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Journal Objectives

International Surveying Research Journal (ISrJ) is an international journal dedicated to the publication of theoretical and empirical refereed articles, case studies or critical literature surveys in the field of surveying research and policy. The scope of the journal is international in two aspects: it presents to a worldwide readership a view of the surveying practices of particular countries, and it encourages knowledge sharing among researchers, policy makers and practitioners.

The purpose of the **International Surveying Research Journal (ISrJ)** serves to provide a forum for discussion and research to keep abreast of the new technologies developments and to stimulate research in the various surveying disciplines.

Editor Message

Welcome to this International Surveyor Journal (ISrJ) Vol. 2, Issue December 2020 for the Royal Institution of Surveyors Malaysia (RISM).

This Journal gathers publication of all four divisions in RISM namely Quantity Surveying (QS), Property Surveying (PS), Geomatic and Land Surveying (GLS), and Building Surveying (BS). The publication of ISrJ gives opportunity to the academicians, practitioners as well as students to share their research outcome. There is a vast area of coverage within the four divisions waiting to be explored.

This particular issue consists of five selected papers reviewed by the editorial committee and international experts which include building issues, geomatic land surveying issues, property issues, affordable housing and the role of Quantity Surveyor.

Sr Wan Ainon Zuraiha W. A. Khalid
Editor
December 2020

Dampness Assessment Diagnosis in Malaysian University's Accommodation with the Application of Thermal Imager

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Abstract
Universities' accommodations in Malaysia are one of the complex buildings that normally associated with dampness issues due to factors of users' density. Since many public universities were built more than 30 years, sign of dampness, especially rising damp issues in students' accommodations are evident over-time. This issue arises due to buildings' age which leads to deterioration of anti-dampness membrane or waterproofing agent in the building structure. This problem needs proper maintenance care in order to avoid severe problems for the buildings in the near future. The aim for this paper is to perform an assessment that is related to the diagnosis work for dampness issues in university's accommodation using three phases of survey, namely (i) visual inspection, (ii) building condition assessment (BCA) survey and (iii) non-destructive testing (NDT) survey. A case study in a public university in Perak with 1 block of accommodation has been chosen for this study. Through visual inspection, common defects related to dampness issues has been found at all related rooms located near to the bathroom areas. For BCA survey, the Building Assessment Ranking System (BARIS) has been applied with the aid of NDT approach. For this phase, a Thermal Imager has been used in order to diagnose the level of defect based on temperature and relative humidity (RH) factors. From the findings, it is found that the walls of all students' accommodation in the case study, which located near to the bathroom were affected by dampness, with RH more than 50%.
Keywords – Defects, Dampness, NDT, Thermal Imager, University's accommodation

Introduction

To date, humidity accumulates in many public universities in Malaysia influenced by the factor of buildings' age which creates many issues of dampness (Ding et al., 2016). This issue can be associated to water or humidity leakage that occurs between the connection of floor and wall of a building (Delgado et al., 2016). The occurrence of water seepage that is related to improper waterproofing installation or deterioration of anti-dampness agent (Shuib & Baharum, 2015). may lead to mould growth, flaking of paint and water stain (Luca, 2014) which can caused Building-Related Illness (BRI) in the space (Nag,2019).

The affected area is usually occurring in spaces or rooms with high density and frequent usage (Kwag et al., 2019). In this case, university's accommodation is usually faced with this issue due to high population of students. This major problem always occurred to rooms that exposed with high humidity, like bathrooms (Jamaludin et al., 2015). If these defects are not treated accordingly, issues may arise in these accommodations which may affect the health of students accommodating the rooms and consequently lead to structural failure (Kwag et al., 2019).

Literature Review

Defect on dampness is categorised into rising damp, lateral damp and condensation damp which involves a situation of extreme moisture that leaks or penetrates into building (RICS, 2017). There are many ways that moisture can access into buildings, such as rainwater penetrating through leaks in building structure (Engebretsen et al., 2016) and condensation process that penetrates into cracks on building wall (Tham, 2016). One of the concerns on controlling or mitigating defect on dampness is due to the issue of Building Related Illnesses (BRI). Compared to western countries, building in Malaysia is heavily exposed to BRI problems due to its Tropical climate characteristic (Nag,2019), which may lead to adverse effect on the building elements that comes from a heavy expose of moisture (Delgado et al., 2016). This scenario can deteriorate the building even faster.

