers.

Furthermore, culture can play a part in whether students admit they do not understand. In a Thai context, students may lose face or become anxious when showing a lack of understanding in front of their peer group. The instructor may also be deemed to be at fault if students do not understand the content of the lesson. This can suggest a poor explanation by the instructor and thus a loss of face (3). It has been suggested that the use of red, yellow and green coloured cards or cups can assist the instructor in checking for understanding. For example, students can show red cards when they do not understand and yellow for partial understanding and green for full understanding. The cards may encourage the students to show they do not understand. This can help create a culture within the classroom where a lack of understanding is part of the learning process (1). Although this idea has been around for a number of years, there appears to be little research available on whether it works. The following paper examines students' perceptions of using coloured cards as a form of formative assessment to gauge understanding.

Across the world, science grades continue to fall. This scenario is in an era when scientific skills are key factors in the economic success of a nation. Mujtaba and Reiss (2014) suggest there are problems with student engagement in science and mathematics. Students generally see these subjects as being both difficult and uninteresting. These perceptions may be formed through past experiences linked to a lack of understanding. Instructor and peer support has been shown to help increase motivation and self-efficacy levels in science subjects (10).

Clough (2015) suggests that there is a failure within science to take seriously the research on how people learn. The author suggests that science is taught in a manner where scientific concepts are memorized and not understood. This results in negative attitudes towards the subject and misconceptions about what scientists actually do (4). It would appear that science education needs reforming to ensure enough graduates are produced to meet the demands of society.

In the current era, educational institutions face various challenges and issues. There is currently much focus placed on raising student achievement levels in order to prepare them for the workplace. In this regard, governments have devised various policy changes and reforms related to curriculum, technology, the manner of governance and or organization. In reality though, many of these changes have had little overall impact (15).

Financial investment in the professional development of instructors often makes little difference to student achievement levels. Furthermore, there are instructors that believe that their lessons do not need adapting. From an instructors view, it can be difficult to accept that a lesson did not work as planned and little understanding occurred. In the event of students receiving low scores or failing an exam it is easier to shift the blame on to the students. Such an approach though is not sustainable in the long term. This situation is not suitable for the students or the instructor. Failing students have negative consequences for a nation's economy. In regard to science subjects, failure can slow the development of a country due to a lack of innovation (5, 14).

Governments across the world recognise the importance of improving their educational establishments. A weak education system that produces a poorly trained workforce will suffer economically and socially. Instructors must therefore improve and develop their classroom practices. In the modern, ever changing world, improvement needs to occur quickly. Research has shown though that change in education is often slow. Instructors are well qualified and possess the ability to change their practices but need time to adapt. For example, high tech gadgets and various forms of software are often seen as a quick fix to repair a failing education system. Instructors are given technology but receive little or no additional support. This technology then has to be mastered and integrated successfully into a lesson. A lack of support and time to master and integrate the technology into a course often leads to disappointing learning outcomes. Therefore, new innovations should be introduced slowly and in small steps. A simpler approach to improving teaching practice may prove more effective than spending vast amounts of money on classroom technology (2, 14).

As part of the assessment for learning project, Wiliam, Lee, Harrison and Black (2004) proposed a number of simple instructional techniques. The "traffic light" or coloured cup system is an example of self-assessment and self-regulated learning. In the study, students in science and maths classes used red, yellow and green cups to show levels of understanding. This idea helped the instructor to quickly identify and respond to students' problems. In addition, the instructor could pair up those displaying green and yellow cups and allow the students to peer teach and thus clarify their own areas of

confusion. Students themselves can identify their own areas of weakness and thus can improve their own learning outcomes through self-assessment and the sharing of their difficulties and problems (1, 16).

Although, little data exists on the coloured card or cup method, anecdotal evidence suggests instructors and students are generally positive regarding its use in the classroom. The use of coloured cards to gauge for understanding has encouraged students to share their knowledge and assist their peers. The simple instructional approaches outlined by Black, Harrison, Lee, Marshall and Wiliam (2004) have helped to transform and improve the classroom environment. Instructors are given real-time feedback on the levels of understanding among the learners from the simple use of coloured cards or cups (11).

The coloured card or cup method could be adapted to suit different learning situations and various levels of students. For example, a coloured card system could be used as an indicator of students' confidence in their understanding and to show the ability for self-assessment. The instructor could also use their time more efficiently to help students that lack understanding of the concept being taught (9). This study aims to answer the following research question: What are students' perceptions and thoughts on using coloured cards as a form of formative assessment in the physics the classroom?

2. METHOD

The outlined method was based on previous studies. At the start of the course, students were given 3 cards and asked to write their names on them. The cards were green, yellow and red. The green card was used to show understanding, the yellow card to show partial understanding and the red card to show little or no understanding. At appropriate times during the lesson students were encouraged to show the coloured cards based on their levels of understanding. The instructor or fellow students would then clarify the point. During the activities, a green, yellow or red card was placed on the corner of the desk to show that students understood or needed assistance. This helped the instructor in recognising which students required extra help. The coloured cards were also used to verify a student's weekly attendance. Cards that were not collected could be used to confirm an absence (6, 13).

