# PREFACE

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# TRAFFIC SIGN RECOGNITION

**Nguyen Dinh Cong, Pham Van Trung, Pham Do Tuong Linh**

**Abstract:** The paper is targeted to apply state-of-the-art algorithms to solve the problem of Traffic Sign Recognition. In doing so, the first solution is detect possible locations of traffic signs from input images. Then, the data used is to be classified, so that two main stages will be focused on, which are feature extraction and classification. This paper aims to implement Histogram of Oriented Gradients (HOG) feature extraction and Support Vector Machine (SVM) classifier using OpenCV library. After that, the optimal parameters will be chosen from the experiment results with 93.7% accuracy in the best case in cooperation 73.26% accuracy in the worst case.

**Keywords:** HOG Feature, traffic sign, SVM technique

## 1. Introduction

In traffic environment, there are many types of traffic signs such as warning, regularization, command or prohibition. The role of a sign recognition system is to support and disburden the driver, and thus, increasing driving safety and comfort. Recognition of traffic signs is a challenging problem that has engaged the attention of computer vision community for more than 30 years. The first study of automated traffic sign recognition was reported in [4]. Since then, many methods have been developed for traffic sign detection and identification to improve the accuracy of the problem for detecting and recognizing traffic signs. There are many difficulties, for example, weather and lighting conditions vary significantly in traffic environments; the sign installation and surface material can physically change over time, influenced by accidents and weather, etc.

Recently, computing power increases that have brought computer vision to consumer grade applications, both image processing and machine learning algorithms are continuously refined to improve on this task. The availability of benchmarks for this problem, notably, German Traffic Sign Recognition Benchmark [1], gives us a clear view on state-of-the-art

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approaches to this problem. In general, they have good performance but there are still challenging problems.

All the experiments in this work were done by using the benchmark dataset [1]. The dataset was created from 10 hours of video that were recorded while driving in different road types in Germany during daytime. The selection procedure reduced the number of images about 50000 images of 43 classes. The images are not necessary the same size; as mentioned above, they have been through the detection process. The main split separates the data into the full training set and the test set. Class orders the training set. In contrast, the test set does not contain image's temporal information.

## 2. Feature Extraction

In this section, one of the most popular feature extraction algorithms will be presented. Once the features of data are computed, they will fed to a classifier to process the data.

### *HOG Feature*

Histogram of Oriented Gradients (HOG) is feature descriptors used for the purpose of object detection and recognition. It was first described by Navneet Dalal and Bill Triggs in 2005 [2], has outperformed existing feature set for human detection. The idea of HOG is that local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. The HOG descriptors of an image can be obtained by dividing the image into small spatial regions, called cells, and for each cell accumulating a local 1-D histogram of gradient directions or edge orientations for the pixels within the cell [2]. The combination of the histograms represents the descriptor. The local histograms can be contrast-normalized by calculating the intensity over larger regions, called blocks, and using the results to normalize all the cells in the block, for better invariance to illumination, shadowing. Below are the steps implemented by the authors in their research in human detection [5]:
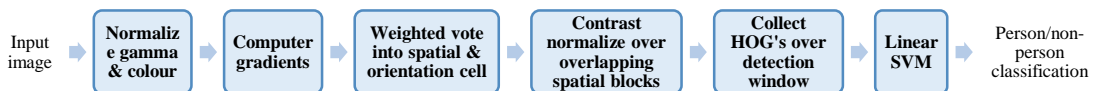


**Figure 1. Feature extraction and object detection chain**

## 3. Classification

In this section, Support Vector Machine technique would be shown to tag the label on the chosen image.

### *3.1. SVM Classifier*

Support Vector Machine (SVM) was first introduced by Boser, Guyon, Vapnik in COLT-92 [3], has been widely used in many applications such as object detection and

recognition. SVM solves classification and regression problems based on the idea of decision planes that define decision boundaries. Decision planes separate objects in different classes with different features. It has outperformed many well-known classification algorithms.

### 3.2. SVM in Pattern Recognition

We need to learn the mapping: $X \rightarrow Y$ where $x \in X$ is some object and $y \in Y$ is the class label. In the case of two classes, $x \in R^n$ and $y \in \{-1,1\}$, suppose that we have "m/2" images of "stop" sign and "m/2" images of "do not enter" sign (see figure 2), each image is digitized into "n*n" pixel image. Now, we are given a different photo, therefore, we need to identify whether the photo is "stop" sign or "do not enter" sign.
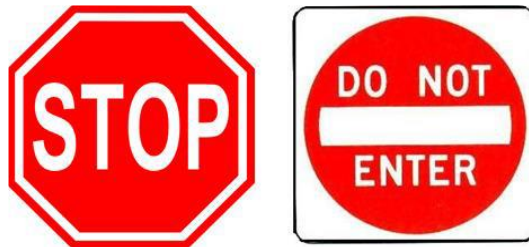
**Figure 2. "Stop" sign and "Do not enter" sign**

To do so, there are many feature extraction algorithms which can be applied to extract features to the training data. One of those is to read all the pixels of each sample image into each sample vector of training data (see figure 3).
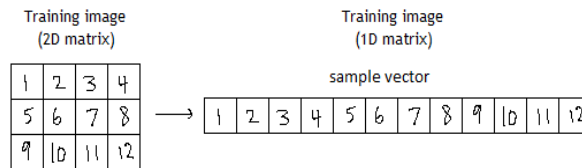
**Figure 3. Reading pixel into 1D data**

Now the obtained training set is: $(x_1, y_1)...(x_m, y_m)$. And, decision function model $X \rightarrow Y$: $f(x) = w.x + b$. In linear separable case, we need to optimize $\min_{m,b}$ honoring $y_i (w.x_i + b)$, $\forall i \in [0, m]$.

### 4. Evaluation and Discussion

### 4.1. Parameter Setting

We use HOG feature of OpenCV with C++, the parameter is unchanged window size = 32*32, block size = 2*2 cells; cell size = 4*4 pixels; block stride (overlap) = 4*4 pixel;

We use the SVM train function of OpenCV with C++, the parameters are changed in order to study the impact of each parameter to the performance of this project.

Specifically, the parameters are set in this project as follows:

- Kernel type: POLY, RBF, LINEAR, SIGMOID.
- Gamma: parameter of POLY, RBF and SIGMOID.
- Degree: parameter of POLY kernel.
- Term criteria iteration for LINEAR kernel.

### 4.2. Traffic Sign Dataset

In this paper, we evaluate traffic sign classification on the German Traffic Sign Recognition Benchmark (GTSRB), and German Traffic Sign Dataset (GTSD) [6]. There are 43 classes in GTSD. The images are PPM images, named based on the track number and the running number within the track. Figrure 4 provides some random representatives of the 43 traffic sign images in GTSRB.



**Figure 4. Representatives of traffic sign classes in dataset**

The training set is divided into two subsets training set and test set. The idea of this algorithm is to evaluate the performance of the system with various set of parameters, and then to select the most optimal set of parameters according to the accuracy we obtain.

### 4.3. Experimental Evaluation

#### a. F1-score metric

To calculate the accuracy of the experiment, we use F1-score metric, it is implemented in this study thanks to F1-score function in sicker-learn [7]. Suppose we have to test a number of images, we are to predict if the images are in class "positive" or not. After the system returns the labels, for each class, we have:

TN/True Negative: image is not in the class, and predicted to be in another class.

TP/True Positive: image is in the class, and predicted to be in the class

FN/False Negative: image is actually in the class, but predicted to be in others

FP/False Positive: image is not in the class, but predicted to be in the class.

Precision:              $\text{Precision} = \frac{TP}{TP+FP}$

Recall:              $\text{Recall} = \frac{TP}{TP+FN}$

F-measure: the weighted harmonic mean of precision and recall.

$$F = 2 \text{ x } \frac{precision * recall}{p\,recision + recall}$$

However, there are more than two classes in our test set; the measure should account the order of the images. In this case, we can use average precision

$$AP = \sum_1^n \frac{p(n) * cor(n)}{N}$$

Where $cor(n) = 1$ when the $n^{th}$ image is relevant, 0 otherwise and $p(n)$ is the precision at position n.

*b. Obtained results and evaluation*

We compare the impacts of each parameter on the performance by evaluating this accuracy of each experiment.

The impacts of gamma and degree on POLY kernel.

To see how gamma and degree affect the performance of this study, we apply a number of different pairs of gamma and degree. The range of gamma is from 0.01 to 2, while degree is in {1,2,3,4}. Table 1 presents the results of using gamma and degree parameters:

**Table 1. Accuracy on POLY kernel**

| Degree / Gamma | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 0.01 | 81.9% | 86.42% | | |
| 0.05 | 93.26% | 93.62% | 93.69% | 93.25% |
| 0.1 | 93.53% | 93.7% | 93.69% | 93.25% |
| 0.2 | 93.47% | 93.7% | 93.69% | 93.25% |
| 0.3 | 93.48% | 93.7% | 93.69% | 93.25% |
| 0.5 | 73.26% | 93.62% | 93.69% | 93.25% |
| 1 | 93.39% | 93.62% | 93.69% | 93.25% |
| 2 | 93.39% | 93.62% | 93.69% | 93.25% |

Results from *Table 1* show that the value of gamma does not affect the accuracy for a degree of 4 as well as 3, as the accuracy remains constant (93.25%) when degree = 4, and for all gamma values (0.01 - 2). However, some noticeable changes occur in accuracy for degree values of 1 and 2. Further analysis on the result suggests the following:

- Best-case accuracy (93.7%) occurs when degree is 2, and gamma = 0.01 through 0.3.
- Worst-case accuracy (73.26%) occurs when degree is 1, gamma value is 0.5.
- The time consuming of training varies from 2 - 4 minutes.
- The impact of gamma on RBF kernel.

**Table 2. Accuracy of RBF kernel**

| Gamma | 0.01 | 0.02 | 0.05 | 0.1 | 0.2 | 0.3 | 0.4 |
|---|---|---|---|---|---|---|---|
| Accuracy (%) | 91.28 | 92.77 | 92.36 | 90.5 | 73.25 | 45.09 | 27.76 |

*Table 2* shows the impact of gamma on RBF kernel. The result demonstrates that an inverse relationship exists between accuracy and gamma (i.e. the smaller the gamma, the higher the accuracy). In addition, the larger the gamma, the larger the time it takes to train. So, it could take approximately 4 to 10 minutes to train larger gamma values. The best-case accuracy occurred for the smallest gamma value, while the worst-case accuracy occurred for the max gamma value of 0.4.

The impact of Termcriteria iteration on LINEAR kernel.

**Table 3. Accuracy of Linear kernel**

| Term crititeration | Default | 10 | 50 | 100 | 150 | 200 | 300 | 1000 |
|---|---|---|---|---|---|---|---|---|
| Accuracy (%) | 93.4 | 80.88 | 91.46 | 93.79 | 93.55 | 93.47 | 93.47 | 93.4 |

The impact of Termcriteria iteration on LINEAR kernel is shown in the *Table 3*. Analysis shows that the best-case accuracy occurred when termcrit iteration equals 100, while the worst-case accuracy occurred when termcrit iteration equals 10. No change is accuracy which is observed for termcrit iteration 200 and 300.

The impact of gamma on SIGMOID kernel

**Table 4. Accuracy of Sigmoid kernel**

| Gamma | 0.01 | 0.02 | 1 |
|---|---|---|---|
| Accuracy (%) | 0.79 | 0.78 | 10.7 |

*Table 4* shows the impact of gamma on SIGMOID kernel. Compared with accuracy obtained from other experiments, this gives very low accuracy (max 10.7%) and takes long time to train.

### 4.4. Comparative Results

**Table 5. Best and worst-case accuracy**

| Kernel | Best case accuracy (%) | Worst case accuracy (%) |
|---|---|---|
| POLY | 93.7 | 73.26 |
| RBF | 91.28 | 27.76 |
| SIGMOD | 10.7 | 0.79 |
| LINEAR | 93.79 | 80.88 |

*Table 5* shows the best and worst case accuracy for the kernels. The result shows that the best-case accuracy decreased by 0.09%, 2.51%, and 83.09% for POLY, RBF, and SIGMOID kernel respectively when compared to linear kernel. Thus, linear kernel gives the overall best-case accuracy. The worst-case accuracy increased by 72.47%, 26.97%, and 80.09% for POLY, RBF, and linear kernel respectively when compared to that of SIGMOID kernel. Thus, SIGMOID kernel gives the overall worst-case accuracy.

## 5. Conclusion and future work

Traffic Sign Recognition is a challenging work. However, good benchmarks for traffic sign recognition have been provided, many algorithms can be applied. The method in this paper is to apply HOG feature extraction and SVM classification seems to give good result with accuracy approximately 93%. However, the time consuming is quite much when each training costs several minutes due to the complexity of SVM. For future works, we claim to have more convincing conclusion as well as more experiments using other datasets. There still exist many limitations such as the project is still console based. Thus, a good GUI needs to be carried out. As mentioned above, the main aim of this work is to apply and compare many machine learning techniques, different learning algorithms should be used in further work.

## References

[1]    J. Stallkamp, M. Schlipsing, J. Salmen, and C. Igel (2011), *"The German Traffic Sign Recognition Benchmark: A multi-class classification com-petition"*, In International Joint Conference on Neural Networks.

[2]    N. Dalal and B. Triggs (2005), *"Histograms of oriented gradients for human detection"* IEEE Conference on Computer Vision and Pattern Recognition, vol. 1, pp. 886 - 893.

[3]    Support Vector Machine.
       http://docs.opencv.org/modules/ml/doc/support_vector_machines.html

[4]    Paclik, P.: Road sign recognition survey. Online,
       http://euler.fd.cvut.cz/research/rs2/files/ skoda- rs- survey.html

[5]    J. Stallkamp, M. Schlipsing, J. Salmen, and C. Igel (2012), *"Man vs. computer: Benchmarking machine learning algorithms for traffic sign recognition"* Neural Networks, no. 0, pp.

[6]    S. Houben, J. Stallkamp, J. Salmen, M. Schlipsing, and C. Igel (2013), *"Detection of traffic signs in real-world images: The German Traffic Sign Detection Benchmark"* in International Joint   Conference on Neural Networks (submitted).

[7]    Scikit -learn. http://scikit-learn.org/stable/.

# AN EFFICIENT ALGORITHM FOR QUALITY OF SERVICE ASSESSMENT

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**Abstract:** In environmental monitoring systems, services are developed both in sensors and the server (base station) to provide interfaces where users can interact to systems to retrieve required information. Because of network's resource limitation, some services may not keep their quality level stable over long period which could lead to the violation of quality of service agreements. In order to keep quality level stable, risk factors must be realized and monitored as soon as possible. Based on information retrieved through the monitoring process, an algorithm is built for estimating the quality of services. In this paper, we introduce how this algorithm is built and how it is applied to estimate the quality of internet services.

**Keywords:** Algorithm, internet services

## 1. Introduction

In environmental assessment systems where sensors are used to retrieve noise and air pollution data, QoS level management becomes significant. There are efforts of developers to provide sensed data to users. Internet services are considered as a means of sensed data distribution to interested users. However, due to resource limitation of sensor networks, developed services' quality changes during execution time which leads to the violation of quality of service agreements.

To deal with the drawbacks described above, firstly, it is necessary to recognize that potential failures may happen in the system during runtime. From the aforementioned failures, several factors, which may impact on the performance of the system, are defined. Then, QoS parameters have been added to the system to indicate the performance of the services. In our work, we focus on two importance QoS parameters: speed of the system's response (to user

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requests) and reliability of delivered data. Finally, the QoS level of a service must be estimated before a service invocation to help selecting the most appropriate one [1].

We propose a Naive Bayesian algorithm for estimating QoS values of services in sensor networks deployed for environmental assessment. This algorithm uses as input measurable service parameters - for example service availability and service response time - that can be regularly monitored. The proposed algorithm must be able to reliably estimate in near real-time QoS levels to avoid the degraded performance of the composed service. The constraint on near real-time estimation can be met with an algorithm based on a Naive Bayesian classifier which is known for its ease of implementation, good performance, and good accuracy [2].

## 2. Service profiling

Considering the QoS agreement between service providers and service consumers, quality of Web services can be represented by a six dimensional model which includes expected value, agreed value, delivered value, perceived value, transmitted value, and statistic value [3]. The key point of this approach is to use agents, which capture the data on the service performance at both client-side and provider-side in order to evaluate the QoS agreement.

As presented in [4], the authors used machine learning techniques such as Bayesian Classifiers and Decision Trees to assign the quality of marine sensor data to discrete quality flags that indicate the level of uncertainty associated with a sensor reading. To do that, the authors built multiple classifiers and multiple training sets corresponding with each classifier. Output of classifiers is used to make the final decision using majority voting. QoS monitoring is also presented in [5], when Zeng et al., proposed a model for QoS monitoring in service composition.

Service profiling implies the identification of factors that affect QoS levels in environmental sensor networks and the strategies to measure directly or indirectly their respective parameters. The results of service profiling, i.e. measured service parameters, serve as input to our QoS level classification model. In next subsections, we present how service-related factors are identified and how their relationship is defined.

### 2.1. Potential Failures in Sensor Networks and Service-based Applications

Sensor networks are resource-constrained and usually deployed in outdoor, inaccessible environments in order to collect data about the real world. Although advances in microelectronics provide sensor nodes that are becoming more powerful and robust, sensor nodes can still fail due to a number of causes such as exposure to harsh environments, low battery levels, or communication failures. Moreover, node failures can hinder the network's capacity to deliver acceptable QoS levels. Understanding potential

failures (will be listed in Figure 1) is a very first step in handling and controlling the quality of service of the entire network. There are main nine failures which may occur in sensor network in runtime as followings: *Sensor Failures, Data Acquisition Platform Failure, Battery Failure, Power Source Failure, Timing Synchronization Accuracy, Communication Channel Failure, Communication Channel Overload, Server Overload, Service Failure.*

### 2.2. Service Parameters

Because the system architecture is sensor-based and service-based (the values of QoS level of services) depend on the performance of the sensors and the server. The state of the sensors and the state of the communication network also play an important role, which determines the QoS level of services. Based on the observation of the potential failures mentioned in the previous subsection, we identify five measurable parameters that reflect the profile of a service and determine directly or indirectly their QoS levels.

- *Quality of measurement* represents quality of the sensors at the moment data is recorded. Its value shows how good the sensors measure a phenomenon in reality. The higher values, the better quality of sensed data.
- *Data availability* refers to the percentage of data that can be directly accessed. The availability of data depends on two aspects: the requested location and the status of sensor nodes around that location.
- *Data freshness* is an expression of the time between the moment data is measured and the moment data is returned to a user request.
- *Service response* represents how fast a service can respond to a request. It is the duration between the *sending request* time and the *receiving result* time.
- *Service availability* indicate*s* the percentage of successful calls to a service. To check the service availability, a service invocation will be made.

### 2.3. QoS Parameters and the Relationship with Service Parameters

Considering the performance of an environmental monitoring system, we consider the two most important quality parameters, the speed of processing data and the reliability of the provided data. Therefore, we define two QoS parameters and offer them to end-users and application developers:

- *Reliability:* indicates the correctness of the data, which are recorded by sensors and provided to end-users.
- *Responsiveness:* represent show quickly the system can respond to given requests from users

As depicted in Figure 1, there are dependencies between potential failures and aforementioned service parameters.
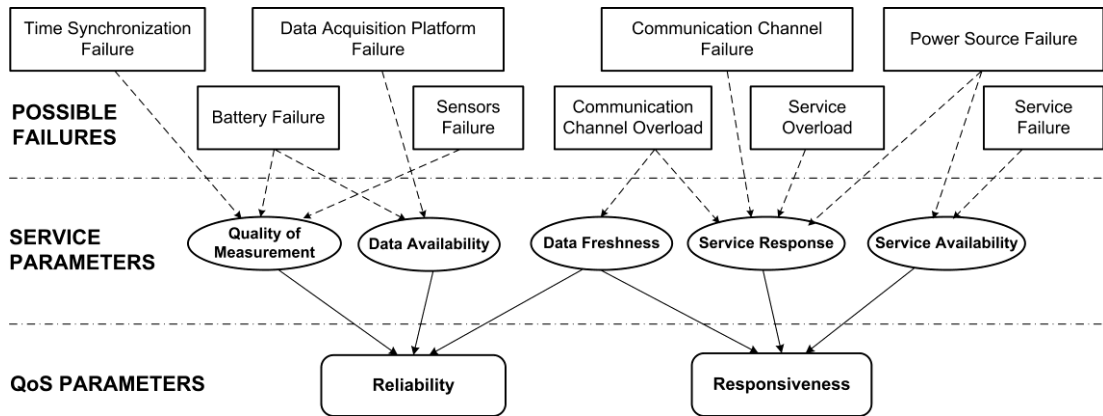
**Figure 1. The relationship between failures, service parameters and QoS parameters clearly illustrates the connection between offered QoS levels and system failures**

## 3. The QoS level estimation model

The service profile parameters presented in the previous section are used as inputs to our QoS level estimation model. This model needs to process a service's profile parameters and to output a QoS level estimation in near real-time. To support online estimation, our model needs to be flexible, highly accurate, and needs a very short time to train. Although, there are several well-known machine learning techniques used for data classification and estimation such as Neutral Networks, Support Vector Machines, and Decision Trees, we have chosen for the method based on Bayesian Networks (BN). This method is easy to construct, requires a small amount of training data to estimate, has fast performance, high accuracy, and can work with both numerical and non-numerical data [6].

The structure of a BN is represented in the form of a directed, acyclic graph in which nodes correspond to random variables of interest and directed arcs represent direct causal or influential relation between nodes. The uncertainty of the interdependence of variables is represented locally by the Conditional Probability Table. Each cell of the table contains a function $P(B|A)$, which is the probability that event B occurs given that event A has already occurred:

$$P(B|A) = \frac{P(A|B)P(B)}{P(A)} \qquad (3.1)$$

P(A) and P(B) are the probabilities of the occurrence of event A and B respectively, P(A|B) is the probability of the occurrence of event A, given that event B has already occurred.

The BN for QoS level estimation in our approach is a Naive Bayesian Network consisting of a root node and several leaf nodes. There are no arcs between any two leaf nodes because we assume that service profile parameters are independent - i.e. the value of a particular parameter does not impact the value of another. Use of a Naive BN has the

following benefits: the model is fast to train and fast to estimate data; it is able to handle real and discrete data; the model is not sensitive to irrelevant features. This means if more features are used as inputs of the model, the model may work better.

In Naive Bayesian Networks used in our case, QoS parameters (*reliability* and *responsiveness*) are represented with root nodes, and the measurable profile parameters will be leaf nodes. Since there are two QoS parameters to be taken into account, two BNs are developed, one for the *reliability* parameter and the other one for the *responsiveness* parameter Figure 2. The two BNs are presented as following.
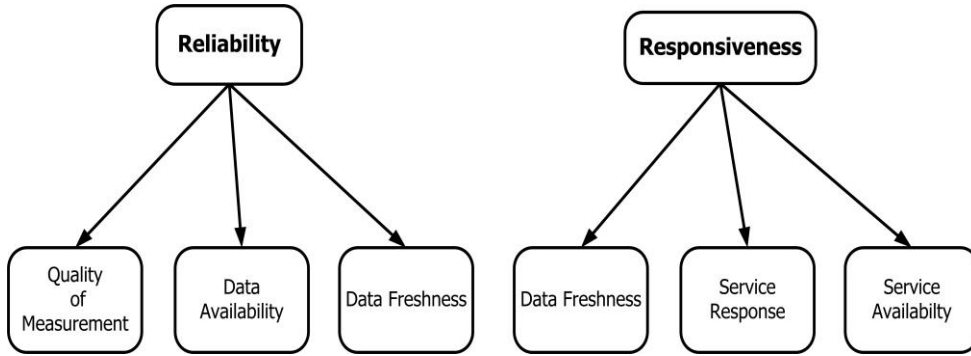


**Figure 2. Two naive Bayesian Networks represent two QoS parameters**

In the Naive Bayesian algorithm, each sample $x$ can be represented by a set of measurable parameters, $x = \langle a_1, a_2, .., a_n \rangle$ where $n$ is the number of service parameters (in our case, n = 5). Sample $x$ will be classified to one of the levels in a definite set $L = \langle l_1, l_2, .., l_m \rangle$ where $m$ is the number of levels (in our case, $m$ is 3). With a given sample $x = \langle a_1, a_2, .., a_n \rangle$ the corresponding level assigned to the parameters must satisfy:

$$l_{max} = argmax_{l_i \in L} P(l_i | a_1, a_2, .., a_n) \qquad (3.2)$$

Where the $argmax$ function returns the value of $l_{max}$ for which the probability function $P(l_i | a_1, a_2, .., a_n)$ attains is largest value.

Applying Bayes theory to formula (3.2) and because $P(a_1, a_2, .., a_n)$ is independent from $l_i$, we have:

$$
\begin{aligned}
l_{max} &= argmax_{l_i \in L} \frac{P(a_1, a_2, .., a_n | l_i) * P(l_i)}{P(a_1, a_2, .., a_n)} \\
&= argmax_{l_i \in L} P(a_1, a_2, .., a_n | l_i) * P(l_i)
\end{aligned}
\qquad (3.3)
$$

Assume that the attributes are independent. In which:

$$P(a_1, a_2, .., a_n | l_i) = \prod_{j=1}^{n} P(a_j | l_i)$$

Then $l_{max}$ is determined:

$$l_{max} = argmax_{l_i \in L} \prod_{j=1}^{n} P(a_j | l_i) * P(l_i) \qquad (3.4)$$

Based on Equation (3.4), an algorithm (see Algorithm 1) is developed to estimate the QoS level of the offered services. The algorithm consists of two phases: training phase and classification phase.

- *Training phase:* Compute the probability of the value of service parameters and the value of labels in the training data set.
- *Classification phase:* Assign the sample to the label name which gets the highest probability.

The algorithm is applied to two QoS parameters to estimate their values before the data service is consumed. Because the algorithm uses a training data set, which is created based on historical observations; the value of QoS level based on the probability theorem could be estimated. After being trained, the estimation models can be tested with other data sets to check its accuracy. These data sets were also created by experienced experts. The number of records in the training data set is finite, so the algorithm is finished after a limited time.

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*Algorithm 1: QoS level estimation Algorithm*

**Input**: $Web service x = \langle a_1, a_2, .., a_n \rangle$     $\gg a_j : parameter\ values$

$\quad\quad\quad Set\ of\ levels\ L = \langle l_1, l_2, .., l_m \rangle$     $\gg l_i : a\ name\ of\ a\ level$

**Begin**

$\quad f_{max} \leftarrow 0$     $\gg Used\ to\ store\ the\ highest\ probability\ value$

$\quad l_{max} \leftarrow null$     $\gg Used\ to\ store\ the\ level\ with\ the\ highest\ value$

$\quad$ **Foreach** $l_i \in L$ **do**

$\quad$ **Begin**

$\quad\quad P(l_i) \leftarrow Probability\ of\ l_i\ in\ the\ training\ data\ set$

$\quad\quad f(l_i) \leftarrow P(l_i)$     $\gg Initialize\ the\ f(l_i)$

$\quad\quad$ **Foreach** $a_j \in x$ **do**

$\quad\quad$ **Begin**

$\quad\quad\quad\quad P(a_j|l_i) \leftarrow Probability\ of\ a_j\ given\ l_i\ in\ the\ training\ data\ set$

$\quad\quad\quad\quad f(l_i) \leftarrow f(l_i) * P(a_j|l_i)$   $\gg Calculate\ the\ acculumative\ value$

$\quad\quad$ **End**

$\quad\quad$ **If** $f(l_i) \geq f_{max}$ **then**     $\gg Check\ whether\ the\ new\ value\ is\ higher\ than\ f_{max}$

$\quad\quad$ **Begin**

$\quad\quad\quad\quad f_{max} \leftarrow f(l_i)$   $\gg Assign\ f_{max}\ with\ a\ new\ value$

$\quad\quad\quad\quad l_{max} \leftarrow l_i$   $\gg Assign\ l_{max}\ with\ a\ new\ value$

$\quad\quad$ **End**

$\quad$ **End**

$\quad$ **End**

**Output**:     $Web\ service\ x = \langle a_1, a_2, .., a_n \rangle\ is\ assigned\ to\ the\ class\ l_{max}$

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## 4. Experiments & results

The estimation model is implemented based on the proposed algorithm and built-in libraries coming from the Waikato Environment for Knowledge Analysis (Weka). The Weka is an open source software that implements many state-of-the-art machine learning and data mining algorithms. It has achieved widespread acceptance within academic environment and business market, and has become a widely used tool for data mining research. The Weka project aims at providing a comprehensive collection of machine learning algorithms and data pre-processing tools to researchers and practitioners alike.

### 4.1. Building Training Data Sets

A training set is a set of data used to discover potentially predictive relationships. It consists of an input vector and an answer vector. In the machine learning model, like the QoS estimation model, the training set is used to train the model that can be used to estimate a concerned value from one or more values of available parameters.

In the context of our estimation model, data training sets are made by experienced developers and service users. The model trainers will query the latest measurement data at sensors node. Returned values include a sound level value (dB) and other values related to the performance of the service. Based on knowledge and experience, trainers express their evaluation by selecting one of the available options for each QoS parameters. The trainers' choice will be stored and used as training data for the estimation model. To guarantee the validation of the outputs, model trainers have to provide both selections before submitting. At the moment of writing, we have two training data sets for two estimation models (one for *responsiveness* parameter and another for *reliability* parameter). Each training data set contains 114 records.
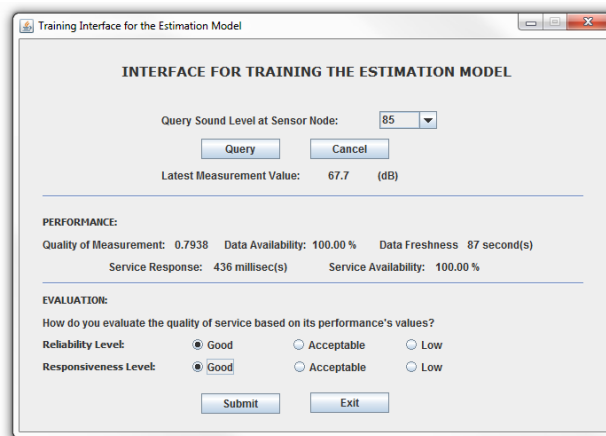


**Figure 3. Developers and experienced users can express their evaluation on service quality based on monitored performance factors via this interface. Outputs of this phase are used for training the estimation model**

### 4.2. Cross-validation for Training Data Sets

Cross-validation is a technique used for evaluating and comparing learning algorithms by dividing data into two segments. The first segment is used to learn or train the model and the other one is used to validate the model [7].

The purpose of using cross-validation is to check the fit of a model to a hypothetical validation when an explicit validation set is not available. The basic form of cross-validation is a *k*-fold cross-validation. Other forms are special cases of *k*-fold cross-validation or involve repeated rounds of *k*-fold cross-validation.

The cross-validation method used for this training data set is 10-fold cross-validation. The results of the cross-validation are 66.67% and 68.42% for *reliability* and *responsiveness* models correspondingly.

### 4.3. Experiment Results

The accuracy of the Naive Bayes classification algorithm can be evaluated by testing the model with several *testing data sets*. These sets were created by developers and service users using the aforementioned interface. Its size is increased from 100 to 500 records during tests. A test is done by first estimating a testing data set with the model; and then comparing the estimated labels with the real labels (as evaluated by developers and users) in the testing data set.

The accuracy of the model is determined based on the percentage of records that are estimated correctly (i.e. matching to labels assigned by experts) by the model. For each number of test sets, the estimation model on 5 different same-size test sets is repeated. Afterward, the mean values are determined; the confidence level of 95% is chosen when calculating the confidence interval of mean values.

The performance of the QoS estimation models was evaluated based on their execution time - the amount of time needed to finish the given task (s). In our tests, we considered execution time as the total time spent for estimating a number of records. Particularly, it is a summation of the time spent for training the models, time spent for estimating records, and time spent for returning the result.

Table 1 presents the results of 5 tests in terms of execution time and accuracy. The accuracy of the estimation model for the *reliability* parameter is between $74 \pm 1\%$ and $79 \pm 1\%$, while it is between $75 \pm 1\%$ and $78 \pm 1\%$ for the *responsiveness* parameter. Additionally, the bundle performed well in terms of the execution time, i.e. it took a short time to finish the tests.

The average time spent for estimating a record decreases when the size of the testing data set increases. The obtained results prove the possibility of using these estimation models for the online service suggestion.

**Table 1. Reliability and Responsiveness estimation accuracy and performance for differently sized testing data sets**

| # testing records | Reliability | | Responsiveness | |
|---|---|---|---|---|
| | Execution time (millisecond) | Accuracy (%) | Execution time (milliseconds) | Accuracy (%) |
| 100 | $72 \pm 2$ | $74 \pm 1$ | $41 \pm 1$ | $77 \pm 1$ |
| 200 | $84 \pm 2$ | $77 \pm 1$ | $46 \pm 2$ | $78 \pm 1$ |
| 300 | $93 \pm 2$ | $76 \pm 1$ | $55 \pm 3$ | $78 \pm 1$ |
| 400 | $96 \pm 2$ | $79 \pm 1$ | $65 \pm 3$ | $77 \pm 1$ |
| 500 | $103 \pm 2$ | $78 \pm 1$ | $75 \pm 3$ | $75 \pm 1$ |

## 5. Conclusions and future work

An efficient algorithm to estimate the value of QoS parameters offered in an environmental assessment system based on monitoring measurable parameters is studied. This approach could help developers and users to understand about quality of service they may be interested in. From the relationships between risk factors and QoS parameters, a probabilistic graphical model, Naive BN based model, for estimating the values of QoS parameters from the monitored data is built. This model consists of two main phases: the training and the classifying phases. The training phase is used to train the model based on a training data set built by the model developer. The classifying phase labels the given service to a class, which has the highest value of the probabilistic distribution. This model helps to determine the value of QoS parameters of services when they are invoked to answer a service composition request. Due to limitation of data training sets, the accuracy of estimation is not high as expected. The data training sets for our two models should be improved in the future work.

## References

[1] Q. Tao, H. Chang, C. Gu, and Y. Yi (2012), *"A novel prediction approach for trustworthy QoS of web services"*, Journal of Expert Systems with Applications, vol. 39, no. 3, pp. 3676 - 3681.

[2] D. Smith, G. Timms, P. De Souza, and C. D'Este (2012), *"A Bayesian Framework for the Automated Online Assessment of Sensor Data Quality"*, Sensors, vol. 12, pp. 9476 - 9501.

[3] N. Guo, T. Gao, and B. Zhang (2008), *"A Trusted Quality of Web Services Management Framework Based on Six Dimensional QoWS Model and End-to-End Monitoring"*, in Proceedings of the 11th Asia-Pacific Symposium on Network Operations and Management: Challenges for Next Generation Network Operations

and Service Management, pp. 437 - 440.

[4]    A. Rahman, D. Smith, and G. Timms (2014), *"A Novel Machine Learning Approach towards Quality Assessment of Sensor Data"*, IEEE Sensors Journal, vol. 14, no. 4, pp. 1035 - 1047.

[5]    L. Zeng, H. Lei, and H. Chang (2007), *"Monitoring the QoS for Web Services"*, in Service-Oriented Computing – ICSOC 2007, vol. 4749, Springer Berlin / Heidelberg, pp. 132 - 144.

[6]    P. Bhargavi and S. Jyothi (2009), *"Applying Naive Bayes data mining technique for classification of agricultural land soils"*, International Journal of Computer Science and Network Security, vol. 9, no. 8, pp. 117 - 122.

[7]    M. W. Browne (2000), *"Cross-Validation Methods"*, Journal of Mathematical Psychology, vol. 44, no. 1, pp. 108 - 132, Mar.

# AN ASSESSMENT OF THE IMPACTS OF LABOUR FORCE ON THANH HOA PROVINCIAL ECONOMIC DEVELOPMENT

**Nguyen Thi Dung**

**Abstract:** Labour force plays a key role in economic development of a country or an area. Even though Thanh Hoa has the third largest population in Vietnam, its industry and services are not well developed. Overall, Thanh Hoa is still low quality of human life and labour force doesn't meet the requirements of the markets. Therefore, it's necessary to assess labour force for both current and future development. This not only meets the immediate needs but also for sustainable growth in long terms. The article evaluated labour force impacting on economic development of Thanh Hoa province in current period, in terms of scale, structure, distribution, increasing, quality and limitations. Also, the article stated some orientations for reasonable use of labour force in the next coming years.

**Keywords:** Labour force, economic development, Thanh Hoa

## 1. Introduction

The ultimate goals of economic development are to improve the quality of life and meet people's increasing demand. These goals can only be achieved if labour force is truly appropriate and have positive impacts on economic growth. Thanh Hoa province is in the early stages of industrialization and modernization while it has abundant labour force; therefore, studying the impacts of labour force on economic development is one of the great significance and necessity.

## 2. Concepts and research indicators

### 2.1. Concepts

Labour force comprises all people aged 15 and over who are employed and those at working age having working capacity but unemployed, doing housework in the family or having no demand for work [2].

Economic development is the growth (GDP per capita, GNI per capita) and fundamental changes in the economic structure that are created by the participation of the

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people and nations, and significant changes in consumption, healthcare conditions, health care, education and welfare.

### 2.2. Research indicator

Assessing the impacts of labour force on Thanh Hoa economic development at present, we take into account the following indicators:

The indicators evaluate the relation between the scale and the growth of labour force and economic development.

The indicators evaluate the structure of labour force and economic development: age structure, gender structure and industry structure and structure of economic sectors.

The indicators evaluate the distribution of labour force in relation with economic development.

The indicators evaluate the relation between the quality of labour force and economic development: the proportion of trained workers, the proportion of qualified technical workers, labor productivity, job skills and foreign language capacity, health and awareness, responsibilities, work discipline, labor export.

## 3. Research content

### 3.1. Size and growth of labour force and economic development

Thanh Hoa province has abundant labour force due to its large population size and relatively high rate of natural population growth in the late twentieth century (annual rate >1.3%). From 2010 to 2013, the workforce at the working age rose from 2115.6 thousand to 2239 thousand people and the average growth rate of 1.9% per year. Regarding scale, labour force accounted for 65.1% of the provincial population in 2013, 4.2% of the total labor force throughout the country and 19.1% of the total labor force in North Central and South Central Coast.

**Table 1. Population and labour force of Thanh Hoa province in period 2010 - 2013**

*(Unit: thousand people)*

| Year/Criterion | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|
| Population | 3412.0 | 3423.0 | 3426.0 | 3440.0 |
| Labour force | 2217.2 | 2237.0 | 2258.0 | 2239.0 |
| Proportion of labor force in population | 64.9 | 65.3 | 65.9 | 65.1 |

In the period 2010 - 2013, there were 50,000 - 55,000 people entering the working age in Thanh Hoa each year. In addition, labor supply in the province was larger with the soldiers having fulfilled their mission and returning home, the graduates coming back to their province to look for work and those in the areas with conversed land-use purpose needing to find a job.

Abundant and considerably annually increasing labour force is great motivation to maintain the pace of economic development: average economic growth in the period 2010 - 2013 was 11.2% per year (higher than Vietnam: 5.7% per year). Furthermore, abundant and cheap labor force facilitates and encourages investors, development of labor-intensive industries in the early industrialization and labor export earning foreign currency.

However, labor supply increases rapidly while the provincial economic development and structure shifts slowly, which emerges many problems to solve. Especially, employment for young people who are entering the working age annually and redundant of rural labor are remaining a burning issue. In 2013, the provincial unemployment rate was 2.12% - a considerable pressure on the provincial economic development.