Othman, et al (2015) has listed that the common moisture problems in buildings were due to: (i) rainwater or groundwater leaking into the building elements, (ii) plumbing leaks, (iii) water seeps from capillary suction through porous building materials, (iv) rainwater, condensation or plumbing water, (v) infiltration of warm or moist outside air, through cracks and holes in the enclosure during warm and humid weather, (vi) exfiltration of warm or moist indoor air through cracks and holes in the enclosure during cold weather, (vii) unvented or poorly vented sources such as swimming pools, (viii) insufficient dehumidification by heating, ventilating and air-conditioning systems, poor condensate drainage due to heating, ventilation and air-conditioning, system deficiency and (ix) enclosure of wet materials in building during construction. In addition, Halim, Harun, & Hamid (2012) also strengthened that moisture is as a major cause of building defect and by Hassan et al., (2015) identified that moisture-related defects occur almost 75% at building envelopes. Therefore, defect diagnosis is needed to analyse the causes of this issue, and with the aid of BCA ranking tool (RISM, 2017) and NDT instrument, it is aim to determine the exact condition of the defects (RICS, 2017).

Research Methodology

The methodology used in this study is aim to perform an assessment that is related to the diagnosis work for the dampness issues in the selected university's accommodation by using three (3) phases of survey, which categorised into (i) visual inspection, (ii) building condition assessment (BCA) survey and (iii) non-destructive testing (NDT) survey. An explanatory research design (Odzamar et al., 2018) is performed to identify in detail the aspects related to climatic characteristics involved with dampness issues, mainly related to temperature and relative humidity aspects. It is also to foresee the correlation related to time frame (morning, afternoon and evening). A case study in a public university in Perak with 1 block of accommodation has been selected for this study. Through visual inspection, common defects related to dampness issues were identified and then plotted in the Building Assessment Ranking System (BARIS) (RISM, 2017). Independent variables (IV) (Temperature, RH and Time) and Dependent Variables (DV) (Types of Dampness Occurrence) were compiled and accessed using NDT

tool, known as Thermal Imager. Figure 1.0 explains the process of research methodology obtained for this study.

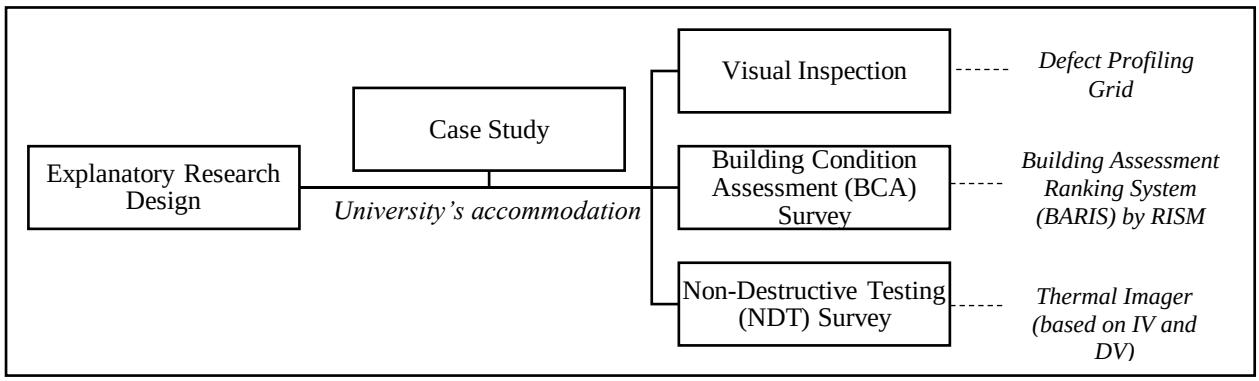


Figure 1.0 Research Methodology for this study

1. Phase 1 - Visual Inspection: Field Survey and Observation

For the condition survey, it is important to perform visual inspection during the site visit in order to identify the potential location of defects in the case studies. During observation and site visit, a defect profiling grid has been created in order to allow the visual inspection to be more systematic (see Figure 2.1 to 2.3). This is to make sure that all important spaces have been inspected during data collection for both levels.