The participants of this research study were 64, general education students studying a physics course at a public university in Bangkok, Thailand. The students were of Thai nationality and mixed gender. Data was collected through a 5 point Likert scale questionnaire survey. Data were collected during semester 2 of the 2018 academic year.

Data analysis was carried out through descriptive statistics of the mean and standard deviation. Questionnaire data related to the usage of the coloured cards was measured against a defined scale of 1.00-1.80 = Strongly Disagree, 1.81-2.60 = Disagree, 2.61-3.40 = Neutral, 3.41-4.20 = Agree and 4.21-5.00 = Strongly Agree. This method has been previously used in various social science based studies to add comprehensibility and meaning to the data. The data analysis methods are standard and were chosen to ensure that the research could be easily replicated by others (7, 12). Reliability of the questionnaire was conducted using Cronbach's Alpha analysis. The alpha values were shown to be greater than .70, (Cronbach's Alpha=.74) which is considered reliable for final data collection (8). Further data was collected through informal interviews and discussions between the instructor and the participants.

3. RESULTS

The following table displays the results from the 5 point Likert scale questionnaire (see Table 1). The table shows the mean average and the standard deviation for students' responses to the given statements.

Table 1. The mean average and standard deviation for each questionnaire item.

Statement	Mean	SD
1) I feel anxious when asking the instructor questions during the lesson.	3.28	.86
2) I feel anxious asking questions in front of my fellow students.	3.30	.87
3) I do not like to admit that I do not understand the lesson.	3.22	1.06
4) I may lose face if I show that I do not understand.	3.08	.98
5) I pretend that I understand when I do not.	3.22	.92
6) The use of coloured cards makes it easier to show that you do not understand.	4.22	.74
7) It is easier to show the cards than to ask a question.	4.19	.79
8) I feel less anxious using the cards than asking a question.	4.11	.74
9) The use of coloured cards helped my understanding of the lesson.	3.91	.83
10) I would like to use the coloured cards again.	4.08	.90

The results were found to be in the neutral area (2.61-3.40) of the scale in relation to statements 1-5. The participants were in strong agreement (4.21-5.00) for statement 6 and in agreement (3.41-4.20) for statements 7-10. The results showed that the issue of asking questions and feeling anxious and losing face was not serious. The findings of the study showed the participants were generally positive towards the use of the coloured cards for showing understanding. The participants reported that generally they did not have a major issue asking for clarification from the instructor. Students reported that they often required time to formulate a question. It was also found that several students lacked basic science skills that were needed to follow the lessons. These students could not understand the lesson and therefore were unable to ask for clarification. Such students required further training and help in order to bring them up to a level needed for their current classes.

4. DISCUSSION AND CONCLUSION

In general students did not have an issue with reporting a lack of understanding related to the content of the lesson. A lack of basic science knowledge among some students prevented them from participating in lessons. The use of the coloured cards, gave the students that lacked basic science skills an opportunity to ask questions related to prior lessons. The instructor was then able to clarify some of the content in the current lessons by explaining content that had not been understood from previous classes. Overall, the coloured cards were a popular addition to the lessons and helped to highlight students' lack of previous knowledge and understanding of physics. The coloured cards also allowed the instructor more time to spend with students that were clearly struggling with the content. The results show that students are less concerned with losing face among their peers than previously thought. The study has shown students often require time to formulate questions and require an easier way to show a lack of understanding (1, 3).

Coloured cards can be used at any time during a lesson as an aid for checking understanding and to confirm student attendance. The cards can be used during long explanations in order to keep students engaged and interested. During activities the cards can help the instructor recognise struggling students.

The cards can also be useful at the beginning of a lesson to review and activate prior knowledge and at the end of the lesson to check understanding. In addition, there appears to be a lack of understanding when learning science subjects. In order to progress as a nation, Thailand must produce innovators and inventors. Further studies could focus on the use of coloured cards and compare the achievement levels of a control group and an experimental group.

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Oral presentation schedule

Room 1	(session 1)			
Chair : Dr.Krish Sa-nguanpuag Co - chair : Dr. chiabwoot ratanavilisagul				
20-Jun-19	**No.**	**PaperID**	**Title**	**Speaker**
14:00-14:15	1	TR52001-01-1-1	The influence of reasoning and writer's voice on the overall quality of argumentation	Chamnong Kaewpet
14:15-14:30	2	TR42002-06-1-1	Success Factors of Thailand E-Commerce	Nuth Otanasap
14:30-14:45	3	TR42004-06-1-1	Formal and Informal Learning and its Role in Developing Entrepreneurial Intention Among Students	H.M. Kamrul Hassan
14:45-15:00	4	TR12013-01-1-1	Simulation of Edge Effect in High Voltage Composite Insulators	Salakjit Nilboworn
15:00-15:15	5	TR12001-11-1-1	Modified Ant Colony Optimization with mutation and Reset Pheromone for Travelling Salesman Problem	chiabwoot ratanavilisagul
15:15-15:30	6	TR22002-07-1-1	Emotion Detection System for Student during Studying in the Laboratory using Kinect Sensor V2	Orasa Patsadu
15:30-15:45	Coffee Break			