### 3.2. Impacts of labour force structure on economic development

#### 3.2.1. Structure of labour force by age

Labour force by age are fairly different: the largest proportion is made up by those aged 25-29 (274,359 people, accounting for 13.4% of the total labor force), and the smallest is the group of those between the ages of 15 and 19 (103,055 people, representing 4.9% of the total labor force). The group aged from 18 to 40 accounting for 54.7%, all complete secondary school and high school education. These are favorable conditions to organize vocational training and attract high skill labor into the labor market and economic sectors.

#### 3.2.2. Structure of labour force by gender

Of the total workforce, the proportion of men and women is approximately equal (49.9% and 50.1%, respectively). However, there is difference between male and female in coastal areas. The reason is fishing activities need more men than women (52.8% and 47.2%, respectively). In addition, the percentage of urban females is 1.2%, lower than of males mainly because women participate in family chores and are less involved in economic activities.

#### 3.2.3. Shift in labor use structure by industries and the shift in provincial economic structure:

In the period 2010 - 2013, Thanh Hoa developed dual economic model [5] by Arthur Lewis which focused its investment on both industry and services in order to gradually cut down the number of workers in agriculture. Thanks to the recovering provincial economy and the key economic industrial zones such as Nghi Son Economic Zone, Thanh Hoa city built and developed to attract investment projects, the provincial economic structure had a dramatic shift. The shift of labor division by economic sectors was closely linked to shifting and forming of respective labor structure (economization of production factors).

**Table 2. Structure of labor use by industries and economic structure of Thanh Hoa in the period 2010 - 2013**

*(Unit: %)*

| Total | Labor use structure | | | Economic structure by GDP | | |
|---|---|---|---|---|---|---|
| | 2010 | 2013 | Shift (2010 - 2013) | 2010 | 2013 | Shift (2010 - 2013) |
| | 100.0 | 100.0 | | 100.0 | 100.0 | |
| **Agriculture - Forestry - Fishery** | 55.7 | 52.1 | - 3.6 | 24.1 | 20.0 | - 4.1 |
| **Industry - Construction** | 19.4 | 21.5 | + 2.1 | 36.3 | 43.9 | + 7.6 |
| **Services** | 24.9 | 26.4 | + 1.5 | 39.6 | 36.1 | - 3.5 |

It can be seen that the shift of labor structure was slow compared to that of economic structure in some industries. Moreover, it has not yet met the needs of the provincial economic transformation towards industrialization - modernization. The shift of economic structure has not greatly affected the structural changes of the provincial labor. We can observe that industry - construction are still dominant and lead in the shifts of both labor and economic structures (+2.1% and +7.6%, respectively). Although the labor structure still had the tendency to rise (+ 1.5%) in services, there was a decline in economic structure (-3.5%).

This mismatch leads to forming of two separate economic sectors: One of the modernly equipped industrial sector and services employing fewer workers, having high productivity and concentrating in the areas with relatively good infrastructure like Thanh Hoa City, Nghi Son Industrial Zone, etc. The other is agriculture, forestry and aquaculture with small-scaled production, low productivity, out-of-date technologies and concentrating mainly in the mountainous and coastal districts such as Quan Son, Quan Hoa, Ba Thuoc and Nga Son.

*3.2.4. Labour force by economic sectors*

"State" economic sector - one of the key economic sectors in the 70s which made substantial contributions to socialism establishment - now shares a very small percentage (5.7% of the provincial labor structure). "Non-state" economic sector occupy a high proportion of 91.8%. "Foreign invested" sector in recent years has the tendency to increase (due to good income and working conditions), but still accounts for a modest proportion of 2.5% of the labor market.

*3.3. Distribution of labour force*

Labour force by region of Thanh Hoa province shows an uneven distribution. Since its population concentrated in cities, towns, industrial zones, and coastal plain districts, labor force in these regions also accounts for a large proportion. Therefore, the labor in the

mountainous districts takes a small share in the total labor force (11 mountainous districts accounted for only 28.2% of total provincial labor force in 2013).

The districts with large labor force proportions are Quang Xuong (8.01%), Hoang Hoa (6.55%), Trieu Son (6.44%), Tho Xuan (6.15%), Tinh Gia (6.16%), Nong Cong (4.99%), Thieu Hoa (4.94%), and Thanh Hoa City (4.43%). The uneven distribution of labour force has considerable impact on the provincial economic development. In urban areas, abundant labour force cause a lot of difficulties for employment, labor productivity and quality of life while in the mountainous districts, there are manpower shortages, especially skilled workers and waste of resources.

### 3.4. Quality of labour force and economic development

In addition to natural factors, capital, the quality of labour force has great significance in contributing to the economic development of the province.

#### 3.4.1. Physical strength, mental health, discipline and industrial working style

Labour force in Thanh Hoa has the stereotype of being hard-working, intelligent, eager to study, having physical strengths, being highly active and being able to absorb knowledge of advanced and modern technological science. This is one of the economic advantages of Thanh Hoa under the eye of investment searching businessmen.

However, labour force has low starting point and thinking styles of small producers; most workers have not been trained and practiced in modern industrial production environments; the ability to work in teams is limited; discipline has not yet been strong. Therefore, the economic/labor productivity has not been high.

#### 3.4.2. Trained workforce

Trained manpower in general and vocationally trained workers in particular in Thanh Hoa in recent years have increased significantly. By the end of 2013, trained workers reached 49% (exceeding the target of 45% by 2015, in which vocational trained was 34.6%). However, this figure is still lower than the national average and much lower than the Red River Delta and the Southeast of Vietnam. In addition, the proportion of untrained workers in the companies specialized in processing industry, trading, minerals, restaurant, tourism, and agriculture, etc. is extremely high. Most employees in urban areas are generally trained or vocationally trained at elementary level or higher. Meanwhile, the rural workforce is largely untrained. In 2013, the proportion of rural trained workers only reached 21.7% (including 19.6% of vocationally trained workers).

Another noteworthy issue is the manpower working in enterprises accounted for only 8.04% of the total number of employees by the end of 2013. This suggests that businesses in Thanh Hoa are merely able to absorb a very small proportion of the workforce in the province. The main reason is that the number of enterprises is smaller than workers. By 2013, Thanh Hoa had 4536 active businesses and there were about 1000 workers per 2 enterprises. This

rate is lower than the national average (6.37) and the North Central Coast - Central Coast (3.83). Thus, it can be seen that the province is still in the stage of surplus labour force system that are underutilized by businesses.

### 3.4.3. Percentage of workers with technical expertise

The percentage of workers with technical expertise of Thanh Hoa province is lower than the national average. People with technical expertise from elementary to graduate only accounted for 11.8% and the number of people with university and postgraduate degrees is only a very small fraction (2.8%). This is really an alarming figure for the province's workforce - the supply is abundant, but in short of skilled workforce. There is quite a large gap between urban and rural areas in the number of people trained in technical expertise in all fields: the rate of those trained from colleges or less in urban areas is twice higher than in rural areas; particularly, the rate of workers with university and postgraduate degrees in urban areas is even 8 times higher than in rural areas.

Overall, the figure 11.8% of workers trained in technical expertise reflects the low quality of labour force of Thanh Hoa. Moreover, the training structure also shows the imbalance: The number of people being on apprenticeship (elementary and intermediate) tends to decrease, while the number of those attending colleges and universities tends to rise; training has not yet met the demands of the market, leading to a lack of workers and teacher surplus; cases of the employees doing jobs unrelated to their major are common nowadays.

### 3.4.4. Labor productivity

The shifting of economic structure in the province in recent years along with the impact of science - technology has led to the shift of labor structure, which has positive effects on labor productivity. In the period 2010 - 2013, labor productivity in Thanh Hoa continued to increase, from 25.0 million VND per year (2010) to 39.8 million VND in 2013. Labour productivity also shows apparent differentiation by economic industries: industry has the highest productivity (77.2 million), followed by construction (58.5 million); the lowest is agriculture - forestry and fishery (12.8 and 32.8 million, respectively).

**Table 3. Labour productivity in Thanh Hoa the period 2010 - 2013 by sectors**

*Unit: Millions/year*

| Year | 2010 | 2011 | 2012 | 2013 |
|------|------|------|------|------|
| **The national average** | 40.4 | 50.3 | 56.7 | 62.8 |
| **Thanh Hoa** | 25.0 | 31.8 | 37.4 | 39.8 |
| Agriculture - Forestry | 9.8 | 12.8 | 17.2 | 18.0 |
| Fishery | 25.8 | 32.8 | 33.3 | 35.6 |
| Industry | 62.4 | 67.2 | 72.4 | 78.4 |
| Construction | 53.9 | 58.5 | 60.1 | 62.9 |
| Trading | 37.8 | 39.9 | 46.3 | 59.6 |

| | | | | |
|---|---|---|---|---|
| Hotels and restaurants | 40.7 | 46.1 | 48.1 | 54.2 |
| Transportation and communication | 52.6 | 58.7 | 60.1 | 64.8 |
| Culture, health care and education | 53.6 | 65.4 | 66.2 | 68.9 |
| Other services | 59.6 | 63.1 | 64.7 | 66.6 |

With social labor productivity of 39.8 million in 2013, the current labor productivity of Thanh Hoa is equal to 63.2% of the national labor productivity and 60% of labor productivity of ASEAN [5]. In specific, productivity growth of Thanh Hoa is mainly due to the shift from agriculture to processing industry. This trend emerges under the impact of economic integration of the province into the country and the world, and will continue in the coming years.

*3.4.5. Foreign language skills, vocational skills for laborers to work abroad*

Currently, in most of the markets, there is a strongly increasing demand for labour force with knowledge and skills at a high level. In fact, many employees of Thanh Hoa are unqualified when recruited by foreigners because they cannot perform basic professional operations required by recruitment. The main reason is due to the lack of cooperating strategies between vocational training institutions with labor export enterprises. This poses significant challenges to improving the quality of vocational training for workers in Thanh Hoa province.

*3.4.6. Labor exports and economic development*

In the 2010 - 2013 period, Thanh Hoa province has exported 54,346 laborers to countries such as Malaysia, Republic of Korea, and Japan. All of the 27 districts/ towns/ cities of the province have laborers working abroad.

Labor export has contributed to the increases in households' income and foreign currency for the province. Provincial manpower temporarily working abroad send to their families about $ 65 million, equivalent to 1,300 billion VND; one employee on average sends to his/ her family 35 million VND per month. This capital is invested in production, sales, service and creating new jobs. Labor export and specialists have an important contribution to the job creating programs and poverty reduction in the province. Poor households which have laborers working abroad have basically been out of poverty and got rich.

## 3.5. Some solutions to use labour force in Thanh Hoa province effectively

For rational use of labour force for industrialization - modernization, Thanh Hoa needs to implement the following solutions synchronically:

Improve labor's physical strength, skills and concentrate on training manpower for sciences and high technology and skilled managers to meet the requirements of the shifts of economic structure and labor structure; raise awareness of employees about consciousness, behavior, discipline and the collective coordination in work.

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Promoting propaganda about education, training and law on labour force development. Improve organization management and development of labour force, capacity and effectiveness of the management apparatus.

Attracting domestic and foreign investment in education - training, especially high-quality education - training. Create favorable conditions for enterprises to implement policies supporting vocational training for rural labor to train the labor force for society, but firstly serve the requirements of businesses which vocational training institutions have not yet met.

Developing labor market information network and training, searching and job lacement services; strengthening inspection and monitoring compliance with the law in labor relations as labor contracts, salaries and other benefits to employees.

Expanding and strengthen cooperation with international agencies and organizations in training of labour force, finding funding to support the development of local labour force in various forms to learn and share experiences, timely grasp market information, technology and science to meet the requirements of international integration.

## 4. Conclusions

This paper evaluates the impacts of labour force for the economic development of Thanh Hoa province at present by different criteria. It can be seen that:

(i) Thanh Hoa province has the abundant labor supply which even exceeds the demand of the economy.

(ii) Labour force structure differentiates across ages, genders, industries and economic sectors, which creates diversity for economic development.

(iii) Labour force is distributed unevenly across regions and districts/ towns/ cities, which causes difficulties for equal economic development in the province.

(iv) Quality of labour force in Thanh Hoa has not been high, represented by high rates of labors with low technical expertise, limited ability of foreign language and limited skills and labor costs on added value is high but productivity is not high.

In the context of natural resources keeping running out, the development of high quality labour force is the most powerful measure to create the province's competitive advantages in order to transform Thanh Hoa province into an industrial province with high average income per capita in 2020.

## References

[1] People's Committee of Thanh Hoa province, the Department of Planning and Investment (2013), *Adjustment and supplement to the overall planning of socio-economic development in Thanh Hoa province until 2020 and orientations towards 2030*, Thanh Hoa.

[2] Thanh Hoa Statistics Department, *Results of the population and housing census in Thanh Hoa in 2009; Thanh Hoa Statistical Yearbook from 2010 to 2013*. Statistical Publishing House, Ha Noi.

[3]     Thanh Hoa provincial Department of Labour, Invalids and Social Affairs (2013), *Statistical tables and reports of labor market in Thanh Hoa province*, Thanh Hoa.

[4]     Thanh Hoa Statistics Department, *Thanh Hoa Statistical Yearbook from 2010 to 2013*. Statistical Publishing House, Ha Noi.

[5]     Nguyen Minh Tue (chief editor) (2006), *General socio-economic geography*, Publishers Pedagogical University, Ha Noi.

# ON NEARLY PRIME SUBMODULES

**Truong Thi Hien**

**Abstract**. We know that a fully invariant submodule of an $R$- module $M$ is called a *prime submodule* if for any ideal $I$ of $S = End_R(M)$, and any fully invariant submodule $U$ of $M$, $I(U) \subset X$ implies $I(M) \subset X$ or $U \subset X$. In this paper, we study nearly prime submodules and their properties as an extension of prime submodules.

**Mathematics Subject Classification (2000):** 16D50, 16D70, 16D80.

**Keywords:** Nearly prime submodules, nearly prime ideals, prime modules

## 1. Introduction and preliminaries

In [10], weakly prime ideals in a commutative ring with non-zero identity have been studied. Many authors have studied the notion of weakly prime ideals in module theory. In particular, many properties of weakly prime submodules have been introduced by M. Behboodi and H. Koohi in [11]. In this paper, we introduce nearly prime submodules and study their properties, which are similar to weakly prime submodules. Throughout this paper, all rings are associative rings with identity, all modules are unitary right $R$- module and $S = End_R(M)$, its endomorphism ring. A submodule $X$ of $M$ is called a *fully invariant submodule* of $M$ if for any $f \in S$, we have $f(X) \subset X$. Following [8], a fully invariant proper submodule $X$ of $M$ is called a *prime submodule* of $M$ if for any ideal $I$ of $S$ and any fully invariant submodule $U$ of $M$, if $I(U) \subset X$, then either $I(M) \subset X$ or $U \subset X$. In particular, an ideal $P$ of $R$ is a *prime ideal* if for any ideals $I, J$ of $R$, if $IJ \subset P$, then either $I \subset P$ or $J \subset P$. A right $R$- module $M$ is called a *self-generator module* if it generates all its submodules.

For notations are not defined here we refer the reader to [1], [2], [3], [4], [5], [6], [7].

## 2. On nearly prime submodules

### *Definition 2.1.*

A fully invariant submodule $X$ of $M$ is called a *nearly prime submodule* if for any ideal $I, J$ of $S$ and any fully invariant submodule $U$ of $M$, if $IJ(U) \subset X$, then either $I(U) \subset X$

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or $J(U) \subset X$. Especially, an ideal $P$ of $R$ is a nearly prime ideal if for any ideals $I, J, K$ of $R$ and $IJK \subset P$ implies $IK \subset P$ or $JK \subset P$. A right R- module M is called a *nearly prime module* if $0$ is nearly prime submodule in $M$. A ring $R$ is called a *nearly prime ring* if $R_R$ is nearly prime module.

It is clear that whenever $P_i, i \in I$ is a chain of nearly prime submodules of an $R$-module $M$, then $Q = \bigcap_{N \in G} N$, is always a nearly prime submodule.

The following first theorem gives some characterizations of nearly prime submodules similar to that of prime submodules.

### Theorem 2.2.

Let $X$ be a proper fully invariant submodule of $M$. The following conditions are equivalent:

(1)    $X$ is a nearly prime submodule of M.

(2)    For any right ideal $I, J$ of $S$, any submodule $U$ of $M$, if $IJ(U) \subset X$, then either $I(U) \subset X$ or $J(U) \subset X$.

(3)    For any left ideal $I, J$ of $S$, any subset $A$ of $M$, if $IJS(A) \subset X$, then either $I(A) \subset X$ or $J(A) \subset X$.

(4)    For any $\varphi, \gamma \in S$ and for any $m \in M$, if $\varphi S \gamma(m) \subset X$, then either $\varphi(m) \in X$ or $\gamma(m) \in X$.

(5)    Moreover, if M is a quasi-projective, then the above conditions are equivalent to:

(6)    M/X is a nearly prime module.

*Proof.*

**(1) $\Rightarrow$ (2).** Suppose that $X$ is a nearly prime submodule of $M$ and $I, J$, right ideals of $S$. Then $I = IS; J = JS$ and $SI, SJ$ are ideals of $S$. Since $U$ is a submodule of $M$, we have $S(U)$ is a fully invariant submodule of $M$. If $IJ(U) \subset X$, then $(SI)(SJ)(S(U)) = SIJ(U) \subset X$. This shows that either $(SI)(S(U)) = SI(U) \subset X$ or $(SJ)(S(U)) = SJ(U) \subset X$. Hence, either $I(U) \subset X$ or $J(U) \subset X$.

**(2) $\Rightarrow$ (3).** Let $I, J$ be left ideals of $R$ and a subset $A$ of $M$ which are satisfied $IJS(A) \subset X$. From this, we have $IJS(A)R \subset X$. It follows that $ISJS(AR) \subset X$. By (2), we have either $IS(AR) \subset X$, or $JS(AR) \subset X$. Hence, $I(A) \subset X$ or $J(A) \subset X$.

**(3) $\Rightarrow$ (4).** Since $X$ is a fully invariant submodule of $M$, the condition $\varphi S \gamma(m) \subset X$ implies that $S(\varphi S \gamma(m)) \subset X$. Hence $(S\varphi)(S\gamma)(m) \subset X$. By (3), we have $S\varphi(m) \subset X$, or $S\gamma(m) \subset X$. It is easy to see that $\varphi(m) \in X$, or $\gamma(m) \in X$.

**(4) $\Rightarrow$ (1).** Let *I, J* be ideals of *S* and *U*, a fully invariant submodule of *M* with $IJ(U) \subset X$. Suppose that $I(U) \not\subset X$ and $J(U) \not\subset X$. Then, there exists $\varphi \in I$, $\gamma \in J$ and $m \in U$ such that $\varphi(U) \not\subset X$ and $\gamma(m) \in J(U) \setminus X$. Therefore, $\varphi S \gamma(m) \not\subset X$, a contradiction.

**(4) $\Rightarrow$ (5).** Let any $\overline{m} \in \overline{M} = M/X$ and $\overline{\varphi}, \overline{\gamma} \in End_R(\overline{M})$ such that $\overline{\varphi} \overline{S} \overline{\gamma}(\overline{m}) = \overline{0}$. Since *M* is a quasi - projective module, there exist $\varphi, \gamma \in S$ such that $\overline{\varphi}v = v\varphi$ and $\overline{\gamma}v = v\gamma$, where $v: M \to M/X$ is the canonical projection. Therefore, $v\varphi S \gamma(m) = \overline{0} \Leftrightarrow \varphi S \gamma(m) \subset X$. It means that $\varphi(m) \in X$ or $\gamma(m) \in X$. It is easy to see either $\overline{\varphi}(\overline{m}) = \overline{0}$ or $\overline{\gamma}(\overline{m}) = \overline{0}$, proving that *M/X* is a nearly prime module.

**(5) $\Rightarrow$ (4).** Now let $\varphi, \gamma \in S$ and any $m \in M$ such that $\varphi S \gamma(m) \subset X$ and suppose M/X is a nearly prime module. Since *X* is a fully invariant submodule of *M*, we can find endomorphism $\overline{\varphi}, \overline{\gamma} \in \overline{S}$, such that $v\varphi = \overline{\varphi}v$ and $v\gamma = \overline{\gamma}v$ where $v: M \to M/X$ is the canonical projection. Since $\varphi S \gamma(m) \subset X$, it follows that $v\varphi S \gamma(m) = \overline{\varphi} \overline{S} \overline{\gamma}(\overline{m}) = \overline{0}$. Hence either $\overline{\varphi}(\overline{m}) = \overline{0}$ or $\overline{\gamma}(\overline{m}) = \overline{0}$. Showing that $\varphi(m) \in X$ or $\gamma(m) \in X$. The proof of our theorem is now complete.

### Corollary 2.3.

*If P is a proper ideal in a ring R, the following conditions are equivalent:*

*(1)     P is a nearly prime ideal of R.*

*(2)     If I, J, K are right ideals of R such that $IJK \subset P$, either $IK \subset P$ or $JK \subset P$.*

*(3)     If I, J, K are left ideals of R such that $IJK \subset P$, either $IK \subset P$ or $JK \subset P$.*

*(4)     If $a, b, c \in R$ with $aRbc \subset P$, either $ac \in P$ or $bc \in P$.*

*(5)     R/P is a nearly prime ring.*

**Proposition 2.4.** *([8], Lemma 1.9).*

*Let M be a right R- module and $S = End_R(M)$. Suppose that X is a fully invariant submodule of M. Then the set $I_X = \{f \in S \mid f(M) \subset X\}$ is a two-sided ideal of S.*

### Theorem 2.5.

*Let M be a right R- module and $S = End_R(M)$. Suppose that X is a fully invariant submodule of M. If X is a nearly prime submodule of M, then $I_X$ is a nearly prime ideal of S. Conversely, if M is a self - generator and if $I_X$ is a nearly prime ideal of S, then X is a nearly prime submodule of M.*

*Proof.* Suppose that $X$ is a nearly prime submodule of $M$. Let $J$, $K$, $H$ be two sided ideals of $S$ with $JKH \subset I_X$. It is easy to see that $I_X$ is a two sided ideal of $S$, by Proposition 2.4. Since $JKH \subset I_X$, we have $JKH(M) \subset X$. We can see that if $H$ is a two sided ideal of $S$, then $H(M)$ is a fully invariant submodule of $M$. From this, we have either $JH(M) \subset X$ or $KH(M) \subset X$, proving that $I_X$ is a nearly prime ideal of $S$.

Conversely, assume that $I_X$ is a nearly prime ideal of $S$, $X$ is a fully invariant submodule of $M$ and $M$ is a self-generator. Suppose that $\varphi, \gamma \in S$ and any $m \in M$ such that $\varphi S \gamma(m) \subset X$. It implies that $\varphi S \gamma(mR) \subset X$. Since $M$ is a self-generator, we have: $mR = \sum_{i \in A} \psi_i(M)$, for some subsets $A$ of $S$, then $\psi_i(M) \subset mR$, $\forall i \in A$. Therefore, $\varphi S \gamma \psi_i(M) \subset X$, or $\varphi S \gamma \psi_i \subset I_X$, $\forall i$. It follows that $\varphi \psi_i \in I_X$ or $\gamma \psi_i \in I_X$, $\forall i$. Hence, $\varphi(mR) \subset X$ or $\gamma(mR) \subset X$. Easy to see $\varphi(m) \in X$ or $\gamma(m) \in X$, proving that X is a nearly prime submodule of M.

### Lemma 2.6.

*Let M be a quasi-projective module, P be a nearly prime submodule of M, $A \subset P$ be a fully invariant submodule of M. Then P/A is a nearly prime submodule of M/A.*

*Proof.* Put $\overline{S} = End(M/A)$. Let $\overline{\varphi}, \overline{\gamma} \in \overline{S}$, $\overline{m} \in \overline{M} = M/A$ such that $\overline{\varphi} \, \overline{S} \, \overline{\gamma}(\overline{m}) \subset \overline{P} = P/A$. Since $M$ is a quasi - projective, we can find $\varphi, \gamma \in S$ such that $\overline{\varphi} v = v \varphi$ and $\overline{\gamma} v = v \gamma$, where $v : M \to M/X$ is the canonical projection. Then, $\overline{\varphi} \, \overline{S} \, \overline{\gamma}(\overline{m}) = \overline{\varphi} \, \overline{S} \, \overline{\gamma} v(m) = v \varphi S \gamma(m) \subset \overline{S}$, implies $\varphi S \gamma(m) \subset P$, then $\varphi(m) \in P$ or $\gamma(m) \in P$. Therefore, $\overline{\varphi}(\overline{m}) \in \overline{P}$ or $\overline{\gamma}(\overline{m}) \in \overline{P}$. It follows that *P/A* is a nearly prime submodule of *M/A*. The proof of our lemma is now complete.

### Lemma 2.7.

*Let M be a quasi - projective module and X be a fully invariant submodule of M. If $\overline{P} \subset M/X$ is a nearly prime submodule of M/X, then $v^{-1}(\overline{P})$ is a nearly prime submodule of M.*

*Proof.* Put $P = v^{-1}(\overline{P})$ and suppose that $f, g \in S$, $m \in M$ such that $fSg(m) \subset P$. Since $X$ is a fully invariant submodule of $M$, there exist $\overline{f}, \overline{g} \in \overline{S}$, which are satisfied $vf = \overline{f} v$ and $vg = \overline{g} v$ where $v : M \to M/X$ is the natural epimorphism. From $fSg(m) \subset P$, we have $v fSg(m) \subset v(P)$. This shows that $\overline{f} \, \overline{S} \, \overline{g}(\overline{m}) \subset \overline{P}$. By assumption, either $\overline{f}(\overline{m}) \in \overline{P}$ or $\overline{g}(\overline{m}) \in \overline{P}$. It follows that $f(m) \in P$ or $g(m) \in P$, proving $P$ is a nearly prime submodule of $M$.

Minimal nearly prime submodules are defined in a natural way. A nearly prime submodule *X* of a right *R*- module *M* is called a minimal nearly prime submodule of *M* if it does not contain other nearly prime submodules of M. A nearly prime ideal *P* in a ring *R* is called a minimal nearly prime ideal if there are no nearly prime ideals of *R* properly contained in *P*. In [8], we know that if *P* is a prime submodule of a right *R*- module *M*, then *P* contains a minimal prime submodule of *M*. Next, we will show that if *X* is a nearly prime submodule of *M*, then *X* contains a minimal nearly prime submodule of *M*.

### *Proposition 2.8.*

*If X is a nearly prime submodule of M, then X contains a minimal nearly prime submodule of M.*

*Proof.* We modify the argument in [8] to process the proof. Let *F* be the set of all nearly prime submodules of *M* which are contained in *X*. Since $X \in F$ , this means that *F* is non- empty. We will show that *F* has a minimal element with respect to the inclusion operation provided we show that any non- empty chain $G \subset F$ has lower bound *Q* in *F*. Put $Q = \bigcap_{N \in G} N$, then *Q* is a fully invariant submodule of *M*. We will show that *Q* is a nearly prime submodule of *M*.

Assume that $\varphi, \gamma \in S$ , $m \in M$ such that $\varphi S \gamma(m) \subset Q$ and $\gamma(m) \notin Q$ . Since $\gamma(m) \notin Q,$ there exists $N \in G$ , which is $\gamma(m) \notin N$ . By *N* is a nearly prime submodule of *M*, we have $\varphi(m) \in N$ . For any $U \in G$ , either $U \subset N$ or $N \subset U$ . If $N \subset U$ , we see that $\varphi(m) \in U$ , easily. For the case $U \subset N$ , from $\varphi S \gamma(m) \subset Q$ which implies $\varphi S \gamma(m) \subset U$ . Then $\varphi(m) \in U,$ since *U* is a nearly prime submodule. Thus $\varphi(m) \in U$ for any $U \in G$ . This shows that *Q* is a nearly prime submodule of *M*. Clearly, $Q \subset F$ , therefore, *Q* is a lower bound for *G*. By Zorn's Lemma, there exists a nearly prime submodule $X^*$ which is minimal among the nearly prime submodules in *F*. We conclude that $X^*$ is a minimal nearly prime submodule of *M*.

We know that [9], Proposition [1.1] if *M* is a quasi-projective, finitely generated right *R*- module which is self-generator and *X* is a minimal prime submodule of *M*, then $I_X$ is a minimal prime ideal of *S*. Certainly, if $I_X$ is a minimal prime ideal of *S*, then *X* is a minimal prime submodule of *M*. Motivated by this result, we will introduce some results in the following proposition.

*Proposition 2.9. Let M be a quasi- projective, finitely generated right R- module which is a self- generator. Then we have the following:*

(1)    *If X is a minimal nearly prime submodule of M, then $I_X$ is a minimal nearly prime ideal of S.*

(2)    If P is a minimal nearly prime ideal of S, then $X := P(M)$ is a minimal nearly prime submodule of M and $I_X = P$.

It was shown that in [3], Theorem 3.4, that there exist only finitely many minimal prime ideals in a right Noetherian ring $R$. It is easy to see that if $R$ is a right Noetherian ring, then we have only finitely many minimal nearly prime ideals. We have also known in [9],

*Theorem 2.1*, that if $M$ is a quasi- projective, finitely generated right $R$- module which is a self- generator and $M$ is a Noetherian module, then there exist only finitely many minimal prime submodules. Motivated this result, we have the following theorem.

### Theorem 2.10.

*Let M be a quasi- projective, finitely generated right R- module which is a self-generator. If M is a Noetherian module, then there exist only finitely many minimal nearly prime submodules.*

*Proof.* Since $M$ is a quasi- projective, finitely generated which is a self- generator and $M$ is a Noetherian module, then $S$ is a Noetherian ring. Therefore, we have only finitely many minimal nearly prime ideals. By Proposition *2.9*, we can see that $M$ has only finitely many minimal nearly prime submodules, proving our theorem.

## References

[1]    F.W. Anderson and K.R. Fuller (1974), *"Rings and Categories of Modules"*, Springer- Verlag, New York.

[2]    C. Faith (1976), *"Algebra II: Ring Theory"*, Springer- Verlag, Berlin.

[3]    K. R Goodear and R.B. Warfield, Jr (2004), *"An Introduction to Noncommutative Noetherian rings"*, Cambridge University Press, Cambridge, UK.

[4]    F. Kash (1982), *"Modules and Rings"*, Academic Press, London, New York.

[5]    T. Y. Lam (1991), *"A First Course in Noncommutative Rings"*, Springer Graduate Text.

[6]    J. C. McConnell and J. C. Robson (2011), *"Noncommutative Noetherian Rings"*, Graduate Studies in Mathematics 30, Amer, Math. Soc., Province, Rhode Islans.

[7]    R. Wisbaeur (1991), *"Foundations of Module and Ring Theory"*, Gordon and Breach, Tokyo.

[8]    N. V. Sanh, N. A. Vu, K. F. U. Ahmed, S. Asawasamrit and L. P. Thao (2010), *Primness in module category*, Asian - European Journal of Mathematics, 3 (1), 145 - 154.

[9]    N. V. Sanh and L. P. Thao, A *generalization of Hopkins- Levitz Theorem*, Southeast Asian Bulletin of Mathematics, accepted for publication.

[10]   D. D. Anderson and E. Smith (2003), *Weakly prime ideals*, Houston J. of Math. 29, 831 - 840.

[11]   M. Behboodi and H. Koohi (2004), *Weakly prime submodules*, Vietnam J. Math. 32 (2), 185 - 195.

# WASHBACK EFFECT ON ENGLISH LANGUAGE CURRICULUM AT HONG DUC UNIVERSITY CONTEXT WITH REFERENCE TO TOEIC TEST

**Le Hoang Huong**

**Abstract:** The article presents theory on washback effect and curriculum innovation as well as analyzes a case of washback effect on English language curriculum at Hong Duc University with reference to TOEIC test. TOEIC-oriented teaching and learning has great impacts on English curriculum design from all perspectives such as content, methodology, testing and evaluation. Such influences are discussed in terms of both positive and negative characteristics to express a comprehensive view on the relationship between tests and curriculum design.

**Keywords:** Washback effect, TOEIC

## 1. Introduction

It has been argued that the relationship between assessment and the curriculum arouses great passion (Andrews, 2003) because the quickest way to change students' learning styles is believed to be changing assessment system (Elton & Laurillard, 1979 as cited in Andrews, 2003). In reality evaluating the washback effects on curriculum in general and English curriculum in particular has been paid much attention to by people in relations, especially curriculum designers. Simultaneously the bloom of international certificates of English proficiency by international testing agencies such as TOEFL, IELTS and TOEIC has driven pedagogical instructions and educational principles among language institutions. Consequently, English language institutions have placed those examinations in the first and foremost place or considered it as the keystone in their curriculum. This situation is really true to English teaching and learning context in Vietnam where English is a mandatory subject in universities as well as an important criterion in any job applications in the open age. It is quite hard to say the Vietnamese favor these international tests for acknowledging their validity and reliability in defining learners' language competence or for assuming their popularity as an assessment tool for entrance into foreign universities or at least into promising workplaces. Regardless of all these controversial issues, these tests have widespread and in-depth influences on the whole English teaching and learning process.

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In order to have an insightful understanding of the washback effects on English curriculum, I would like to describe and analyze the latest English curriculum for English non-majored students with reference to TOEIC test in Hong Duc University where I am currently working as a teacher of English.

## 2. Literature review

### 2.1. English language curriculum and curriculum innovation

According to Graves (2008), curriculum is defined as a set of three interrelated processes including planning, implementing/enacting and evaluating. These three processes inform and influence one another, for example, classroom enactment shapes planning and vice-versa, planning decides evaluating and vice-versa. This interrelation shows curriculum's nature of dynamicity and complexity, thus dramatic changeability. Educators, therefore, frequently get curriculum innovated or changed (Nation & Macalister, 2010) for the sake of teaching and learning quality with the ultimate aim of enhancing students' achievement (Karavas - Doukas, 1998).

There is a list of these changes based on the situation analysis, needs analysis, formulation of aims and goals, etc. *(Graves, 2008)* including an introduction to a new course book, or new teaching techniques, or a new method of assessments, etc. among which changing in assessment seems to have significant impacts to all other changes in the whole teaching and learning process. Any innovations in curriculum are by all means aimed at contributing to students' success (Breen & Candlin, 1980) which is somehow evaluated by assessment tools such as a testing system.

### 2.2. Washback effect

While Hughes (1989) defines washback effect as the way a test affects teaching materials and classroom management, the term is widened as "the way in which tests influence teaching and learning" *(Chen, 2006, p.206)*. It is commonly assumed that when being influenced by the knowledge that their students are planning to take a certain test, teachers will adapt their teaching methodology and lesson content to reflect the test's demands *(Taylor, 2005)*. It is therefore, washback effects should be considered before an innovated curriculum is introduced and processed.

Scholars have considered washback as being either negative *(harmful)* or positive *(beneficial) (Taylor, 2005)*. Negative washback is supposed to occur when a test's content or format is based on a narrow definition of language ability. For example, using multiple choice questions to test students' writing skill will force students to practice this type of exercise instead of practice writing skill itself *(Davies et al. as cited in Taylor, 2005)*. On the other hand, positive washback is produced by a testing procedure which encourages 'good' teaching practice; for example, an oral proficiency test is taken to purposively promote the teaching of speaking skills.

*2.3. Washback and curriculum innovation*

As mentioned above, washback effect is both negative and positive. Oxehem (1984) as cited in Andrews (2003) describes negative washback as "the restrictions they will impose upon curricula, teachers and students in terms of encouraging the most mechanical, boring and debilitating forms of teaching and learning" *(p.38)*. The curriculum designers will give priority to students' passing examinations in terms of recommending teaching methods, materials, and assessments which are all exam - oriented. In doing so, on one side, teachers will edit their teaching techniques so as to ensure that their students can pass the specific exams and on the other side students are motivated to study the language not just for the nature of interest itself, but instead for the pressure of exams.

In order to avoid those drawbacks, Andrews (2003) suggests using tests as a strategy to promote curricular innovation basing on Elton and Laurillard's argument (1979) as cited in Andrews *(2003, p.39)* of how to change students' way of learning in the shortest time by changing the assessment system. Referenced tests have influences on all the elements of curriculum ranging from lessons' contents, materials, teachers' teaching methods, students' learning motivation and styles to assessment; therefore, a change of tests might lead to a great innovation in the whole teaching and learning process. In this sense, which tests should be chosen to positively motivate students' learning is a question of concern. The favorite answer to this matter seriously elected by educators seems to be using an international test which is valuable in terms of popularity and reputation.

## 3. An analysis of a case study: washback effects on English language curriculum at Hong Duc University with reference to Toeic

In order to have an insight into washback effect on curriculum, this part of the essay is aimed at proposing a case study of Hong Duc University with reference to a specific test: TOEIC test. In the first part, the paper will cover context background of this English curriculum with a description of Common European Framework of References for Languages (CEFR) and TOEIC test followed by English teaching and learning situation in universities in Vietnam. In the second part, the essay will describe and analyze washback effect on English curriculum for English non- majored students in Hong Duc University referencing to TOEIC. By interviewing 150 English non-majored students and 10 English teachers at Hong Duc University, the paper provides an insight into the real situation of how TOEIC-based test impacts on English teaching and learning in the university.

*3.1. Context and background*

*3.1.1. Common European Framework of References for Languages (CEFR)*

CEFR *(Council of Europe, 2001)* has been known as the major document of reference for language in education throughout Europe and beyond which brings common standards and

transparency, formulates objectives of foreign - language learning curricula and certifies learners' foreign language proficiency skills (Hulstijn, Schoonen, De Jong, Steinel, and Florijn, 2011). According to David (2011), the most innovative feature of the framework is that it relates curriculum, pedagogy and assessment into much closer interdependence than ever before. The framework is therefore widely used as the key principle in both testing agencies and ministries of education.

In more details, the major international testing agencies have been quick to adopt its reference levels as a common metric, with evident gains in transparency and comparability. For example, ETS-a prestigious examining body who is famous for TOEFL and TOEIC has converted its scores to CEFR levels (http://toefl.com.vn). Simultaneously ministries of education frequently associate their L2 curricula with the CEFR's reference levels. For instance, in Vietnam some universities require English non-majored students to reach B1 CEFR level, which is equivalent to 550 TOEIC score after completing 12 credits of English (Vu, 2006).

*3.1.2. TOEIC test*

The TOEIC *(Test of English for International Communication)* introduced and held by Educational Testing Service (ETS) is an English-language proficiency test for people whose native language is not English. According to its authors, the test measures the everyday English skills of people working in an international environment. The scores indicate how well people can communicate in English with others in business, commerce, and industry. The test does not require specialized knowledge or vocabulary beyond that of a person who uses English in everyday work activities (http://ets.org).

The TOEIC test is a two-hour multiple-choice test that consists of 200 questions divided into two sections: listening and reading.

- **Listening Section:** The Listening section tests how well you understand spoken English. It consists of four parts: photos, questions-responses, conversation and talks contained in 100 questions administered by audiocassette or CD. The total time is approximately 45 minutes.
- **Reading Section:** The Reading section includes three parts: incomplete sentences, text completion, and reading comprehension to test how well test-takers understand written English. The total time is 75 minutes.

*3.1.3. TOEIC in Vietnam*

TOEIC test has been chosen by a lot of Vietnamese universities as an official means of assessment to meet the CEFR's reference levels for English non-majored students (Vu, 2006). The choice of TOEIC among other tests is mostly for the claim that 550 TOEIC score which is equivalent to B1 CEFR level is not only accessible for English non- majored students but also meets the requirements of almost all business employers (http://ets.org).