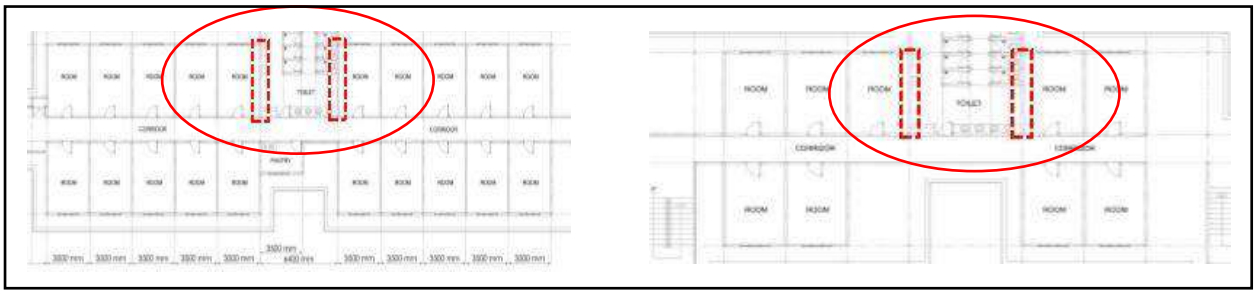


Figure 2.1 (a) Ground Floor of the Case Study (University's Accommodation)

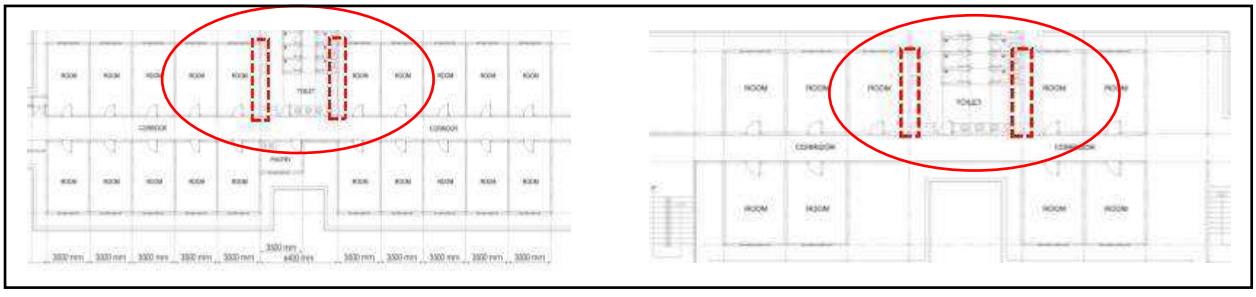


Figure 2.1 (b) First Floor of the Case Study (University's Accommodation)

Figure 2.1 (a) and (b) The spotted areas with visible dampness occurrence it is identified through a visual observation (see Figure 2.1), the spotted areas with visible dampness occurrence can be found in all rooms for both levels of the case study, that is located next to the bathrooms. Figure 2.2 and Figure 2.3 presents the defect profiling grid that has been used to allocate the defects with the dimension of 2 metres x 1 metres for each grid. Each grid also has specific codes to be used during the Building Condition Assessment (BCA) in Phase 2.