Room 1	(session 2)			
Chair : Dr. Sutham Sivawut Co - chair : Dr. Panudet Sangsidum				
20-Jun-19				
15:45-16:00	7	TR12022-07-1-1	The Feasibility Study for Preventing the Formation of Fouling in The Heat Exchanger by Using Electric Charge Properties	Sarun Seubkrasair
16:00-16:15	8	TR12028-04-1-1	Heuristics for inventory routing problem in two-echelon distribution system	Warut Boonphakdee
16:15-16:30	9	TR12026-01-1-1	THE TIME DELAY OF DUAL PHASE LOCK LOOP FOR INDUCTION HEATING IN HIGH TEMPERATUREAPPLICATION	Phanom Tawdee
16:30-16:45	10	TR12021-04-1-1	An Efficient Influence Analysis for Main Economical crop yields in Central Area of Thailand Using Mathematical Models	Pitsanu Tongkhow
16:45-17:00	11	TR12008-04-1-1	An application Single Minute Exchange of Die technique to reduce setup time on water pipe extrusion machine	Noppadol Sriputtha
17:00-17:15	Poster section			

Room 2	(session 1)			
Chair :นายปริญญา ศรีสัตยกุล Co - chair : นายณรงค์ เฉลิมวัฒนชัย				
20-Jun-19	**No.**	**PaperID**	**Title**	**Speaker**
14:00-14:15	1	TR11014-03-1-1	การหาเนื้อที่ดินอย่างง่ายด้วยตนเอง	ณรงค์ เฉลิมวัฒนชัย
14:15-14:30	2	TR11031-03-1-1	ระบบสนับสนุนการตัดสินใจเพื่อเลือกแผนการซ่อมบำรุง และการปรับปรุงทางรถไฟ กรณีศึกษาทางรถไฟสายตะวันออกเฉียงเหนือ	ธวัชชัย ปัญญาคิด
14:30-14:45	3	TR11003-04-1-1	เครื่องกระเทาะเปลือกถั่วดาวอินคาเพื่ออุตสาหกรรมขุมขน	ดุสิต สิงห์พรหมมาศ
14:45-15:00	4	TR11019-04-1-1	พื้นผิวตอบสนองสำหรับปัจจัยที่ส่งผลต่อความเงาผิวในกระบวนการฉีดพลาสติกแบบควบคุมอุณหภูมิ	อดิเรก ชัยนวกุล
15:00-15:15	5	TR11030-04-1-1	การศึกษาตัวแปรการกลึงผิวเชื่อมพอกแข็งเหล็กกล้า JIS SS 400 ที่ส่งผลกระทบต่อการสึกหรอ ของเม็ดมีด	ทวี หมัดสะ
15:15-15:30	6	TR11034-04-1-1	การประยุกต์ใช้หลักการออกแบบและวิเคราะห์การทดลอง สำหรับพารามิเตอร์ที่เหมาะสมในกระบวนการฉีดพลาสติก	ปริญญา ศรีสัตยกุล
15:30-15:45	Coffee Break			

Room 2	(session 2)			
Chair : ผศ.ดร.สุวิมล พิชญไพบูลย์ Co - chair : ผศ.ปิติพร จูปราง				
20-Jun-19				
15:45-16:00	7	TR11007-11-1-1	แอปพลิเคชันตามหาผู้สูงอายุ	ปิติพร จูปราง
16:00-16:15	8	TR11015-11-1-1	การออกแบบระบบฐานความรู้จากเทคนิคการเรียนรู้ของเครื่องเพื่อพยากรณ์ผลผลิตและคุณภาพของอ้อย	นิตยา เกิดประสพ
16:15-16:30	9	TR11016-11-1-1	การสำรวจการประยุกต์การเรียนรู้ของเครื่องในงานวิเคราะห์ภาพทางการแพทย์	นิตยา เกิดประสพ
16:30-16:45	10	TR11023-11-1-1	การพัฒนาระบบจัดการคลังอะไหล่รถยนต์ กรณีศึกษาร้านเจี๋ยเฮงยนต์	หทัยวรรณ วิชัยดิษฐ
16:45-17:00	Poster section			
17:00-17:15				