Using this test as a mechanism to drive teaching instructions has aroused emotions (Andrews, 2003). Everyone here talks about TOEIC. The test has become a hot and controversial topic in academic language teaching conferences, seminars, workshops, even in daily conversations. There exist contrary attitudes towards the test, some considers it as a trendy and reliable assessment whereas others doubt its academic concern as it focuses on only two language skills (listening and reading). Regardless of all those arguments, TOEIC is still the one selected and plays an important role in any curriculum design and innovation. In the light of TOEIC test, designers might adapt their curriculum in different ways to be suitable to various teaching contexts and minimize its disadvantages.

*3.1.4. Hong Duc University and TOEIC - oriented English curriculum for English non-majored students*

Hong Duc University in Thanh Hoa province, Vietnam is a university training students majored in different careers including Social Science, Natural Science, Information and Technology, Economics and finance, etc. Therefore, the number of English non-majored students accounts for the majority. As a result, teaching English to these students is far more than a compulsory task but are paid great attention to from the authority and teachers to guarantee that the students' English competence would both fulfill the requirements of high-stakes tests and meet the demands of future employers.

This has led the university to update the TOEIC-oriented English curriculum for English non-majored students (Nguyen, 2011). More details of the curriculum will be described in the following part of this paper.

### 3.2. TOEIC- oriented English curriculum for English non-majored students

*3.2.1. A description of TOEIC-oriented English curriculum*

*a. Aims*

The latest edition of TOEIC-oriented English curriculum for English non-majored students in Hong Duc University designed by a group of English teachers in Foreign Language Department was issued in 2011. It is aimed at providing students with general knowledge of basic grammar, linguistics and four communicative language skills *(listening, speaking, reading, and writing)*. After finishing a 12-credit-course, students are expected to pass the achievement test in the form of a TOEIC test with the minimum score of 400 points. This score is 150 points lower than B1 level of CEFR which is equivalent to 550 TOEIC points. This requirement of lower score is resulted from students' performance in an English diagnostic test held before they start learning English unit in their second semester. The result of this diagnostic test reveals the truth that most students are not very good at English and they should learn English as beginners regardless of how many years they learned the language in secondary schools. This score is believed to be accessible for these students after finishing the course and reduce their pressure of learning.

*b. Approach*

The curriculum is designed in the light of Communicative Language Teaching approach *(CLT)* with the focus on language communicative skills. The curriculum is expected to leave a spacious place for students to cooperatively interact with one another through communicative activities.

*c. Content*

The entire course covers both grammar and four communicative language skills; however, time allotted for each of them is different. The course is divided into four units: English 1, English 2, English 3, and English 4 including four, three, three, two credits respectively. Each credit consists of twenty-one 50-minutes periods; therefore, we have 84 periods for English 1, 63 periods for English 2, 63 periods for English 3, and 42 periods for English 4. The content and time allotted (in periods) for these four units are briefly summarized in the following table:

|  | **Grammar** | **Listening** | **Reading** | **Speaking** | **Writing** |
|---|---|---|---|---|---|
| English 1 | 44 | 10 | 10 | 10 | 10 |
| English 2 | 11 | 13 | 13 | 13 | 13 |
| English 3 | 0 | 16 | 16 | 16 | 15 |
| English 4 | 0 | 21 | 21 | 0 | 0 |

It is easy to see the differences in terms of content among four English units. English 1 focuses on grammar which accounts for half of the unit because it is believed that grammar is the basement from which other language communicative skills can develop. Therefore, the first part of the unit is time for students to revise grammatical items then the other half is equally divided by four language skills. In English 2, the time allotted for grammar is reduced whereas the time for language skills is increased. In English 3, there is no time left for grammar, instead the time for four skills equally divided among one another occupies the whole unit. In English 4, only two skills (listening and reading) are performed. This bias for listening and reading skills are supposed to be resulted from the knowledge that students are going to take an achievement test in the form of a TOEIC test where only these two skills are examined so that they need more space for these two tested skills. The content of listening and reading lessons and their choice of tasks are strictly followed TOEIC format. For the other two skills, while speaking lessons cover different conversation in daily life and at the workplaces, writing lessons focus on various topics and writing styles.

*d. Materials*

The materials include core-books and supplementary or reference books. The core books are Know How (Oxford university press) used to teach grammar items and Longman Preparation Series for New TOEIC Test (Longman) for English communicative skills. The reference books are TOEIC Analyst and Target TOEIC. These TOEIC books are designed to

prepare test-takers for TOEIC test; therefore, each task item presented is one typical example of a real test item.

### e. Assessments

To complete the entire English course, students have to take achievement tests in the form of a TOEIC test at the end of each unit and are expected to achieve a certain score. For example, after finishing English 1, students must achieve at least 275 points in order to pass the unit and get through to English 2. The required score for finishing English 2, English 3, and English 4 are 350, 400, and 450 respectively.

### 3.2.2. How TOEIC influences the English curriculum: positive impacts vs. negative ones

### a. In terms of content

As discussed above, the target aim of this English course which is to help students to achieve 400 points in a TOEIC test directs each lesson's content. It is the fact that by focusing on language skills, each lesson's content is really connected with the test which helps students to get familiar with its format and common topics. Students have much time on practicing test items; hence their confidence of having enough opportunities to be successful in the test will be gradually increased.

However, because the test examines only two language skills *(listening and reading)*, more time is spent on them to prepare students for the upcoming test. The curriculum designers have tried to avoid bias in their time allotted for all four skills; however, there still exists students' doubt of why they have to spend time on learning what they will not be tested about. When interviewed, 150/150 English non-majored students admitted that they almost spent no time on practicing speaking and writing skills as these skills would not appear in their achievement test. This will somehow affect students' motivation of learning as well as their learning styles. These students are TOEIC-oriented so they adapt their English learning to practicing test items in order to gain the required score. An obviously foreseen consequence is that students are much more proficient of the language skills about which they are more dedicated. A truly sad story has happened in which TOEIC-oriented curriculum has produced students who can effectively listen and read pieces of English information but can not speak or write a correct, appropriate and fluent statement of English.

At the same time, this change in students' motivation of learning and their learning styles will on its turn influences teachers' perceptions of teaching and their choice of teaching methods which will be discussed in the following part.

### b. In terms of teaching methods

From my discussion with 10 English teachers, these teachers are all somehow oriented by one specific test have adapted their teaching methods to reflect the test's demands. Their teaching methodology has been changed from teaching language skills into tutoring students for the exam. Practicing listening and reading tasks are highly recommended with the

expectation that the more opportunities students are provided to work with the samples of test, the better performance they could have. Such teachers' focus is partly due to teachers' recognition of their role in helping students to gain satisfactory result and partly for the pressure of being evaluated by authorities who use final students' score as one of the criteria.

Furthermore, the heavy load of tasks presented in the textbooks has forced teachers to urge themselves and their students to complete all the given tasks in limited time. Consequently, less cooperative activities are performed which leads to less students' interaction and communication.

### c. In terms of materials

TOEIC books published by foreign publishers have been used as textbooks and reference books. Because these books are written for test-takers, they are presented in the form of a real test aimed at providing them with techniques in doing the tests, even some tips or hints for success. Such strategy sounds appealing to students and teachers who are suffering from the test pressure.

However, these books contain the so-called authentic situations in Western workplaces and daily conversations, which are not really familiar with Vietnamese students. This hinders students' communicative skill development because they cannot connect what they are taught with what actually happens in life. Moreover, by introducing tips for doing the test illustrated by examples for practice, these books change students' perceptions of learning. Some students tend to practice tips instead of learning how to listen and read in a communicative way. As a result, they might get a fairly good result in the test but can not get involved in a real conversation or understand a piece of information in real English. 150/150 students who were asked if they felt confident when talking in English with foreigners admitted that their confidence was equal to almost zero and most of the time they kept silence or used gestures to express their ideas.

### d. In terms of assessment

At the end of each English unit *(usually at the end of each semester)*, students have to sit for the final test designed in the form of a TOEIC test. All students need to achieve 400 points in order to be considered as fulfilling the requirements for graduation. Anyone who can not get such score will have to re-take the English unit and re-do the English final test. By this way, students' effort in learning English language for a period of at least one semester is assessed by just only one final test raises the question of the test result's reliability. A student' learning result possibly varies due to inside and outside factors such as their mental and physical condition. Therefore, it is possible that a good student may gain bad score when he is ill on the day the examination is organized.

Moreover, such final tests can not evaluate students' competence of English in one sufficient way from multiple dimensions of the language because they only examine listening and reading skills. Though speaking and writing skills are included in the curriculum as an

attempt of designers to avoid bias and to provide students with enough space for practicing all four language skills, students unconsciously have priority on listening and reading skills which are going to be tested.

## 4. Conclusion

The paper has just discussed theoretical issues of washback and its influences on curriculum innovation. In the light of these theories, the paper has also proposed one case study of TOEIC-referenced English curriculum which has been used in Hong Duc University, Vietnam by focusing on a description and an analysis of how TOEIC test has influenced this curriculum. So far TOEIC test has revealed both negative and positive impacts on the curriculum from different perspectives including lesson content, teachers' teaching methods, materials, and assessment, etc. Referencing English curriculum to a specified international examination such as TOEIC seems to be an updated strategy favored by educational authorities, especially when employers and foreign educational institutions require candidates to include English certificates recognized by prestigious testing agencies in their application forms. However, the question of how much washback effect on curriculum is reasonable needs seriously considering so as to keep this curriculum on the right track of teaching English for communicative purposes and not to change universities into TOEIC centers.

## References

[1]     Andrews, S (2003). Washback and Curriculum. In L. Cheng (Eds.), *Washback and Language Testing: Research Context and Methods* (pp.37-50). London: LEA Publishers.

[2]     Breen, P.M. & Candlin, N.C (1980), The essentials of a communicative curriculum. In Hall, R.D. & Hewings, A (2001), *Innovation in English Language Teaching: A Reader*. USA: Routledge.

[3]     Chen, L (2006), Washback Effects on Curriculum Innovation. *Academic Exchange*. 206 - 210.

[4]     David, L (2011), The Common European Framework of Reference for Languages: A research agenda. *Cambridge Journals*, 44(3). 381-393.

[5]     ETS (2008), *TOEIC Examinee Handbook: Listening & Reading*. Retrieved from http://ets.org on May 27, 2012.

[6]     Graves, K (2008), The Language Curriculum: A Social Contextual Perspective. *Language Teaching*, 41(2), 147 - 181.

[7]     Hughes, A (1989), *Testing for Language. Teachers*. Cambridge: Cambridge University Press.

[8]     Hulstijn, H. J, Schoonen, R., De Jong, H. J., Steinel, P. M. and Florijn, A (2011), *Linguistic competences of learners of Dutch as a second language at the B1 and B2*

*levels of speaking proficiency of the Common European Framework of Reference for Languages (CEFR).* Language Testing, 29(2). 203 - 221.

[9]  Karavas-Doukas, K (1995), Evaluating the Implementation of Educational Innovations: Lessons from the Past. In Rea-Dickins, P. & Germaine, P.K. (1998). Managing Evaluation an Innovation in Language Teaching: Building Bridges. USA: Longman.

[10]  Nation, I.S.P. & Macalister, J (2010), Language Curriculum Design. USA: Routledge.

[11]  Nguyen, H.T (2011), *English curriculum for English non- majored students in Hong Duc University.* ThanhHoa: Hong Duc Publisher.

[12]  Taylor, L (2005), Key concepts in ELT: Washback and Impact. ELT Journal, 59(2). 154 - 155.

[13]  Vu, T.P.A (2006), CEFR and the improvement of English teaching and learning's efficiency in Vietnam National University, HCMC.Science and Technology Journal, 9(10). 31 - 47.

# TOWARDS THE DEVELOPMENT OF PROTEIN EXPRESSION BY INDUCIBLE ECDYSONE SYSTEM

**Nguyen Thi Thu Huong**

**Abstract:** The ecdysone inducible system was generated for checking the toxicity of target gene which was transected into the cells. The transcription unit, modified ecdysone receptor (IND) was cloned into vector pcDNA-Dest40 to form the new inducible expression plasmid pDest40-IND via cloning technique. A clear band with size about 487bp of PCR product indicated the success of amplification IND promoter. The coding gen for GFP was inserted into pDest40-IND via gateway cloning technique to generate pDest40-IND-GFP. This plasmid afterward was co-transected with pVG-RXR into Hep-2 cell and induced by 1µM ponasteron A for GFP expression small amount transected cells showed the fluorescence signal informed the function of new plasmid.

**Keywords:** Ecdysone inducible system, ecdysone receptor, pcDNA- Dest40, pVG-RXR

## 1. Introduction

The cellular protein expression systems are widely utilized in order to generate the target proteins for scientific work. However, besides other influences, the success of protein expression experiments can be limited due to a toxic side effect of over expression of target protein. In order to overcome this limitation, inducible expression systems like the glucocorticoid inducible mouse mammary tumor virus (MMTV) system, ecdysone - inducible Drosophila analog promoter/receptor (EcP) system and the tetracycline - dependent system (Tet) are commonly used (Meyer-Ficca et al, 2004).

The ecdysone inducible system displays a low basal activity, high inductivity and fast response. And the most important feature is its switch on or off ability depending on certain requirements (Padidam et al, 2003; Meyer-Ficca et al, 2004). In addition, due to the natural lipophilic form, ecdysones are able to penetrate into all tissues and have a short half-live which allow precise and potent inductions (No et al, 1996; Oehme et al, 2005). Moreover, ecdysteroids are not toxic and are not known to affect mammalian physiology (No et al, 1996).

Ecdysone, belonging to ecdysteroid family, is the insect molting steroid hormone triggering metamorphosis in insects, for example Drosophila melanogaster. An increasing of

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ecdysone concentration in Drosophila leads to the expression of genes coding for proteins that are necessary for larva development. The synthesized ecdysone inducible system bases on two plasmids. One is a receptor expression plasmid, pVg-RXR containing the modified ecdysone receptor (VgEcR) with the ecdysone binding domain and the retinoid X receptor (RXR). Another is a plasmid containing the ecdysone- responsive IND promoter which is a fusion of the ecdysone responsive elements and minimal heat shock promoter. In general, the binding of ecdysone or its synthesis analog (ponasteron A, minestrone A) to ecdysone binding domain of VgEcR promotes the demonization of modified ecdyson receptor (VgEcR) and the retinoid X receptor (RXR). The heterodyne afterwards binds to the ecdysone responsible elements in the synthesis ecdysone responsive IND promoter. (Lueers et al, 2000).The interaction results in the activation transcription of target gene fused downstream to minimal heat shock promoter.

## 2. Materials and Methods

### 2.1. Materials

HEK293FT cells *(Life Technology)* and HEp-2 cells were selected from the Laboratory of Cell Biology, Brandenburgische Technische University, Cottbus - Senftenberg, Germany, pDNA-Dest 40, pVG-RXR ((Invitrogen), pIND-GFP (Addgene).

The chemicals used in this research were high quality of Merck (Germany), Sigma – Aldrich (Germany), Invitrogen (USA), Carl Roth (Germany), Fermentas (Germany), VWR (Germany).

### 2.2. Methods

#### 2.2.1. Cell culture

HEK293FT cells were cultivated in Dulbecco's Modified Eagle Medium (D-MEM). HEp-2 cells cultivation was performed in Minimal Essential Medium (MEM). Cell medium was added 10 % fetal bovine serum (FBS), 2 mM L-Alanyl-L-Glutamine, 1 % non-essential amino acids, 2.25 mM sodium bicarbonate and 1 mM sodium pyruvate. The experiments were performed according to Lab manual and SOPs Molecular Cell biology (Kuepper, 2009).

#### 2.2.2. Cloning strategy

In this research, expression plasmids based on pcDNA-Dest40 which contains a strong *Cytomegalovirus* (CMV) promoter. This promoter was replaced by inducible IND promoter to generate the inducible plasmid. In order to deal with this task, the primers were designed based on the open source bioinformatics software Primer3Plusto amplify the DNA coding sequence for IND promoter and attach the restriction sites for *Spe*I and *Sac*I enzym via PCR technique. After cutting by the same single cut enzym *Spe*I and *SacI*, IND promoter and IND promoter removed pcDNA-Dest40 were legated to generate pcDNA-Dest40-IND plasmid. Afterward, green fluorescence protein (GFP) from donor plasmid pDONR-GFP was

inserted into pDest40-IND to generate the expression plasmid pDest40-IND-GFP via gateway technique.

## 3. Results and Discussion

### 3.1. PCR and restriction enzyme digestion

The PCR product was analyzed by agarose gel electrophoresis and the result was presented in figure 1. No band was seen in the negative control lane (A). In contrast, a clear band with size around 487bp was detected, correlating with the expected band size (B).These results pointed out that PCR running for amplifying IND promoter sequence was successful.
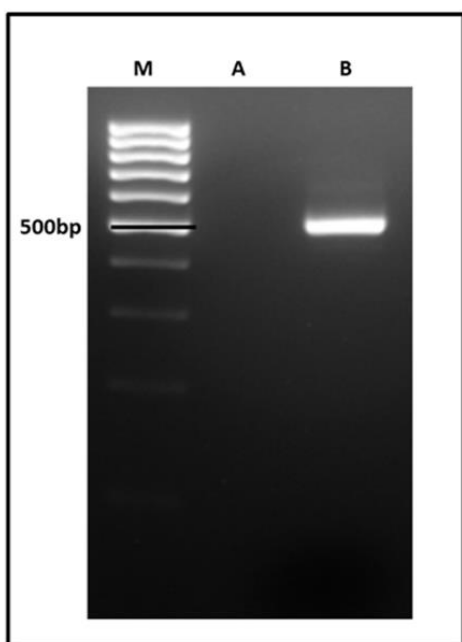


Figure 1
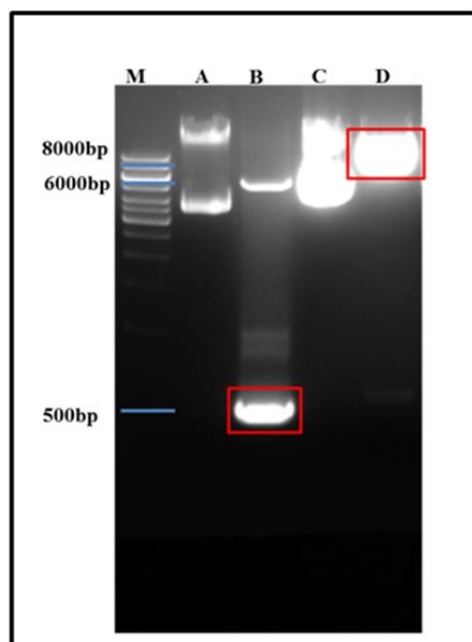


Figure 2

**Figure 1. Agarose gel electrophoresis result for analysis of the IND PCR fragment**

*(M). No signal was detected in the negative control (A).A clear band with size about 487bp, correlated with the estimated size was seen in PCR product lane (B)... Fragment sizes were calculated with Clone Manager (Version 7.01, SciEd Central).*

**Figure 2. Agarose gel electrophoresis results for analysis PCR product and pcDNA-Dest40 plasmid digestions**

*(A)Undigested PCR product, (B) digested PCR product, (C) undigested pcDNA-Dest40, (D) digested pcDNA-Dest40. Fragment sizes were calculated with Clone Manager (Version 7.01, SciEd Central).*

Both PCR product and pcDNA-Dest40 plasmid were cut by two single cut Fast Digest

enzymes, SpeI and SacI, to introduce the matching cohesive ends and then were analyzed by 1% agarose gel electrophoresis. In theoretical, restriction of PCR product should result in two bands with a size of 487bp and 4545 bp whereas pcDNA-Dest40 plasmid could be cut into 6570bp and 573bp fragments. The real result was presented in figure 2. In the agarose gel, two separated bands correlated to the estimated sizes were detected for the cut PCR product (lane B) and the restricted pcDNA Dest40 (lane D). Two bands in undigested PCR products (lane A) and pcDNA-Dest40 (lane C) could be explained by DNA supercoiling. The expected bands (shown in the red box) were cut out and used for DNA extraction.

### 3.2. Ligation and analysis pDest40-IND

A ligation of extracted IND promoter and pcDNA Dest40 linear lacking CMV promoter was performed by using T4 DNA ligase, resulted in pDest40-IND plasmid. Its map is illustrated in figure 3-I. A FastDigest restriction enzyme *Pdm*I was utilized in order to verify the ligated plasmid. There 1% agarose gel electrophoresis was used to analyze the samples. Theoretical, the plasmid is restricted with this enzyme should lead to three fragments with size of 3383bp, 2679bp and 1022bp. The result in figure 3-II indicated that three bands correlated to the estimated sizes were detected after plasmid digestion, illustrated in lane B. The uncut plasmid is applied in lane A and showed the difference in comparison to the digested plasmid. Two bands in the undigested plasmid could be explained by DNA supercoiling.
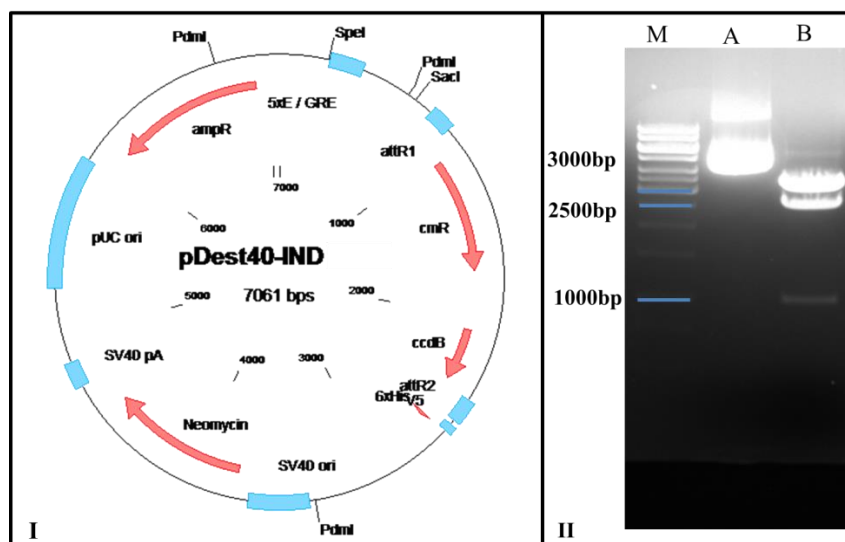


**Figure 3. Plasmid map and restriction enzyme analysis of pDest40-IND**

*I. The pDest40-IND plasmid map. The CMV promoter was replaced by IND promoter (5xE/GRE). Other sequences were kept the same as in pcDNA-Dest40 plasmid.*

*II. M) Marker. A) Undigested pDest40-IND plasmid. B) Digested pDest40-IND plasmid. Three clear bands correlated to calculated sizes were detected in the digested*

*plasmid, and show the difference in comparison to the control. Fragment sizes were calculated with Clone Manager (Version 7.01, SciEd Central).*

### 3.3. Generation of pDest40-IND-GFP

Via Gateway cloning technique, the coding sequence for green fluorescence protein (GFP) from pDONR-GFP was inserted into new the pDest40-IND plasmid, resulting in the inducible expression plasmid pDest40-IND-GFP and its map is illustrated in figure 4-I.

The plasmid was analyzed by using two of the single cut Fast Digest enzymes, *PpuM*I and *Puv*I and the correct expression plasmid pDest40-IND-GFP could be cut into two linear fragments with size of 4190bp and 2136bp. The samples were separated by 1% agarose gel electrophoresis and presented in figure 4-II.

In agarose gel, two discriminated bands correlated to the estimated sizes were seen in the digested plasmid *(lane B)*. In addition, the difference between the digested and undigested plasmid *(lane A)* is obvious. Other bands in the undigested sample could be explained by DNA supercoiling. These results demonstrated the success of the gateway cloning process.
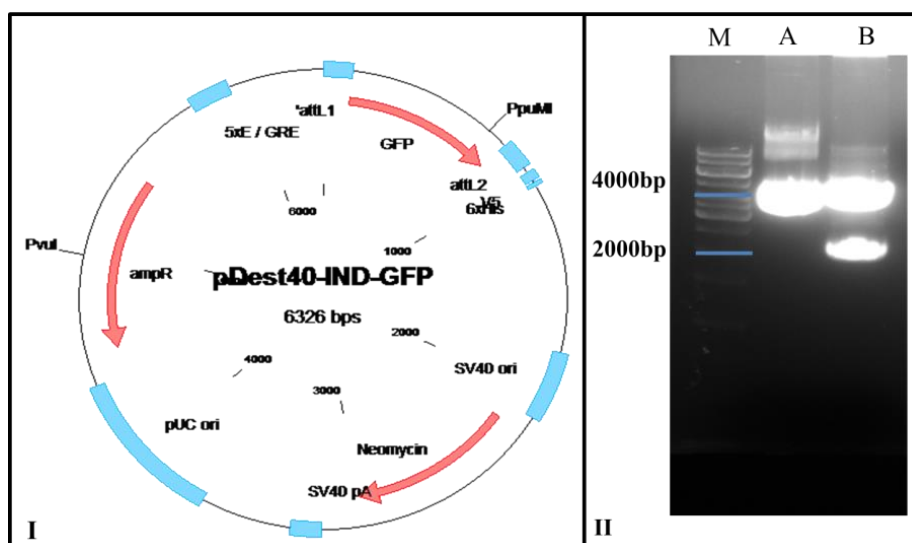


**Figure 4. Plasmid map and restriction enzyme analysis of pDest40-IND- GFP**

*I. pDest40-IND-GFP map. II. (M). Marker, A: negative control, B: digested plasmid. Two clear bands correlated to the estimated sizes were recognized in digested plasmid lane. The difference between the undigested and digested samples was seen. Fragment sizes were calculated with Clone Manager (Version 7.01, SciEd Central).*

### 3.4. Checking the function of pDest40-IND-GFP

In order to analyze the function of pDest40-IND-GFP, this plasmid and pVG-RXR plasmid with ratio 1:1 were co-transfected into HEp-2 cells using Nanofectin. For controlling, the purchased inducible plasmid, pIND-GFP and pVG-RXR plasmid was also co-transfected

into Hep-2 cells. One day following incubation, the cells were supplemented with 1µM ponasteron A to stimulate GFP expression. The results are presented in figure 5. As expected, the transfected cells without ponasteron A induction showed no signal (A). In contrast, green fluorescence signal was seen in a small amount of transfected cells with ponasteron A induction (B). The signal was also detected in the positive control cells (C). No clear difference in fluorescence signal was seen in comparison between the newly designed inducible plasmid, pDest40-IND-GFP and the purchased inducible plasmid, pIND-GFP.
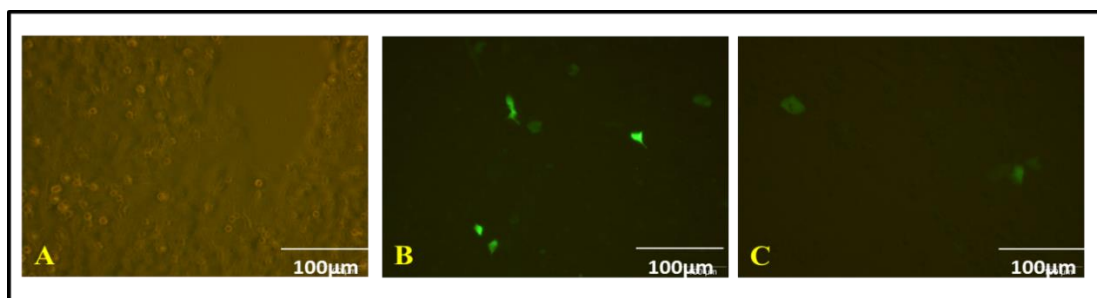


**Figure 5. Characterization of the inducible plasmid via fluorescence detecting the target gene expression**

*A) The transfected cells without induction.*
*B) The cells transfected with pDest40-IND-GFP and pVg-RXR with ponasteron A induction.*
*C) The cells were transfected with pIND-GFP and pVg-RXR with ponasteron A induction. No signal was detected in the negative control. Only small amount transfected cells showed the fluorescence signal in both new designed inducible and purchased inducible plasmid. The pictures were taken at fluorescence microscope CKX41 48hours after induction. Expose time: 2.0 s. Scale bar: 100 µm.*

### 3.5. Discussion

In general, the gene of interest was expressed under the control of *cytomegalo virus* promoter (CMV) which is methylated in a course of time (Grassi et al, 2003; Brooks et al, 2003). A class of enzymes, DNA methyl-transferase covalently links methyl group to the cytosine residues within CpG islands in CMV promoter (Grassi et al, 2003). Afterward, the particular proteins containing a methyl cytosine binding domain (MBD) are recruited and interacted with the methylated CMV promoter DNA. This could lead to block the interaction between transcription factors and promoter, resulting in down regulation of the transcription resulting in less protein expression toward zero. For this reason, CMV promoter was replaced by inducible IND promoter to generate inducible plasmid pDest40-IND. After inserting thereporter gen GFP into to form pDest40-IND-GFP, this plasmid was co transfected with pVG-RXR into Hep-2 cells and induced by ponasteron A.

A small amount of transfected cells with ponasteron A induction showed the GFP expression. This could be explained by the drawbacks of the transient transfection. First of all,

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the plasmid size could affect the transfection efficiency (Kreiss et al, 1999). The big size of the tested plasmids (pVG-RXR: 8.7kb, pDest40-IND-GFP: 6.3kb, pIND-GFP: 5kb) could be problematic for the cell transfection efficiency. Additionally, to be functional the cell had to uptake two plasmids simultaneously and was treated with 1μM ponasteron A. In general, ponasteron A would bind to ecdysone binding domain of VgEcR leading to heterodimeric interaction with RXR. The receptor was afterward bound to the glucoticoird/ecdysone response element (GRE) in IND promoter. The complex then acts as the transcription factor and initiates target gene transcription. Therefore, if one plasmid was favored to be uptake compared to another one the procedure was not completed, resulting in low amount of cells expressed GFP after induction.

## 4. Conclusion

The inducible plasmid was successfully generated. For further research, in order to circumvent the low signal problem, a stable receptor expressing cell line should be investigated. For checking the function, the pIND-GFP could be inserted into and induced by ponasteron A for GFP expression.

## References

[1]    David No, Tso - Pang Yao, and Ronald M. Evan (1995*), Ecdysone - inducible gene expression in mammalian cells and transgenic mice*, *Proc. Natl. Acad. Sci. USA*, Volume 93, pp: 3346 -  3351.

[2]    Georg Hermann Lueers, Nicole Jess, Thomas Franz (2000), *Reporter - linked monitoring of transgene expression in living cells using the ecdysone - inducible promoter system*, *European Journal of Cell Biology*, Volume 79, pp: 653 - 657.

[3]    I Oehme, S Bo¨sser, and M Zo¨rnig (2006), *Agonists of an ecdysone - inducible mammalian expression system inhibit Fas Ligand - and TRAIL - induced apoptosis in the human colon carcinoma cell line RKO*, *Cell Death and Differentiation*, Volume 13, pp:189 - 201.

[4]    *Invitrogen (2006),* Lipofectamin[TM] 2000 user guider.

[5]    Invitrogen user guider, Gateway® Technology, *A universal technology to clone DNA sequences for functional analysis and expression in multiple systems*, Available online at lifetechnology.com.

[6]     Invitrogen™ life technology (2002), *pcDNA-DEST40 Gateway™ Vector*, available online.

[7]     Kupper JH (2009*), Lab Manual and SOPs Molecular Cell Biology*. Senftenberg.

[8]     Malla Padidam, Michael Gore, D. Lily Lu and Olga Smirnova (2003), *Chemical inducible, ecdysone receptor based gene expression system for plant,* Transgenic Research, Volume 12, pp: 101 - 109.

[9]     Mirella L. Meyer - Ficca, Ralph G. Meyer. Heike Kaiser, Alexandra R. Brack, Reinhard Kandolf, Jan-Hainer Kuepper (2004), *Comparative analysis of inducible expression systems in transient transfection studies,* Analytical Biochemistry, Volume 334, pp: 9 - 19.

[10]    Patrick Kreiss, Béatrice Cameron, Ravi Rangara, Philippe Mailhe, Olivier Aguerre-Charriol, Marc Airiau, Daniel Scherman, Joel Crouzet1 and Bruno Pitard (1999*), Plasmid DNA size does not affect the physicochemical properties of lipoplexes but modulates gene transfer Efficiency*, Nucleic Acids Research*,* Volume27, No. 19.

# MIXTURE DESIGN FOR HIGH STRENGTH CONCRETE

**Ngo Si Huy, Luu Dinh Thi, Le Thi Thanh Tam, Trinh Thi Ha Phuong**

**Abstract:** Cement amount and water content are two key parameters that need to be considered for designing the mix-proportion of high performance concrete. The objective of this research is to design mixture proportions for high strength concrete with controlled amount of cement and water through the application of densified mixture design algorithm (DMDA) method, which is comparable with conventional method (ACI). Cylindrical concrete specimens in size of $10 \times 20$ cm were prepared for compressive strength test. The effect of superplasticizer (SP) on workability of fresh concrete is also investigated. Test results indicate that the concrete specimens designed by DMDA method achieve higher compressive strength than that designed by ACI method. Additionally, the use of SP significantly increases the workability of fresh concrete.

**Keywords:** High strength concrete, compressive strength, ACI method, DMDA method, superplasticizer

## 1. Introduction

High strength concrete has been defined as that having a specified compressive strength of 41 MPa or greater [1]. It is applied for concrete components that must resist high compressive loads or to reduce the structure dimension. High strength concrete is typically used in the components of high-rise structures such as columns (especially on lower floors where the load is great), shear walls, and foundations. It is also occasionally used in bridge applications as well.

Most high strength concretes were produced with a low water-to-cement ratio (less than 0.40) [2]. Thus, high amount of cement was used. However, to design concrete with high

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performance and long-term durability, the amount of water and cement content should be controlled in a suitable range [2 - 7]. High water content induced to increase pores in concrete, but the water should be provided enough for cement hydration. As suggested by Hwang and Hung (2002) [7], water content should be below 160 kg/m$^3$. Whereas, high cement content could cause cracks, volume instability, and decayed long-term performance of concrete. Therefore, pozzolanic materials, such as fly ash, slag, and silica fume have been used to partially replace the amount of cement in concrete mixture.

ACI 211.4R (1993) [1] provides the applicable method for selecting mixture proportions for high strength concrete. Recently, Hwang and Hung (2005) [8] have been developed DMDA method, which has been considered as a design method for high performance concrete with high density and a low amount of cement and water content. In this research, concrete mixtures were designed using both DMDA and ACI methods. Properties of concrete specimens prepared using these two methods were checked and compared. Moreover, the effect of SP on workability of fresh concrete was also investigated in the present study.

## 2. Experimental program

### 2.1. Materials

Binder materials used for this study were cement, fly ash, and slag with specific gravities of 3150 kg/m$^3$, 2350 kg/m$^3$, and 2850 kg/m$^3$, respectively. The fine aggregate was locally sand, passed through a No. 4 (4.75 mm) sieve, with fineness modulus of 2.75 and specific gravity of 2630 kg/m$^3$. The coarse aggregate was crushed limestone with a maximum size of 12.5 mm, specific gravity of 2650 kg/m$^3$, and dry rodded weight of 1600 kg/m$^3$. The SP with a specific gravity of 1150 kg/m$^3$ was used to control concrete workability.

### 2.2. Mixture design

ACI 211.4R (1993) [1] is known as criteria to design high strength concrete used pozzolanic materials, which is based on large previous experimental works. DMDA method is considered as a new method to design high performance concrete. In this method, the mixture proportion was divided into two phases: aggregate and paste. The aggregate phase consists of coarse aggregate, fine aggregate, and fly ash, which forms the major skeleton of concrete structure. While the paste phase includes cement, slag, water, and superplasticizer, which is for lubricating and filling pores to achieve concrete workability. In the aggregate phase, there are voids among coarse aggregates that are filled by fly ash and fine aggregate as shown in Figure 1. The key point in DMDA method is to find out the optimized amount of fly ash and fine aggregate so that aggregate phase reaches the highest density. This also means the porosity of concrete structure is minimized, thus reducing the amount of cement paste.
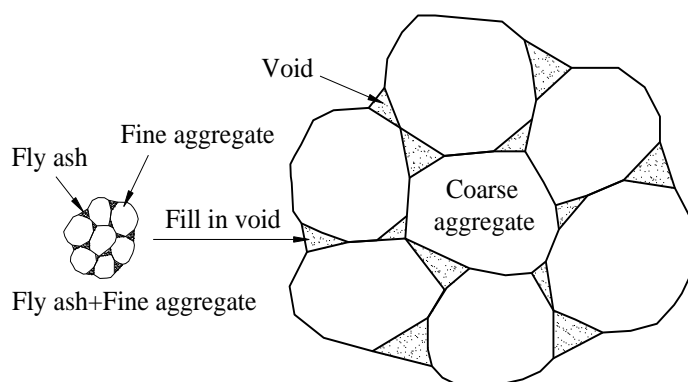
**Figure 1. Design concept of DMDA method**

*Figure 2* shows the experimental work to determine optimized amount of fly ash and sand. First, sand was filled with different percentage of fly ash to determine the bulk density of mixture. The ratio of fly ash to sand corresponding to maximum dry loose density of mixture is optimized ratio. Then, mixture of fly ash and sand under optimized ratio above was blended with different amount of coarse aggregate to find optimized amount of fly ash and sand, which was corresponding to the highest bulk density.

Two mixtures were designed based on ACI 211.4R (1993) [1] (Mix no. ACI) and DMDA method (Mix no. DMDA), as shown in Table 1. The water-to-binder ratio of 0.28 was kept the same for two mixtures. The water-to-cement ratios of ACI and DMDA mixtures were 0.43 and 0.48, respectively, higher than 0.42 as suggested by Hwang and Hung (2002) [7] to prevent autogenously shrinkage. The slag and fly ash were used to replace 10% and 25% amount of cement in ACI mixture, respectively. The amount of slag and fly ash replacement for cement in DMDA method were determined by experimental work to make the specimen with maximum density. As can be seen from Table 1, the amount of binder and water designed by DMDA method are 28% less than that designed by ACI method. The amount of cement designed by DMDA method is only 63% that designed ACI method. The purpose of adding SP in DMDA mixture is to obtain high-flowing concrete for construction requirements.



(a)                                          (b)

**Figure 2. a) Mixture of sand, fly ash, and coarse aggregate; b) determine the bulk density**

**Table 1. Mixture proportion (kg/m³)**

| Mix no. | w/b | w/c | Mix proportion (kg/m³) | | | | | | |
|---------|-----|-----|--------|---------|------|------------------|--------------------|-------|-----|
|         |     |     | Cement | Fly ash | Slag | Fine aggregate | Coarse aggregate | Water | SP |
| ACI     | 0.28 | 0.43 | 406 | 156 | 63 | 620 | 1088 | 173 | 2 |
| DMDA    | 0.28 | 0.48 | 255 | 149 | 85 | 1040 | 775 | 122 | 15 |

*__Note__: w/b=water-to-binder ratio; w/c=water-to-cement ratio; binder=cement + fly ash + slag.*

### 2.3. Test method

Cylindrical concrete specimens with 10 cm in diameter and 20 cm in length were prepared in the laboratory for the tests of slump, slump flow spread, and compressive strength. The specimens were de-molded after one day of casting and then stored in lime-saturated water at a temperature of $23 \pm 2^{\circ}C$ until the testing age. The compressive strength test was conducted at 7, 14, and 28 day ages. The reported compressive strength value is average value of three concrete specimens. Figure 3 and Figure 4 show the slump and slump flow spread tests, and compression test, respectively.
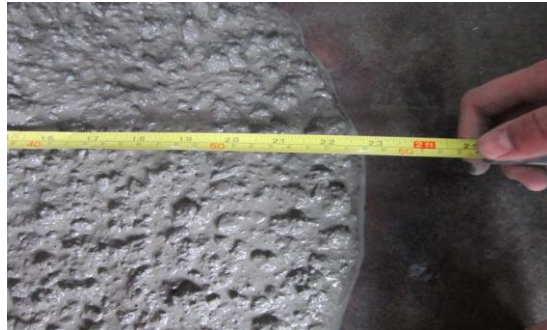


(a)                                                                 (b)

**Figure 3. a) Slump test; and b) slump flow spread test**



**Figure 4. Compression test of concrete cylinder**

## 3. Test result and discussion

### 3.1. Slump and slump flow spread

The slump and slump flow spread of ACI mixture are 5 cm and 30 cm, while those of DMDA mixture were 26 cm and 57 cm, respectively. Experimental results indicate that the concrete designed by DMDA obtained very good fresh properties as compared with ACI concrete. This finding is mainly due to the use of high SP dosage in DMDA mixture. Furthermore, the excellent slump and slump flow spread of DMDA mixture in this research may provide a possible consideration to design self-compacting concrete with high strength in the future research.