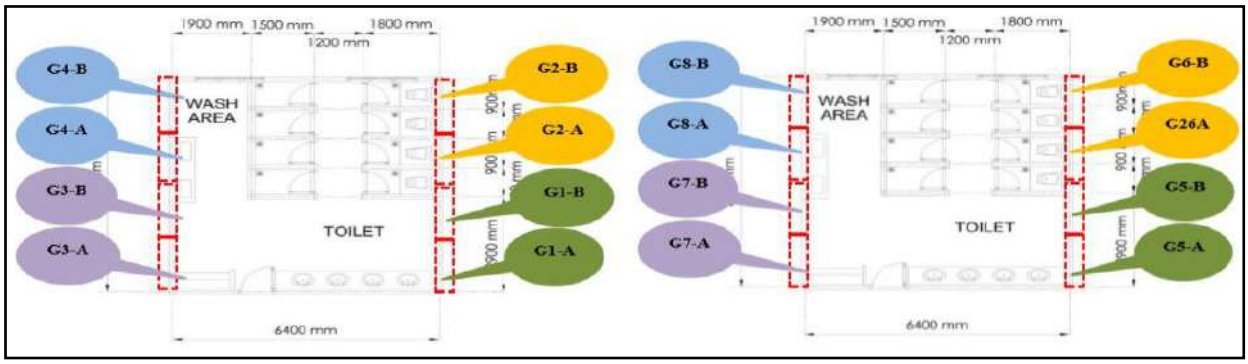


Figure 2.2 Layout grid of each space with a code system

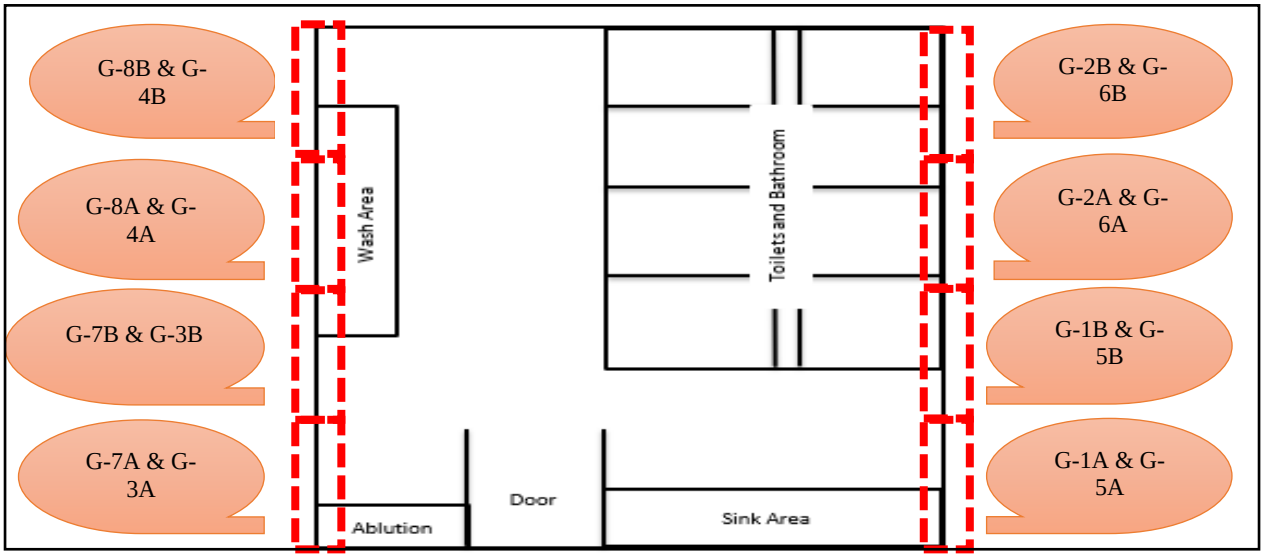


Figure 2.3 Example of Defect Profiling Grid for the Case Study

2. Phase 2 – Building Condition Assessment (BCA): Using of BARIS

For Phase 2, Building Assessment Rating System (BARIS) has been used to collect and compile the data of defects from the case study. Figure 3.0 shows the schedule of BARIS used during the data collection stage. In BARIS, it contains related information such as the location of defect, related photos, the element and components involved, the condition of the defects using scoring system (condition,

priority, matrix and colours), the description of defect, possible causes and remedial works for defect (RISM, 2017).

Defect Sheet No :	Level			
Photo :	Location			
	Element/ Component			
	BARIS			
	Condition	Priority	Matrix	Colour
	Defect Description			
	Possible Causes			
	Remedial Works			

Figure 3.0 Example of BARIS schedule

3. Phase 3 – Non-Destructive Testing Survey: Using of Thermal Imager Tool

During this stage, to get an accurate data about the defect, thermal imager has been used to analyse and scan the condition of the dampness. Thermal imager is used to examine the condition of the rising damp with more scientific variables, namely temperature, relative humidity, and time (Szajewska, 2017). Through this approach, it can detect hidden problems and linked between Independent variables (IV) (Temperature, RH and Time) and Dependent Variables (DV) (Types of Dampness Occurrence) which will ease the researcher's works in making detail assessments on the defects and identify the significant influential factors of the occurrence of each dampness. Figure 4.0 shows the thermal imager tool used during the data collection phase.