Room 3	(session 1)			
Chair : ดร.เพชรา พิพัฒน์สันติกุล Co - chair : นายสุกิจ ชีรนรวนิชย์				
20-Jun-19	**No.**	**PaperID**	**Title**	**Speaker**
14:00-14:15	1	TR51003-01-1-1	การวิเคราะห์การนำรูปแบบเว็บเควสเชิงสมรรถนะไปสู่วิธีการสอนแบบเว็บเควสท์เชิงสมรรถนะตามบริบทของสภาพแวดล้อมที่มีแหล่งทรัพยากรแตกต่างกันด้วยกรอบแนวคิดทีแพค	วิสิฐ ตั้งสถิตกุล
14:15-14:30	2	TR51008-01-1-1	การใช้สื่อกิจกรรมโดยใช้ “เกมส์บิงโก” ในการจัดการเรียนการสอน รายวิชากลศาสตร์เครื่องกล ระดับประกาศนียบัตรวิชาชีพชั้นปีที่ 3 ภาคเรียนที่ 2/2561 แผนกช่างยนต์ วิทยาลัยเทคโนโลยีหมู่บ้านครู	เพชรา พิพัฒน์สันติกุล
14:30-14:45	3	TR51010-01-1-1	การพัฒนาสื่อการสอนเรื่อง ภาพฉาย ในรายวิชาเขียนแบบเทคนิคเบื้องต้น	เพชรา พิพัฒน์สันติกุล
14:45-15:00	4	TR51014-01-1-1	วิจัยในชั้นเรียน ชุดแบบฝึกการคำนวณเรื่องเครื่องเจาะและงานเจาะ สำหรับนักเรียนระดับ ปวช.1 แผนกช่างกลโรงงาน วิทยาลัยอาชีพกาญจนบุรี	สุกิจ ชีรนรวนิชย์
15:00-15:15	5	TR51009-01-1-1	การใช้โปรแกรมเขียนแบบภาพสามมิติช่วยในการเขียนแบบและการอ่านแบบ วิชาเขียนแบบเครื่องมือกล ระดับชั้น ปวช.2 สาขาช่างกลโรงงาน วิทยาลัยการอาชีพกาญจนบุรี	เพชรา พิพัฒน์สันติกุล
15:15-15:30	6	TR51006-01-1-1	การพัฒนาการใช้สื่อการเรียนการสอนโมเดล (MODEL) มีดกลึง	ดุสิต สิงห์พรหมมาศ
15:30-15:45	Coffee Break			

Room 3	(session 2)			
Chair : ดร.เพชรา พิพัฒน์สันติกุล Co - chair : ผศ.ดร.สายชล ชุดเจือจีน				
20-Jun-19				
15:45-16:00	7	TR51018-01-1-1	ข้อสังเกตเรื่องสถิติในงานวิจัยเกี่ยวกับธรรมาภิบาลของไทย	สุรพล ศรีบุญทรง
16:00-16:15	8	TR51007-01-1-1	การเปรียบเทียบผลสัมฤทธิ์ของผู้เรียน ก่อนเรียนและหลังเรียน วิชาวิชาเขียนแบบเทคนิคเบื้องต้น โดยใช้เทคนิคการสอนแบบ Jigsaw ตามหลักของ CIPPA MODEL	อัญชลี อินคำปา
16:15-16:30	9	TR51017-01-1-1	สื่อส่งเสริมการเรียนรู้ เรื่อง ภัยจากสื่อสังคมออนไลน์	รุ่งทิพย์ โคบาล
16:30-16:45	10	TR51004-01-1-1	การออกแบบโมเดลการบูรณาการการเรียนรู้ตามสภาพจริงผ่านโครงการบริการวิชาการ	อ้อมใจ บุษบง
16:45-17:00	Poster section			
17:00-17:15				

Room 4	(session 1)			
Chair : ผู้ช่วยศาสตราจารย์ ดร.กิตติพงษ์ โสภณธรรมภาณ Co - chair : ผศ.ดร.สายชล ชุดเจือจีน				
20-Jun-19	**No.**	**PaperID**	**Title**	**Speaker**
14:00-14:15	1	TR41001-01-1-1	การบริหารจัดการแบบแบ่งปันใช้น้ำมันไบโอดีเซลตามรอยพ่อเพื่อแก้ปัญหาราคาปาล์มน้ำมันของกลุ่มเกษตรกรผู้ปลูกปาล์มน้ำมันในภาคใต้	ชณทัต บุญรัตนกิตติภูมิ
14:15-14:30	2	TR41002-01-1-1	การวิเคราะห์องค์ประกอบเชิงยืนยันคุณภาพชีวิตของแรงงานต่างด้าวในประเทศไทย	เพ็ชราภรณ์ ชัชวาลชาญชนกิจ
14:30-14:45	3	TR41003-01-1-1	ปัจจัยจูงใจที่ส่งผลต่อประสิทธิภาพการปฏิบัติงานพนักงานบริษัท ไทยซัมมิทโกลด์เพรส จำกัด	เพ็ชราภรณ์ ชัชวาลชาญชนกิจ
14:45-15:00	4	TR41011-01-1-1	ภาวะผู้นำ 4.0 ในการบริหารงานยุคดิจิทัล	รุจิภาส ประชาทัย
15:00-15:15	5	TR41014-01-1-1	ปัจจัยที่มีอิทธิพลต่อการเลือกใช้สินค้าที่เป็นมิตรต่อสิ่งแวดล้อมของผู้บริโภคในจังหวัดพระนครศรีอยุธยา	ชนาถณัฏฐ์ ผลดี
15:15-15:30	6	TR42003-02-1-1	การศึกษาปัญหาของผู้ดำเนินการของธุรกิจส่งออกทุเรียนไปประเทศจีนที่มีผลต่อลักษณะบางประการของผู้ประกอบการ	Huang Yongxing
15:30-15:45	Coffee Break			