### 3.2. Compressive strength

The compressive strength development of concrete specimens over the time is shown in Figure 5. As can be seen from the figure, the respective compressive strength at the ages of 7, 14, and 28 days are 44.8, 46.9, and 67.6 MPa for ACI specimens and are 61.7, 78.6, and 79.2 MPa for DMDA specimens, respectively. It is noticed that for water-to-binder ratio of 0.28, the expected compressive strength at 28 days is 70 MPa as recommended by ACI 211.4R (1993) [1]. The compressive strength of ACI specimen is close to expected strength. While the strength value obtained from DMDA specimen is 13% higher than expectation. Under fixed water-to-binder ratio, DMDA specimens shows higher compressive strength than ACI specimens, even the amount of cement and total binder in DMDA specimens is about 63% and 78% of those in ACI specimens, respectively. The use of DMDA method to design mixture proportions can not only increase the compressive strength, but also reduces the amount of binder and cement as compared with ACI 211.4R (1993) [1] method.
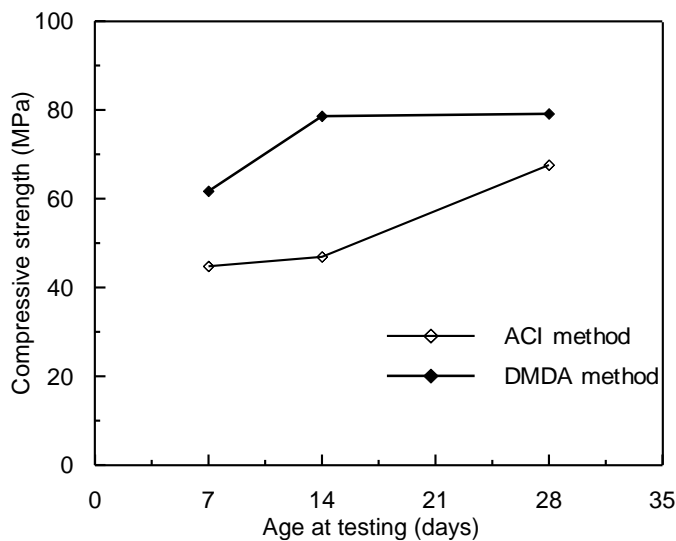


**Figure 5. The strength development of concrete**

**4. Conclusions**

Two concrete mixtures are designed followed by DMDA and ACI methods. Based on the above experimental results, some major conclusions may be drawn as follows:

(1) The use of DMDA method can reduce the amount of binder and cement, thus the amount of water is controlled.

(2) For the same water-to-binder ratio, concrete designed by DMDA method achieves a much higher compressive strength value than that designed by ACI method.

(3) The use of SP reduces the water content but increases the concrete workability significantly.

**References**

[1] American Concrete Institute (1993), *"Guide for Selecting Proportions for High-Strength Concrete with Portland Cement and Fly Ash"*, ACI 211.4R - 93, 13 pp.

[2] Caldarone, M. A. (2008), *"High-Strength Concrete: A Practice Guide"*, Taylor and Francis, 273 pp.

[3] Mehta, P. K., and Burrows, R. W. (2001), *"Building Durable Structures in the 21$^{st}$ Century"*, Concrete International, 23 (3), pp. 57 - 63.

[4] Aitcin, P., Neville, A. M., and Acker, P. (1997), *"Integrated View of Shrinkage Deformation"*, Concrete International, 19 (9), pp. 35 - 47.

[5] Neville, A. (2000), *"Water and Concrete: A Love-Hate Relationship"*, Concrete International, 22 (12), pp. 34 - 38.

[6] Mather, B. (2000), *"Use Less Cement"*, Concrete International, 22 (11), pp. 55 - 56.

[7] Hwang, C. L., and Hung, M. F. (2002), *"Comparison of ACI Mixture Design Algorithm to HPC Densified Mixture Design Algorithm in the Anti-Corrosion and Durability Design"*, Journal of Chinese Corrosion Engineering, 16 (4), pp. 281 - 296.

[8] Hwang, C. L., and Hung, M. F. (2005), *"Durability Design and Performance of Self-Consolidating Lightweight Concrete"*, Construction and Building Material 19, pp. 619 - 626.

# PILLARS AND SOLUTIONS FOR HONG DUC UNIVERSITY BECOME A MAJOR TRAINING AND RESEARCH CENTER IN VIETNAM AND SOUTHEAST ASIA IN 2030

Le Van Truong

**Abstract:** Enhancing the quality of education is one of the important strategies for social economic development plan of Vietnam in general and at Hong Duc University in particularly. Overcoming the limitations in the training of human resources, proposing and implementing solutions in a uniform level of management are essential. Moreover, human resources training will create resources and contribute to national development. Basing on formal statistics data, this article gives an overview of human resources training in Hong Duc University. Besides that, it also presents a number of solutions to improve Hong Duc University to become a strong university and attract more students and investment projects.

## 1. Introduction

After 19 years development since the Decision N°797 (1997) issued by the Prime Minister of the Socialist Republic of Vietnam for establishing Hong Duc University (HDU), HDU has obtained significant achievements and come from the lowest to middle rank in Vietnam University Education system. By 2030, with the aspiration to become the major training and research centre in Vietnam and the South East Asia. What will HDU need to do and how to achieve its goals?

## 2. Methods of study

This research applied the following methods:
- Assess the achievements gained after nearly two decades of development of HDU according to 61 criteria for accrediting universities and the strategic objectives for 2010 - 2020.
- Assess the strengths, weaknesses, opportunities and challenges to HDU's development in the future.

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- Study the choice of objectives to be achieved by 2030.
- Determine pillars solutions for HDU to become a major training and research center in Vietnam and Southeast Asia by 2030.

## 3. Research Results

### 3.1. Significant achievements after two development decades of Hong Duc university

Since 2000, HDU has established two strategies for development in the 2000 - 2010 and 2010 - 2020 periods. After 5 years of implementation of the development strategy for 2010 - 2020, HDU has obtained many important achievements. By the end of 2015, out of the 23 indicators that Strategy 2010 - 2020 outlined, 15 have been fulfilled (65.2%) and the remaining 8 indicators have not reached the target. These indicators include the proportion of foreign language students meeting international standards, the scale of training, international cooperation in training, technology products reaching the national level. The cause of the unreached targets are adjust the scale of training, actively reducing the amount of in services and regular training, lacking of research laboratories. There are a number of staff and students not being aware of the importance of English, the state budget has been cut down [5].

Compared with the 61 criteria from accreditation (issued under Decision No. 65/QD-BGD dated 01/11/2007 and Circular No. 37/TT-BGD dated 10/30/2012 of the Ministry of Education and Training), in the period 2004 - 2009, HDU has satisfied 55 out of 61 criteria (90.16%) and the number for the period 2009- 2014 is 60/61 (98.36%). Unfulfilled criteria including training programs which are periodically evaluated and implemented to lead to quality improvement based on assessment results. HDU has developed in accordance with the trajectory of higher education in Vietnam [5].

### 3.2. The strengths, weaknesses, opportunities and challenges for HDU

#### 3.2.1. The strengths

HDU has been among the central interests of the Ministry of Education and Training, the provincial Party Committee, People's Council, People's Committee of Thanh Hoa province.

After 19 years of development, HDU has confirmed its position as a leading education and training centre of Thanh Hoa, greatly contributing to the development of the province's education.

HDU has trained from 3-year-courses and 4-year-courses, to Master and Ph.D. levels.

There are high quality staffs.

There are training programs which are within updated and modernized direction under domestic and international standards, which have been converted to credit training system since 2009.

HDU has participated in testing the quality of education and has been assessed as level 1, there are some indicators reaching 2.

Staffs: perform tasks on a democratic spirit, innovation and creativity.

The financial transparency is always maintained.

### 3.2.2. Weaknesses

There are many criteria which have not met the requirements of the established criteria and ranking of higher education establishments.

8/23 criteria have not reached the 2020 - 2020 strategy.

The quality of training and the quality of scientific research have not met the needs of industrialization, modernization and international integration.

Some leaders have not kept pace with the innovation; some staff members, teachers are slow to reform, lack of creative spirit and enthusiasm for the job; working experience of management does not meet the requirements.

HDU facilities have not been commensurate with the demands of training and scientific research.

Limited financial resources, financial management is not good, backward thoughts still exist which do not meet the requirements of innovative training.

The number of works published in prestigious journals in the world is very limited.

The level of HDU autonomy is low.

### 3.2.3. Opportunities

The Vietnam political stability, obtaining many achievements of socio-economic development; The Party, the State and society's special attention, care for the development of education and training at HDU.

Higher Education law came into effect in 01.01.2013; Resolution No. 29-NQ/TW to fundamentally renew the content, comprehensive education and training and meet the requirements of industrialization - modernization in conditions of socialist - oriented market economy and international integration.

Revolutionary science and technology, especially information and communications technology, knowledge - based economy thrives.

The process of international integration, extensive on going education on a global scale in order to create favorable opportunities for our country to access to new trends, new knowledge, the education model and management education are modern.

Education in the world is going on the new trend: building a learning society, along with the conditions that ensure life - long learning; diversification, globalization, integration and cooperation with the international competition in education, etc.

People in Thanh Hoa in particular and in the whole country in general have tradition of academic excellence and care for education, will continue to take interest, high investment in education and training.

Enterprises, especially businesses with alumni of HDU hold key leadership roles, always with the support of the university and link the education of students with social needs.

The country has more than 86% of the workforce who have not been properly trained, manpower training need is a huge opportunity to develop the university.

HDU has a new generation of leaders, teachers of young, dynamic, inherit the achievements, experiences and lessons of the management of previous generations.

*3.2.4. Challenges*

The quality of human resources is low, posing challenges for the development of education and training.

The gap between the rich and the poor, uneven development among local areas.

Backward thinking, bureaucratic behavior in dealing with the education of various levels and branches of teachers and education personnel manager, which do not keep up with the rapid development of socio-economic and technological sciences;

The gap in economic and social development, science and technology, education and training between Vietnam and the advanced countries in the region, the world tends to increase.

The impact of the downside of the market mechanism in the field of education and training in general, the university and the staffs in particular has become more complex.

The growing competition for HDU in the country and abroad on training content and methods of training. Some training products have limited opportunities to be used such as: teacher training, humanities, etc.

The risk of lack of scientists and highly qualified teacher.

*3.3. Aspirations to 2030*

By 2030 HDU will have become a major training and research center in Vietnam and Southeast Asia. Specifically:
- From 2020 to 2030, it will reach level 2 out of 3 and level 1 out of 3 in the rating system of application oriented training in higher education [1].
- There will be 20 Ph.D. students who complete their dissertation. The university will expand its post graduate training to 40 specializations in master degrees, 55 specializations in undergraduate training.
- There will be at least 15 professors and 80 associate professor, the proportion of the staffs who have Ph.D. degrees will be over 45%. The rate of students who get the job suitable with their specialization will be from 60-70%, reaching level 2 out of 3.
- In 2020 and 2030 the university will reach the third position of the system of application oriented training in  higher education higher education [1].

*3.4. The four pillars and solutions*

Based on the analysis of the strengths and weaknesses of the school; trends, opportunities and risks and the school, at home and abroad and the development of higher

education, HDU is focusing on four main goals: improving team faculty, applying exchange program; modernizing infrastructure; building capacity and management responsibilities.

**Pillar 1. Develop competent faculty**

To carry out this goal, there should be at least 6 solutions:

- Lecturers must frequently have professional practice (two or three times every year) to update practical knowledge to put on lectures [1].
- Mainly, teachers play the role as a teacher and a guide, each faculty should actively learn trades, industry and the content of programs and curricula that teachers are responsible for teaching it. This is also the essence of teaching towards promoting capacity - it means to help students do and how to do it at the end of each stage of learning in schools.
- Lecturers should write and publish teaching materials (monographs, textbooks, reference books, manuals). The lecturers who have PhD or higher diplomas within seven years after the thesis defense publish 01 book which can be used in training and after 12 years publish a book for master training, they must participate in compiling the book for training [3].
- The staffs with PhD or higher diplomas within three years after the thesis defense must conduct at least 01 research at provincial level; qualified instructors with master degrees must carry out at least 01 research at university level or higher [3].
- The staffs should announce their research findings in at least 01 article every year nationally and internationally [3]. Electric teachers must be trained in teaching methodology.

**Pillar 2. Developing application oriented training**

In the current period, application oriented training is an appropriate direction, meets social needs best. *"The training program is application-oriented training and contents are targeted to build towards the development of basic research results, applying source technologies into technology solutions, process management, designing the complete tool serving the diverse needs of the people"* [1]. The program - oriented applications that require the trainer not only help learners to describe the principles that have guided mainly learners develop basic research results, applying source technologies into technology solutions, process management, designing tools to fully serve the diverse needs of the people.

When building application- oriented courses, the following steps must be performed in the following order [4]:

- Surveying the world of work today and predicts the future employment needs.
- Building career record. Career Framework is meant to be the work executed by the quest and specific activity (with the necessity of knowledge, skills and attitudes) in a discipline/profession.
- Building industry capacity profile / vocational training.

- Designing training programs (curriculum, curriculum framework, syllabi credits) industry/vocational training.
- Organizing training activities and evaluating training results.

### Pillar 3. Modernizing infrastructure

Complete the items in HDU university construction project which has been approved by the Prime Minister and Chairman of the province.

Build a laboratory for research reaching international standard.

Cycle linked to form active grassroots network of research, practice, practice outside the school, especially in foreign countries and research in Vietnam with investment from abroad.

### Pillar 4. Capacity building and management responsibilities

The fact is that no education in the world can go in the first place without a good management [6]. Institutionalization is an art which aims to achieve its objectives through the control, command, coordination and guide the activities of the university's members. To strengthen the capacity and accountability in the management of the university, it needs to implement the following solutions:

- Building an autonomous implementation roadmap of the HDU's activities.
- Being an open and transparent in all university's activities.
- Building a management system based on reasonable spirits. Increase accountability for the faculties, staff, especially the deans of each department.
- Stating detailed and clear responsibilities, issued in the legal documents (Education Law, University Regulations, etc.).

## 4. Conclusion

Following the important achievements which have been achieved in the development of nearly two decades, HDU has outlined an ambitious future, be invigorated by the development aspirations of the school officials and lecturers. Opportunities continue to open in the integration process of higher education in the country, the region and the broader international ambitions to promote it. Certainly, Hong Duc university will become a big university and creates opportunities and excellence for students in the shortest time.

## References

[1]     Decree No. 73/2015 dated September 08, 2015 of the Regulation on the stratification criteria, frame rate, the standard rate of higher education establishments.

[2]     Ministry of Education and Training, *Documents on FAQs General education program.*

[3]     Circular 36/2014 dated November 28, 2014 of the Ministry of Home Affairs Education and Training on Regulations codes and standards officer positions teaching careers in public universities.

[4]     Documentation of the project-oriented professional training, Ministry of Education and Training (Project POHE) 2013.

[5]     Le Van Truong, *Scientific arguments adjust, supplement, complete Development Strategy Hong Duc University until 2020 and vision to 2030*, Subject Provincial Science and Technology. Acceptance: November, 2015.

[6]     World Bank and Ministry of Planning and Investment, Vietnam 2035.

# A STUDY ON MULTIPLICATION OF ONCIDIUM-SWEET SUGAR BY USING CELL TISSUE CULTURE

**Le Hoai Thanh, Le Huu Can**

**Abstract:** Orchid is a specious kind of flower that brings about high economic value to flower production and flower business. Production of Orchids in Vietnam has been limited to its development, especially production of Oncidium-Sweet Sugar Orchids. Research on a process of rapid multiplication of Oncidium-Sweet Sugar Orchids by using cell tissue culture in order to create high quality varieties that help serve flower production industry. This is also hoped to contribute to the Orchids production in Thanh Hoa province.

- The most appropriate mode of disinfection for bud samples is 7 minutes + 1 minute, and for blooming samples is 7 minutes.

- Both BA and Kinetine have effects on the forming generation of the blooming Oncidium Orchids. The best treatment for BA is MS+2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar + 2 pmm BA, and for Kinetine is MS + 2% sugar + 0.1g/liter of Inositol + 6.5g agar + 2 ppm Ki.

- The best medium that contains the growth control substances for forming generation of slicing is MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar + 1 pmm BA.

- The best medium for the Oncidium Orchids' bud multiplication when added with growth control substances is: MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar + 0.5 ppm Ki.

- During the process of rapid multiplication of the Oncidium Orchids' buds, it is possible to add organic extracts to the medium (like bananas and potatoes) following the treatment:  MS + 2% of sugar + 0.1 g/liter of Inositol + 6.5g of agar + 50g Potato + 50g Banana.

**Keywords:** Sweet Sugar, disinfection, organic substances, bud multiplication process

## 1. Introduction

Orchid is a specious kind of flower that brings about high economic value to flower production and flower business. However, the production of Orchids in Vietnam has been

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limited to its development, especially production of Oncidium-Sweet Sugar Orchids. Our attempt in this study is to research on a process of rapid multiplication of Oncidium-Sweet Sugar Orchids by using cell tissue culture in order to create high quality varieties that help serve flower production industry. This is also hoped to contribute the Orchids production in Thanh Hoa province.

## 2. Subjects and research methods

### 2.1. Subjects for research

Fresh, yellow Oncidium Sweet Sugar Orchids, small flowers, and many flowers on a branch.

### 2.2. Research methods

Experiments implemented in the artificial conditions, which enable adjustments in lights and temperature, in the plant cell tissue culture labs of Hong Duc University.

The experiments were arranged as follows:

- Randomly, repeated every three times, each treatment using 10 samples.
- Regularly observed, data collected and calculated after every 10 to 15 days.
- Data analyzed using IRRISTAT.

## 3. Results and discussion

### 3.1. Effects of disinfection time on clean scale and forming generation scale of samples after 8 weeks cultured

**Table 3.1. Effects of disinfection time on clean scale and forming generation scale of samples after 8 weeks cultured**

| Observation Index / Treatment (T) | Auxiliary bud samples | | | Blooming samples | | |
|---|---|---|---|---|---|---|
| | | Clean samples | | | Clean samples | |
| | Infected samples % | Dead scale % | Forming generation scale % | Infected samples % | Dead scale % | Forming generation scale % |
| **T1: 7 mins** | 95.1 | 0.0 | 4.9 | **40.0** | **13.3** | **46.7** |
| T2: 10 mins | 95.0 | 5.0 | 0.0 | 26.7 | 60.0 | 13.3 |
| **T3: 7 mins + 1 min** | **20.0** | **20.0** | **60.0** | 20.0 | 73.3 | 6.7 |
| T4: 10 mins + 1 min | 15.0 | 65.0 | 20.0 | 0.0 | 100.0 | 0.0 |

The Table 3.1 shows that: The single disinfection for 7 minutes is best for blooming. Dual disinfection for 7 minutes + 1 minute is best for the samples as axillary buds.

*3.2. Effects of Benzamin Adenin (BA) on forming generation scale of Oncidium blooming samples*

**Table 3.2. Effects of the BA on forming generation scale of Oncidium blooming samples after 8 weeks cultured**

| Observation Index / Treatment (T) | Forming generation scale (%) | Protocorm scale (%) | Bud scale (%) |
|---|---|---|---|
| T1: MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar | 5.3 | 9.4 | 90.6 |
| T2: 0.5 ppm BA | 40.0 | 66.2 | 34.8 |
| T3: 1 ppm BA | 75.2 | 88.3 | 11.7 |
| **T4: 2 ppm BA** | **84.7** | **96.6** | **3.4** |
| T5: 3 ppm BA | 45.3 | 60.7 | 39.3 |

The data of the Table 3.2 show that: The best treatment for forming generation and Protocorm generation of blooming Oncidium Orchids is T4 (2 ppm).

*3.3. Effects of Kinetine on form generation of oncidium blooming orchids after 8 weeks in culture medium*

**Table 3.3. Effect of Kinetine on form generation scale and protocorm scale after 8 weeks**

| Observation Index / Treatment (T) | Form generation scale (%) | Protocorm scale (%) | Bud scale (%) |
|---|---|---|---|
| T1: MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar | 13.3 | 9.4 | 90.6 |
| T2: 1 ppm BA | 65.7 | 76.9 | 23.1 |
| **T3: 2 ppm BA** | **100.0** | **89.2** | **10.8** |
| T4: 3 ppm BA | 83.3 | 71.5 | 28.5 |
| T5: 4 ppm BA | 50.0 | 50.2 | 49.8 |

The data show that: The concentration of Ki that is best for blooming Oncidium Orchids' forming generation and protocorm is 2ppm.

*3.4. Effects of growth control substance on bud multiplication process*

*3.4.1. Effects of the BA on bud multiplication process*

**Table 3.4.1. Effect of the BA on multiplying coefficient after 8 weeks of culture**

| Observation Index / Treatment (T) | Bud multiplying coefficient (times/sample/ total time) | Bud creation scale (%) | Protocorm creation scale (%) |
|---|---|---|---|
| T1: MS + 20 g/ liter of saccarose + 0.1g/ litter of Inositol + 6.5g of agar | 0.38 | 6.01 | 93.09 |
| T2: T1+0.5 ppm BA | 1.63 | 53.53 | 46.47 |
| T3: T1+1 ppm BA | 1.63 | 71.24 | 28.76 |
| **T4: T1+1.5 ppm BA** | **2.12** | **76.15** | **23.85** |
| T5: T1+2 ppm BA | 1.43 | 68.47 | 31.53 |
| LSD (5%) | 0.66 | | |
| CV% | 2.20 | | |

The data show that: Concentration of the BA that is best for bud multiplication process is 1.5 ppm BA.

*3.4.2. Effects of Kinetine on the process of bud multiplication*

**Table 3.4.2. Effects of Kinetine on bud multiplying coefficient after 8 weeksof culture**

| Observation Index / Treatment (T) | Bud multiplying coefficient (times/ sample/ time) | Bud creation scale (%) | Protocorm creation scale (%) |
|---|---|---|---|
| T1: MS + 20g/ liter of saccarose + 0.1g/ litter of Inositol + 6.5g of agar | 0.38 | 8.56 | 91.44 |
| **T2: T1+0.5 ppm Ki** | **2.47** | **93.30** | **6.70** |
| T3: T1+1 ppm Ki | 2.02 | 86.71 | 13.29 |
| T4: T1+1.5 ppm Ki | 2.10 | 70.27 | 29.73 |
| T5: T1 + 2 ppm Ki | 2.20 | 56.50 | 43.50 |
| LSD (5%) | 0.10 | | |
| CV% | 2.80 | | |

The data from Table 3.4.2 show that: The adding of Ki to the culture medium would increase in the bud multiplying coefficient (T1-T4). The concentration of Kinetine which is best for bud multiplication of Oncidium Orchids is 0.5 ppm of Kinetine.

*3.5. Effects of organic substances on bud multiplication process*

**Table 3.5. Effects of organic extract on bud multiplying coefficient**
**after 8 weeks of culture**

| Observation Index / Treatment (T) | Bud multiplying coefficient (times/ sample/ time) | Bud height (cm) | Number of leaves/buds (leaves) |
|---|---|---|---|
| T1: MS + 20g/ liter of saccarose + 0.1g/ litter of Inositol + 6.5g of agar | 0.06 | 0.17 | 0.57 |
| T2: T1+ 30g Potato | 1.85 | 1.00 | 2.86 |
| T3: T1+ 50g Potato | 2,54 | 1.10 | 3.45 |
| T4: T1+ 70g Potato | 1.74 | 1.10 | 2.10 |
| T5: T1+ 100g Potato | 1.53 | 1.19 | 2.25 |
| T6: T1+ 30g Banana | 1.80 | 1.01 | 2.91 |
| T7: T1+ 50g Banana | 2.00 | 1.06 | 3.17 |
| T8: T1+ 70g Banana | 1.76 | 1.06 | 2.15 |
| T9: T1+ 100g Banana | 1.50 | 1.15 | 2.96 |
| T10: T1+ 30g Banana + 30g Potato | 1.30 | 1.39 | 2.86 |
| T11: T1+ 50g Banana + 50g Potato | 1.49 | 1.11 | 2.99 |
| T12: T1+ 70g Banana + 70g Potato | 1.49 | 1.03 | 2.47 |
| T13: T1+100g Banana + 100g Potato | 1.30 | 1.31 | 2.73 |
| LSD (5%) | 0.10 | | |
| CV% | 3.70 | | |

The data of the Table 3.5 show that: The treatments that are added with organic extract produce higher quality of bud multiplying coefficient and bud shoot than Treatment 1 that is not added with organic extract. The different organic extracts (potatoes and bananas) in an appropriate concentration produce good quality of buds and bud multiplying coefficient. The combination of these two kinds also show good results, and the best treatment is 50g Potato + 50g Banana.

*3.6. Effects of the BA and Kinetine on developmental formation of the thin slicing samples after 8 weeks observed*

*3.6.1. Research on the effects of the BA on developmental formation of the thin slicing samples*

**Table 3.6.1. Effects of the BA and Kinetine on developmental formation of the thin slicing samples after 8 weeks observed**

| Observation Index / Treatment (T) | Formation generation scale (%) | Protocorm scale (%) | Number of Protocorm/LC |
|---|---|---|---|
| T1: MS + 20g/ liter of saccarose + 0.1g/ liter of Inositol + 6.5g of agar | 6.7 | 100 | 2.4 |
| T2: T1+ 0.3 ppm BA | 100 | 100 | 2.6 |
| T3: T1+ 0.5 ppm BA | 100 | 100 | 4.4 |
| T4: T1+ 1 ppm BA | 100 | 100 | 5.2 |
| T5: T1+ 2 ppm BA | 90.1 | 100 | 4.6 |

The Table 3.6.1 shows that the best culture medium for slicing is MS+ 2% sugar + 6.5g agar + 1 ppm BA.

*3.6.2. Research on effects of Kenetine on developmental formation of the thin slicing samples*

**Table 3.6.2. Effects of Kenetine on developmental formation of the thin slicing samples**

| Observation Index / Treatment (T) | Formation generation scale (%) | Protocorm scale (%) | Number of Protocorm/LC |
|---|---|---|---|
| T1: MS + 20g /liter of saccarose + 0.1g/liter of Inositol + 6.5g of agar | 6.67 | 100 | 2.43 |
| T2: T1+ 0.3 ppm Ki | 87.50 | 100 | 4.15 |
| T3: T1+ 0.5 ppm Ki | 100.00 | 100 | 6.75 |
| T4: T1+ 1 ppm Ki | 75.12 | 100 | 5.38 |
| T5: T1+ 2 ppm Ki | 75.05 | 100 | 5.35 |

The Table 3.6.2 shows that the BA has more significant effects on the development of slicing than Ki, especially when BA added, the scale of forming generation and number of Protocorm/LC are higher than when Ki added.

## 4. Conclusion and recommendations

### 4.1. Conclusion

The most appropriate mode of disinfection for bud samples is 7 minutes + 1 minute, and for blooming samples is 7 minutes.

Both BA and Kinetine have effects on the forming generation of the blooming Oncidium Orchids. The best treatment for BA is MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar + 2 pmm BA, and for Kinetine is MS + 2% sugar + 0.1g/liter of Inositol + 6.5g agar + 2 ppm Ki.

The best medium that contains the growth control substances for forming generation of slicing is MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar + 1 pmm BA.

The best medium for the Oncidium Orchids' bud multiplication when added with growth control substances is: MS + 2% of sugar + 0.1g/ liter of Inositol + 6.5g of agar + 0.5 ppm Ki.

During the process of rapid multiplication of the Oncidium Orchids' buds, it is possible to add organic extracts to the medium (like bananas and potatoes) following the treatment: MS + 2% of sugar + 0.1 g/liter of Inositol + 6.5g of agar + 50g Potato + 50g Banana.

### 4.2. Recommendations

It is possible to apply researched techniques to the multiplication of the Oncidium Orchids.

Continue developing the processes of multiplying different kinds of Orchids with a more focus on native Orchids which are rapidly extinction.

## References

[1]     Nguyen Hoang Loc, Mai Van Pho (2000), *Preliminary investigation orchid species composition of Thua Thien Hue and conservation in vitro initially some species here*. Biological Journal 22 (3b): 173 - 178.

[2]     Nguyen Quang Thach, Hoang Thi Nga (2000), *Applied research methods in human culture quickly sliced vanda orchid, Cattleya and Phalaenonopsis*. Journal of Agriculture and Food Branch, No. 462. 12 / 2000. 546 - 552

[3]     Nguyen Quang Thach (2005), *Orchid - technique selection, propagation and cultivation*, Hanoi Agriculture Publisher.

[4]     Le Van Tuong Huan, Takamura T, Tanaka M (2004a), *Callus formation and plant regeneration from callus through somatic embryo structures in Symbidium orchid*, Plant Science 166: 1443 - 1449.

[5]     Le Van Tuong Huan and Tanaka M (2004b) *Callus induction form protocorm-like body segments and plant regeneration in Cymbidium (Orchidaceae)*, The Journal of Hortucultural Science and Biotechnology 79 (3): 406 - 410.

[6]     Murashige T, Skoog F (1962) *A revised medium for rapid growth and bioassays with tobacco tissue cultures,* Physiologia Plantarum 15: 473 - 497.

# MIDDLEMEN BEHAVIOR IN VIETNAM'S TRADITIONAL FOOD DISTRIBUTION SYSTEM: THE CASE OF UPSTREAM MARKET POWER

**Ngo Chi Thanh**

**Abstract:** Based on the Vietnamese case, this paper proposes an industrial organization model of the middlemen behavior in the traditional food distribution system for developing countries. This conventional system is often characterized by small farmers and of several retailers called middlemen who sell their products on market. Since most of works in this field have adopt an empirical approach, the focus of our study in this paper will be instead on theoretical model. In order to analyze this situation, we borrow several arguments from the theory of imperfect competition. We assume that middlemen have oligopoly market power in the upstream of the food system. We defined the consumer behavior by discrete choice model and study the quantity flow from small producers to the consumers by mean of Cournot competition.

**Keywords:** Food distribution, imperfect competition, middlemen, opligopsony power

## 1. Introduction

Viet Nam's traditional food distribution system was formed and developed through many stages. In recent years, the traditional system has been largely developed to deliver enough foods to the consumers. According to the Viet Nam's General Statistic Office, as 2015, there exists 8550 markets (traditional organized bazaar) in the whole country (General Statistic Office (GSO), 2015). This conventional system accounts for the majority of delivering agricultural products since most of the food production is distributed by this system in domestic market. In this system, the flow of foods basically moves from the farmers to the consumers through several collectors called the middlemen.

The behaviors of middlemen and the traditional distribution system has some typical characteristics. Middlemen go around farm fields to buy foods from farmers and sell these products in the traditional markets (see Wiersinga, 2004), which are characterized by having basic but poor conditions and sell products without really taking care to the quality of the products (see Maruyama and Trung 2007, 2010, 2012). Because of acting as an intermediary between the farmers and the consumers, the behavior of the middlemen and their market power has an effect on both the wealth of consumers and on the profit of farmers. Despite the

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fact that the middlemen is the key factor to deliver products from farmers to the consumers, they are, however, always thought to gain excessive profit from the farmers. Based on this observation, the objective of this paper is to study the behavior of the middlemen in the traditional food distribution system. Since most of food producers are small farmers who only exploit small lands (see Moustier *et al.*, 2007 and Hung P.V *et al.*, 2007) and live in rural and pre-urban areas at commune level (see GSO, 2015), this paper focuses on studying middlemen behavior in the case of upstream market power. This case typically based on the fact that there are the large number of farmers, who just exploit in small part of land and live at commune level around the city (or pre-urban areas). On the other hand, there are not too many middlemen who transport foods to the cities to sell at competitive markets.

The subject of market power and middlemen behavior was studied in many literatures. Johri and Leach (2000) modeled the middlemen behavior on the relationship with the allocation of heterogeneous goods. Fingleton (2003) examined the competition among middlemen when buyers and sellers can trade directly. Robinstein and Wholinsky (1987) studied a model of a market with sellers, buyers, and middlemen, which highlighted the relation between the trading and the distribution of the gains from trade. Related to market power of middlemen, Chau, Goto and Kanbur (2007) studied on middlemen, non-profits, and poverty. They build the model of middlemen by using the Bertrand Benchmark competition. Merel, Sexton and Suzuky (2009) argued that high transport cost can be important reason which can lead to middlemen's market power. The focus of our study in this paper will be on theoretically modeling the middlemen behaviors in the food market products of low quality.

In the case of Viet Nam, there are several studies about the traditional retail system. Maruyama and Trung (2007) described the traditional retail system in Viet Nam, and point out the weak points of this system to compare with supermarkets. Wijk *et al.* (2006) analyzed the characteristics of the traditional vegetable retail system in Ha Noi, which describes the vegetable producers, the traders, and the location of bought these products. Wiersinga (2004) distinguished two types of collectors in Viet Nam, which are seasonal collectors and professional collectors. He observes that collectors go around farm fields, negotiate the price, then transport and sell fruits and vegetables to the markets. P. Moustier *et al.* (2007) described the trader of vegetables in Ha Noi, they emphasized that middlemen are responsible for collecting foods from different locations. Based on this observation, it is obviously that there has not yet the theoretically modeling of the middlemen behavior in the food markets of Viet Nam. This is the reason why we propose a theoretical model of middlemen market behavior in the traditional food distribution system.

## 2. Methodology and frameworks

Since the intermediaries and their market powers are largely considerable in the food market(see Myers *et al.*, 2010, McCorriston 2002, Sexton and Lavoie 2001, and Ngo Chi Thanh 2015). The strategy of this paper is to borrow several arguments based on the theory of

the imperfect competition. We assume that the middlemen have oligopoly market power in the upstream of the food distribution system. This is typically the case of Viet Nam where middlemen buy foods from farmers, then transport and sell them to the consumer markets. Small farmers are characterized by a production function, and the consumer's behaviors are defined by a discrete choice model. The inverse demand function is introduced associated to Mussa - Rosen type of demand with vertically differentiated products (Mussas and Rosen, 1978). Since we introduce Count competition, we assume that the middlemen are able to anticipate the effect of their demand or supply for fruits and vegetables on the prices that should be paid to the farmers. From this point of view, the middlemen market behavior is analyzed in the case of upstream market power.

Under such consideration, we construct the model of middlemen in the traditional food distribution system for developing countries typically based on the context in Viet Nam. Based on the optimal profit problem of middlemen in market competition, we characterize the behavior of middlemen at market equilibrium in the case of upstream market competition.

## 3. General assumption and notation

### 3.1. The traditional Food Distribution System

We assume that the foods, which middlemen sell on markets, are products with low quality. This is typically the case of Viet Nam, because: (i) the middlemen do not add more value for the products which they buy from farmers, and (ii) the traditional retail markets are described as market low quality by having basic conditions but normally without preserved equipment, lack of waste treatment systems, and without branded name. From that point of view, the food distribution system is described as following:

Farmers (producers) ------ Middlemen (collectors) ------ market low quality

In this system, we assume that there is only one level of intermediaries, and middlemen have relationship with both market sides of the food system. From that point of view, middlemen buy food from farmers with the quantity denoted by $Q_m$, they paid to farmers the food price $P_{fm}$. The quantity, which the middlemen sell at the final market low quality, denoted $Q_\ell$. We assume that, middlemen will sell all the quantity which he buys from farmers to the consumers market which implies that the quantity at final market must be equal to the supply of the farmers or in other word, $Q_\ell = Q_m$. Middlemen sell foods to the consumers with the price $P_\ell$. Farmers obtain profit $\pi_{fm}$, and the wealth of middlemen remained when selling products to the market is denoted by $\pi_m$.

### 3.2. Farmers, middlemen and the consumers

We introduce N farmers supplying foods for the middlemen. A farmer is characterized by production function. Since a farmer is symmetric and products are homogeneous, the production function of a farmer is characterized:

$$q = f(\lambda)$$

With $\lambda$ is denoted for the labor used which transform in fruits and vegetables.

We introduce m middlemen indexed $i$. They are symmetric and characterized by a linear cost function with simply is the transportation cost. The cost function therefore is defined as following:

$$C_m(q_{m,i}) = C_m . q_{m,i}$$

Since the traditional food market is described as market low quality, and middlemen do not really taking care about the quality of the products, we define the willingness to pay by the low quality index which denoted by $\ell$. Consumers at market low quality actually have two choices, they can buy low quality or do not buy the products.

With the weight in the utility $\theta \in [0, K]$, if consumers buy low quality, the utility in this case is given by $U_\ell^\theta = \theta . \ell - P_\ell$, and if consumers buy nothing $U_\emptyset = 0$.

From the utility function, of course we can consider that, the index low quality is larger than the cost of the middlemen in the natural way. Since K is the ranking of population who may enjoy to buy in market low quality, we have natural assumed that $\ell K > C_m$. This assumption implies that the willingness to pay must be larger than the cost of the middlemen.

## 4. Theoretical modeling

### 4.1. Demand for low quality food

Let us now compute the demand for low quality, we obviously have two cases:

*Case 1:* Consumers buy nothing, since $\theta \in [0,K]$, we immediately observe, for $P_\ell > \ell K$, that for each individual $\theta$, $\max\{U_\ell^\theta\} < U_\emptyset$, in other words, nobody wants to buy either low quality food.

*Case 2:* Demand for low quality when we take prices with the property that $P_\ell \le \ell K$. Since the low quality good is increasing in $\theta$, we identify the agent $\underline{\theta} = \left(\frac{P_\ell}{\ell}\right)$ is indifferent between buying nothing and buying low quality.

But this requires that $0 \le \underline{\theta} \le K$. Since the consumers are uniformly distributed on $[0,K]$, the demands $D_\ell(p_\ell)$ for low quality food are respectively given by:

$$D(p_\ell) = \begin{cases} 0 \; if \; P_\ell > l\mathrm{K} \\ \left[K - \dfrac{P_\ell}{\ell}\right] \; if \; P_\ell \le \ell\mathrm{K} \end{cases}$$

Since we have in hand $D(p_\ell)$, we can verify the inverse demand function, the inverse demand correspondence P:$(Q_\ell) \in$ R.² therefore is given by

$$P_\ell(Q_\ell) = \ell(\mathrm{K} - Q_\ell) \; if \; Q_\ell \gneqq 0 \qquad (2)$$

If we have in hand: (i) the production function of the farmers; (ii) the price $P_{fm}$ paid to the farmers by middlemen; (iii) and the inverse demand function; we can now move to study middlemen behavior.