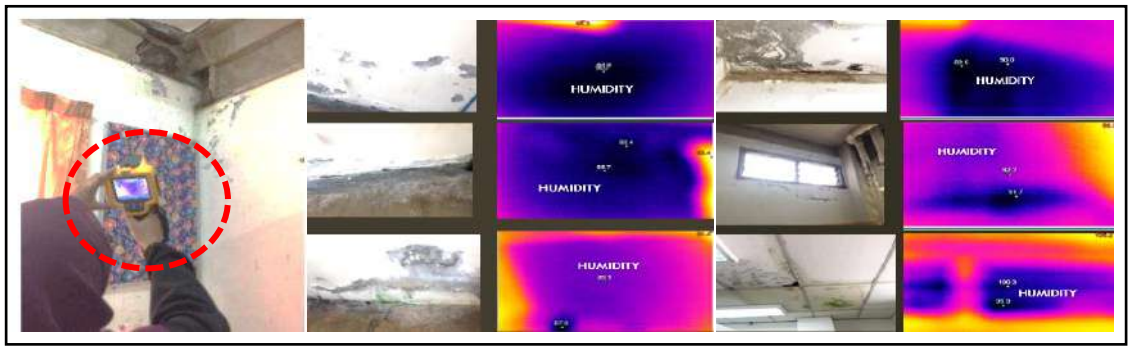


Figure 4.0 The used of Thermal Imager tool during NDT survey

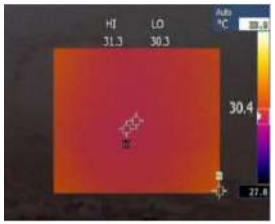
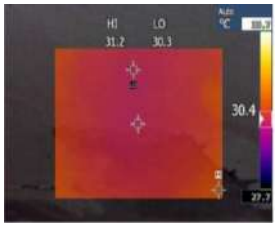
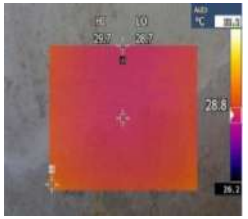
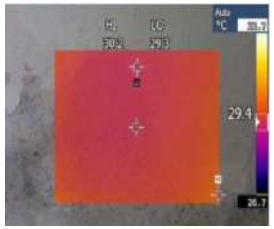
During this stage, thermal imager tool has been used based on three (3) allocation of time (morning, afternoon and evening). For morning session, the data has been collected from 8 am to 10 am, and from 10 am to 11.59 am. For afternoon session, the data has been collected from 12 pm to 2 pm, and for evening session, the data has been collected from 2 pm to 3 pm. This period of time is selected based on the standard Peak Sun Hour (PSH) of Malaysia, which is from 8 am to 3 pm (Jabatan Meteorologi, 2018). The range of variables involved are temperature, RH, transmission of heat (T), emissivity (ξ) and the weather condition for the data collection is during a sunny day. This condition is significant since the heat and moisture transfer during a sunny day have a more constant reading in comparison to rainy day.

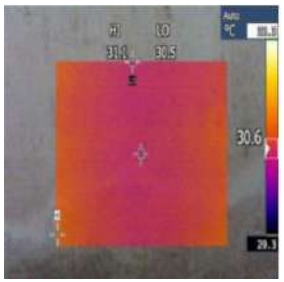
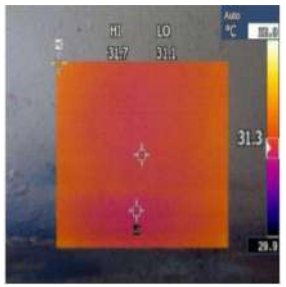
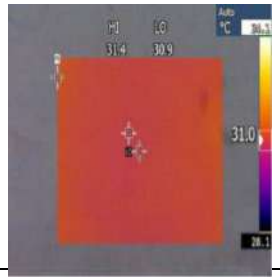
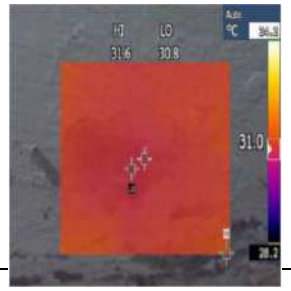
This is necessary in order to identify the actual dampness content inside the building' elements (wall, floor and others). The colour image of the Thermal Imager tool indicates that depth of dampness inside the building elements, where (i) the colour of blue and dark blue represents high level of humidity and (ii) the bright colour of yellow and orange represents low level of humidity. Section 4.0 presents the data findings based on thermal imager tool. All data were collected with no building users on-site in order to get a reliable data.

Data Collection Based on the Thermal Imager Reading

Below are the results that have been collected from the case study for all levels of the building. The defect profiling grid and code have been applied for each thermal imager readings. From 670 readings that have been collected on site, only readings from grid G1A and G1B have been shown in this paper as a benchmark (based on the condition of high content of dampness and low content of dampness in the rooms) for the session of morning, noon and evening.