Room 4	(session 2)			Meeting mania 6th floor
Chair : ดร.มัลลิกา สุบงกฎ Co - chair : นาย สุริยา สงค์อินทร์				
20-Jun-19				
15:45-16:00	7	TR41005-04-1-1	การจัดการท่องเที่ยว OTOP นวัตวิถีเชื่อมโยงภูมิปัญญา วิถีชุมชน คนบ้านเสียบญวน อำเภอสวี จังหวัดชุมพร	ชณทัต บุญรัตนกิตติภูมิ
16:00-16:15	8	TR41010-04-1-1	การพัฒนาแอปพลิเคชันแชทบอทเพื่อส่งเสริมข้อมูลการท่องเที่ยวในพื้นที่จังหวัดชุมพร	มัลลิกา สุบงกฎ
16:15-16:30	9	TR41007-06-1-1	พฤติกรรมของผู้ซื้อสินค้าผ่านสื่อเฟซบุ๊คไลฟ์	สงกรานต์ จรรจลานิมิตร
16:30-16:45	10	TR31001-02-1-1	การออกแบบและผลิตอุปกรณ์ส่งเสริมสมรรถนะและอุปกรณ์นวดสำหรับผู้สูงอายุในเขตภาคกลาง	สุริยา สงค์อินทร์
16:45-17:00	Poster section			
17:00-17:15				

Room 1	(session 1)			
Chair : Dr. Sutham Sivawut Co - chair : Dr. Panudet Sangsidum				
21-Jun-62				
Time	No.	PaperID	Title	Author
08.30-08.45	1	TR12014-04-1-1	Evaluation on Aluminum Laminate Wall Under Fixed-Heat Input of DP-GMAW Base WAAM	Jukkapun Greebmalai
08.45-09.00	2	TR12017-04-1-1	Detection of Dynamic Physical Data for Welder Skill Evaluation in GTAW process	Veng Socheat
09.00-09.15	3	TR12018-04-1-1	Optimal Conditions for Controlling a CNC Turning Machine for Metal Turning Operation	Nattachai Pothi
09.15-09.30	4	TR12007-11-1-1	The Development of Website and Animation for Learning about Female Genital Cancer	NIKORN KANNIKAKLANG
09.30-09.45	5	TR12016-06-1-1	Synthesized and characterization of WO3-doped TiO2 thin films with visible light antibacterial activity	Phatcharee Phoempoon
10:00-10:15	Coffee break			

Room 1	(session 2)			
Chair : Prof. Dr. Kanchit Kamlangkla Co - chair : Asst. Prof. Dr. Prasert Phaochoo				
21-Jun-62				
10:15-10:30	7	TR22006-01-1-1	Optimization of free fatty acid reduction in coconut oil via sulfamic acid-catalyzed esterification	Piyanuch Nakpong
10.30-10.45	8	TR22001-01-1-1	Development of Spectrophotometric Method for Determination of Gabapentin in Pharmaceutical Formulations by Derivatization with Chromogenic Agent Cresol Red	Tapparath Leelasattarathkul
10:45-11:00	9	TR22005-01-1-1	Hybrid finite difference for solving differential equations	Prasert Phaochoo
11:00-11:15	10	TR22003-07-1-1	Effect of silver yarn on mechanical and antibacterial properties of polyester woven fabric	Sineeporn Chalermchutidaj
11:15-11:30	11	TR22004-07-1-1	Effect of some yarn types on tensile strength, tearing strength and air permeability of polyester woven fabrics for Uniform	Sakoltee Cheepchol

Room 2	(session 1)			
Chair : Mr.Komm Pechinthorn Co - chair : Dr.Pattarinee White				
21-Jun-19	No.	PaperID	Title	Author
08:30-08:45	1	TR52002-01-1-1	A study of Thai hospitality students' self-reported proficiency levels and attitudes towards English	Alan Robert White
08:45-09:00	2	TR52003-01-1-1	The use of social networking applications for learning hospitality related English vocabulary	Alan Robert White
09:00-09:15	3	TR52006-01-1-1	Using coloured cards for formative assessment in the physics classroom	Dr.Pattarinee White
09:15-09:30	4	TR52004-01-1-1	A study on student self-responsibility at a Thai public university	Alan Robert White
09:30-09:45	5	TR52005-01-1-1	Using video technology to improve students' English presentation and verbal communication skills	Alan Robert White
09:45-10:00	6	TR42001-05-1-1	Recent contentment of technological Grab taxi service against normal taxi service: the case study from the new generation university students in Bangkok	Komm Pechinthorn
10:00-10:15	Coffee break			