### 4.2. Upstream Market Power and profit maximization

We now move to the case of imperfect competition in that middlemen have an oligopsony power over the farmers. Since we introduce Cournot competition, we assume that the middlemen are able to anticipate the effect of their demand for fruits and vegetables on the price that should paid to the farmers. This anticipated price is given by $P_{fm}\left(\sum_{j=1,j\neq i}^{m} q_j^* + q_i, N\right)$. The proposition of equilibrium is therefore given by:

**Proposition:** *At equilibrium of imperfect competition in the upstream case:*

(i) Middle man maximize profit:

$$\forall i, q_i^* \in max_{q_i}\left(P_\ell - P_{fm}\left(\sum_{j=1,j\neq i}^{m} q_j^* + q_i, N\right) - c_m\right).q_i$$

(ii) $P_\ell(Q_\ell) = \ell(K - Q_\ell) \ if \ Q_\ell \geqq 0$

(iii) $P_{fm}\left(\sum_{j=1,j\neq i}^{m} q_j^* + q_i, N\right); \sum_{j=1}^{m} q_j^* = D(p)$

From this model, we observe in the case of upstream market power that:

(i) Profit of middlemen depends on price selling to consumers $P_\ell$, price given to farmers$P_{fm}$ and the cost$c_m$. To study how this model of oligopoly case linked to the case of Vietnam, let us firstly describe more specifically the situation in Vietnamese case. First of all, this upstream market power case is typically based on the fact that: there are the large number of farmers, who just exploit in small part of land and live at commune level around the city (or pre - urban areas). On the other hand, there are not too many middlemen who transport foods to the cities to sell at competitive markets. The basic property of this case therefore appears in the way that there is a distortion expected to perfect competition in the price paid to farmers.

(ii) We observe that: the price paid by middlemen to the farmers $P_{fm}\left(\sum_{j=1,j\neq i}^{m} q_j^* + q_i, N\right)$ directly depends on the numbers of middlemen, the number of farmers, the willingness to buy of consumers and the cost of middlemen. We can consider that, more competition between middlemen (more middlemen *m*) reduce the price given to the farmers; moreover, more number of the farmer (*N* very large) also reduce the price which farmers receive from middlemen. This illustrates the situation in Viet Nam: middlemen paid to the farmers at very low prices when the number of farmers is very larger. In fact, it exists when several same products are produced by numerous farmers and are harvested at the same time but do not have enough preserved condition to keep it longer. As consequence, most of farmers try to sell it as soon as possible at cheap price. In contrast, farmers sell at higher price since the number of farmers decreases; this case appears when farmers produce the products which are not very popular. For instance, some products are grown and harvested in sub-crop and sold at higher prices.

(iii) If we consider from the model that, the cost of middlemen ($c_m$) has directly affected on the profit of the middlemen, it implies that the higher cost may lower the profit of the farmers. Also, in downstream, the higher cost of middlemen causes higher price selling products to consumes.

**5. Policy Implication**

Since we construct the theoretical model of middlemen behavior base on an imperfect competition approach, let us now move to discuss the policy implication directly toward increasing the wealth of farmers reducing market power of the middlemen based on the intervention on market imperfect competition. In more precisely.

*5.1. Land reform*

According to General Statistic Office of Viet Nam (GSO), by the year 2011, there are still 69% of households using agricultural production land with scale under 0,5 ha, and 34,7 % households with land scare under 0,2 ha (see GSO, 2012). Such small lands can be seen to have an impact on the benefit of small food producers and consumers as well. Based on this consideration, it is obviously that, if small lands can be used more effectively and frequently, it may not only improve their productivity but also, control food market imperfect competition.

If we have in mind that the profit of the farmers depends on the supply quantity of the food, we observe that it is important to conduct land reform policy. This instrument is expected to improve productivity and create quantity shock in supply market of the farmers. Of course, land reform policy can reduce market power of farmers but fortunately they gain benefit by supplying more foods in the market.

*5.2. Implemented Cooperative*

Since most of the food producers are small farmers, the appearance of cooperatives is a solution to support small farmers in accessing product markets. In fact, cooperative will improve market power of farmers. This organization support farmers in delivering their product by several activities. For instance, cooperative adds value to products including package and brand name for the products, food preservation and negotiate contract with modern channel.

Moreover, when farmers serve for cooperatives, they not only receive incentive quantity price paid from cooperative but also obtain profit sharing from this organization. This is the reason why farmers have opportunities to increase their wealth when supplying foods through cooperatives.

*5.3. Improve infrastructure to reduce transaction cost*

It can be seen that the higher of transaction cost leads to the higher market power of middlemen. That is the reason why we introduce the solution of improve infrastructure. This instrument in fact reduce market power of middlemen. Based on the competitive model of middlemen behavior, we observe that since the infrastructure is in good condition, it will reduce the cost of the middlemen and therefore farmers have opportunities to receive higher price paid from middlemen.

**6. Conclusion**

We present the model of middlemen behavior in the traditional food distribution system. Based on an imperfect competition approach, the paper focuses on economic analysis of the behavior of middlemen at market equilibrium. We show that, since middlemen act as intermediaries between farmers and consumers, their market power directly affects the wealth of both food producers in the upstream and consumers in the downstream of the food system. We indicate that, since middlemen have market power in the upstream, there is always a distortion with respect to perfect competition in the price paid to farmers and sold to the consumers. As a consequence, the wealth of farmers becomes lower even consumers buying foods at higher price. This is the reason why we can go to conclude that with their market power, middlemen capture some profit from the farmers and also take a part in the wealth of the consumers in traditional food distribution system. These results make following intuitions particularly in the context of Viet Nam where the price of fruits and vegetables fluctuates and the intermediaries always exercise a pressure on the price paid to the farmers while they sell at very high prices at consumer market (see Maathuis, 2006; Wiersinga 2004; and Moustier 2007).

Based on the result of middlemen behavior model, we analyze policy implication directly toward improving the wealth of food producers and reducing market power of the middlemen. The main policy focuses on land reform to create productivity shock, develop cooperative to support farmers accessing product market, and improve infrastructure to reduce market power of middlemen.

**References**

[1]    Chau, N.H., H. Goto, and R. Kanbur (2009), *"Middlemen, Non-Profits, and Poverty"*, C.E.P.R Discussion papers, CEPR Discustion papers:7459, http://www.cepr.org/pubs/dps/DP7459.asp

[2]    Cadilhol J.J, P. Moustier, N. P. Poole, P.T.G Tam and A. P. Fearne, 2006, *"Traditional vs. Modern Food System? Insights from Vegetable Supply Chains to Ho Chi Minh city (Viet Nam)*, Development policy review, 2006, (24) 1:31 - 49.

[3]    Figuie M. (2003)., *"Vegetable Consumption Behavior in Vietnam".* In: Susper Project "Sustainable Development of Peri-urban Agriculture in South-east Asia (Cambodia, Lao, Vietnam). Hanoi, AVRDC, MAE, 25 p.

[4]    Fingleton, J., (1997), "*Competition Among Middlemen When Buyers and Sellers Can Trade Directly"*, The Jounal of Industrial Economics, Volume XLV, No 4, December 1997.

[5]    Genenal Statistic Office of Vietnam (2011), *"Statistical Year Book of Viet Nam 2011"*, Statistical Publishing House, 876p.

[6]    General Statistics Office of Vietnam (2012), *"Result of the 2011 Rural, Agricultural and Fishery Cencus"*, Statistical Publishing House - 2012.

[7] Hung. P. V., et al., (2007), *"The Economics of Land Fragmentation in the North of Vietnam"*, Australian Journal of Agricultural and Resource Economics 51: 195 - 211.

[8] Johnri, A. and J. Leach., (2000), *"Middlemen and the Allocation of Heterogeneous Goods"*, International Economics Review, Vol. 43, No.2, May 2002.

[9] Koen Maathuis (2006), *"Market Access for Small Family Farmers in 2015*", Final Report on Preparation Study:
http://veco.vredeseilanden.org/files/docs/sacd/Vietnam_internationalforum_ENG.pdf

[10] Merel, P.R., R.J. Sexton, A. Suzuky., (2009), *"Optimal Investment in Transport Infrastructure When Middlemen Have Market Power: A Developing Countries Analysis"*, American Journal of Agricultural Economics, 91 (2), 462 - 76.

[11] Maruyama. M and L. V. Trung., (2007), *"Supermarket in Viet Nam: Opportunies and Obstacles*", Asian Economic Journal 2007, Vol.21 No. 1, 19 - 46.

[12] Maruyama. M and L. V. Trung, (2010), *"The Nature of Informal Food Bazaars: Empirical Results for Urban Hanoi, Vietnam",* Journal of Retailing and Consumer Services, Vol.17, Issue 1, pp.1 - 9.

[13] Maruyama. M and L. V. Trung., (2012), *"Modern Retailers in Transition Economies: The case of Viet Nam"*, Journal of Macro Marketing 32 (1), 31 - 51.

[14] Mergenthaler. M, Weinberge. K, Qaim. M., (2009), *"The Food System Transformation in Developing Countries: A Disaggregate Demand Analysis for Fruits and Vegetables in Viet Nam"*, Food Policy 34 (2009) 426 - 436.

[15] Myers J. R., R.J. Sexton and W.G. Tomek., (2010), *"A Century of Research on Agricultural Markets"*, American Journal of Agricultural Economics 92(2): 376 - 402.

[16] Moustier. P, (2007). *"Final Summary Report of Susper (Sustainable Development of Peri-urban Agriculture in South-East Asia)"*. Hanoi, The Gioi Publishers, 144 p.

[17] Moustier. P, Phan. T.G.T, Dao. T.A, Vu. T.B, Nguyen. T.T.L., (2010), *"The Role of Farmer Organizations in Supplying Supermarkets with Quality Food in Viet Nam"*, Food policy 35 (2010) 69 - 78.

[18] McCorriston, S, (2002), "*Why Should Imperfect Competition Matter to Agricultural Economists?"*, European Review of Agricultural Economics Vol 29 (3) (2002) pp. 349 - 371.

[19] Mussa, M., Rosen, S, 1978. *"Monopoly and Product Quality"*. Journal of Economic Theory 18, 301--317Journal of Economics theory 18, 301 - 317.

[20] Ngo Chi Thanh, (2015), *Market power in agricultural product market: a theoretical review and linking to context of Vietnam,* Vietnam Journal of Rural Development (in Vietnamese), ISSN 1859 - 4581.

[21] Robinstein, A, and A. Wholinsky. (1987), *"Middlemen"*, The quarterly Journal of Economics, August 1987.

[22] Rogers Richard T. and Richard J. Sexton, (1994), *"Assesing the Important of Oligopsony Power in Agricultural Markets"*, American Journal of Agricultural Economics, Vol. 76, No 5. pp. 1143 - 1150.

[23]    Sexton R. J. and Nathalie Lavoie, (2001), *"Food Processing and Distribution: an Approach Industrial Organization"*, Handbook of Agricultural Economics, vol. 1, Edited by B. Garner and G.Rausser, Elsevier Science B.V.

[24]    Van Wijk M.S et al., (2006), *"The Traditional Vegetable Retail Marketing System of Ha Noi and the Possible Impacts of Supermarkets"*, Acta Horticulturae, volume 699, P 465 - 475.

[25]    Wiersinga R., (2004), *"Farmer's Strategies to Increase the Price of Vegetable; Research on Marketing Channel Choice and Marketing Timing in Viet Nam"*. VEGSYS project report no. PR 26, www.vegsys.nl.

# ON NON - LINEAR APPROXIMATIONS OF PERIODIC FUNCTIONS OF BESOV CLASSES USING GREEDY ALGORITHMS

**Mai Xuan Thao**

**Abstract:** In the present paper, we extend the results of Dinh Dung [5] on non-linear $n$-term $L_q$ - approximation and non-linear widths to the Besov class $SB_{p,\theta}^{\omega}$ where $1 \le p, q \le \infty$, $0 < \theta \le \infty$, and $\omega$ is a given function of modulus of smoothness type.

**Keywords:** Non-linear approximation, non-linear widths, Besov classes, Greedy algorithms

## 1. Introduction

Recently it has been of great interest in non-linear $n$-term approximations.

Among many papers on this topic we would like to mention [6], [7], [8] and [10] which are related to our paper. For brief surveys in non-linear $n$-term approximation and relevant problems the reader can see [4], [6].

Let $X$ be a quasi - normed linear space and $\Phi = \left\{ \varphi_k \right\}_{k=1}^{\infty}$ a family of elements in $X$. Denote by $M_n(\Phi)$ the set of all linear combinations $\varphi$ of $n$ free terms of the form $\varphi = \sum_{k \in Q} a_k \varphi_k$, where $Q$ is a set of natural numbers having $n$ elements. We also put $M_0(\Phi) = \{0\}$. Obviously, $M_n(\Phi)$ is a non-linear set. The approximation to an element $f \in X$ by elements of $M_n(\Phi)$ is called the $n$-term approximation to $f$ with regard to the family $\Phi$. The error of this approximation is measured by:

$$\sigma_n(f, \Phi, X) := \inf_{\varphi \in M_n(\Phi)} \|f - \varphi\| \tag{1}$$

Let $W$ be a subset in $X$. Then the worst case error of $n$-term approximation to the elements in $W$ with regard to the family $\Phi$, is given by:

$$\sigma_n(W, \Phi, X) := \sup_{f \in W} \sigma_n(f, \Phi, X) \tag{2}$$

An algorithm of the $n$-term approximation with regard to $\Phi$ can be represented as a mapping $S$ from $W$ into $M_n(\Phi)$. If $S$ is continuous, then the algorithm is called continuous.

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Denote by $\mathcal{F}(X)$ the set of all bounded $\Phi$ such that for any finite - dimensional subspace $L \subset X$, the set $\Phi \bigcap L$ is finite. We will restrict the approximation by elements of $M_n(\Phi)$ only to those using continuous algorithms and in addition only for families $\Phi$ from $\mathcal{F}(X)$.

The $n$-term approximation with these restrictions leads to the non-linear $n$-width $\tau_n(W, X)$ which is given by:

$$\tau_n(W, X) := \inf_{\Phi, S} \sup_{f \in W} \|f - S(f)\| \qquad (3)$$

Where the infimum is taken over all continuous mappings from $W$ into $M_n(\Phi)$ and all families $\Phi \in \mathcal{F}(X)$. The non-linear $n$-width $\tau_n'(W, X)$ is defined similarly to $\tau_n(W, X)$, but the infimum is taken over all continuous mappings $S$ from $W$ into a finite - dimensional subset of $M_n(\Phi)$ or equivalently, over all continuous mappings $S$ from $W$ into $M_n(\Phi)$ and all finite families $\Phi$ in $X$.

Let $l_\infty$ be the normed space of all bounded sequences of numbers $x = \{x_k\}_{k=1}^\infty$ equipped with the norm

$$\|x\|_\infty := \sup_{1 \leq k < \infty} |x_k|$$

Denote the set of all $x \in l_\infty$ for which $x_k = 0, k \notin Q$ by $M_n$.

Consider the mapping $R_\Phi$ from the metric space $M_n$ into $M_n(\Phi)$ which is defined as follows

$$R_\Phi(x) := \sum_{k \in Q} x_k \varphi_k$$

where $x = \{x_k\}_{k=1}^\infty$ and $x_k = 0, k \notin Q$. Notice that $M_n(\Phi) = R_\Phi(M_n)$ and if the family $\Phi$ is bounded, then $R_\Phi$ is a continuous mapping. Any algorithm $S$ of the $n$-term approximation to $f$ with regard to $\Phi$, can be treated as a composition $S = R_\Phi o G$ for some mappings $G$ from $W$ into $M_n$. Therefore, if G is required to be continuous, then the algorithm $S$ will also be continuous. These preliminary remarks are a basis for the notion of the non-linear $n$-width $\alpha_n(W, X)$ which is given by:

$$\alpha_n(W, X) := \inf_{\Phi, G} \sup_{f \in W} \|f - R_\Phi(G(f))\| \qquad (4)$$

where the infimum is taken over all continuous mappings $G$ from $W$ into $M_n$ and all bounded families $\Phi$ in $X$.

The non-linear widths $\tau_n, \tau_n', \alpha_n$ were introduced by Dinh Dung [5]. There are other non-linear $n$-widths which are based on continuous algorithms of non-linear approximations, but different from the $n$-term approximation. They are the Alexandroff $n$-width $\alpha_n(W, X)$,

the non-linear manifold $n$-width $\delta_n(W,X)$, introduced by DeVore, Howard and Micchelli [2], the non-linear $n$-width $\beta_n(W,X)$ (see [5] for its definition). All these non-linear $n$-widths are different. However, they possess some common properties and are closely related (see [6] for details).

We now give a definition of Besov. Let $1 \leq q \leq \infty$ and $\mathbb{T} := [-\pi, \pi]$ be the torus. Denote by $L_q = L_q(\mathbb{T})$ the normed space of functions on $\mathbb{T}$, equipped with the usual $p$-integral norm. Let

$$\omega_l(f,t)_q := \sup_{|h|<t} \left\| \Delta_h^l f \right\|_{L_q}$$

be the $l$-th modulus of smoothness of $f$, where the $l$-th difference $\Delta_h^l f$ is defined inductively by

$$\Delta_h^l := \Delta_h^1 \Delta_h^{l-1}$$

Staring from

$$\Delta_h^l f := f(. + h/2) - f(. - h/2).$$

The class $MS_l$ of functions $\omega$ of modulus of smoothness type is defined as follows. It consists of all non-negative $\omega$ on $[0,\infty)$ such that

(i) $\omega(0) = 0$.

(ii) $\omega(t) \leq \omega(t')$ if $t \leq t'$.

(iii) $\omega(kt) \leq k^l \omega(t)$ for $k = 1,2,3,\ldots$

(iv) $\omega$ satisfies Condition $Z_l$, that is, there exist a positive number $a < l$ and positive constant $C_l$ such that

$$\omega(t)t^{-a} \geq C_l\omega(h)h^{-a}, \ \ 0 \leq t \leq h$$

(v) $\omega$ satisfies Condition $BS$, that is, there exist a positive number $b$ and positive constant $C$ such that

$$\omega(t)t^{-b} \geq C\omega(h)h^{-b}, \ \ 0 \leq t \leq h \leq 1$$

Let $\omega \in MS_l, 1 \leq p \leq \infty, 0 < \theta \leq \infty$. Denote by $B_{p,\theta}^{\omega}$ the space of all functions $f \in L_p$ for which the Besov semi-quasi norm

$$|f|_{B_{p,\theta}^{\omega}} := \begin{cases} \left( \int_0^{\infty} \left\{ \omega_l(f,t)_p \big/ \omega(t) \right\}^{\theta} dt/t \right)^{1/\theta} & for \ \theta < \infty \\ \sup_{t>0} \left\{ \omega_l(f,t)_p \big/ \omega(t) \right\} & for \ \theta = \infty \end{cases} \qquad (5)$$

is finite. The Besov quasi-norm is defined by

$$\|f\|_{B_{p,\theta}^{\omega}} := \|f\|_p + |f|_{B_{p,\theta}^{\omega}} \tag{6}$$

For $1 \le p \le \infty$, the definition of $B_{p,\theta}^{\omega}$ does not depend on $l$, it means for a given $\omega$, (5) and (6) determine equivalent quasi-norms for all $l$ such that $\omega \in MS_l$ (see [4]). Denote by $SB_{p,\theta}^{\omega}$ the unit ball of the Besov space $B_{p,\theta}^{\omega}$.

The trigometric polynomial

$$V_m(t) := \frac{1}{3m^2} \sum_{k=m}^{2m-1} D_k(t) = \frac{\sin\dfrac{mt}{2}\sin\dfrac{3mt}{2}}{3m^2\sin^2\left(\dfrac{t}{2}\right)}$$

is called the de la Vallée Poussin kernel of order $m$ where $D_m(t) = \sum_{|k| \le m} e^{ikt}$ is

the Dirichlet kernel of order $m$.

We let

$$\upsilon_{k,s} := \upsilon_k\left(. - \frac{2\pi s}{2k}\right), \quad s = 0,1....,2^k - 1$$

be the integer translates of the dyadic scaling functions

$$\upsilon_0 := 1; \qquad \upsilon_k := V_{2^{k-1}}; \qquad k = 1,2,...$$

Each function $f \in L_q$ has a wavelet decomposition

$$f = \sum_{k=0}^{\infty} \sum_{s=0}^{2^k - 1} \lambda_{k,s} \upsilon_{k,s} \tag{7}$$

with the convergence in $L_q$, where $\lambda_{k,s}$ are certain coefficient functional of $f$ (see [4] for details). Let $V_k$ be the span of the functions $\upsilon_{k,s}, s = 0,1,...,2^{k-1} - 1$. Then the family $\{V_k\}_{k=0}^{\infty}$ forms a multiresolution of $L_q$ with the following properties:

*MR*1. $V_k \subset V_{k'}$, for $k < k'$

*MR*2. $\bigcup_{k \in Z} V_k$ is dense in $L_q$

*MR*3. For $k = 0,1,...$ dim $V_k = 2^k$ and the functions $\upsilon_{k,s} := \upsilon_k(. - 2\pi s/2^k)$, $s = 0,1,....,2^{k-1} - 1$, form a Riesz basis for $V_k$, it means there are positive constants $C_q$ and $C_q'$ such that

$$C_q 2^{-k/q} \|\{a_s\}\|_q \le \left\|\sum_{s=0}^{2^k-1} a_s \upsilon_k(.-s)\right\|_q \le C_q' 2^{-k/q} \|\{a_s\}\|_q$$

for all $\{a_s\}_{s=0}^{2k-1} \in l_q^{2k} (see [4])$.

We use the notations $a_+ := \max\{a,0\}$; $A \asymp B$ if $A \ll B$ and $B \ll A$; and $A \ll B$ if $A \le cB$ with $c$ an absolute constant.

Let us give a wavelet decomposition and discrete characterization for the Besov space $B_{p,\theta}^{\omega}$ of functions on $\mathbb{T}$. Let $1 \le p < \infty$ and $0 < \theta \le \infty$. A function $f \in L_p$ belongs to the Besov space on $B_{p,\theta}^{\omega}$ if $f$ has a wavelet decomposition (7) and in addition the quasi - norm of the Besov space $B_{p,\theta}^{\omega}$ given in (6) is equivalent to the discrete quasi - norm

$$\|f\|_{B_{p,\theta}^{\omega}} \asymp \left( \sum_{k=0}^{\infty} \left( \frac{\left\| \{\lambda_{k,s}\} \right\|_p}{2^{k/p} \omega(2^{-k})} \right)^{\theta} \right)^{1/\theta} \tag{8}$$

(the sum is changed to the supremum when $\theta = \infty$). For the space $B_{p,\theta}^{\omega}$, $r > 0$, a proof of the equivalence of quasi - norms and a construction of continuous coefficient functional $\lambda_{k,s}$ were given in [5]. In the general case they can be obtained similarly.

For the $n$- term approximation of the functions from $SB_{p,\theta}^{\omega}$ we take the family of wavelets

$$V := \left\{ \upsilon_{k,s} : s = 0,1,...,2^k - 1; \ k = 0,1,2,.... \right\}.$$

Denote by $\gamma_n$ any one of the non-linear $n$-widths $\tau_n, \tau_n', \alpha_n, \beta_n, a_n$ and $\delta_n$. We say that $\omega$ satisfies Condition $R(p,q)$ if $\omega(t) t^{-(1/p-1/q)_+}$ satisfies Condition $BS$. The main result of the present paper is the following

**Theorem 1.** *Let* $1 \le p, q \le \infty, 0 < \theta \le \infty$ *and* $\omega$ *satisfy Condition* $R(p,q)$. *Then we have:*

$$\delta_n\left(SB_{p,\theta}^{\omega}, V, L_q\right) \asymp \gamma_n\left(SB_{p,\theta}^{\omega}, L_q\right) \asymp \omega(1/n) \tag{9}$$

The case $\omega(t) = t^{\alpha}$, $\alpha > 0$, of Theorem 1 was proved in [5]. To prove Theorem 1 we develop further the method of [5]. However, the smoothness of the class $B_{p,\theta}^{\omega}$ is complicated, we have to overcome certain difficulties.

## 2. Auxiliary results

In this section we give necessary auxiliaries for proving Theorem 1. For $0 < p \le \infty$, denote by $l_p^m$ the space of all sequence $x = \{x_k\}_{k=1}^m$ of numbers, equipped with the quasi - norm

$$\left\| \{x_k\} \right\|_{l_p^m} = \|x\|_{l_p^m} := \left( \sum_{k=1}^m |x_k|^p \right)^{1/p}$$

(the sum is changed to max when $p = \infty$). Let $\varepsilon = \{e_k\}_{k=1}^{m}$ be the canonical basis in $l_p^m$. It means that $x = \sum_{k=1}^{m} x_k e_k$ for $x = \{x_k\}_{k=1}^{m} \in l_{k=1}^{m}$. We let the set $\{k_j\}_{j=1}^{m}$ be ordered so that

$$\left|x_{k_1}\right| \geq \left|x_{k_2}\right| \geq ... \geq \left|x_{k_j}\right| \geq ... \geq \left|x_{k_n}\right| \geq .... \geq \left|x_{k_m}\right|$$

The greedy algorithm $G_n$ for $n$-term approximation with regard to $\varepsilon$ is defined by

$$G_n(x) := \sum_{j=1}^{n} x_{k_j} e_{k_j}$$

Clearly, $G_n$ is not continuous. However, the mapping

$$G_n^C(x) := \begin{cases} \sum_{j=1}^{n} \left(x_{k_j} - \left|x_{k_{n+1}}\right| sign\, x_{k_j}\right) e_{k_j}, & for\ \ p < q \\ \sum_{k=1}^{n} x_k e_k & for\ \ p \geq q \end{cases}$$

defines a continuous algorithm of the $n$- term approximation.

The unit ball in $l_p^m$ denoted by $B_p^m$.

**Lemma 1.** *Let $0 < p,\ q \leq \infty$, any positive integer $n < m$, we have:*

$$\sup_{x \in B_p^m} \left\| x - G_n(x) \right\|_{l_q^m} \leq \sup_{x \in B_p^m} \left\| x - G_n^C(x) \right\|_{l_q^m} \leq A_{p,q}(m,n)$$

*where*

$$A_{p,q}(m,n) := \begin{cases} n^{1/q-1/p} & for\ \ \ p < q \\ (m-n)^{1/q-1/p} & for\ \ p \geq q \end{cases}$$

Lemma 1 and the following two lemmas were proved in [7].

**Lemma 2.** *Let $0 < q \leq \infty$ and L be a s - dimensional linear subspace in $l_p^m\ (s \leq m)$.*

*It is $\sigma_n\left(B_\infty^m \cap L, \varepsilon, l_\infty^m\right) = 1$ for any positive integer $n < s$ and*

*$\sigma_n\left(B_\infty^m \cap L, \varepsilon, l_\infty^m\right) \geq (m-n-1)^{1/q}$. when $n < s - 1$.*

**Lemma 3.** *Let $0 < q \leq \infty$ and $n < s \leq m$. Let L be an s - dimensional linear subspace in $l_p^m$ and $P: l_p^m \to L$ is a linear projector in $l_q^m$. We have:*

$$a_n\left(B_\infty^m \cap L, l_q^m\right) \geq \|P\|^{-1}(m-n)^{1/q}$$

## 3. Upper bounds

To prove the upper bound of $\sigma_n\left(SB_{p,\theta}^{\omega}, V, L_q\right)$, we explicitly construct a finite subset $V^*$ of $V$ and a positive homogeneous mapping $G^* : B_{p,\theta}^{\omega} \to M_n$ such that

$$\sup_{f \in SB_{p,\theta}^{\omega}} \left\| f - S_n^*(f) \right\|_q \ll \omega(1/n) \qquad (10)$$

where $S_n^* := R_{V^*} \circ G^*$. This means that the algorithm $S^*$ of the $n$-term approximation with regard to $V$ is an asymptotically optimal for $\sigma_n$. Because $\|.\|_{B_{p,\theta}^{\omega}} \leq C \|.\|_{B_{p,\theta}^{\omega}}$ (for $0 < \theta < \infty$), the space $B_{p,\theta}^{\omega}$ can be considered as a subpace of the largest space $B_{p,\infty}^{\omega}$. Hence, it is sufficient to construct $S_n^*$ for $H := SB_{p,\infty}^{\omega}$.

For each function

$$g = \sum_{s=0}^{2^k-1} a_s \upsilon_{k,s} \qquad (11)$$

belonging to $V_k$, we have by *MR3*

$$\|g\|_q \asymp 2^{-k/q} \left\| \{a_s\} \right\|_q \qquad (12)$$

Using the equivalence of quasi - norms (8) for $H$, from (7) we find that a function $f \in L_p$ belongs to $H$ if $f$ can be decomposed into the functions $f_k$ by a series

$$f = \sum_{k=0}^{\infty} f_k, \qquad (13)$$

where the functions

$$f_k = \sum_{s=0}^{2^k-1} \lambda_{k,s} \upsilon_{k,s}$$

are from $V_k$ and satisfy the condition

$$\|f_k\|_p \asymp 2^{-k/p} \left\| \{\lambda_{k,s}\} \right\|_{l_p^{2^k}} \leq C\omega\left(2^{-k}\right), \quad k = 0,1,2,... \qquad (14)$$

(see [4]).

For a non- negative number $n$, let $\{n_k\}$ be a sequence of non - negative integers such that

$$\sum_{k=0}^{\infty} n_k \leq n. \qquad (15)$$

Let $\varepsilon = \{e_s\}_{s=0}^{2^k-1}$ be the canonical basis $l_q^{2^k}$. For $a = \sum_{s=0}^{2^k-1} a_s e_s \in l_q^{2^k}$, we let the set $\{s_j\}_{j=0}^{2^k-1}$ be ordered so that

$$\left|a_{s_0}\right| \geq \left|a_{s_1}\right| \geq ... \geq \left|a_{s_{n_k-1}}\right| \geq ... \geq \left|a_{s_{2^k-1}}\right|$$

Then, the greedy algorithm $G_{n_k}$ for the $n_k$-term approximation with regard to $\varepsilon$ is:

$$G_{n_k}(a) := \sum_{j=0}^{n_k-1} a_{s_j} e_{s_j} \qquad (16)$$

For any positive integer $n_k < 2^k$ and all $a \in B_q^{2^k}$, by Lemma 1 we have:

$$\left\|a - G_{n_k}(a)\right\|_{l_q^{2^k}} \leq A_{p,q}\left(2^k, n_k\right) \qquad (17)$$

where

$$A_{p,q}\left(2^k, n_k\right) := \begin{cases} n_k^{1/q-1/p} & \text{for} \quad p < q \\ \left(2^k - n_k\right)^{1/q-1/p} & \text{for} \quad p \geq q. \end{cases}$$

Observe that the greedy algorithm $G_{n_k}$ in $l_q^{2^k}$ corresponds to the greedy algorithm $G_{n_k}^{/}$ of the $n_k$-term approximation in $V_k$, which is given by

$$G_{n_k}^{/}(g) := \sum_{j=0}^{n_k-1} a_{s_j} \upsilon_{k,s_j} \qquad (18)$$

for a function represented as in (11). Because of the norm equivalence (12) for each function $g \in V_k$, we have:

$$\left\|g - G_{n_k}^{/}(g)\right\|_q \asymp 2^{-k/q} \left\|\{a_s\} - G_{n_k}\left(\{a_s\}\right)\right\|_{l_q^{2^k}} \qquad (19)$$

For each function $f \in H$ represented as in (13), from (19) we obtain

$$\left\|f_k - G_{n_k}^{/}(f_k)\right\|_q \asymp 2^{-k/q} \left\|\{\lambda_{k,s}\} - G_{n_k}\left(\{\lambda_{k,s}\}\right)\right\|_{l_q^{2^k}}$$

$$\leq C.2^{k/p-k/q} \omega\left(2^{-k}\right) \left\|\{\lambda_{k,s}^*\} - G_{n_k}\left(\{\lambda_{k,s}^*\}\right)\right\|_{l_q^{2^k}}$$

$$\leq C.2^{k(1/p-1/q)} \omega\left(2^{-k}\right) A_{p,q}\left(2^k, n_k\right),$$

Where

$$\lambda_{k,s}^* = \frac{\lambda_{k,s}}{C.2^{k/p} \omega\left(2^{-k}\right)} \quad \text{and} \quad \{\lambda_{k,s}^*\} \in B_p^{2^k} \qquad (20)$$

Because $\omega$ satisfies Condition $R(p,q)$, there exist $C_1 > 0$ and $\delta > 0$ such that for $k \geq k'$

$$\omega\left(2^{-k}\right)\left(2^{-k}\right)^{-(1/p-1/q)-\delta} \leq C_1 \omega\left(2^{-k'}\right)\left(2^{-k'}\right)^{-(1/p-1/q)-\delta} \qquad (21)$$

Let us now select a sequence $\{n_k\}_{k=0}^{\infty}$ satisfying the condition (15). For simplicity we consider the case $p < q$ (the other cases can be treated similarly). Fix a number $\varepsilon$ so that

$0 < \varepsilon < \delta / \left( 1/p - 1/q \right)$. For a given natural number $n$, let the integer $r$ be defined from the conditions $2^{r+2} \le n < 2^{2r+3}$. Then an appropriate selection of $\left\{ n_k \right\}_{k=0}^{\infty}$ is given by

$$n_k = \begin{cases} 2^k & for \quad k \le r \\ \left[ an2^{-\varepsilon(k-r)} \right] & for \quad k > r \end{cases} \qquad (22)$$

where $a = \dfrac{2^{\varepsilon} - 1}{2}$ and $[t]$ denotes the integer part of $t$. Then we have

$$\sum_{k=0}^{\infty} n_k \le \sum_{k=0}^{r} 2^k + \sum_{k=r+1}^{\infty} an2^{-\varepsilon(k-r)} = \left( 2^{r+1} - 1 \right) + \frac{an}{2^{\varepsilon} - 1} \le \frac{n}{2} + \frac{n}{2} = n.$$

This means that (15) is satisfied. We take a positive constant $\lambda$ so that

$$\frac{1 + \varepsilon}{\varepsilon} > \lambda > \frac{1/p - 1/q + \delta}{\delta}$$

and put $k^* = \left[ \lambda r \right]$.

We construct a mapping $S_k : H \to M_{n_k} \left( V \right)$ as follows

$$S_k \left( f \right) := \begin{cases} G'_{n_k} \left( f_k \right) & for \quad k \le k^* \\ 0 & for \quad k > k^*. \end{cases}$$

Notice that for $k \le r$, we have $S_k \left( f \right) = f_k$ and therefore,

$$\left\| f_k - S_k \left( f \right) \right\|_q = 0 \qquad (23)$$

Next, for $r < k \le k^*$ from (20) we have

$$\left\| f_k - S_k \left( f \right) \right\|_q \le C 2^{k(1/p - 1/q)} \omega \left( 2^{-k} \right) A_{p,q} \left( 2^k, n_k \right) \qquad (24)$$

and for $k > k^*$, we have

$$\left\| f_k - S_k \left( f \right) \right\|_q = \left\| f_k \right\|_q \le C' 2^{k(1/p - 1/q)} \omega \left( 2^{-k} \right) \qquad (25)$$

Put

$$S_n^* \left( f \right) := \sum_{k=0}^{\infty} S_k \left( f \right) \quad for \quad f = \sum_{k=0}^{\infty} f_k .$$

Then by (21), (23), (24) and (25) we get

$$\left\| f - S_n^* \left( f \right) \right\|_q \le \sum_{k=r+1}^{\infty} \left\| f_k - S_k \left( f \right) \right\|_q \le C^* \omega \left( 2^{-k_0} \right) \approx C^* \omega \left( 1/n \right) \qquad (26)$$

Put

$$G^* \left( f \right) := \left\{ G'_{n_k} \left( f_k \right) \right\}_{k \le k^*} \quad for \quad f = \sum_{k \le k^*} f_k \in H.$$

Then $G^*$ is a positive homogeneous mapping $H$ into $M_n$, and $S_n^* = R_{V^*} \circ G^*$, where $V^* := \left\{ \upsilon_{k,s} : s = 0,1,...,2^k - 1; k \leq k^* \right\}$. From (26) we obtain (10). This also proves the upper bound of $\sigma_n \left( SB_{p,\theta}^\omega, V, L_q \right)$.

We now prove the upper bound

$$\gamma_n \left( SB_{p,\theta}^\omega, L_q \right) \ll \omega(1/n) \tag{27}$$

Using inequalities between $\alpha_n, \tau_n, \tau_n', \delta_n, \beta_n,$ and $a_n$ (see [6]), we prove only for one of them, namely for $\alpha_n$. If in (26), $G_{n_k}^/$ are replaced by $G_{n_k}^{c'}$, then $S_n$ is a continuous algorithm of the $n$-term approximation, which satisfy (14). Hence, we prove the upper bound of $\alpha_n \left( SB_{p,\theta}^\omega, L_q \right)$ and we receive (27). The upper bounds of (9) in Theorem 1 are proved.

## 4. Lower bounds

We first prove the lower bound for $\sigma_n$:

$$\sigma_n \left( SB_{p,\theta}^\omega, V, L_q \right) \gg \omega(1/n) \tag{28}$$

Because of the inequality $\| . \|_\infty \geq c \| . \|_p$ $for$ $1 \leq p < \infty$, it is sufficient to prove (28) for the case $p = \infty$. For a positive integer $k$, denote by $B(k)$ the space of all trigonometric polynomials $f$or the form

$$f = \sum_{s=0}^{2^k - 1} \lambda_{k,s} \upsilon_{k,s},$$

and for $1 \leq \eta \leq \infty$, denote by $B(k)_\eta$ the subspace in $L_\eta$, which consists of all $f \in B(k)$. For $SB(k)_\infty$ the unit ball $B(k)_\infty$ by (8) we have $\omega \left( 2^{-k} \right) SB(k)_\infty \subset a SB_{\infty,\theta}^\omega$ with some $a > 0$. Hence

$$\sigma_n \left( SB_{\infty,\theta}^\omega, V, L_q \right) \gg \omega \left( 2^{-k} \right) \sigma_n \left( SB(k)_\infty, V, L_q \right) \tag{29}$$

Let $X$ be a normed space and $Y$ be a subspace of $X$, $W \subset X$ and let $\Phi$ be a family in $X$. If $P : X \to Y$ is a linear projection such that $\| P(f) \| \leq \| f \|$ for every $f \in X$, then $\sigma_n (W, \Phi, X) \geq \sigma_n (W, P(\Phi), Y)$. Applying this inequality to the linear projection

$$P(k, f) = \sum_{s=0}^{2^k - 1} \lambda_{k,s} \upsilon_{k,s}$$

in the space $L_q$, gives

$$\sigma_n\left(SB(k)_\infty, V, L_q\right) \geq \sigma_n\left(SB(k)_\infty, V', B(k)_q\right) \tag{30}$$

where $V' = P(k, V)$ (see [4]). From (29) and (30) we have

$$\sigma_n\left(SB_{\infty,\theta}^\omega, V, L_q\right) \gg \omega\left(2^{-k}\right)\sigma_n\left(SB(k)_\infty, V', B(k)_q\right) \tag{31}$$

Let us give a lower bound for $\sigma_n\left(SB(k)_\infty, V', B(k)_q\right)$.