Table 1.0 The Findings from the Thermal Imager

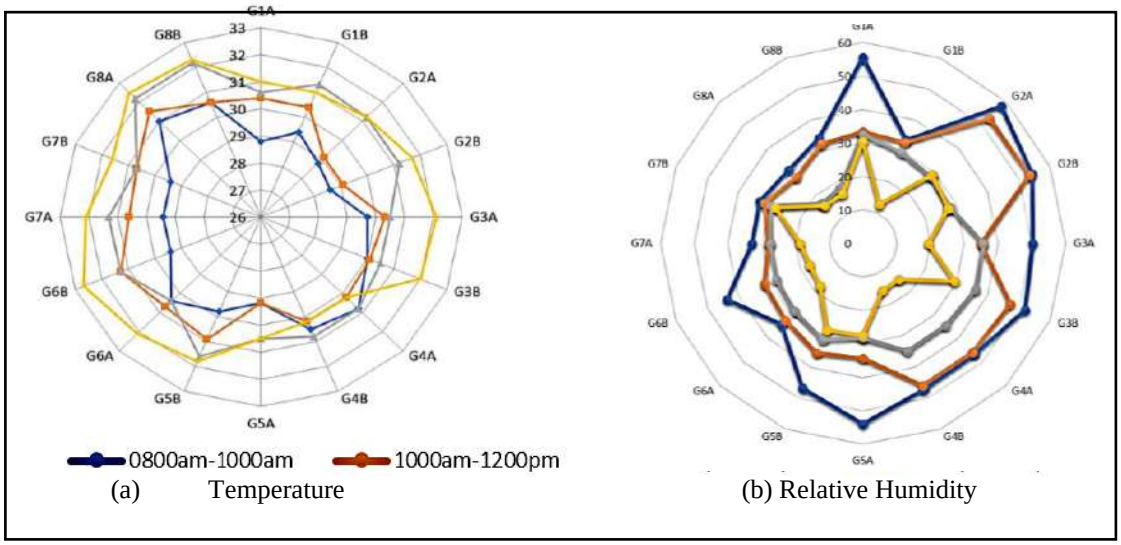
Transmission (T) = 100%	**Emissivity (ℰ) = 0.95%**	**Dewpoint (◦C) = Automatic**	**Weather = Sunny Day**		
TIME	**INFO**	**Grid Code Area: G1A**	**INFO**	**Grid Code Area: G1B**	**Remarks**
8.00 am – 10.00 am	1) Room Name: A1003 2) Temperature: a. Normal: 28.8 b. High: 29.7 c. Low: 28.7 3) Relative Humidity (RH) : 55.6%	 Types of dampness - G1A: Rising damp, condensation and lateral damp	1) Room Name: A1003 2) Temperature: a. Normal: 30.4 b. High: 31.2 c. Low: 30.3 3) Relative Humidity (RH): 29.5%	 Types of dampness - G1B: Rising damp and lateral damp	G1A: Have high RH due to the location of exposure near to the sink. G1B: Lower RH since the area is far from the sink and shower areas
10.00 am- 11.59 am	1) Room Name: A1003 2) Temperature: a. Normal: 30.4 b. High: 31.1 c. Low: 30.5 3) Relative Humidity (RH): 33.5%	 Types of dampness - G1A: Rising damp, condensation and lateral damp	1) Room Name: A1003 2) Temperature: a. Normal: 31.3 b. High: 31.7 c. Low: 31.1 3) Relative Humidity (RH): 28.5%	 Types of dampness - G1B: Rising damp and lateral damp	G1A: Have high RH due to the location of exposure near to the sink. G1B: Lower RH since the area is far from the sink and shower areas

12.00 pm-2.00 pm	1) Room Name: A1003 2) Temperature: a. Normal: 30.6 b. High: 31.3 c. Low: 30.3 3) Relative Humidity (RH) :30.5%	 Types of dampness - G1A: Rising damp, condensation and lateral damp	1) Room Name: A1003 2) Temperature: a. Normal: 39.4 b. High: 40.2 c. Low: 29.3 3) Relative Humidity (RH): 12.6%	 Types of dampness - G1B: Rising damp and lateral damp	G1A: Have high RH due to the location of exposure near to the sink. However, the RH (%) decreased since it is afternoon. Temperature starts to increase. G1B: Lower RH since the area is far from the sink and shower areas, even drier during afternoon due to high temperature
2.00 pm - 3.00 pm	1) Room Name: A1003 2) Temperature: a. Normal: 31.0 b. High: 31.4 c. Low: 30.9 3) Relative Humidity (RH) :32.7%		1) Room Name: A1003 2) Temperature: a. Normal: 31.0 b. High: 31.6 c. Low: 30.8 3) Relative Humidity (RH): 31.5%		Conditon almost the same for both grid (G1A and G1B) during evening.