Room 2	(session 2)			
Chair : ผู้ช่วยศาสตราจารย์ ดร. กิตติพงษ์ โสภณธรรมภาณ Co - chair : ดร.ปรมินทร์ โฆษิตกุลพร				
21-Jun-62				
10:15-10:30	7	TR51016-01-1-1	แนวทางการใช้กรอบอ้างอิงความสามารถทางภาษาอังกฤษ (CEFR) สำหรับระดับอุดมศึกษา	วิภาดา สุทธิโรจน์
10.30-10.45	8	TR51012-01-1-1	การพัฒนาเว็บไซต์ระบบประเมินผลนักศึกษาฝึกประสบการณ์วิชาชีพครูในสถานศึกษา คณะครุศาสตร์ มหาวิทยาลัยราชภัฏนครศรีธรรมราช	อาทิตย์ อรุณศิวกุล
10:45-11:00	9	TR51005-03-1-1	การบริหารจัดการด้านคุณธรรมและความโปร่งใสในการดำเนินงานของหน่วยงานภาครัฐ กรณีศึกษาองค์การบริหารส่วนตำบลทรัพย์อนันต์ อำเภอท่าแซะ จังหวัดชุมพร	ชณทัต บุญรัตนกิตติภูมิ
11:00-11:15	10	TR51013-03-1-1	การวิเคราะห์เนื้อหาประเภทนโยบายสาธารณะของพรรคการเมืองตามแนวคิดของชอว์น กริมสเลย์ : ศึกษากรณีการเลือกตั้งทั่วไป 24 มีนาคม 2562	ไพบูลย์ โพธิ์หวังประสิทธิ์
11:15-11:30	11	TR51015-01-1-1	การพัฒนาสื่อส่งเสริมการเรียนรู้ภาษาอังกฤษ สำหรับนักเรียนชั้นประถมศึกษาปีที่ 2 กรณีศึกษาโรงเรียนบูรณะศึกษา	วาสนา ด้วงเหมือน
11:30-11:45	12	TR51002-03-1-1	การศึกษาพฤติกรรมความมีวินัยในตนเอง เพื่อส่งเสริมการฝึกปฏิบัติงานของนักศึกษา ตามความต้องการของสถานประกอบการ	ดิเรก กาญจนรูจี
11.45-12.00	13	TR21014-01-1-1	ระบบสารสนเทศเพื่อการประเมินผลการปฏิบัติงานของบุคลากรสายวิชาการคณะวิทยาศาสตร์และเทคโนโลยี มหาวิทยาลัยเทคโนโลยีราชมงคลกรุงเทพ	มนรดา ศิริมงคล

Room 3	(session 1)			
Chair : ผศ.ชูศักย์ กมลขันติธร Co - chair : นายวินัย เมธาวิทิต				
21-Jun-19	**No.**	**PaperID**	**Title**	**Author**
08:30-08:45	1	TR11002-07-1-1	เครื่องบำบัดน้ำเสียอัตโนมัติ Automatic Wastewater Treatment Machine	สุรเทพ แป้นเกิด
08:45-09:00	2	TR11033-01-1-1	การศึกษาและเปรียบเทียบเทคนิคการเรียนรู้ด้วยเครื่องในการตำแหน่งสำหรับระบบอัตโนมัติโดยใช้สัญญาณวายฟาย	ชัชชล เปรมชัยสวัสดิ์
09:00-09:15	3	TR12010-01-1-1	ตัวเก็บประจุแรงสูงกระแสตรงในน้ำมันละหุ่ง	วินัย เมธาวิทิต
09:15-09:30	4	TR11020-01-1-1	การออกแบบและพัฒนาวงจรแปลงผันกำลังไฟฟ้าสำหรับปรับเปลี่ยนความสว่างของหลอดแอลอีดีชนิด T8	ปรินทร สีนวนสกุลณี
09:30-09:45	5	TR11021-01-1-1	การปรับปรุงค่าตัวประกอบกำลังของสัญญาณไฟจราจร	พงษ์พัฒน์ บัวมณี
09:45-10:00	6	TR11017-01-1-1	ระบบตรวจวัดปริมาณก๊าซชีวภาพจากขยะอินทรีย์แบบไร้สายโดยใช้โหนดเอ็มซียู	สลักจิตร นิลบวร
10:00-10:15	Coffee break			

Room 3	(session 2)			
Chair : ดร.กฤษณ์ สงวนพวก Co - chair : ผู้ช่วยศาสตราจารย์ อลงกรณ์ อยู่สำราญ				
21-Jun-62				
10:15-10:30	7	TR11008-04-1-1	การลดของเสียจากกระบวนการผลิตผ้าถักตามแนวเส้นด้ายยืน (ราเชล) กรณีศึกษา: บริษัท ปัญจรีย์ จำกัด	ปัญจรีย์ จุลไกรอานิสงส์
10.30-10.45	8	TR11012-12-1-1	ศึกษาการเพิ่มประสิทธิภาพการทอผ้าโดยลดอัตราเครื่องหยุดอันเนื่องมาจากสาเหตุเส้นด้ายพุ่ง	นภาพร เลิศสถิตย์พงษ์
10:45-11:00	9	TR21001-07-1-1	การปั่นเส้นด้ายไหมใยสั้นแบบลูกถ้วยจากเศษไหมที่เกิดจากกระบวนการสาวไหม Spun silk yarn produced on rotor spinning from silk waste in reeling process	ณัฐวัชร นิธิทองสกุล
11:00-11:15	10	TR21004-04-1-1	การศึกษาสมบัติของวัสดุคอมพอสิตที่เตรียมจากเศษผ้าเหลือทิ้ง	นิศาชล เกตุสุวรรณ
11:15-11:30	11	TR21002-04-1-1	การศึกษาสมบัติของวัสดุคอมพอสิตใยมะพร้าวเคลือบน้ำยางพารา	ธัญลักษณ์ ศรีสุข
11:30-11:45	12	TR21008-01-1-1	การเปรียบเทียบเทคนิคการสกัดสารออกฤทธิ์ทางชีวภาพจากใบขลู่เพื่อใช้ยับยั้งการเจริญเติบโตของแบคทีเรีย	อลงกรณ์ อยู่สำราญ
11:45-12:00	13	TR21007-04-1-1	การพัฒนาผลิตภัณฑ์กระเจี๊ยบแผ่นปรุงรสเสริมซังขนุน	ดวงทิพย์ ไข่แก้ว