Define $k = k(n)$ from the conditions

$$n \asymp 2^k \asymp \dim B(k) > 2n \tag{32}$$

From (8) we have

$$\|f\|_{B(k)_\infty} \asymp \|J(f)\|_{l_\infty^{2^k}}, \quad \|f\|_{B(k)_q} \asymp 2^{-k/q}\|J(f)\|_{l_q^{2^k}} \tag{33}$$

where $J$ is the positive homogeneous continuous mapping from $B(k)_q$ into $l_\infty^{2^k}$, given by

$$J(f) := \left\{\lambda_{k,s}\right\}_{s=0}^{2^k-1} \text{ for } f = \sum_{s=0}^{2^k-1} \lambda_{k,s}\upsilon_{k,s}$$

Clearly, $J(V') = \varepsilon'$ and $J\left(B(k)_q\right) = l_q^{2^k}$, where $\varepsilon'$ is the canonical basis in $l_\infty^{2^k}$ (see [4]). Also, if $S$ is an algorithm of the $n$-term approximation with regard to $V'$ in $B(k)_q$, then $J \circ S$ will be an algorithm of the $n$-term approximation with regard to $\varepsilon'$ in $l_\infty^{2^k}$. Therefore, by (32), (33) and Lemma 2, we obtain

$$\sigma_n\left(SB(k)_\infty, V', B(k)_q\right) \asymp 2^{-k/q}\sigma_n\left(B_\infty^{2^k}, \varepsilon', l_q^{2^k}\right)$$

$$\geq 2^{-k/q}(m-n-1)^{1/q} \gg 1 \tag{34}$$

Where $m \asymp \dim B(k) \asymp 2^k$. From (34) and (31) we obtain (28). Because of the inequalities between $\alpha_n, \tau_n, \tau_n', \beta_n, a_n$ and $\delta_n$ (see [6], it is enough to prove $a_n\left(SB_{\infty,\theta}^\omega, L_q\right) \gg \omega(1/n)$. It can be proved in the same way as the proof of the lower bound for $\sigma_n\left(SB_{\infty,\theta}^\omega, V, L_q\right)$, but by using Lemma 1 and Lemma 3. Thus, we have completed the proof of Theorem 1.

## References

[1]     R. DeVore (1998), *Nonlinear approximation*, Acta Numerica 7, 51 - 150.

[2]     R. DeVore, R. Howard, and C. Micchelli, *Optimal non-linear approximation,* Manuscripta Math. 63(1989), 469 - 478.

[3]     R.DeVore (1993), G. Lorentz, *Constructive Approximation,* Springer - Verlag.

[4]     Dinh Dung (2001), *Non-linear approximations using wavelet decompositions*, Vietnam J. Math. 29, 197 - 224.

[5]     Dinh Dung (1998), *On non-linear n-widths and n-term approximation*, Vietnam J.Math, 26, 165 - 176.

[6]     Dinh Dung (2000), *Continuous algorithms in n-term approximation and non-linear n-widths,* J. Approx. Theory 102, 217 - 242.

[7]     Dinh Dung (2001), *Asymptotic orders of optimal non-linear approximations*, East J. on Approx. 7, 55 - 76.

[8]     B. Kashin and V. Temlyakov (1994), *On best m-term approximation and the entropy of sets in the space* $L^1$, Math. Notes 36, 1137 - 1157.

[9]     V. Temlyakov (1993), *Approximation of periodic functions,* Nova Science Publishers, New York.

[10]    V. Temlyakov (2000), *Greedy algorithms with regard to the multivariate systems with a special structure,* Constr. Approx. 16, 339- 425.

# THE EXPONENTIAL BEHAVIOR AND STABILIZABILITY OF STOCHASTIC 2D G-NAVIER-STOKES EQUATIONS

**Hoang Van Thi, Nguyen Tien Da, Nguyen Huu Hoc**

**Abstract:** The aim of this paper is to study the exponential behavior and stabilizability of stochastic 2D g-Navier-Stokes equations

$$\begin{cases} \dfrac{\partial u}{\partial t} - v\Delta u + (u.\nabla)u + \nabla p = f + h(t,u)\dfrac{dW(t)}{dt} & \text{in } \Omega \times \mathbb{R}^+, \\ \nabla.(gu) = 0 & \text{in } \Omega \times \mathbb{R}^+, \\ u = 0 & \text{on } \partial\Omega, \\ u(x,0) = u_0(x,0) & x \in \Omega, \end{cases}$$

in a bounded domain satisfying the Poincare's inequality. Also, some results and comments concerning the stabilization of these equations are stated.

**Keywords:** Stochastic 2D g-Navier-Stokes equations, exponential stability, stabilization

## 1. Introduction

Let $\Omega$ be a bounded domain in $\mathbb{R}^2$ with smooth boundary $\partial\Omega$. We consider the following 2D g-Navier-Stokes equations

$$\begin{cases} \dfrac{\partial u}{\partial t} - v\Delta u + (u.\nabla)u + \nabla p = f + h(t,u)\dfrac{dW(t)}{dt} & \text{in } \Omega \times \mathbb{R}^+, \\ \nabla.(gu) = 0 & \text{in } \Omega \times \mathbb{R}^+, \\ u = 0 & \text{on } \partial\Omega, \\ u(x,0) = u_0(x,0) & x \in \Omega, \end{cases} \quad (1.1)$$

where $u = u(x,t) = (u_1, u_2)$ is the unknown velocity vector, $p = p(x,t)$ is the unknown pressure, $v > 0$ is the kinematic viscosity coefficient, $u_0$ is the initial velocity.

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The 2D g-Navier-Stokes equations arise in a natural way when we study the standard 3D Navier-Stokes problem in a 3D thin domain $\Omega_g = \Omega \times (0, g)$ (see [12]). As mentioned in [11, 12], good properties of the 2D g-Navier-Stokes equations can lead to an initial study of the 3D Navier-Stokes equations in the thin domain $\Omega_g$ . In the last few years, the existence and long-time behavior of solutions in terms of existence of attractors for 2D g-Navier-Stokes equations have been studied extensively in both autonomous and non-autonomous cases (see e.g. [1, 2, 8, 9,10] and references therein).

In this paper we will study the problem of stability and stabilization for strong stationary solutions to (1.1). To do this, we assume that the function $g$ satisfies the following assumption:

$$(G)\; g \in W^{1,\infty}(\Omega) \text{ such that}$$

And $\qquad 0 < m_0 \le g(x) \le M_0 \text{ forall } x = (x_1, x_2) \in \Omega, \text{and} \,|\nabla_g|_\infty < m_0 \lambda_1^{1/2}$

This paper is organized as follows. In Section 2, for convenience of the reader, we recall some basic results on the function spaces and operators related to the problem. In Section 3, we consider the existence of stationary solution of deterministic 2D g-Navier-Stokes equations, moreover in this Section, we also prove some results on the exponential stability in mean square with their corollary on the path wise exponential stability of problem (1.1). In Section 4, we deal with the interesting stabilization problem for stationary solution, we shall analyze the possible reasons implying a stabilizing effect on the deterministic problem by the appearance of a random disturbance.

## 2. Preliminary results

### 2.1. Function spaces and operators

Let $\mathbb{L}^2(\Omega, g) = \left(L^2(\Omega)\right)^2$ and $\mathbb{H}_0^1(\Omega, g) = \left(H_0^1(\Omega)\right)^2$ be endowed, respectively with the inner products

$$(u, v)_g = \int_\Omega u.vgdx, u, v \in \mathbb{L}^2(\Omega, g)$$

and

$$\left((u, v)\right)_g = \int_\Omega \sum_{j=1}^{2} \nabla u_j . \nabla v_j gdx, u = (u_1, u_2), v = (v_1, v_2) \in \mathbb{H}_0^1(\Omega, g)$$

and norms $|u|^2 = (u, u)_g, u^2 = ((u, u))_g$. Thanks to assumption $(G)$, the norms $|.|$ and $\|.\|$ are equivalent to the usual ones in $(L^2(\Omega))^2$ and in $(H_0^1(\Omega))^2$.

Let $\qquad\qquad \mathcal{V} = \left\{ u \in \left( C_0^\infty (\Omega) \right)^2 : \nabla.(gu) = 0 \right\}$

Denote by $H_g$ the closure of $\mathcal{V}$ in $\mathbb{L}^2(\Omega, g)$, and by $V_g$ the closure of $\mathcal{V}$ in $\mathbb{H}_0^1(\Omega, g)$. It follows that $V_g \subset H_g \equiv H'_g \subset V'_g$, where the injections are dense and continuous. We will use for the norm in $V'_g$ and $.,.$ for duality pairing between $V_g$ and $V'_g$.

We define the $g$ – Stokes operator $A : V_g \to V'_g$ by

$$(Au, v) = ((u,v))_g, \text{ forall } u, v \in V_g$$

Then $A = -P_g \Delta$ and $D(A) = H^2(\Omega, g) \cap V_g$, where $P_g$ is the ortho-projector from $\mathbb{L}^2(\Omega, g)$ onto $H_g$. We also define the operator $B : V_g \times V_g \to V'_g$ by

$$(B(u,v), w) = b(u, v, w), \text{ forall } u, v, w \in V_g$$

Where $\qquad\qquad b(u,v,w) = \sum_{i,j=1}^{2} \int_\Omega u_i \frac{\partial v_j}{\partial x_i} w_j \, g \, dx$

It is easy to check that if $u, v, w \in V_g$, then $b(u,v,w) = -b(u,w,v), b(u,v,v) = 0$.
We recall some existing results which will be used in the paper.

**Lemma 1.1.** [1] *If* $n = 2$, *then*

$$
|b(u,v,w)| \leq
\begin{cases}
c_1 |u|^{\frac{1}{2}} \|u\|^{\frac{1}{2}} \|v\| \, |w|^{\frac{1}{2}} \|v\|^{\frac{1}{2}}, & \forall u, v, w \in V_g, \\
c_2 |u|^{\frac{1}{2}} \|u\|^{\frac{1}{2}} |v|^{\frac{1}{2}} |Av|^{\frac{1}{2}} |w|, & \forall u \in V_g, v \in D(A), w \in H_g, \\
c_3 |u|^{\frac{1}{2}} |Au|^{\frac{1}{2}} \|v\| |w|, & \forall u \in D(A), v \in V_g, w \in H_g, \\
c_4 |u| \|v\| |w|^{\frac{1}{2}} |Aw|^{\frac{1}{2}}, & \forall u \in H_g, v \in V_g, w \in D(A),
\end{cases}
$$

**Lemma 1.2.** [2] *Let* $u \in L^2(0,T; D(A)) \cap L^\infty(0,T; V_g)$, *then the function Bu defined by*

$$(Bu(t), v)_g = b(u(t), u(t), v), \forall v \in H_g, a.e.\, t \in [0,T]$$

*belongs to* $L^4(0,T; H_g)$, *therefore also belongs to* $L^2(0,T; H_g)$.

**Lemma 1.3.** *Let* $u \in L^2(0,T; V_g)$, *then the function Cu defined by*

$$(Cu(t), v)_g = \left( \left( \frac{\nabla g}{g}.\nabla \right) u, v \right)_g = \left( \frac{\nabla g}{g}, u, v \right), \forall v \in V_g$$

*belongs to* $L^2(0,T; H_g)$, *and hence also belongs to* $L^2(0,T; V'_g)$. *Moreover,*

$$|Cu(t)| \leq \frac{|\nabla g|_\infty}{m_0}.\|u(t)\|, \text{ for a.e.} \, t \in (0,T)$$

And

$$|Cu(t)|_* \le \frac{|\nabla g|_\infty}{m_0 \lambda_1^{1/2}} \cdot \|u(t)\|, \textit{ for a.e. } t \in (0,T)$$

### 2.2. Stochastic 2D g-Navier-Stokes equations

We first introduce stochastic integrals in Hilbert space. Let $(\Omega, F, P)$ be a probability space on which an increasing and right continuous family $\{F_t\}_{t \ge 0}$ of complete sub-$\sigma$-algebra of $F$ is defined. Let $\beta_n(t)$ (n = 1,2,3...) be a sequence of real valued one-dimensional standard Brownian motions independent on $(\Omega, F, P)$. We set $W(t) = \sum_{n=1}^{\infty} \sqrt{\lambda_n'} \beta_n(t) e_n$, where $\lambda_n' \ge 0$, (n=1, 2, 3,...) are non-negative real numbers such that $\sum_{n=1}^{\infty} \lambda_n' < +\infty$, and $\{e_n\}$, (n=1, 2, 3,...) is a complete orthonormal basis in the real and separable Hilbert spaces K. Let $Q \in L(K,K)$ be the operator defined by $Qe_n = \lambda_n' e_n$. The above K-valued stochastic process $W(t)$ is called a Q-Wiener process. By the properties of stochastic integral, it is natural to introduce the space $K^0 = Q^{\frac{1}{2}} K$ for a symmetric, positive-defined operator Q on Hilbert space K. Here $Q^{\frac{1}{2}}$ is the operator defined by $Q^{\frac{1}{2}} e_n = \sqrt{\lambda_n'} e_n$. For simplicity we assume Q is positive-definite, otherwise, we can just consider Q restricted on the orthogonal complement of the kernel space of Q in K. Let $Q^{-\frac{1}{2}}$ be the inverse of $Q^{\frac{1}{2}}$. Now define a scalar product

$$\langle u,v \rangle_0 = \left\langle Q^{-\frac{1}{2}}u, Q^{-\frac{1}{2}}v \right\rangle, \forall u,v \in K^0$$

Then $K^0$ with this scalar product is a Hilbert space.

Next, we will study the stability of the stochastic 2D g-Navier-Stokes equations. We now assume that $W(t)$ is an infinite-dimensional Wiener process. Then the stochastic 2D g-Navier-Stokes equations can be rewritten as follows:

$$du(t) = \left[ -\upsilon Au(t) - \upsilon Cu(t) - B(u(t),u(t)) + f \right] dt + h(t,u(t)) dW(t) \qquad (1.2)$$

Moreover, we consider the deterministic version of this equations, namely,

$$du(t) = \left[ -\upsilon Au(t) - \upsilon Cu(t) - B(u(t),u(t)) + f \right] dt \qquad (1.3)$$

First, we give the definition of the weak solutions to stochastic 2D g-Navier-Stokes equations (1.1).

**Definition 1.1.** *$u(t), t \ge 0$ is said to be a weak solution of (1.2) if*

*a) $u(t)$ is $F_t$-adapted,*

b)  $u \in L^{\infty}(0,T;H_g) \bigcap L^2(0,T;V_g)$  almost surely for all T > 0, the following equation

holds as an identity in almost surely, for $t \in [0,\infty)$.

As we are mainly interested in analysis of the exponential stability of the weak solutions to the problem (1.2), we will assume the existence of such weak solutions.

**Definition 1.2.** We say that a weak solution  $u(t)$  to (1.2) converges to  $u_{\infty} \in H_g$ exponentially in the mean square if there exist  $a > 0$  and  $M_0(u(0)) > 0$  such that

$$E\left|u(t) - u_{\infty}\right|^2 \le M_0 e^{-at}, \forall t \ge 0$$

In particular, if  $u_{\infty}$  is a solution to (1.2), then it is said that  $u_{\infty}$  is exponentially stable in the mean square provided every weak solution to (1.2) converges to  $u_{\infty}$  exponentially in the mean square with the same exponential order  $a > 0$ .

**Definition 1.3.** We say that a weak solution  $u(t)$  to (1.2) converges to  $u_{\infty} \in H_g$ almost surely exponentially if there exists  $\gamma > 0$  such that

$$\limsup_{t \to +\infty} \frac{1}{t} \log\left|u(t) - u_{\infty}\right| \le -\gamma , \text{ almost surely.}$$

In particular, if  $u_{\infty}$  is a solution to (1.2), then it is said that  $u_{\infty}$  is almost surely exponentially stable provided that every weak solution to (1.2) converges to  $u_{\infty}$  almost surely exponentially with the same constant  $\gamma$ .

## 3. The exponential stability of solutions

First, we introduce the following definition.

**Definition 2.1.** Let  $f \in \mathbb{L}^2(\Omega, g)$  be given.  A  strong stationary solution to problem (1.1) is an element  $u^* \in D(A)$  such that

$$\upsilon Au^* + \upsilon Cu^* + B\left(u^*,u^*\right) = f \text{ in } \mathbb{L}^2(\Omega, g) \tag{2.1}$$

**Theorem 2.1.** If  $f \in \mathbb{L}^2(\Omega, g)$ , then problem (1.1) admits at least one strong stationary solution  $u^*$ . Moreover, if the following condition holds

$$v > \sqrt{\frac{c_1|f|}{\lambda_1}} \left(1 - \frac{|\nabla g|_{\infty}}{m_0 \lambda_1^{1/2}}\right)^{-1} \tag{2.2}$$

where  $c_1$  is the constant in Lemma 1.1, then the strong stationary solution to (2.1) is unique and globally exponentially stable.

### *3.1. The exponential stability in mean square*

We recall that $|u|^2 \le c_1^2 \|u\|^2$, $\forall u \in V_g$, moreover we also use the notion

$$\|h(t,u)\|^2_{\mathcal{L}^2(K^0,H_g)} = tr\left(h(t,u)Qh(t,u)^*\right)$$

We assume that $h(t,.): H_g \to \mathcal{L}^2\left(K^0, H_g\right)$ and satisfies the following conditions

$$(\mathcal{H}1)\begin{cases} a) & h(t,u_\infty) \equiv 0 \text{ for all } t \ge 0, \\ b) & \|h(t,u) - h(t,v)\|^2_{\mathcal{L}^2(K^0,H_g)} \le \gamma(t)|u-v|^2, \quad \forall u,v \in V_g, \end{cases}$$

where $\gamma(t): \mathbb{R}^+ \to \mathbb{R}^+$ is a bounded and continuous function such that there exists positive real number $\gamma_0$ satisfying

$$\limsup_{t \to +\infty} \frac{1}{t}\int_0^t |\gamma(s) - \gamma_0|ds = 0 \tag{3.1}$$

**Theorem 2.2** *Suppose that the condition* $(\mathcal{H}1)$ *holds. If*

$$2\upsilon > \gamma_0 \lambda_1^{-1} + \frac{2c_1|f|}{\lambda_1 \upsilon}\left(1 - \frac{|\nabla_g|_\infty}{m_0 \lambda_1^{\frac{1}{2}}}\right)^{-1} \tag{3.2}$$

*then any weak solution* $u(t)$ *to (1.2) converges to the stationary solution* $u_\infty$ *to (1.3) exponentially in the mean square and so* $u_\infty$ *is an exponentially stable in the mean square. That is, there exists a real number* $\lambda > 0$ *such that* $\mathbb{E}|u(t) - u_\infty|^2 \le \mathbb{E}|u(0) - u_\infty|^2 e^{-\lambda t}$, $t \ge 0$.

*Proof.* From condition (3.2), we can choose a positive real number $a > 0$ small enough such that. $2\upsilon > (a + \gamma_0)\lambda_1^{-1} + \frac{2c_1|f|}{\lambda_1 \upsilon}\left(1 - \frac{|\nabla_g|_\infty}{m_0 \lambda_1^{\frac{1}{2}}}\right)^{-1}$. Then by applying the Ito formula to the function $e^{at}|u(t) - u_\infty|^2$, we obtain

$$e^{at}\mathbb{E}|u(t) - u_\infty|^2 = \mathbb{E}|u(0) - u_\infty|^2 + \int_0^t ae^{as}\mathbb{E}|u(s) - u_\infty|^2 ds - 2\int_0^t e^{as}\mathbb{E}\left(Au(s), u(s) - u_\infty\right)ds$$

$$-2\int_0^t e^{as}\mathbb{E}B(u(s)), u(s) - u_\infty ds - 2\int_0^t e^{as}\mathbb{E}C(u(s)), u(s) - u_\infty ds$$

$$+2\int_0^t e^{as}\mathbb{E}f, u(s) - u_\infty ds + \int_0^t e^{as}\mathbb{E}\| h(s,u(s)) \|^2_{\mathcal{L}^2(K^0,H_g)} ds$$

Note that, $B(u(s)) - B(u_\infty), u(s) - u_\infty = (u(s) - u_\infty, u_\infty, u(s) - u_\infty)$. Then, we have:

$$e^{at}\mathbb{E}|u(t) - u_\infty|^2 \leq \mathbb{E}|u(0) - u_\infty|^2 + \int_0^t ae^{as}\mathbb{E}|u(s) - u_\infty|^2\, ds - 2\int_0^t e^{as}\mathbb{E}\big(A(u - u_\infty), u(s) - u_\infty\big) ds$$

$$-2\int_0^t e^{as}\mathbb{E}B\big(u(s) - u_\infty, u_\infty, u(s) - u_\infty\big) ds$$

$$\leq \mathbb{E}|u(0) - u_\infty|^2 + \int_0^t \left( a\lambda_1^{-1} + \frac{2c_1|f|}{\lambda_1 \upsilon}\left(1 - |\nabla_g|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1} - 2\upsilon \right) e^{as}\mathbb{E}\|u(s) - u_\infty\|^2\, ds$$

$$+ \int_0^t e^{as}\gamma(s)\mathbb{E}|u(s) - u_\infty|^2\, ds$$

$$\leq \mathbb{E}|u(0) - u_\infty|^2 + \int_0^t \left( a\lambda_1^{-1} + \frac{2c_1|f|}{\lambda_1 \upsilon}\left(1 - |\nabla_g|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1} - 2\upsilon \right) e^{as}\mathbb{E}\|u(s) - u_\infty\|^2\, ds$$

$$+ \int_0^t |\gamma(s) - \gamma_0| e^{as}\mathbb{E}\|u(s) - u_\infty\|^2\, ds + \int_0^t \gamma_0\lambda_1^{-1}e^{as}\mathbb{E}\|u(s) - u_\infty\|^2\, ds$$

$$\leq \mathbb{E}|u(0) - u_\infty|^2 + \int_0^t \left( a\lambda_1^{-1} + \frac{2c_1|f|}{\lambda_1 \upsilon}\left(1 - |\nabla_g|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1} - 2\upsilon \right) e^{as}\mathbb{E}\|u(s) - u_\infty\|^2\, ds$$

$$+ \int_0^t |\gamma(s) - \gamma_0| e^{as}\mathbb{E}|u(s) - u_\infty|^2\, ds$$

This follows that $e^{at}\mathbb{E}|u(t) - u_\infty|^2 \leq \mathbb{E}|u(0) - u_\infty|^2 + \int_0^t |\gamma(s) - \gamma_0| e^{as}\mathbb{E}|u(s) - u_\infty|^2\, ds$

By applying the Gronwall inequality, we have

$$e^{at}\mathbb{E}|u(t) - u_\infty|^2 \leq \mathbb{E}|u(0) - u_\infty|^2\, e^{\int_0^t |\gamma(s) - \gamma_0|ds} \qquad (3.3)$$

On the other hand, $\qquad\qquad \limsup_{t \to +\infty} \frac{1}{t}\int_0^t |\gamma(s) - \gamma_0|\, ds = 0$

Then there exists $T(a) > 0$ such that

$$\int_0^t |\gamma(s) - \gamma_0|\, ds \leq \frac{at}{2}, \quad \forall t \geq T(a) \qquad (3.4)$$

Putting (3.4) into (3.3), we get $e^{at}\mathbb{E}|u(t) - u_\infty|^2 \leq \mathbb{E}|u(0) - u_\infty|^2\, e^{\frac{at}{2}}, \forall t \geq T(a)$.

and so $\qquad\qquad \mathbb{E}|u(t) - u_\infty|^2 \leq \mathbb{E}|u(0) - u_\infty|^2\, e^{-\lambda t}, \quad \forall t \geq T(a)$

where $\lambda = \dfrac{a}{2}$. The proof of the theorem is finished.

### 3.2. The almost surely exponential stability

#### Theorem 2.3.

*Suppose that $u_\infty$ is a unique stationary solution of (1.3) and the condition $(\mathcal{H}1)$ holds.*

$$If \quad 2\upsilon > \gamma_0 \lambda_1^{-1} + \frac{2c_1 |f|}{\lambda_1 \upsilon}\left(1 - \frac{|\nabla_g|_\infty}{m_0 \lambda_1^{\frac{1}{2}}}\right)^{-1}, \quad then \quad any \quad weak \quad solutions \quad u(t) \quad to \quad (1.2)$$

*converges to the stationary solution $u_\infty$ of (1.3) almost surely exponentially and so $u_\infty$ is almost surely exponentially stable. That is, there exists $\gamma > 0$ such that*

$$\limsup_{t \to +\infty} \frac{1}{t} \log |u(t) - u_\infty| \leq -\gamma, \quad \text{almost surely.}$$

*Proof.* Let $N$ be a natural number. By applying the Ito formula, with any $t \geq N$, we obtain

$$|u(t) - u_\infty|^2 = |u(N) - u_\infty|^2 - 2\int_N^t (Au(s), u(s) - u_\infty)ds$$

$$-2\int_N^t (C(u(s)), u(s) - u_\infty)ds - 2\int_N^t (B(u(s)), u(s) - u_\infty)ds + 2\int_N^t (f, u(s) - u_\infty)ds$$

$$+\int_N^t \|h(s, u(s))\|^2 ds + 2\int_N^t (u(s) - u_\infty, h(s, u(s))dW(s))$$

Furthermore, by using the Burkholder-Davis-Gundy lemma, we have:

$$2\mathbb{E}\left[\sup_{N \leq t \leq N+1} \int_N^t (u(s) - u_\infty, h(s, u(s))dW(s))\right] \leq n_1 \mathbb{E}\left[\int_N^{N+1} |u(N) - u_\infty|^2 \|h(s, u(s))\|_{\mathcal{L}^2(K^0, H_g)}^2 ds\right]^{\frac{1}{2}}$$

$$\leq n_1 \mathbb{E}\left[\sup_{N \leq s \leq N+1} |u(N) - u_\infty|^2 \int_N^{N+1} \|h(s, u(s))\|_{\mathcal{L}^2(K^0, H_g)}^2 ds\right]^{\frac{1}{2}}$$

$$\leq n_2 \int_N^{N+1} \mathbb{E}\|h(s, u(s))\|_{\mathcal{L}^2(K^0, H_g)}^2 ds + \frac{1}{2}\mathbb{E}\left[\sup_{N \leq t \leq N+1} |u(t) - u_\infty|^2\right]$$

where $n_1, n_2 > 0$. Therefore, we obtain a positive real number $n_0$ such that

$$\mathbb{E}\sup_{N \leq t \leq N+1} |u(t) - u_\infty|^2 = \mathbb{E}|u(N) - u_\infty|^2 - 2\upsilon \int_N^{N+1} \mathbb{E}\|u(s) - u_\infty\|^2 ds$$

$$+\left(\frac{2c_1\,|f|}{\lambda_1\upsilon}\left(1-\big|\nabla_g\big|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1}+2\upsilon\big|\nabla_g\big|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)\int\limits_N^{N+1}\mathbb{E}\big\|u(s)-u_\infty\big\|^2\,ds$$

$$+n_0\int\limits_N^{N+1}\mathbb{E}\big\|h\big(s,u(s)\big)\big\|_{\mathcal{L}^2\big(K^0,H_g\big)}^2\,ds+\frac{1}{2}\mathbb{E}\left[\sup_{N\le t\le N+1}\big|u(t)-u_\infty\big|^2\right]$$

Hence, since $\upsilon>\dfrac{c_1\,|f|}{\lambda_1\upsilon}\left(1-\big|\nabla_g\big|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1}+\upsilon\big|\nabla_g\big|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}$, by some simple

computations,

$$\frac{1}{2}\mathbb{E}\left[\sup_{N\le t\le N+1}\big|u(t)-u_\infty\big|^2\right]\le\mathbb{E}\,|u(N)-u_\infty|^2+n_0\int\limits_N^{N+1}\mathbb{E}\big\|h\big(s,u(s)\big)\big\|_{L_2^0}^2\,ds$$

$$\le\mathbb{E}\big|u(N)-u_\infty\big|^2+n_0\int\limits_N^{N+1}\gamma(s)\mathbb{E}\big|u(s)-u_\infty\big|^2\,ds$$

On the other hand, $\gamma(t)$ is bounded, that there exists $M_\gamma$ such that $\gamma(t)\le M_\gamma$. Then thanks to the Theorem 1, it follows

$$\mathbb{E}\left[\sup_{N\le t\le N+1}\big|u(t)-u_\infty\big|^2\right]\le 2\mathbb{E}\big|u(0)-u_\infty\big|^2e^{-\lambda N}+2n_0\mathbb{E}\big|u(0)-u_\infty\big|^2\int\limits_N^{N+1}M_\gamma e^{-\lambda s}\,ds$$

$$=2\mathbb{E}\big|u(0)-u_\infty\big|^2\,e^{-\lambda N}+\frac{2M_\gamma}{\lambda}n_0\mathbb{E}\big|u(0)-u_\infty\big|^2\left(1-e^{-\lambda}\right)e^{-\lambda N}=M_1e^{-\lambda N}$$

where $M_1=2\left[1+\dfrac{M_\gamma}{\lambda}\left(1-e^{-\lambda}\right)n_0\right]\mathbb{E}\big|u(0)-u_\infty\big|^2$. Thus, $\mathbb{E}\left[\sup\limits_{N\le t\le N+1}\big|u(t)-u_\infty\big|^2\right]\le M_1e^{-aN}$. Let

$\varepsilon_N$ be any fixed positive real number. Then, by the Chebyshev inequality we have that

$$\mathbb{P}\left(\sup_{N\le t\le N+1}\big|u(t)-u_\infty\big|^2>\varepsilon_N\right)\le\left(\frac{1}{\varepsilon_N}\right)^2\mathbb{E}\sup_{N\le t\le N+1}\big|u(t)-u_\infty\big|^2\le\left(\frac{1}{\varepsilon_N}\right)^2M_1e^{-aN}$$

Therefore, since $\varepsilon_N$ is any fixed real number, let $\varepsilon_N=\exp\left(\dfrac{1}{2}(-a+\delta)N\right)$, where

$a>\delta>0$. Then by the Borel - Cantelli lemma, we obtain

$$\limsup_{t\to+\infty}\frac{1}{t}\log\big|u(t)-u_\infty\big|\le\frac{1}{2}(-a+\delta),\quad\text{almost surely.}$$

Letting $\delta\to 0^+$, which completes the proof of lemma.

## 4. Stabilizability and stabilization of solutions by infinite-dimensional Wiener process

We assume that

$(\mathcal{H}2)$  $\quad \tilde{Q}\psi(s,u) := tr\left[\left(\psi_u(u)\otimes\psi_u(u)\right)\left(h(s,u)Qh(s,u)^*\right)\right] \geq v(s)|u(s)-u_\infty|^4$

where $\psi = |u-u_\infty|^2$ and $v(t)$ is a non-negative continuous function such that there exists $v_0 > 0$ satisfying:

$$\liminf_{t\to+\infty}\frac{1}{t}\int_0^t v(s)ds \geq v_0 > 2\gamma_0$$

**Theorem 2.4**. *Suppose that the conditions* $(\mathcal{H}1)$ *and* $(\mathcal{H}2)$ *hold. If*

$$\left(\upsilon\lambda_1 - \upsilon\left|\nabla_g\right|_\infty m_0^{-1}\lambda_1^{\frac{1}{2}} - \frac{c_1|f|}{\upsilon}\left(1-\left|\nabla_g\right|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1}\right) - \gamma_0 + \frac{1}{2}\upsilon_0 > 0$$

*where* $k, c_1, \mu_0$ *are constants in the Theorem 1, then the stationary solution* $\boldsymbol{u}_\infty$ *is almost surely exponentially stable.*

*Proof.* By applying the Ito formula to the function $\log|u(t)-u_\infty|^2$, and taking into account the hypotheses, it follows

$$\log|u(t)-u_\infty|^2 = \log|u(0)-u_\infty|^2 - 2\int_0^t \frac{1}{|u(s)-u_\infty|^2}b\left(u(s)-u_\infty, u_\infty, u(s)-u_\infty\right)ds$$

$$-2\upsilon\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left(C(u(s)-u_\infty), u(s)-u_\infty\right)ds - 2\upsilon\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left(A(u(s)-u_\infty), u(s)-u_\infty\right)ds$$

$$+\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left\|h(s,u(s))\right\|_{\mathcal{L}^0(K^0,H)}^2 ds - \frac{1}{2}\int_0^t \frac{\tilde{Q}\psi(s,u(s))}{|u(s)-u_\infty|^4}$$

$$+2\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left(u(s)-u_\infty, h(s,u(s))dW(s)\right)$$

$$\leq \log|u(0)-u_\infty|^2 + 2\left(-\upsilon+\upsilon\left|\nabla_g\right|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}+\frac{c_1|f|}{\upsilon\lambda_1}\left(1-\left|\nabla_g\right|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1}\right)\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left\|u-u_\infty\right\|^2 ds$$

$$+\int_0^t \gamma(s)ds + 2\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left(u(s), h(s,u(s))dW(s)\right) - \frac{1}{2}\int_0^t \frac{\tilde{Q}\psi(s,u(s))}{|u(s)-u_\infty|^2}$$

$$\leq \log|u(0)-u_\infty|^2 + 2\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left(u(s), h(s,u(s))dW(s)\right) + \int_0^t \gamma(s)ds - \frac{1}{2}\int_0^t \frac{\tilde{Q}\psi(s,u(s))}{|u(s)-u_\infty|^4} \quad (4.1)$$

Denoting $M(t) := 2\int_0^t \frac{1}{|u(s)-u_\infty|^2}\left(u(s), h(s,u(s))dW(s)\right)$, and applying the exponential martingale inequality, we find that

$$\mathbb{P}\left\{\omega : \sup_{0 \le t \le w}\left[ M(t) - \frac{\delta}{2}\int_0^t \frac{\tilde{Q}\psi(s,u(s))}{|u(s)-u_\infty|^4}\right] > \frac{2\log k}{\delta}\right\} \le \frac{1}{k^2} \tag{4.2}$$

where $0 < \delta < 1$ and $k = 1,2,..,$. We then apply the well-known Borel - Cantelli lemma to get there exists an integer $k_0(\varepsilon,\omega) > 0$ for almost all $\omega \in \Omega$ such that for all $0 \le t \le k\varepsilon, k \ge k_0(\varepsilon,\omega)$. Now, combining (5.1) and (5.2), we can see that there exists positive random integer $k_1(\varepsilon)$ such that

$$\limsup_{t\to\infty} \frac{1}{t}\log|u(t)\text{-}u_\infty| \le -\frac{1}{2}\gamma, \text{ almost surely}$$

where $\gamma := \left( \upsilon\lambda_1 - \upsilon|\nabla_g|_\infty m_0^{-1}\lambda_1^{\frac{1}{2}} - \frac{c_1|f|}{\upsilon}\left(1 - |\nabla_g|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1}\right) - \gamma_0 + \frac{1}{2}\upsilon_0 > 0$

Thus, the proof is completed.

**Remark**

In order to produce a stabilization effect, it is sufficient to consider a one dimensional Wiener process. We assume that $K = \mathbb{R}$, $Q = I$ and $W(t)$ is a one - dimensional Wiener process. Then $h(t,u)$ is defined by $(u-u_\infty, 2h(t,u))^2 \ge \upsilon(t)|u(t)-u_\infty|^4$, where $\upsilon(t)$ is a nonnegative continuous function such that positive real number $\upsilon_0$ satisfying

$$\limsup_{t\to+\infty}\frac{1}{t}\int_0^t \upsilon(s)ds \ge \upsilon_0 > 2\gamma_0$$

More specifically, if we choose $h(t,u) = \sigma(u-u_\infty)$, then $\gamma_0 = \sigma^2, \upsilon_0 = 4\sigma^2$ and the stabilization condition in Theorem 5.1 can be rewritten as follows

$$\left( \upsilon\lambda_1 - \upsilon|\nabla_g|_\infty m_0^{-1}\lambda_1^{\frac{1}{2}} - \frac{c_1|f|}{\upsilon}\left(1 - |\nabla_g|_\infty m_0^{-1}\lambda_1^{-\frac{1}{2}}\right)^{-1}\right) + \sigma^2 > 0$$

**References**

[1]    C.T. Anh and D.T. Quyet (2012), *Long-time behavior for 2D non-autonomous g-Navier-Stokes equations*, Ann. Pol. Math. 103, 277 - 302.

[2]    C.T. Anh, D.T. Quyet and D.T. Tinh (2013), *Existence and _nite time approximation of strong solutions of the 2D g-Navier-Stokes equations*, Acta Math. Vietnam. 28, 413 - 428.

[3]    S. Anita (2001), *Internal stabilizability of di_usion equation*, Nonlinear Studies 8, 193 - 202.

[4]     V. Barbu and C. Lefter (2003), *Internal stabilizability of the Navier-Stokes equations*, Systems Control Lett. 48, 161 - 167.

[5]     V. Barbu and S.S. Sritharan (2001), *Flow invariance preserving feedback controllers for the Navier Stokes equation*, J. Math. Anal. Appl. 255, 281 - 307.

[6]     V. Barbu and S.S. Sritharan, (2002), *Feedback stabilization of the magneto-hydrodynamic system,Semigroups of operators: theory and applications* (Rio de Janeiro, 2001), 4553, OptimizationSoftware, New York.

[7]     H. Bae and J, (2004). *Roh, Existence of solutions of the g-Navier-Stokes equations*, Taiwanese J.Math. 8, 85 - 102.

[8]     J. Jiang and Y. Hou (2009), *the global attractor of g-Navier-Stokes equations with linear dampnesson R2*, Appl. Math. Comp. 215, 1068 - 1076.

[9]     J. Jiang and Y. Hou (2010), *Pullback attractor of 2D non-autonomous g-Navier-Stokes equations onsome bounded domains*, App. Math. Mech. -Engl. Ed. 31, 697 - 708.

[10]    J. Jiang, Y. Hou and X. Wang (2011), *Pullback attractor of 2D nonautonomous g-Navier-Stokesequations with linear dampness*, Appl. Math. Mech., Engl. Ed. 32, 151 - 166.

[11]    J. Roh (2005), *Dynamics of the g-Navier-Stokes equations*, J. Di_erential Equations 211, 452 - 484.

[12]    J. Roh (2006), *Derivation of the g-Navier-Stokes equations*, J. Chungcheon Math. Soc. 19, 213 - 218.

# SEMI-SYNTHESIS OF SOME HETEROCYCLIC TRITERPENE DERIVATIVES ON THE BASIS OF ALLOBETULIN

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**Abstract:** Semi-synthesized products derived from natural compounds currently play an important role in the research and finding new substances. Allobetulin, obtained through a process of transformation from betulin, is compound extracted from the birch trees, could be used as the starting material for some transformation reactions. Some new derivatives containing heterocyclic moieties have been obtained via unique reactions. The results of our research are satisfactory and could be further investigated.

**Keywords:** Triterpenoids, betulin, allobetulone, condensation, tetrahydroquinoxaline, triazine

## 1. Introduction

Semi-synthesis of natural compounds for the purpose of developing biologically active agents have become the basis of the actively advancing scientific direction of perfect organic synthesis and medical chemistry. Triterpenes, such as betulin**1** (the trivial name for lup - 20(29) - ene - 3b, 28 - diol) are abundantly present in birch bark. Betulin and its derivatives possess many interesting biological activities; Therefore, they could be seen as excellent renewable starting materials [1,2,3,4]. Betulin could be converted to the isomeric allobetulin **2** (18α - 19β, 28 - epoxyoleanan - 3β - ol) by Wagner - Meerwein rearrangement reaction in the presence of different acid catalysts [5,6]. In the molecular of betulin **1**, the intermolecular reaction of the functional groups presented, such as hydroxyl and alkenes, reacted each other to form ether group in allobetulin **2** in order to lock this site. Oxidation of allobetulin to allobetulone **3**, (18α - 19β, 28 - epoxyoleanan - 3 - one) was performed by using various oxidative reagents such as sodium hypochlorite [7], chromium (VI) oxide in sulfuric acid [8], meta-chloroperoxybenzoic acid [9], or $FeCl_3/SiO_2$ [10]. In this study, we focus on the reaction of the ring A of the allobetulin **3** in order to synthesize of some new allobetulin - type compounds bearing heterocycles by using different methods.

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## 2. Materials and methods

### 2.1. Chemicals and equipment

Chemicals were purchased from Sigma Aldrich or Acros Company in Belgium; all chemicals were made in Germany, Belgium and Switzerland. All reactions were carried out in flame-dried glassware, but no special precautions were taken to exclude moisture. Solvents were mostly dried and in some cases were used as received. $^1$H-NMR and $^{13}$C-NMR spectra were recorded on a Bruker 300 (operating respectively at 300MHz and 75 MHz respectively) Bruker 400 Advance (operating respectively at 400 MHz and 100 MHz respectably). Infrared spectra were measured and processed on a Bruker Alpha-T FT-IR spectrometer with universal sampling module coupled to OPUS software. All samples were applied neat unless stated otherwise. Melting points were determined with a Reichert Thermovar with microscope, and are uncorrected. Low resolution mass spectra were recorded on a Hewlett-Packard 5989A mass spectrometer (EI or CI mode), coupled with an HP Apollo 900 series. HRMS (EIMS) data were acquired on a Kratos MS50TC with ionization energy of 70eV at 150-250 °C (as required), coupled to a MASSPEC II data analyzing system. These data were measured with a resolution of 10000.

### 2.2. General procedures

#### 2.2.1. Preparation of starting materials 1, 2, 3

A solution of betulin **1** (10 g, 22.59 mmol) and *p*-toluenesulfonic acid, (5 g, 29.0 mmol) was dissolved in dichloromethane (500 ml) in a 1000 ml round bottomed flask. The reaction mixture was heated under refluxed with boiling chip for 15 hours. After reaction, the solvent was evaporated and the crude mixture was washed on a Buchner funnel with water (3x300ml) and cold methanol (2x100ml) to remove any catalyst traces and the resulting compound then was dried in low pressure desiccators. 9.3 gram of white solid obtained, was found to be (NMR) essentially pure allobetulin **2** and used for further synthesis without purification.

In a 500 mL two-neck round-bottomed flask was placed oxalyl chloride (3.96 ml, 45.2 mmol) in 180 ml of dry DCM, stirred while cooling to - 78oC under inert (Ar) atmosphere. Dimethyl sulfoxide (6.55 ml, 90 mmol) was added and the mixture was stirred for 10 minutes. A solution of 10g of allobetulin 2 in 120 ml of dry DCM was added and stirring was continued for 15 minutes. 12.96 ml of Et3N was added and stirring was continued for 15 minutes. After that the mixture was warmed to 0oC, and checked by TLC to show complete reaction. The reaction finished after 2 hours. Then 300 ml of H2O was added to the mixture, stirring was continued for 15 minutes, and was separated by funnel to get DCM layer. This DCM layer was washed by water (2 x 300ml). The organic layer was dried with MgSO4, filtered and concentrated. The crude mixture was separated by chromatography with solvent

mixture of n-heptane: EtOAc = 9:1 to get allobetulone3.

Yield: 90%; Mp: 226-228 $^{\circ}$C, $^1$H-NMR (CDCl$_3$, 300MHz, δppm): 3.79 (d, J=7.8, 1H, H-28), 3.53 (s, 1H, H-19), 3.46 (d, J=7.8, 1H, H-28), 2.45 (m, 2H, H-2), 1.94 (m, 1H, H-19), 1.64 -1.09 (21H- complex CH, CH$_2$), 1.07 (s, 3H), 1.03 (s, 3H), 1.01 (s, 3H), 0.93 (s, 9H), 0.79 (s, 3H), (all s 7x3H, 23-, 24-, 25-, 26-, 27-, 29-, 30- Me). $^{13}$C-NMR (CDCl$_3$, 75 MHz, δ ppm): 218.2 (C-3), 87.9 (C-19), 71.2 (H-28), 54.9, 50.4, 47.3, 46.7, 41.4, 40.7, 40.5, 39.8, 36.9, 36.7, 36.2, 34.2, 34.1, 33.1, 32.6, 28.8, 26.7, 26.4, 26.2, 24.5, 21.5, 20.9, 19.6, 16.3, 15.5, 13.4.

### 2.2.2. Semi-synthesis of triterpene derivatives 4, 5, 6

A solution of allobetulone **3** (4 gram, 9.08 mmol) and *t*-BuOK 45.4 mmol, (5.2 gr) in *t*-BuOH (125 ml) was vigorously stirred at room temperature with the provision of efficient access of oxygen to the reaction mixture (with balloon). The TLC was checked every hour with solvent mixture of n-heptane: EtOAc = 9: 1. The reaction finished after 5hrs. After the reaction finished, the mixture was diluted with MeOBu$^t$ (400 ml) and neutralized with 1 M HCl (400 ml) on cooling to 0$^{\circ}$C. The organic layer was separated, washed successively with water (2x400 ml) and a saturated solution of NaCl (200 ml), dried over Na$_2$SO$_4$. The crude mixture was purified by column chromatography with solvent mixture of heptane:EtOAc =9:1 to obtain 2-oxoallobetulone **4**.

Yield: 87%; Mp: 236-238 $^{\circ}$C$^1$H-NMR (CDCl$_3$, 300MHz, δ ppm): 6.45 (s, 1H, H-1), 5.92 (s, 1H, OH-2), 3.79 (d, J=7.8, 1H, H-28), 3.53 (s, 1H, H-19), 3.44 (d, J=7.8, 1H, H-28), 1.71-1.27 (20H- complex CH, CH$_2$), 1.21 (s, 3H), 1.15 (s, 3H), 1.11 (s,3H), 1.04 (s, 3H), 0.94 (s, 6H), 0.81(s, 3H), (all s 7x3H, 23-, 24-, 25-, 26-, 27-, 29-, 30- Me). $^{13}$C-NMR (CDCl$_3$, 75 MHz, δppm): 201.2 (C-3), 143.8 (C-2), 129 (C-1), 87.8 (C-19), 71.2(C-28), 54.2, 46.7, 46.1, 44.0, 41.4, 41.0, 38.6, 36.6, 36.2, 34.2, 33.5, 32.6, 31.2, 28.7, 27.0, 26.3, 26.2, 24.5, 21.5, 21.2, 20.5, 18.6, 16.2, 13.3.

In a 50 mL round-bottomed flask was 2-oxoallobetulone **4** (400 mg, 0.88 mmol) and 1, 2-diamino cyclohexane (0.16 ml, 1.32 mmol) in AcOH (15 ml). The mixture was stirred at 80oC. The TLC was checked with solvent mixture ofheptan: EtOAc = 8:2 every hour to confirm the complete reaction. The reaction was finished after 18hrs. Then the solvent was evaporated. The residue was purified by column chromatography with solvent mixture ofheptan: EtOAc = 8:2 to obtain (5, 6, 7, 8-tetrahydroquinoxalino) allobetulin **5**.

Yield: 58%; Mp: 265-267 $^0$C; $^1$H-NMR (CDCl$_3$, 300MHz, δ ppm): 3.79 (d, J=7.7, 1H, H-28), 3.56 (s, 1H, H-19), 3.46 (d, J=7.7, 1H, H-28), 3.01 (d, J=16.3, 1H, H-1α), 2.88 (m, 4H, H2',H5')2.41 (d=16.3, 1H, H-1β),1.89 (m, 4H, H3', H4'), 1.70 -1.09 (22H- complex CH, CH$_2$), 1.27 (s, 3H), 1.25 (s, 3H), 1.04 (s, 3H), 0.96 (s, 3H), 0.94 (s, 3H), 0.84 (s, 3H), 0.81 (s,3H) (all s 7x3H, 23-, 24-, 25-, 26-, 27-, 29-, 30- Me). $^{13}$C-NMR (CDCl$_3$, 75 MHz, δ ppm): 155.8 (C-3), 150.0 (C-2), 148.9 (C-6'), 146.6 (C-1'), 87.9 (C-19), 71.2 (C-28), 53.3, 49.4, 48.6,46.7, 41.5, 40.7, 40.4, 39.0, 36.9, 36.7, 36.3, 34.3, 33.0, 32.7, 31.7, 31.6, 31.5, 28.8, 26.4, 26.2, 24.5, 23.9, 22.9, 22.8, 21.4, 20.0, 16.4, 15.3, 13.5. HRMS: Calculated for C$_{36}$H$_{54}$N$_2$O:

530.42361. Found: 530.42455.

A solution of 2-oxoallobetulone **4** (1.203 mmol, 0.5471 g) and thiosemicarbazide (1.564 mmol, 0.143 g) in 50 ml ethanol was vigorously stirred at reflux for 30 mins, after that 1.564 mmol of $K_2CO_3$ (0.216g) was added and stirred at reflux. The TLC was checked with solvent n-heptane: EtOAc = 8:2. The reaction finished after 20 hours. Then the reaction mixture was diluted with 50 ml of water and acidified with acetic acid till pH = 4.0. The resulting orange compound was immediately precipitated, filtered and washed with water. Triazine was recrystallized from ethanol to get (3-thio-1,2,4-triazino) allobetulin **(6)**

Yield: 83%; Mp: 227-229 °C; $^1$H-NMR (CDCl$_3$, 300MHz, δ ppm): 3.81 (d, J=7.8, 1H, H-28), 3.57 (s, 1H, H-19), 3.49 (d, J=7.5, 1H, H-28),3.0 (d, J=16.4, 1H, H-1), 2.24 (d, J=16.3, 1H, H-1), 1.7-1.4 (21H- complex CH, CH$_2$), 1.36 (s, 3H), 1.32 (s, 3H), 1.03 (s, 3H), 0.95 (s, 6H), 0.82(s, 3H), 0.81(s, 3H), (all s 7x3H, 23-, 24-, 25-, 26-, 27-, 29-, 30- Me). $^{13}$C-NMR (CDCl$_3$, 75 MHz, δ ppm): 180.9 (C-31), 173.1 (C-3), 145.6 (C-2), 87.9 (C-19), 71.2(C-28), 53.0, 48.7, 46.7, 44.8,41.4, 41.1, 40.8, 40.4, 36.9, 36.6, 36.2, 34.2, 32.7, 32.6, 30.9, 28.7, 26.3, 26.2, 26.1, 24.5, 24.2, 21.6, 20.0, 16.3, 15.3, 13.4. HRMS: $C_{31}H_{47}N_3OS$, calculated: 509.3440, found: 509.3436.

## 3. Results and discussion

Synthesis of starting materials from betulin has been described previously [3,4] and went through three optimized steps as presented in Scheme 1 of these many methods described we found the most convenient way to rearrange betulin to allobetulin in multigram quantity to be by using *p*-toluenesulfonic acid as an acid catalyst in dichloromethane at reflux condition. Swern oxidation [11] was then applied to oxidize allobetulin**2** to allobetulone**3** in order to avoid chromium reagents or other less environmentally friendly reagents.
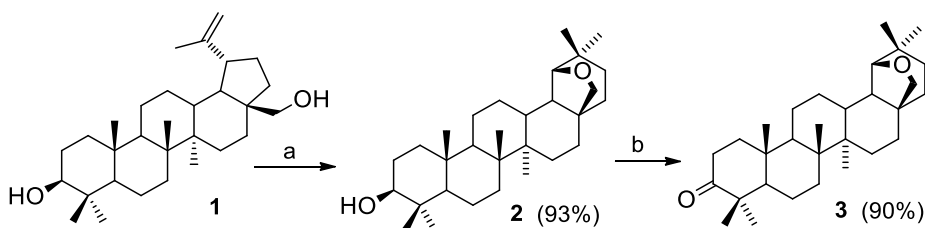


*Reagents and conditions: (a) p-toluenesulfonic acid, dichloromethane, reflux; (b) oxalyl chloride, dimethyl sulfoxide, triethylamine, dichloromethane, -78ºC-0ºC*

**Scheme 1. Synthesis of allobetulone from betulin**

Allobetulone can be oxidized to the 2-oxoallobetulone **4** (here shown in the enol form) by potassium *tert*-butoxide in tertbutanol (Scheme 2) [12]. In this reaction, oxygen resource could be used either oxygen in air or pure oxygen (from balloon). The obtained product is used to prepare fused heterocyclic ring compounds. The products could be ether 2-

hydroxyl-3-ketone derivative (**4**) and 2,3-diketone derivative one (**4'**), however, we found that only compound **4** was obtained. The product structure was confirmed by ^{1}H-NMR spectroscopic method through the presence of signals of the proton H-1 at 6.45 ppm (s, 1H, H-1) and of OH proton at 5.92 (s, 1H, OH-2).
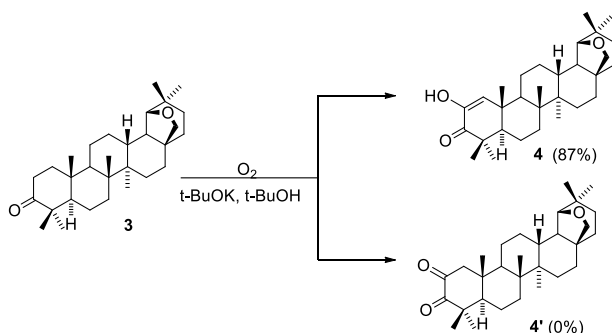


**Scheme 2. Synthesis of 2-oxoallobetulone**

Condensation of 2-oxoallobetulone with 1,2-diaminocyclohexane afforded heterocyclic (tetrahydroquinoxalino) allobetulin 5. This reaction is very interesting because oxidation happened in situ and the product is aromatized to the heterocyclic compound (Scheme 3).
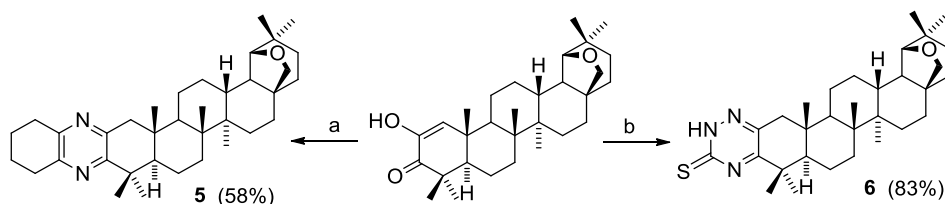


*Reagents and conditions: (a) 1,2-diaminocyclohexane, acetic acid, 80ºC; (b) thiosemicarbazide, $K_2CO_3$, EtOH, reflux*

**Scheme 3. Synthesis of heterocylic derivatives 5, 6**

The condensation of 2-oxoallobetulone **4** with thiosemicarbazide in ethanol with $K_2CO_3$ afforded the desired allobetulin derivative having 1,2,4 - triazine moiety **6** (Scheme 3) [13]. The absolute configuration of compound **6** was optimized by theoretical calculation using the Chem - 3D program (Molecular Mechanics, MM2 force field, Figure 1).
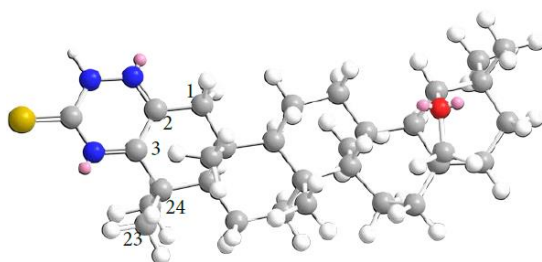


**Figure 1. 3D-Structure of compound 6 (Molecular Mechanics, MM2 force field)**

The structure of this compound was confirmed by 2D-NMR HMBC (measure by Bruker 400 Advance) analysis through the coupling of both C2 with C1 hydrogen and C3 with C23 hydrogen. According to HMBC the signals of the two protons on the C-1 at 3.0 ppm and 2.24 ppm have correlations with C2 at 145.6 ppm and the signal of the proton on the C23 at 1.32 ppm has a correlation with C3 at 173.1 ppm (Figure 2).
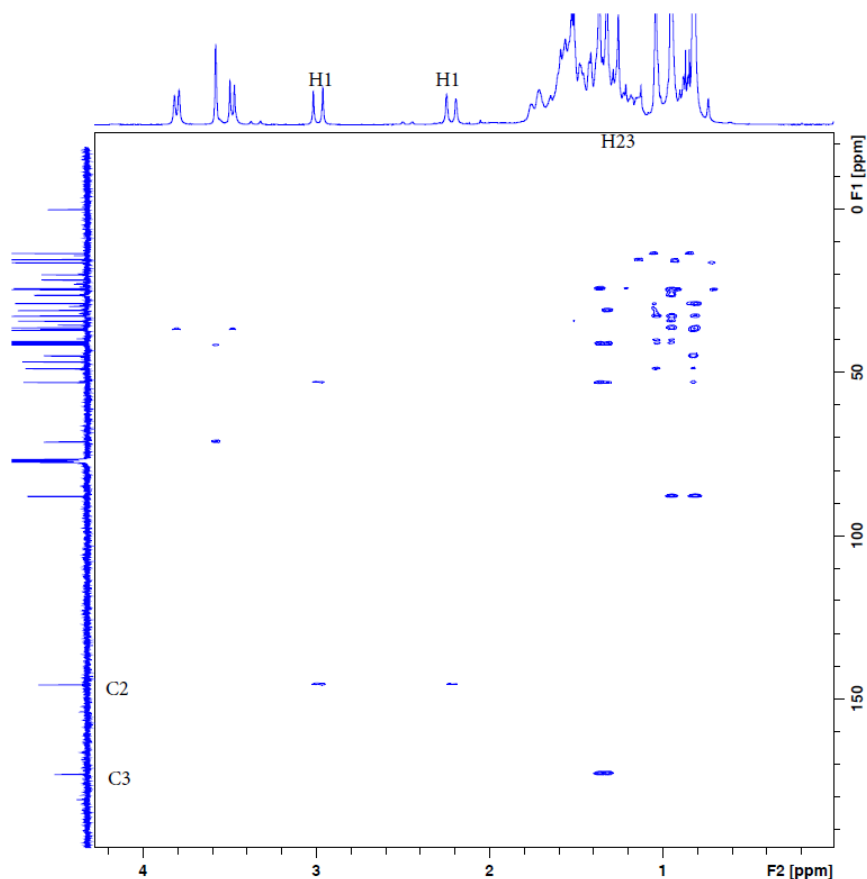


**Figure 2. HMBC of compound 6**

## 4. Conclusion

Based on the betulin, interesting transformations to valuable starting materials, which were used to synthesize a series of new heterocyclic products, have been carried out. The structures of these compounds were confirmed by modern spectroscopic methods. This research direction could be continuous and the obtained products could be investigated for further applications.

**References**

[1]     Dehelean, C.A.a, CîntăPînzaru, S.b,Peev, C.I.a,Soica, C.a,Antal, D.S. (2007), *Characterization of birch tree leaves, buds and bark dry extracts with antitumor activity*. Journal of optoelectronics and advanced materials. Volume 9, Issue 3, March, P 783 - 787.

[2]     Shesadri T. R., Vedanthan T.N.C (1971), *Chemical examination of the barks and heartwoods of Betula species of American origin*. Phytochemistry. 10, 897 - 898.

[3]     Kovac B.E., Duric K, Kalodera Z., Sofic E., *Identification and isolation of pharmacologically active terpenes in Betulae cortex, Betulapendula Roth, Betulaceae Bosnian*. Journal of Basic Medical Science. 2009, 9(1), 32 - 38.

[4]     Dehaen, W; Mashentseva, A.A. and Seitembetov, T.S, (2011), *Allobetulin and Its Derivatives: Synthesis and BiologicalActivity*. Molecules. 16, 2443 - 2466.

[5]     Green B.; Bentley M.D; Chung B.Y.; Lynch N.G.; Jensen B.L. (2007), *Allobetulin and its derivatives: Synthesis and biological activity*. J. Chem. Educ. 84, 1985 - 1987.

[6]      Li T.S.; Wang J. X.; Zheng X. J. (1998), *Simple synthesis of allobetulin, 28-oxyallobetulin and related biomarkers from betulin and betulinic acid catalysed by solid acids*. J. Chem. Soc. Perkin Trans. 3957 - 3965.

[7]     Flekhter, O. B.; Ashavina, O. Y.; Smirnova, I. E.; Baltina, L. A.; Galin, F. Z.; Kabal'nova, N. N.; Tolstikov, G. A. (2004), *Selective oxidation of triterpene alcohols by sodium hypochlorite*. Chem. Nat. Comp. 40, 141 - 143.

[8]      Kim D. S. H. L.; Chem Z.; Nguyen Van T.; Pezzuto J.M.; Quit S.; Lu Z.Z. (1997), *A Concise Semi-Synthetic Approach to Betulinic Acid from Betulin*. Synth.Commun. 27, 1607 - 1612.

[9]     Tori M; Maisuda R.; Sono M.; Kohama Y.; Asakawa Y. (1988), *The reaction of lupane and friedo-oleanane type triterpeneswith m-chloroperbenzoicacid*. Bull. Chem. Soc. Jpn.61, 2103 - 2108.

[10]    Thibeault B.; Legault J.; Bouchard J.; Pichette A. (2007), *Useful approach to access germanicanes from betulin*. Tetrahedron Lett. 48, 8416 - 8419.

[11]    Flekhter, O. B.; Ashavina O. Y.; Boreko E. I.; Karachurina, L. T.; Pavlova, N. I.; Kabalnova N. N.; Savinova O. V.; Galin F. Z.; Nikolaeva S. N. Zarudii F. S.; Baltina L. A.; Tolstikov G. A. (2002). *Synthesis and local anesthetic activity of 1, 2-disubstituted imidazo [1, 2-a] benzimidazoles*. Khim.Pharm.Zh. 36, 21 - 24.

[12]    A. V. Korovin, and A. V. (2001), *Tkachev. Synthesis of quinoxalines fused with triterpenes, ursolic acid and betulin derivatives*. Russ. Chem. Bull. 50, 304 - 310.

[13]    Nagai S.; UedaT.; NagatsuA.; MurakamiN.; SakakibaraJ. (1997), *Synthesis and central nervous system stimulant activity of camphor-1, 2, 4-triazines fused with 1, 2, 4-triazole, tetrazole and 1, 2, 4-triazine. Heterocycles*. 44, 117 - 120.

# EVALUATING THE ROLES OF CREDIT FOR SMALL AND MEDIUM ENTERPRISES IN HUE CITY, THUA THIEN HUE PROVINCE

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**Abstract:** This article was implemented by an investigation using restricted quota random sampling method on 55 small and medium enterprises which are activating in the field of running business in Hue City, Thua Thien Hue province. The article showed that the majority of enterprises in the city have been using credit with the moderate quantity (315.2 million); the interest rate and payment terms were highly consistent for running plans of business. Enterprises evaluated that credit played important roles in expanding of production scale, reducing financial pressure, investing and improving technology and capacity of management. The field of doing business has sharply influenced on the efficiency of using credit; enterprises are facing a number of huge problems with market, developing new products and problems regarding to geographical location. The article used the technique of One sample T - test for evaluating the enterprise's opinion, and most of the testing results were statistical significant at three levels of significance.

**Keywords:** SMEs, credit

## 1. The rational of research

Small and Medium Enterprises (SMEs) not only play crucial role for the sustainable development of countries in general but also for regions in detailed [1]. Thanks to the extension about scale and number of SMEs in quantity, a numerous of SMEs witnessed its duty in the contribution of Province's budget and creating the job opportunities for their citizens. The number of SMEs up to 31st Dec 2011 was 3.072, in which, the percentage of company having capital scale from 1 to 5 billion were highest, with 1.254 firms; the number

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of firms owning capital larger than 27 billion were 27 [2]. SMEs always play a crucial role for the developing of Hue city and also for Thua Thien Hue province, thus the local government needs making more programs, policies and generating advantage conditions, which can help the SMEs to pass the challenges of current economic crisis. There were various kinds of supporting, but developing by giving more financial supports for SMEs is the most necessary because it helps SMEs to continue running business activities and step by step enhancing their efficiency, which based on the developing economy and society of the city and also of the province. In reality, we cannot deny that credit is the most important factor in decision-making of running business, but in many different cases of each firm it will play different role. This article aims to answer some simple questions which are as following: How many percentages of SMEs borrow loans from bank? Asking for the SMEs borrowed credit, what are their main purposes? How did they evaluate the roles of credit for their activities? And this research will try to find out the main drawbacks that SMEs are facing and giving some implications for local authorities in making financial policies.

## 2. Objectives and methods

### 2.1. Objectives

The objectives of research are as following:

(1) To understand in general the using credit of SMEs;

(2) To identify the roles of using credit with business activities of SMEs;

(3) To determine the main drawbacks that SMEs are facing;

(4) To propose some implications for managers and local authorities in making financial policies regarding to SMEs.

### 2.2. Methods

To conduct this research, we combined various different methods. Initially, we used both logical and systematic-structure approach to reach problematic statements. Secondary data and primary data were collected to implement this research. In the case of secondary data, we collected the data from the annual reports of local offices and previous studies to have a general approaching in research problems and; because of the limits of time and cost, primary data were only collected by surveying from 55 SMEs in 2014 with non-probity method of sampling (quota sampling method) from the given list provided by the department of commercial and industrial office. Regarding to investigation, we have just only asked the directors or managers of SMEs, some cases we sent an email and combined with phoning when we missed information. For data processing, all data will be coded and entered to SPSS version 19 to prepare for analyzing. Finally, we used two main types of methods to processes the data that includes statistical method and test the equality of mean (Independent sample - T test).

## 3. Results and discussions

### 3.1. Labor using of SMEs

In generally, labor staffs play an important rational role for the process of developing of SMEs. There is no denial that if SMSs owned high quality labors with professional skills combining with good management's staff from the boss, then SMEs can be easy to gain more achievement in running business. The numbers of labors in average of SMEs in Hue city have just stayed on a medium level, with approximately 30 labors per one SME. In which, directed labors were 20; managing labor and undirected labor were similar (4.6 and 5.4 respectively) (see appendix 1). Considering to the education level of labors, the percentage of labors that had bachelor degree and post-graduated made of highest, but that have been still existed a small number of labors who owned lower level of education. Concerning directed labors and undirected labor, most them had graduated secondary and high school.

To sum up, Hue city now is the central of training which many universities and education centrals, but the education level of SMEs were still intermediate.

### 3.2. Census of borrowing and using credit of SMEs

The fact that capital always play crucial roles in order to prepare for doing business activities. In particularly, SMEs used both sources of capital including their capacity and borrowing from banking system.

**Table 1. The use of loan from banking system of surveyed SMEs**

| Indicators | No | % |
|:---:|:---:|:---:|
| Yes | 31 | 56.4 |
| No | 24 | 43.6 |
| Total | *55* | 100.0 |

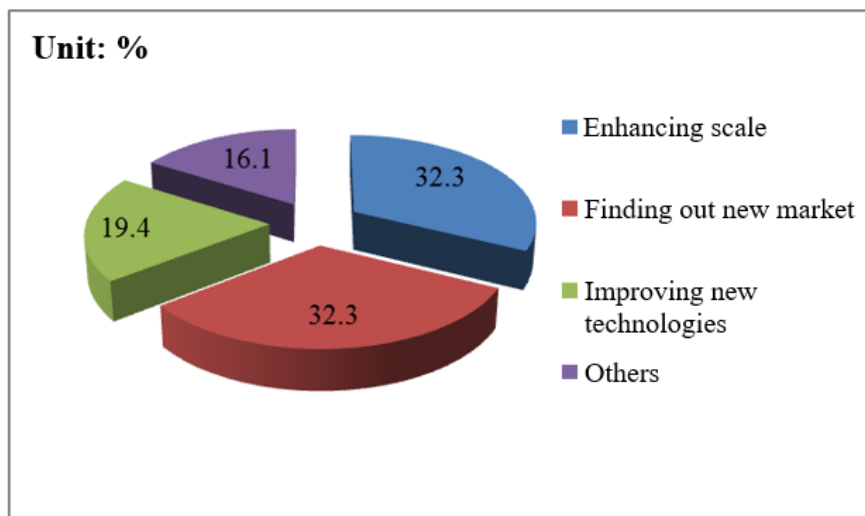*(Sources: Conducted survey in 2014)*

As some given reveals from the table 1, the percentage of SMEs's loans were in medium level with over 56%, which shown the percentage of borrowing SMEs in the City were lower than other regions of Viet Nam (over three quarters). This current situation can be explained by some several reasons. First, the result of crisis period from 2008 until now on the world causing the safe behavior in expanding business activities, thus they do not need more investments; the investment environment can not attract companies from outsides which led SEMs in city not be able to cooperate with each other.

**Table 2. Integrate charge, term and amount of surveyed SMEs**

| Indicators | Unit | Value |
|---|---|---|
| Interest charge | %/year | 9.6 |
| Term | Month | 36 |
| Amount | Million | 315.2 |

*(Sources: Conducted survey in 2014)*

The average interest charge that SMEs must pay in following years was 9.6%, this level was quite similar to the interest charge which imposed by central bank. But, it was still high in comparing with the expected interest charge of SMEs at this time because of the drawbacks of business environment. In choosing the term of loans, SMEs tended to borrow around 36 months/ period, it ensured that SMEs could run business and pay back the debts to the bank. In addition, 315.2 million was the small amount but it can help SMEs in reinvesting and enhancing business level on the market.



*(Sources: Conducted survey in 2014)*

**Figure 1. The purposes of loans**

In the process of conducting this study, we realized that the purposes of SMEs in borrowing loans that served for enhancing scale and finding out new market, that were strong ability of SME in difficult circumstances.

### 3.3. Evaluations of SMEs regarding loan participated abilities and facilities

To borrow money from the banks, SMEs need to spend following many complicated steps. The table below described some criteria involving loan participating abilities and facilities.

**Table 3. The evaluations of SMEs and testing results connecting loan participated abilities and facilities**

*(Level of significant is 0,05, if Sig (2-tailed) =< 0.05 Reject $H_0$:$\mu$ =$\mu_0$ = 3; in which $\mu$ is the average value and $\mu_0$ critical value; Test method is one sample T - test)*

| Indicators | Mean | Standard deviation | Sig (2-tailed) |
|---|---|---|---|
| Loan participating[1] | 4.000 | 0.544 | 0000 |
| Formulation of lend[2] | 2.836 | 1.050 | 0.000 |
| Facilities[3] | 3.782 | 0.738 | 0.252 |
| Term of giving loans [4] | 3.528 | 0.813 | 0.000 |
| Integrate charge[5] | 3.300 | 0.937 | 0.000 |
| Loan proceduces[6] | 3.564 | 0.977 | 0.025 |
| Payment terns[7] | 4.055 | 0.405 | 0.000 |

***Note: Linker level:*** *1: 1-5: Very hard - Very easy; 2: 1 - 5: Much disadvantage - Very advantage; 3: 1 - 5: Very difficult - Very easy; 4: 1 - 5: Very slowly - Very quickly; 5: 1 - 5: Very low suitable - Very high suitable; 6: 1 - 5: Hard facilities - Much facilities; 7: 1 - 5: Very low suitable - Very high suitable*

*(Sources: Conducted survey in 2014)*

Evaluations of SMEs shown that the condition to participate loans were sharply effortless, banks always generate more advantages for SMEs getting loans to satisfy their demands in doing business activities. The payment terms were evaluated with high suitable level for SMEs in rejecting their field of businesses to pay back the loans to the bank. In the case of SMEs faced drawbacks in running their businesses, SMEs will be permitted to enhance the time of paying back the loans to the banks but they must follow some strictly restricted conditions from the banks. On the contrary, SMEs argued that the formulation were bad because the floating integrate charge which led SMEs faced more disadvantages. Most values of T-test were significant at 0.05 level of significant excluding Facilities criteria, because SMEs believed that they should be received more supporting from the government.

### 3.4. Evaluations of SMEs concerning the roles of credit

The results represented that credit plays more and more important roles with their standing situations. In particularly, reducing financial pressure was the best evaluation. This role can be illustrated in the case of SMEs who entered the business registration. Thus, they must satisfy the minimum charter capital. After that, they could be borrowed

money from banking system. In addition, credit plays more important in expanding business scale, investing and improving technology, continuing of business cycle, and establishing of optimal capital structure. All given criteria above were evaluated with high score.

**Table 4. The evaluations of SMEs and testing results concerning the roles of credit**

*(Level of significant is 0.05, if Sig (2-tailed) =< 0.05 Reject $H_0$: $\mu = \mu_0 = 3$; in which $\mu$ is the average value and $\mu_0$ critical value; Test method is One sample T - test)*

| Indicators | Mean | Standard deviation | Sig (2-tailed) |
|---|---|---|---|
| Expanding business scale | 4.110 | 0.937 | 0.000 |
| Enhancing market ability | 3.582 | 1.166 | 0.001 |
| Investing and Improving technology | 4.110 | 0.686 | 0.000 |
| Enhancing SMEs' competiveness ability | 3.582 | 0.762 | 0.000 |
| Improving business efficiency | 3.691 | 1.360 | 0.000 |
| Promoting income for labor | 2.555 | 1.260 | 0.001 |
| Establishing of optimal capital structure | 4.037 | 0.429 | 0.000 |
| Reducing financial pressures | 4.200 | 0.558 | 0.357 |
| Continuing of business cycle | 4.073 | 0.325 | 0.000 |

*Note: Linker level: 1 - 5: very unimportant and - very important*

*(Sources: Conducted survey in 2014)*

In contrast, credit played less important in contributing of promoting income for labor as well as that in Enhancing SMEs' competiveness ability. Remarkably, when we implemented the test to evaluate the significant of given criteria, the Null Hypothesis is **$\mu = 3$,** we met a big strange in the case of criteria: Reducing financial pressures, the test was unsignifying at 0.05 level of significant although the evaluated mean was 4.2 points.

### 3.5. Evaluations involving the factors influencing on efficiency of using credit in surveyed SMEs

Using credit in efficiency way is influenced by numerous factors. It can be divided to external factors and internal factors. In detailed, internal factors included Business ability of SMEs, Structure of capital, Credit scale, Manage ability and quality of labor staff. External factors are as following: Geographical location, Natural condition, Competitors, etc. But, in this research we have just listed some specified factors in Table 5.

**Table 5. The evaluations involving the factors influencing on efficiency of using credit in surveyed SMEs**

*(Level of significant is 0.05, if Sig (2-tailed) =< 0.05 Reject $H_0$:$\mu = \mu_0 = 3$; in which $\mu$ is the average value and $\mu_0$ critical value; Test method is One sample T - test)*

| Indicators | Mean | Standard deviation | Sig (2-tailed) |
|---|---|---|---|
| Credit scale | 3.982 | 0.972 | 0.000 |
| The fields of running business | 4.164 | 0.877 | 0.000 |
| Management ability of business owner | 4.073 | 0.858 | 0.001 |
| Government policies | 3.855 | 0.731 | 0.000 |
| External impacts from nation/ region/ world | 3.927 | 0.662 | 0.0001 |
| Trade market | 4.127 | 0.695 | 0.000 |

*Note: Linker level: 1-5: very uninfluenced - very influenced*

*(Sources: Conducted survey in 2014)*

Processing of conducting the research represented that group of factors such as the fields of running business, trade market and manage ability of business owner has strong influencing on the efficiency of using credit of SMEs. Apparently, they gave the evaluation with over 4 points for each given criteria, and the result of testing supported for this evaluations. Asking for the rest of other criteria, the grades were over 3.9 points. From these evaluations, we have many fundamental bases to conclude that given factors play a crucial core in using efficiency credit of SMEs.

### 3.6. Listed drawbacks of surveyed SMEs

In the sense of global crisis, most of SMEs are facing with enormously drawbacks in the term of doing businesses. By questionnaires, we try to list 10 disadvantages that were happening in current situation. The manager or supervisor of SMEs had to mark 3 biggest drawbacks that they though it involved directly to the business's result of SMEs. The marked results were shown are as below.

**Table 6. Lists of drawbacks from evaluation of surveyed SMEs**

| Indicators | No | % |
|---|---|---|
| Disadvantage concerning geographical location - land used | 29 | 53.7 |
| Developing new products | 30 | 55.6 |
| Participating new technologies | 15 | 27.8 |

| | | |
|---|---|---|
| Financial | 21 | 38.9 |
| Expanding new market | 17 | 31.5 |
| Reducing the cost of business | 4 | 7.4 |
| Shortage of information | 12 | 22.2 |
| Tackling environmental pollution | 4 | 7.4 |
| Training labor staff | 12 | 22.2 |
| High tax of payment | 6 | 11.1 |

*(Sources: Conducted survey in 2014)*

From the result of table 6, a lot of SMEs are directly facing with finance problems, disadvantage concerning geographical location - land used, and developing new products. Similarly, some problems regarding to tackling environmental pollution, High tax of payment were evaluated in high frequencies, but these drawbacks can be solved when SMEs reaching stable situation.

## 4. Conclusions and implications

### 4.1. Conclusions

SMEs are now contributing to the development of Viet Nam/ Thua Thien Hue economy in general and Hue city in detailed. This sector is the core factor in developing economy of Thua Thien Hue province and stimulating on enhancing quality of citizen life, generating job opportunities and creating more motivations in keeping the stability of its economy. After conducting this research, we strongly recommended that some conclusions: credit plays crucial in the development of SMEs in Hue city; most of SMEs rented loans for running business and, the rate of SMEs participated credit were lower than the average rate of Viet Nam; most of SMEs evaluated that the formulation of participating credit was high appropriate, simple formulation, integrate charge, term of paying were suitable; the main roles of credit are presented in expanding business scale, reducing finance pressures and, investing - improving technologies; there were still existed many factors influencing on the efficiency of using credit, but managing ability of business owner and the field of business were highest influenced; SMEs are now facing with a huge problems and the biggest problems involving on finding new markets, developing new products and geographical conditions - land used.

### 4.2. Implications

To develop in new senses, SMEs need to be more activated in finding new credits from baking systems to expanding their business scale. Besides, improving the skills for labors; promoting for managers, directors and members in directorate are also important. In addition, market is the biggest motivation of SMEs, thus finding out new market will be

ensured for processing of doing business, applying new technologies as well as developing new products to serve the market demand.

In the dimension of local authorities, creating more good business environmental business, and attracting more foreign investors participating in business fields are the initial plan of making new policies. Hence, local authorities need to support by establishing new co-organizations to strengthen the linkage among SMEs. Finally, local authorities also should be in line with banking system in supporting for SMEs borrowing credit.

**References**

[1]     Hoa T.V, Phuc N.Q, Tuyen M.C (2013), *Level of participating business supporting services*, Science Journal, Hue University, page 2.

[2]     Department of Economics office in Hue city (2013), *The report of implementing plan and strategy of developing economics and social in Hue city*.

[3]     Statistic office (2013), Yearbook of statistic in Thua Thien Hue 2013.

[4]     Phat N.V (2008), *Developing business supporting services in Thua Thien Hue,* The report of scientific research level of ministry, B2006 - DHH. 06 - 08, Hue.

# GIS APPLICATION IN CLIMATE CHANGE IMPACT ASSESSMENT AT NGA SON DISTRICT, THANH HOA PROVINCE

**Nguyen Anh Tuan, Trinh Thi Hien**

**Abstract:** The study investigated the impacts of climate change on sedge production at Nga Son district, using secondary and primary information with interviewed data. GIS technologies were used to identify and map areas at risk of inundation from sea level rise and analyze land uses most likely to be affected. Results show that: from 1970 to 2013, average temperature has risen up about $0.3^0C$ while the amount of rainfall has decreased approximately 20%. These phenomena have contributed to fresh water shortage and salinity level rising in sedge production regions. These changes were claimed through PRA (Participatory rural appraisal) and FGD (Focus group discussions) with farmers and the district authority as main causes to a decline in sedge planting areas and sedge yield. In order to have a better adaptation to climate change for sedge production, several solutions were proposed, including improving irrigation system, changing land use, building cultivation techniques for better sedge yield and quality as well as finding more stable markets for sedge products.