Room 4	(session 1)			
Chair : ผู้ช่วยศาสตราจารย์ วุฒิชัย สง่างาม Co - chair : ผู้ช่วยศาสตราจารย์ ภูริวัตร คัมภีรภาพพัฒน์				
21-Jun-19	**No.**	**PaperID**	**Title**	**Author**
08:30-08:45	1	TR11018-12-1-1	การศึกษาและออกแบบ ระบบแสดงข้อมูลเวลานับถอยหลังไฟสัญญาณจราจรบนโทรศัพท์เคลื่อนที่ตามเวลาจริง กรณีศึกษา : ทางแยกถนนมหายศตัดกับถนนวรวิชัย ชุมชนมหาโพธิ์ อำเภอเมือง จังหวัดน่าน	ชาญยุทธ์ กาญจนพิบูลย์
08:45-09:00	2	TR11024-10-1-1	การพัฒนาระบบขับเคลื่อนมอเตอร์เหนี่ยวนำสามเฟสที่มีวงจรปรับปรุงตัวประกอบกำลังไฟฟ้าสำหรับเครื่องจักรรีดยางไฟฟ้า	อนุชิต อุไรรัตน์
09:00-09:15	3	TR11035-1-1-1	ชุดควบคุมเครื่องปรับอากาศด้วยคลื่นอินฟาเรดผ่านอินเตอร์เน็ต	วุฒิชัย สง่างาม
09:15-09:30	4	TR21006-01-1-1	โปรแกรมเทคนิคการวิเคราะห์คำที่ไม่มีอยู่ในดัชนีของการจัดหมวดหมู่บนระบบมาตรฐานทศนิยมดิวอี้	ภูริวัตร คัมภีรภาพพัฒน์
09:30-09:45	5	TR21005-01-1-1	การพัฒนาระบบสารสนเทศเพื่อบริหารจัดการมะม่วงส่งออกต่างประเทศ ด้วยคิวอาร์โค้ด กรณีศึกษากลุ่มมะม่วงบ้านท่าทอง จ.สุพรรณบุรี	ศรีสุดา สรนันต์ศรี
09:45-10:00	6	TR51021-03-1-1	การศึกษาเจตคติของนักศึกษาระดับปริญญาตรี มหาวิทยาลัยเทคโนโลยีราชมงคลกรุงเทพที่มีต่อวิชาทฤษฎี และวิชาปฏิบัต	อรทัย เจริญสิทธิ์
10:00-10:15	Coffee break			

Room 4	(session 2)			
Chair : นางนนทลี บุญทัด การุณยศิริ Co - chair : ดร.อรทัย เจริญสิทธิ์				
21-Jun-62				
10:15-10:30	7	TR52009-01-1-1	เปลี่ยนทัศนคติผู้บริโภคที่เป็นลบ ด้วยโซเชียลมีเดีย เพื่อนำไปสู่ทัศนคติที่เป็นบวก	PHINYO UDOMPHOCH
10.30-10.45	8	TR51022-03-1-1	การศึกษาทัศนคติของนักศึกษาชั้นปีที่ 1 มหาวิทยาลัยเทคโนโลยีราชมงคลกรุงเทพที่มีต่อกิจกรรมรับน้องเชิงสร้างสรรค	อรทัย เจริญสิทธิ์
10:45-11:00	9	TR51020-03-1-1	การศึกษาความภาคภูมิใจต่อสถาบันของนักศึกษามหาวิทยาลัยเทคโนโลยีราชมงคลกรุงเทพ	อรทัย เจริญสิทธิ์
11:00-11:15	10	TR41006-02-1-1	ปัจจัยในการตัดสินใจเลือกใช้บริการธุรกิจสื่อภาพยนตร์แบบสตรีมมิ่งบนสมาร์ทโฟนของผู้บริโภค	อรอนงค์ สรรเสริญ
11:15-11:30	11	TR41009-02-1-1	4 ปัจจัยที่ส่งผลกระทบต่อการเลือกบริโภคขนมหวานที่สืบทอดมาจากสมัยกรุงศรีอยุธยา	นนทลี บุญทัด การุณยศิริ
11:30-11:45	12	TR41008-02-1-1	พฤติกรรมและผลกระทบที่มีต่อผู้เล่นเกมส์ออนไลน์ ในเขตกรุงเทพมหานคร	ตติยา องค์ศิริพร
11:45-12:00	13	TR41012-03-1-1	ผลกระทบต่อกิจการก่อสร้างและพัฒนาอสังหาริมทรัพย์ จากการปฏิบัติตามมาตรฐานเรื่องรายได้ฉบับใหม่: กรณีศึกษา บริษัทจดทะเบียนในตลาดหลักทรัพย์ ประเทศสิงคโปร์	ธเรศ สันตติวงศ์ไชย