**Keywords:** Climate change, sea level rise, GIS

## 1. Introduction

Located in the tropical monsoon belt of Southeast Asia, Vietnam is one of the five countries predicted to be most vulnerable to the consequences of climate change due to its long coastlines and a strong reliance on natural resources and agriculture production (World Bank, 2009). Thanh Hoa province located in the North Central Coast of Vietnam was identified as one of the most vulnerable areas (VARCC, 2009). The province is strongly dependent on agriculture sector for income. With a coastline of 102 km and nearly 17,000 $km^2$ of its territorial water, Thanh Hoa has advantages to develop agriculture and fishery. However, agriculture production and fishery strongly relies on natural environment, therefore,

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is strongly affected by climate impacts including drought, flood, sea level rise and salt water intrusion.

Nga Son is a district in the Northeast of Thanh Hoa province, covers an area of 151 km². This place is well known for growing sedge (*Cyperus sp*.) and making sedge mat and other sedge products. Similar to other coastal areas, Nga Son is seriously affected by climate change due to drought, sea level rise and changes in hydrograph in recent years, causing a remarkable decline in sedge yield annually. Several studies about sedge production have been made to find solutions for sedge production improvement. However, most of the studies focused on influences of cultivation techniques on sedge production reduction and did not take into account the effects of climate change. This study was carried out in order to investigate the impacts of climate change and other factors leading to the decline in sedge production; and to find out solutions to improve production output in Nga Son district. To achieve these aims, the case study of Nga Thuy commune was chosen and several objectives have been determined as follows:

- Investigating changes of climatic factors and extreme climate events in the period from 1970 to 2013.
- Mapping the potential future inundation areas due to sea level rise in Nga Son District.
- Developing an adaptable strategy for sedge production in Nga Thuy commune.

## 2. Materials and methods

### 2.1. Data collection

Secondary data: collecting data about climatic factors and crop production status from local offices, e.g. Department of Agriculture and Rural Development of Thanh Hoa, Office of Natural Resources and Environment and Office of Agriculture of Nga Son district, general statistics offices of the province and the district, annual reports of the district.

Primary data: data collection was done by using a semi-structured interview, PRA and focus group discussion methods. In the first collection, 40 households in Nga Thuy commune were interviewed with a prepared questionnaire. The households chosen must be older than 40 years old and have at least 0.5 ha sedge farm. Information obtained includes awareness and understanding of households about climate change, tendency of climatic factors. In the second and the third times, two focus group discussions were organized with farmers, the district and the commune authority to find out impacts of climate change on their agriculture production and what households have done to adapt. Furthermore, solutions for climate change adaptation were discussed and ranked to find out better solutions for the region.

Excel and Matlab programs were used for data analysis (i.e. average values, percentage of study variables to describe the issues involved).

### 2.2. Flood inundation mapping

Land use, hydro-meteorological, CC & SLR data for this study were collected or generated from different sources. Land use map was provided by Thanh Hoa Environmental and Natural Resources Department. The runoff data, meteorological data and cross sections were obtained from Hydro-meteorological Data-Center of Vietnam. Monthly data in the period from 1970 to 2013 were included. The SLR scenarios for Vietnam were developed by MONRE in 2009, computed on the basic of the lowest (B1), medium (B2) and the highest (A2) emission scenarios. The medium emission (B2) was used in this research to generate inundation maps. For the assessment of the projected SLR scenarios the study has used the topographic map at 1:25,000 with 10 m to 20 m contour interval to generate contour. The DEM is constructed using the ArcGIS software for the entire coastal zone.

The flow of methodology used in the research is showed in figure 1. GIS technologies were used to identify and map areas at risk of inundation from sea level rise and analyze land uses most likely to be affected. In particular, high resolution digital elevation model (DEM) with a 10 m pixel size was used to identify areas vulnerable to the SLR scenario of the medium emission (B2). This was carried out using raster reclassification in ArcGIS 9.3 and flooded areas likely to be identified. Finally, FGD with local famers was used in the research to figure out current local adaptations and suggest solutions for CC adaptation and mitigation.
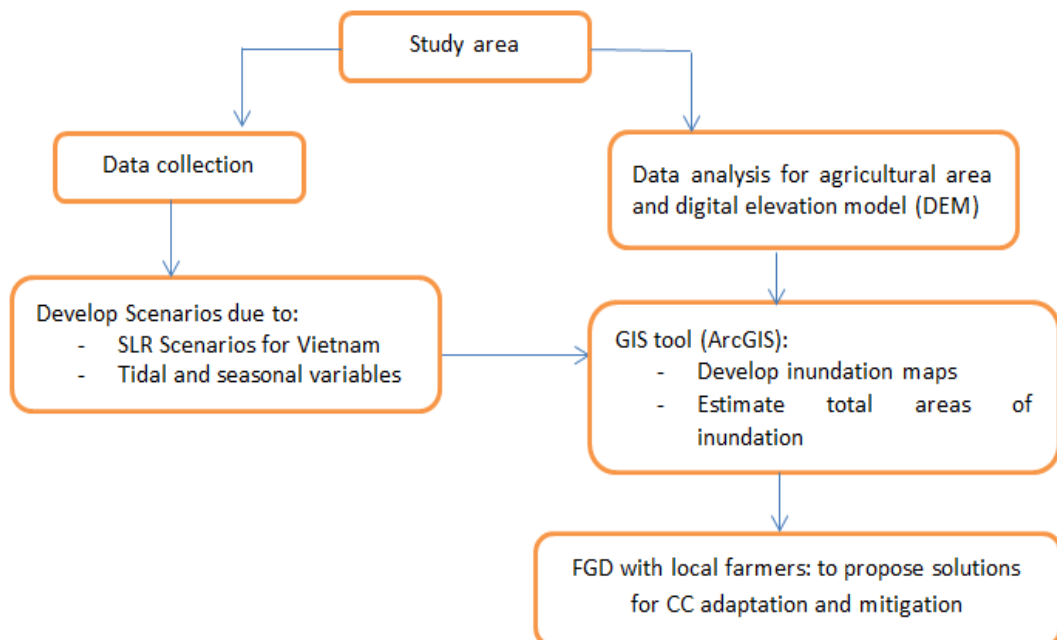


**Figure 1. A flow diagram of the methodology used in the study**

## 3. Results and discussions

### 3.1. The changing trends of climatic factors

Figure 2a shows a trend of increasing in temperature in four recent decades from 1970 to 2012. Generally, average temperature in later decade was about 0.07 to $0.13^0$C higher than previous decade. During the four decades, average temperature has increased $0.3^0$C. According to a report in 2013 from the department of resources and environment of Thanh Hoa, the number of hot days was reported to increase. In 2008, there were 30 continuous hot days with maximum temperature reaching 39 - $41^0$C. Remarkably, the temperature raised up to $43^0$C in summer, the highest recorded temperature in history.
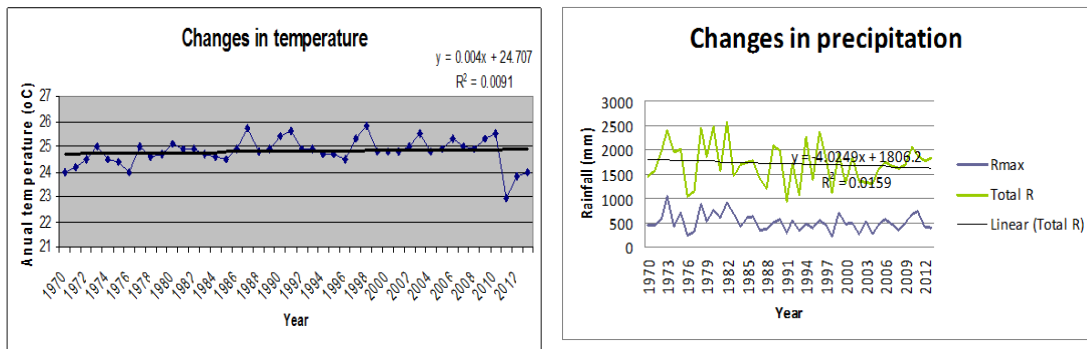


*a. The changing of temperature*          *b. Precipitation changes*

**Figure 2. Changes in temperature and precipitation over the period of time (1970-2012)**

Climate changes show a remarkable impact in annual precipitation in Nga Son district. The amount of annual rainfall has a tendency of decreasing over the years (Figure 2b). During the period from 1970 to 2013, the amount of rainfall in Nga Son has declined approximately 20%. After each period of 15 years, the amount of rainfall decreased and was about 9.4 to 190.5mm lower than the previous 15 years. Furthermore, rainfall sequence has been changed. The dry season tends to get drier but there was 100 mm rainfall occasionally occurred at certain places. In Nga Son, there are two seasons based on amounts of rainfall that are a dry season and a rainy season. The rainy season usually starts from July until November. However, according to records from the Hydro-meteorological, the rainy season came later and finished earlier in recent years. This indicates that the dry season tends to get longer. The decline in the amount of rainfall coupled with the change in rainy pattern could be an explanation for a shortage of irrigation water, more frequent occurrences of drought and more severe floods observed in recent years. According to the report from Thanh Hoa Department of Resources and Environment, rainfall decreasing has caused to declining of river water level and discharge. Len River was 3m$^3$/s, much lower than the river lowest discharge (25m$^3$/s - 30m$^3$/s).

### 3.2. Changes in drought and flood sequence and intensity

According to Hydro-meteorological station for the time period from 1970 to 2013, drought has become more frequent. The average number of drought per 15 years has increased.
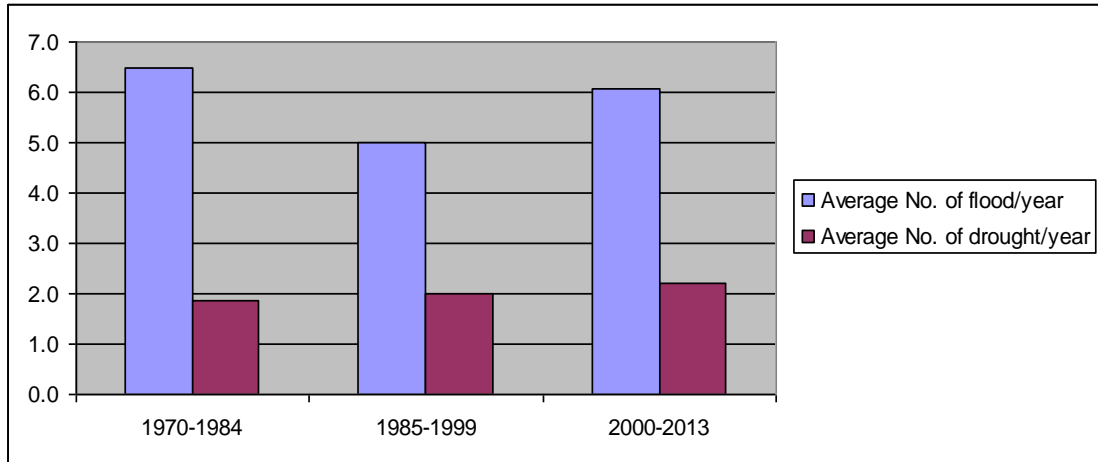


*(Source: Climate data from North Central Hydro-meteorological station, 2014)*

**Figure 3. Average number of flood and drought per year**

Data in figure 3 shows that, there was a tendency of increasing drought occurrences. In the period from 1971 to 1984, drought occurred 1.86 times per year on average, but in the period from 2000 to 2013, the average number of drought per year was higher (2.21 times/year). In Thanh Hoa, drought often appears at two time periods: the first period is from November to the next year's March and the second one is from June to July. This directly affects agriculture production in coastal areas. In 2010, 1552 ha rice and 730 ha sedge fields in Nga Son district were suffered from drought condition.

There is a fluctuation in the average number of flood. In comparison to the period from 1971 to 1984, the number of flood per year in recent years seems to decrease. However, flood sequence has become more unpredictable and flood intensity is increasing. In 2007, the province was hit by a storm with high amount of rainfall, causing severe floods in history. Water level measured at Len river reached 6.95m which was 0.15m higher than water level in a historical flood in 1973.

Yearly amount of rainfall is an important index for water availability assessment. However, high amount of precipitation does not mean that there is enough water available for cultivation because a spatial and temporal distribution of precipitation should be considered. In fact, unequal distribution of rainfall is a main cause for droughts and floods in many regions. Nga Son district is not an exception. In the dry season (from December to May), there is often water shortage for crop. For sedge production, if there is a lack of water in crucial

development periods such as tiller and elongation, sedge growth and development will be reduced, causing a decrease in yield and sedge quality.

### 3.3. Salinity levels measured at Len river

According to hydro-meteorological data obtained from North Central hydro-meteorological station for the time period from 1989 to 2011, the salinity has become more frequent. The figure 4 shows that, there was a tendency of increasing salt - intrusion occurrences.
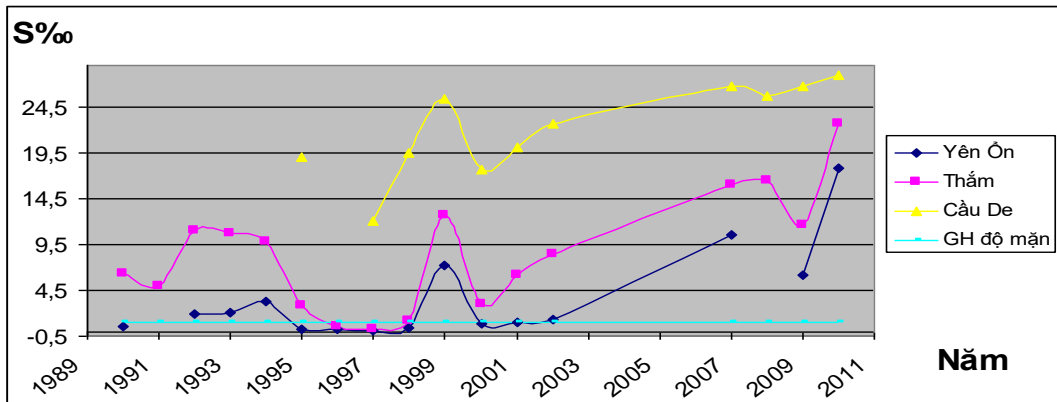


*(Source: Climate data from North Central Hydro-meteorological station, 2014)*

**Figure 4. Salinity levels at Len river in Thanh Hoa**

Before 2003, salinity level measured at Yen On station, which is 13 km from Len river estuary, ranged from 0.2 - 4‰ approximately. However, there is an increase in salinity level in recent years. Remarkably, salinity level raised up to 6.1‰ in 2009; 10.6‰ in 2007 and reached 17.8‰, the highest number observed in history, in 2010 (Figure 4). According to sedge farmers and the district authority, the salinity level increasing over time was main causes of the sedge production lost and field abandon.

### 3.4. Flood inundation mapping in Nga Son district under sea level rise scenario (B2) and the max tide (3.25m)

Assume that the sea level rise scenario in this case has not considered the technical infrastructure and solutions exist to limit the impact of climate change, inundation maps of flooded areas in Nga Son district was generated, according to the scenario of SLR for Vietnam until 2100.

According to the analysis of the impact of SLR in 2050, the total inundation area turned out to be about 4,094.19ha out of total area 15,829.15ha of Nga Son district (Figure 5a), accounting for 25.86%. The highest percentage of inundated area will be the land for rice cultivation (63.64%). Inundation areas in cultivation of other crops, residential land, and aquatic farming account for 29.76%, 5.73%, and 0.87% respectively.
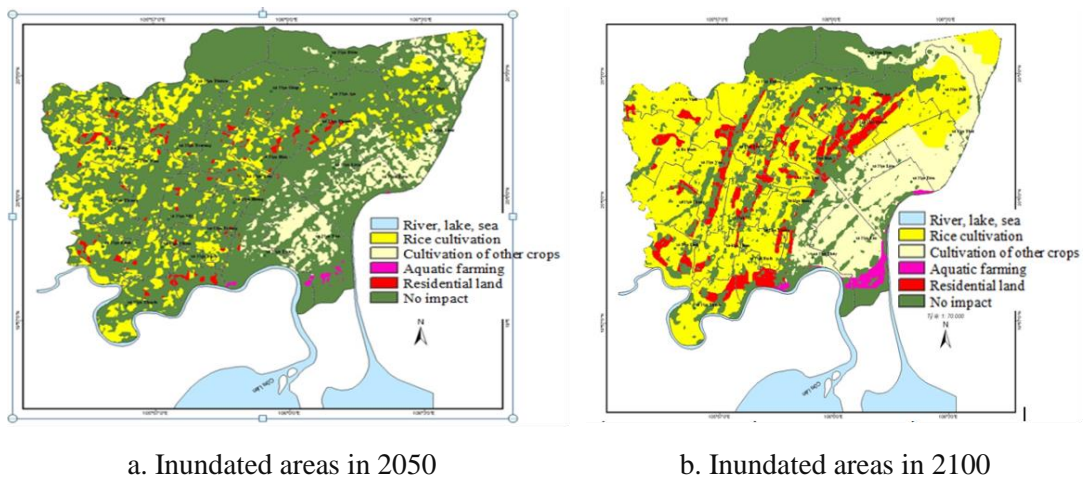
a. Inundated areas in 2050                    b. Inundated areas in 2100

**Figure 5. Flood inundation mapping in Nga Son district**

Based on the scenario of SLR in 2100, the total flooded area was expected to be about 10,241.96ha, account for 64.70% (Figure 5b). In particular, the highest percentage of inundation area will still be the land for rice cultivation (63.52%). Inundation areas in cultivation of other crops, residential land, and aquatic farming account for 27.07%, 7.80%, and 1.61% respectively.

### 3.5. Factors affect sedge production

Based on the survey and farmer interview, causes to the constraints in sedge production in Nga Son can be determined. The first factor is the change in climate pattern. According climate data from North Central hydro-meteorological station, 2014 report the number of hot days was increasing in 2008 have 30 days with $T_{max}$: 39 - 41°C; in 2010: temperature was reached 40 - 43 in summer. The increasing in temperature is the biggest cause of sedge product reducing. In addition, the winter comes earlier than previously.

Secondly, sedge production is affected by extreme weather events caused by climate change such as floods, droughts and fresh water shortage, salt intrusion and sea level rise. Among those, salt water intrusion seems to be the most affecting factor. Salinity on some sedge farms could reach 15 - 20‰, exceeded the critical point for sedge cultivation ($\leq$ 5‰).

Besides, sedge cultivation techniques are limited. According to the survey, most farmers are following traditional sedge cultivation techniques with the use of the same sedge variety coupled with excessive use of chemical fertilizers especially Urea, leading to the decline in production efficiency. Sedge variety is degenerated, showing the decrease in resistance to salinity, pests and diseases.

In addition, irrigation systems are not well conducted and poorly improved over the years to facilitate sedge intensive cultivation. The amount of fresh water is in not the same in cultivation time, in which 80-85% rainfall in June - October and 15-20% in November - May.

The development and outbreak of pests and diseases also affect sedge production. Some most important pests like stem borer, brown plant hopper, beetles are causing remarkable damages to sedge production.

Finally, the lack of capital and labor sources is a factor affecting sedge production. The increase in input costs due to rising in fertilizer; chemicals and low sedge price have made sedge production inefficient. Several farmers stated that they even had to sell sedge at a loss sometimes. This leads to the fact that many farmers had to abandon their farms and migrate to other places.

### 3.6. Adaptation solutions to climate change

Base on the two FGD discussions in Nga son with sedge producers and the district authority, we have come up with several solutions contributing to adapting strategy to climate change. First of all, crops and livestock shall be restructured for adapting to the conditions of climate change. In the long term, the Government should change 30 hectares sedge plant inside dyke protection system to another purpose that can give more income to farmer such as pig rising or aquaculture. However, in short term, the urgent task is finding the supplement fresh water resource to sedge areas. Additionally, coastal dike protection system shall be reinforced and upgraded for preventing natural disasters such as tropical storms and saltwater intrusion. Moreover, innovation technologies such as technical in fertilizer using, cultivation skills and so on shall be transferred and applied to sedge holder, which can adapt to the extreme weather conditions such as drought, flooding, and cold weather. Last but not least, it is also crucial to find out a new market for sedge products, strengthen the relationship between sedge holders with companies as well as diversify sedge species which are adaptable to extreme climate conditions.

### ACKNOWLEDGEMENT

### References

[1]     General Statistical Office, Statistical Yearbook (2006), Statistical Publishing House.

[2]     General Statistical Office, Statistical Yearbook (2007).

[3]     Le Thien (1963), *Cyperales growing experience*, Rural Publishing.

[4]     Pham Thi Mo (2008), *Research on the effects of fertilization regimes on water environment and productivity, Cyperales quality spring* 2008 in Kim Son - Ninh Binh.

[5]     Thanh Hoa People's Committee (2010), *The action plan responds to climate change*.

[6]     People's Committee of Nga Son (2006 - 2013), *The annual report on the situation of agricultural production for Nga Son district.*

[7]     Climate data from North Central Hydro-meteorological station (2014).

[8]     Ministry of Natural Resources and Environment (2009), Climate change level scenarios for Vietnam, Hanoi.

[9]     Bates, B. C., Kundzewicz Z. W,, S. Wu and J.P. Palutikof (2008), *Climate change and water,* IPCC Technical paper VI, Geneva, PP 210.

[10]    Broadlent F,E, (1979), *Mineralization of organic nitrogen in paddy soil*, PP 105 - 118, In: Nitrogen and rice IRRI, PO,BOX 933, Manila, Philippines.

[11]    Dasgupta, Susmita et al (2007), *The impact of sea level rise on developing countries, A comparative analysis,* World Bank policy research working paper 4136, Feb 2007.

[12]    *IPCC (2007), Impacts, Adaptation, and Vulnerability, Contribution of Working group II to the Fourth Assessment Report of the Intergovernmental Panel Climate Change,* Cambridge University Press.

[13]    Koyama J (1981), *The transformation and balance of nitrogen in Japanese paddy fields - Fert*, Res 2: pp 261 - 278.

[14]    Patrick J,W,H; Mahapitra I,C, (1968), *Transformations and availability to nitrogen and phosphorus in waterlogged soils,* Advances in Agronomy, 24, 323 - 259.

[15]    Sinclair, T,R,and Horie, T (1989), *Leaf nitrogen, photosynthesis, and crop radiation use efficiency: A review*, Crop Sci., 29: 90 - 98.

[16]    World bank 2009 report.

[17]    Yearbook FAO Fertilizer Vol, 48 - 1998.

# AN INVESTIGATION ON SPEAKING STRATEGIES OF ASIAN INTERNATIONAL UNIVERSITY STUDENTS IN THE AUSTRALIAN ESL CONTEXT

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**Abstract:** This study examines speaking strategies employed by Asian international university students in the Australian EFL context as well as the frequencies of the strategies used. A quantitative method, employing Wahyuni's 2013 adapted - SILL questionnaire from Oxford's 1990 taxonomy as the research instrument, is used as the tool of collecting data for the present study. The questionnaire was administered to 35 Asian students who were studying at universities in Australia. The results show that the students used a wide range of speaking strategies across six strategy groups. The most frequent speaking strategy group used by the students is cognitive, followed by metacognitive, social, compensation, affective and memory respectively. The study's contributions, limitations and implications for curriculum developers, teachers and students are also addressed.

## 1. Introduction

### *1.1. Rationale for the research*

Learning strategy is one of the most crucial factors in determining learners' success in language learning (Oxford, 1990). As a proverb states, "give a man a fish and he eats for a day. Teaching him how to fish and he eats for a life time". In other words, in language learning, besides transferring knowledge to students, teachers should have a deep understanding into students' learning methods and teach them necessary learning strategies so that they become "…more independent, autonomous and life-long learners" (Oxford & Lee, 2008, p.28). The significant role of learning strategies in acquiring a new language is the core reason that has prompted the researcher to conduct the present study and to gain an insight into this matter.

Another contributor for the selection of speaking strategies as the topic for this investigation emanates from the author's strong desire to help students improve their

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speaking, which is considered a crucial means of communication today when English has become the global language. Research has shown that Asian students often have difficulties and lack confidence in speaking English. Helping these students develop their learning strategies for speaking skills is thus essential. This becomes a dynamic area where the present study treads.

## 1.2. Research aims and research questions

The aim of this study is to help better understand learning strategies of Asian international university learners in learning to speak English in the Australian EFL context. At the same time, the present study aims to compare Asian international students' speaking skills with the results of other studies in the field. In order to achieve the above purposes, the research attempted to answer the three following questions:

- *What kinds of speaking strategies taxonomy do the students report they use?*
- *Amongst the above strategies, what are relative frequencies of the strategies used?*

## 2. Literature review

### 2.1. Definition and classification of learning strategy

Amongst a large number of strategy definitions and classifications that have been used, in the scope of this study, Oxford's (1990) strategy definition and taxonomy, which are easy to understand and cover the nature of language learning strategies, were employed. According to Oxford (1990), learning strategies are "…specific actions taken by the learner to make learning easier, faster, more enjoyable, more self-directed, more effective, and easily transferable to new situations" (p.8). The learning strategy process involves not only comprehending and retaining, but also "transferring" information to "new situations". Oxford's (1990) strategy taxonomy includes two categories: direct and indirect strategies. Within each group, there are three sub - types. The direct group is comprised of "memory strategies for remembering and retrieving new information, cognitive strategies for understanding and reproducing the language, and compensation strategies for using the language despite gaps" (p.14 - 15). The indirect group is made up of "metacognitive strategies for coordinating the learning process, affective strategies for regulating emotions, and social strategies for learning with others" (p.15).

### 2.2. Overall learning strategies of L2 students in ESL contexts

Following the current research on learning strategies across different contexts, some recent studies have been conducted on Asian students' overall learning strategies in ESL contexts (Li, 2007; Razak, Ismail, Aziz & Babikkoi, 2012; Yang, 2005).

Li (2007) used case studies to explore the learning strategy used by Chinese learners and how such learner strategy use relates to their proficiency in the second language. Data were collected from four first year Chinese students studying in the UK at two points over a period of approximately one year. Semi-structured interviews, an oral interview and a listening test were instruments to collect necessary data for the research. The main finding from this study was that the learners used a wide range of strategies overall, including metacognitive, cognitive, social/affective and compensation strategies. The majority of the commonly reported strategies were metacognitive strategies. This finding is quite similar with that of Yang's study (2005) which demonstrates that the students used a variety of learning strategies to facilitate their learning.

Razak, Ismail, Aziz & Babikkoi (2012) investigated the use of English language learning strategies among Malaysian students. A purely quantitative method, with the use of a SILL questionnaire as the research instrument was used. The questionnaire was delivered to 180 ESL secondary school students in Malaysia. The data was collected, coded and categorized in terms of 6 learning groups within a language learning strategy. Interestingly, the affective strategy ranked the first; the compensation strategy was the least popular amongst the students.

### 2.3. Speaking strategies of EFL/ESL students

The most recent studies related to exploring L2 student speaking strategies that were conducted in different EFL/ESL contexts, reveals different results (Cabaysa & Baetiong, 2010; Takeuchi, 2003; Wahyuni, 2013).

By using a qualitative approach, Takeuchi (2003) explored learning strategies for speaking that proficient language learners reported using in the Japanese EFL context. The author analyzed the strategy use and reported in 67 various books on "how I have learned a foreign language". Results suggest that the most often used strategies for speaking were memorizing sentences, pattern-practicing and speaking to oneself in English.

Cabaysa and Baetiong (2010) carried out a causal-comparative study that investigates language learning strategies of seventy Filipino high school students employed when in class, and factors affecting such strategy use. A mix method of quantitative (i.e. a questionnaire) and qualitative (i.e. observations and interviews) was used. The frequency with which the language learning strategies were used follows in this order: metacognitive (highest), social, affective and compensation (lowest). Wahyuni (2013) conducted a study about L2 speaking strategies used by Indonesian EFL tertiary students. One of the findings agrees on the above mentioned study of Cabaysa and Baetiong (2010) that the metacognitive strategy group is the most frequently used amongst the students; nevertheless, it is followed by the compensation strategy, cognitive strategy, affective strategy, social strategy and memory strategy respectively.

## 2.4. Summary

Even though there are a large number of research that scrutinize overall learning strategies of L2 learners in general, studies on L2 learners' speaking strategies are still limited. Additionally, these studies reveal overlaps as well as discrepancies in L2 students' strategy use by speaking in different contexts. Therefore, more studies in other contexts are needed to provide more evidence for the field of speaking strategies, which is considered as contributions of the present study.

## 3. Methodology

### 3.1. Participant profile

The research went through an ethics procedure before data collection began. The research participants were 35 Asian international students of both genders who were studying at six different universities in Australia. Their age ranges from 21 to 43. They came from 9 different countries in Asia. They included both undergraduates and postgraduates who enrolled in different majors. All of the students were speaking English as their L2. Table 1 displays the general information of the participants.

**Table 1. The participants' general background**

|  | Total | Male | Female | Age | Nationalities | Universities |
|---|---|---|---|---|---|---|
| **Undergraduates** | 11 | 5 | 6 | Range from 21 to 43 | Bhutan China Indonesia Japan Korea Laos Malaysia Mongolia Vietnam | University of Adelaide/ Australian National University/ University of Canberra/ Macquarie/ New South Wales/ Wollongong |
| **Postgraduates** | 24 | 13 | 11 | | | |
| **Total** | 35 | 18 | 17 | | | |

### 3.2. Procedure, data collection and analysis

A Wahyuni's adapted - SILL questionnaire is employed as the data gathering instrument for the present research. The questionnaire consists of 39 items which describe speaking strategies used by students. Participants' responses to these items based on the Likert scale from 1 to 5 (never or almost never true of me = 1, usually not true of me = 2, somewhat true of me = 3, usually true of me = 4, always or almost always true of me = 5). The data collected from the participants were analyzed following a rigorous procedure of descriptive analysis, using SPSS software. Standard deviation of each strategy group was also calculated

together with a mean score for the purpose of deeper comparisons of frequencies of strategies used.

## 4. Results

### *4.1. Question 1: What kinds of speaking strategies do the students report they use?*

The 35 participants informed that they used all the 46 speaking strategies across six strategy groups (the memory, cognitive, compensation, metacognitive, affective and social).

These strategies are listed in the table 2:

**Table 2. Strategies used by the students**

| Strategy group | No | Strategies used by the students | Strategy group | No | Strategies used by the students |
|---|---|---|---|---|---|
| Memory | 1 | Placing new words into a context | Metacognitive | 24 | Finding out about language learning |
| | 2 | Representing sounds in memory | | 25 | Organizing |
| | 3 | Structured reviewing | | 26 | Seeking practice opportunities |
| Cognitive | 4 | Repeating | | 27 | Setting goals and objectives |
| | 5 | Formally practicing with sound system | | 28 | Identifying the purpose of a language task |
| | 6 | Recombining | | 29 | Planning for a language task |
| | 7 | Practicing naturalistically | | 30 | Self-monitoring |
| | 8 | Using resources for receiving and sending messages | | 31 | Self-evaluation |
| | 9 | Recognizing and using formulas and patterns | Affective | 32 | Using progressive relaxation, deep breathing, or meditation |
| | 10 | Reasoning deductively | | 33 | Using music |
| | 11 | Translating | | 34 | Using laughter |
| | 12 | Transferring | | 35 | Making positive statement |
| Compensation | 13 | Using mime or gesture | | 36 | Taking risk wisely |
| | 14 | Coining word | | 37 | Rewarding yourself |
| | 15 | Using a circumlocution or synonym | | 38 | Listening to your body |
| | 16 | Switching to the mother tongue | | 39 | Using a checklist |

| | | | | | |
|---|---|---|---|---|---|
| | 17 | Getting help | | 40 | Writing a language learning diary |
| | 18 | Avoiding communication partially or totally | | 41 | Discussing your feelings with someone else |
| | 19 | Selecting the topic | | 42 | Asking for correction |
| | 20 | Adjusting or approximating the message | | 43 | Cooperating with peers |
| **Metacognitive** | 21 | Over viewing and linking with already known material | **Social** | 44 | Cooperating with proficient users of the new language |
| | 22 | Paying attention | | 45 | Developing cultural understanding |
| | 23 | Delaying speech production to focus on listening | | 46 | Becoming aware of others' thoughts and feelings |

### 4.2. Question 2: Amongst the above strategies, what are the relative frequencies of strategies used?

Table 3 provides information about frequencies of strategy groups that student used. Overall, students' strategy use is quite high in this study. Strategy groups that students showed high use of are cognitive, metacognitive and social groups. Compensatory, affective and memory groups were used with a medium level of frequency.

**Table 3. Ranking of mean scores for strategy group**

| Ranking | Strategy Groups | Mean | Standard Deviation |
|---|---|---|---|
| 1st | Cognitive | 3.65 | .52 |
| 2nd | Metacognitive | 3.58 | .63 |
| 3rd | Social | 3.57 | .74 |
| 4th | Compensatory | 3.35 | .53 |
| 5th | Affective | 3.09 | .54 |
| 6th | Memory | 3.06 | .52 |

As can be derived from the table, the highest mean, 3.65, belongs to the cognitive strategy group, followed by 3.58 of the metacognitive strategy group. The third position is the social strategy group, 3.57; then the compensatory strategy group, 3.35; affective strategy group, 3.09 and memory strategy group, 3.06. In other words, the cognitive was the most frequently used strategy group, followed by the metacognitive, social, compensatory, and affective and memory strategy groups respectively.

## 5. Discussion

The first finding is that the students used various speaking strategies spread over six strategy groups identified in Oxford's 1990 taxonomy, namely memory, cognitive, compensation, metacognitive, affective and the social strategy groups. This finding of the present research is consistent with that of many previous studies, which focused on overall learning strategies of students in the ESL context (Li, 2007; Razak, Ismail, Aziz & Babikkoi, 2012; Yang, 2005) and EFL (Hsu, 2008; Oxford & Lee, 2008; Tsan, 2008). Most recently, Wahyuni (2013) points out in her study that Indonesian students used a wide range of speaking strategies that spread over the six strategy groups in the SILL. It suggests that students' L2 speaking strategies are varied, regardless of learning environment.

The second finding reveals that the students reported using the cognitive strategy group most frequently. However, this position of frequency belonged to the metacognitive strategy group in Wahyuni's study (2013). The reason might be that the Australian universities, where they were studying, provided them with good material facilities for their study. They could access the Internet whenever they were at an Australian university. Also, TV, radio, and daily newspapers in English easy for them to access.

Another finding is that students showed a high use of the social strategy group. The Australian ESL environment, where there is a high availability of native English speakers around students, may play a role in high use of the social strategy group by participants. In EFL contexts such as Korea, students found it hard to employ strategies related to native English speakers. According to Oxford & Lee (2008), it is not easy to find native English speakers in EFL countries as in other ESL countries.

It was also pointed out that memory was the strategy group with lowest frequent use. This agrees with findings of Wahyuni's 2013 research where the memory strategy group was in the lowest use. This finding was initially surprising in that there exists a "preconception about Asians as constant memory-strategy users" (Oxford & Lee, 2008, p. 15). However, further literature reviews disclosed that many others studies also had contradictory results to this "preconception" about Asian students (Takeuchi, 2003; Wharton, 2000; Yang, 1999). One possibility is that the Australian ESL environment might have an impact on changes in students' strategy use. Additionally, different definitions of memory strategies in different studies may be another reason (Hong-Nam & Leavell, 2006). Accordingly, memory strategies were defined as rote memorizations of words, phrases and sentences. However, in the present study, statements about memory strategies did not relate to rote memorizations. They were more about placing vocabulary into a context, using rhymes and structure reviewing. It is possible that these statements are not typical learning behaviors about memory strategies of Asian students. The memory strategy group could rank at a higher level if its statements reflected more typical behaviors of Asian students such as writing new words or expressions several times to learn them by heart and memorizing a whole sentence.

## 6. Conclusion

The present study revealed the speaking strategies used by Asian ESL students. The 35 participants of this study used 49 strategies from Oxford's speaking strategy taxonomy, across six strategy groups. The most frequent use of the strategies belonged to the cognitive strategy group, followed by metacognitive, social, compensation, affective and memory respectively. These findings contribute partly to the field of language learning strategies both in theory and in practice. Regarding theory, the study provides more insightful information about speaking strategy of students in ESL contexts. In terms of practice, this study is particularly important for curriculum developers, and teachers. The implication is that curriculum should involve not only content but also teaching students learning strategies. For teachers, if a curriculum allows them a certain amount of time to teach learning strategies for students in class, it is significant that the teachers must raise students' consciousness of using speaking strategies for their studying through various ways. Additionally, the present study's findings provide teachers with an insight into English speaking strategies of Asian ESL university students. Based on these findings, teachers can conduct orientations for their teaching of learning strategies in the classroom. Activities that involve collaboration, problem-solving, inquiry, role-playing, and hand-on experiences also lend themselves to practicing new learning strategies. Students likely benefit a great deal from such activities.

Nevertheless, this study has its limitations. The first weakness is that the number of participants is quite small (N = 35), thus their strategy use may not represent that of the international Asian student community at all universities in Australia. Also, the present study employed only quantitative method. Further research, therefore, should involve a larger and more representative sample of participants so that the first drawback of the present research will be resolved. To overcome these limitations, future studies could incorporate other research instruments such as interviews and observations.

## References

[1]     Cabaysa, C.C., & Baetiong, L. R. (2010), *Language learning strategies of students at different levels of speaking proficiency*, Education Quarterly, 68(1), 16 - 35.

[2]     Hong-Nam, K., & Leavell, A. (2006), *Language learning strategy use of ESL students in an intensive English learning context*, Science Direct system, 34, 399 - 415.

[3]     Hsu, Y.C. (2008), *The comparative study on English Learning strategies of junior high school students between Taiwan and China,* Unpublished master's thesis, National Yunlin University of Science and Technology, Yunlin, Taiwan.

[4]     Oxford, R., & Lee, K. R. (2008), *Understanding EFL learners' strategy Use and Strategy Awareness,* Asian EFL Journal, 10(1), 7 - 32.

[5]  Li, D. *(2007), Coping with linguistic challenges in UK higher education: The use of strategies by Chinese research students*, Language Learning Journal, 35(2), 205 - 219.

[6]  Oxford, R. L. (1990), *Language learning strategies: What every teacher should know,* New York: Newbury House.

[7]  Razak, N.Z.A., Ismail, F., Aziz, A.A., Babikkoi, M.A. (2012), *Assessing the use of English language learning strategies among secondary school students in Malaysia*, Procedia-Social and Behavioral Sciences, 66, 240 - 246.

[8]  Takeuchi, O. (2003), *What can we learn from good language learners? A qualitative study in the Japanese foreign language context*, System, 31, 385 - 392.

[9]  Tsan, S. (2008), *Analysis of English learning strategies of Taiwanese students at national Taiwan normal university*, Educational Journal of Thailand, 2(1), 84 - 94.

[10]  Wahyuni, S. (2013), *Learning strategies for speaking skills employed by Indonesian EFL tertiary students across proficiency and gender*, Unpublished doctoral dissertation, University of Canberra, Canberra, Australia.

[11]  Yang, C. (2005), *Learning strategy use of Chinese PhD Students of Social Sciences in Australian University*, Retrieved from, https://www120.secure.griffith.edu.au/rch/file/ 25e1cc59-9486-f0cf-8e00-d8bfe075c964/1/02Main.pdf

[12]  Yang, N.D. (1999), *The relationship between EFL learners' beliefs and learning strategy use*, System 27, 515 - 535.