Poster presentation schedule

Poster 20-June-19			
16.45-17.15			
No.	Paper ID	Title	Author
1	TR12023-01-1-1	A STUDY OF OUTPUT VOLTAGE HARMONIC DECREASING OF GRID TIE CONNECTED INVERTER FOR SOLAR ENERGY SYSTEM USING LLCL FILTER	Jirapong Jittakort
2	TR12024-01-1-1	LOW Q SERIES RESONANT INVERTER FOR COOKING APPLICATIONS	Jirapong Jittakort
3	TR12025-01-1-1	TWO OUTPUT COILS DESIGN OF AN INDUCTION COOKER	Jirapong Jittakort
4	TR12019-01-1-1	The Half Bridge Inverter using Asymmetrical Duty Cycle Control for Battery charger	Jirapong Jittakort
5	TR12027-01-1-1	CURRENT SOURCE RESONANT INVERTER FOR INDUCTION HEATING APPLICATIONS	Jirapong Jittakort
6	TR12011-02-1-1	Demonstration system for power braking using wind pressure.	Rattapol Phosri
7	TR12012-02-1-1	Energy Consumption of Deep Cycle Lead-Acid Battery and Lithium Battery for Electric Vehicle 2kW	Jackkapan Meearsa
8	TR11022-01-1-1	การวิเคราะห์การไหลของกำลังไฟฟ้าด้วยการต่อระบบกริด	วีระพงศ์ วงศ์ใหญ่
9	TR11026-01-1-1	มุมเฟสและแรงดันตกระหว่างด้านส่งและด้านรับ	ภารดร เตชะสกลรัศมิ์

Poster 20-June-19			
16.45-17.15			
No.	Paper ID	Title	Author
10	TR11027-01-1-1	ข่ายวงจรสายส่งและหม้อแปลงปรับแต่งแรงดันไฟฟ้า	ภารดร เตชะสกลรัศมิ์
11	TR11029-02-1-1	การศึกษาประสิทธิภาพของเตาชีวมวลขนาดเล็ก	ชนิดา ป้อมเสน
12	TR11004-02-1-1	การออกแบบและพัฒนาเครื่องย่อยกิ่งไม้	สุรชัย เหมหิรัญ
13	TR11010-02-1-1	การวัดการสั่นสะเทือนเชิงกลโดยใช้ตัวรับรู้แบบระบบไฟฟ้าเครื่องกลจุลภาค	สิริพงศ์ เอี่ยมชัยมงคล
14	TR21010-02-1-1	สมบัติการต้านปฏิกิริยาออกซิเดชันของสารสกัดจากเปลือกกล้วย บรรจุแคปซูล	รุ่งทิวา วงค์ไพศาลฤทธิ์
15	TR21011-02-1-2	การศึกษาปริมาณอัตราส่วนของแป้งชนิดต่างๆ เพื่อใช้เป็น ผลิตภัณฑ์แป้งอเนกประสงค์ขนมไทย	รุ่งทิวา วงค์ไพศาลฤทธิ์
16	TR21012-02-1-3	การศึกษากระบวนการผลิตลูกชุบในระดับอุตสาหกรรม	รุ่งทิวา วงค์ไพศาลฤทธิ์
17	TR21009-04-1-1	การพัฒนาผลิตภัณฑ์ขนมขบเคี้ยวสำหรับเด็กด้วยกระบวนการเอกซ์ทรูชั่น	รุ่งทิวา วงค์ไพศาลฤทธิ์
18	TR21013-06-1-1	การยืดอายุการเก็บรักษามังคุดตัดแต่งพร้อมบริโภค	กฤษณ์ สงวนพวก
19	TR51023-01-1-1	การพัฒนาวิธีการต่อผ้าบนกระเป๋าถือ	กฤษณ์ สงวนพวก
20	TR11018-12-1-1	การศึกษาและออกแบบ ระบบแสดงข้อมูลเวลานับถอยหลังไฟสัญญาณจราจรบนโทรศัพท์เคลื่อนที่ตามเวลาจริง กรณีศึกษา : ทางแยกถนนมหายศตัดกับถนนวรวิชัย ชุมชนมหาโพธิ์ อำเภอเมือง จังหวัดน่าน	ชาญยุทธ์ กาญจนพิบูลย์

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