Data Analysis

After data have been collected using the NDT tool, known as the Thermal Imager, the data are then analysed using the spider-graphs in order to identify the trends of each variables (temperature and RH). It is categorised into normal, high and low range of readings. Each result has been shown in Section 4.1.

Result Analysis for the Case Study



(a) Temperature (b) Relative Humidity

Figure 4.1 Result Analysis for Temperature and Relative Humidity (Normal Range)

For normal range readings, the temperature is recorded between 29◦c (morning session) to 32◦c (evening session), and relative humidity (RH) is recorded between 15% (evening session) to 55% (morning session). The correlation data can be seen in Figure 4.2, where it indicates that when the temperature is lower (29◦c), the RH % will be higher (55%) (morning session) and when the temperature is higher, the RH% will drop (evening session). It proves that the humidity in air is colder during morning time which may accumulates the damp during this time.

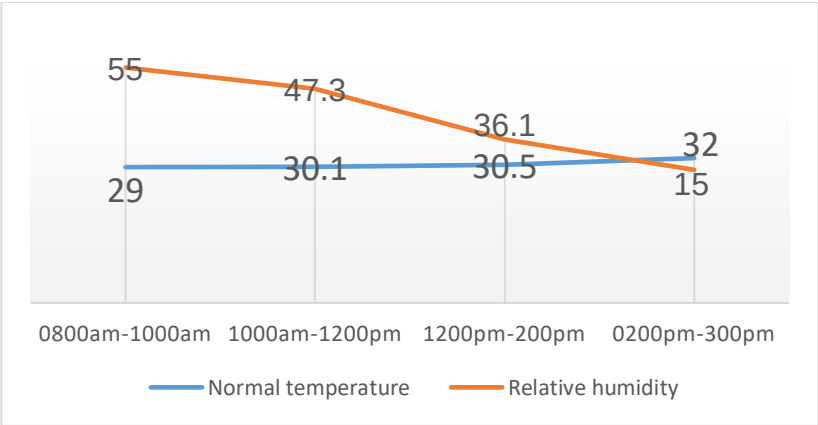
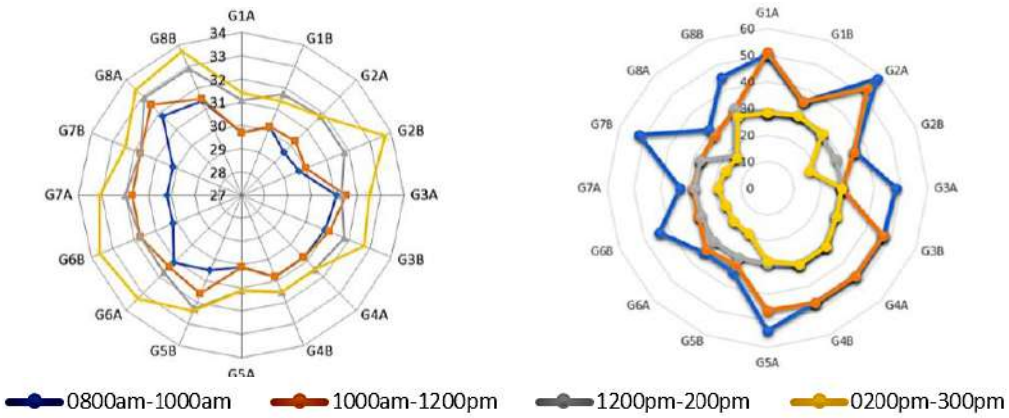


Figure 4.2 Correlation between Temperature and Relative Humidity (for Normal Range)



(a) Temperature (b) Relative Humidity

Figure 4.3 Result Analysis for Temperature and Relative Humidity (High Range)

For high range readings, the temperature is recorded between 29.7◦c (morning session) to 34◦c (evening session), and relative humidity (RH) is recorded between 19.4% (evening session) to 58% (morning session).

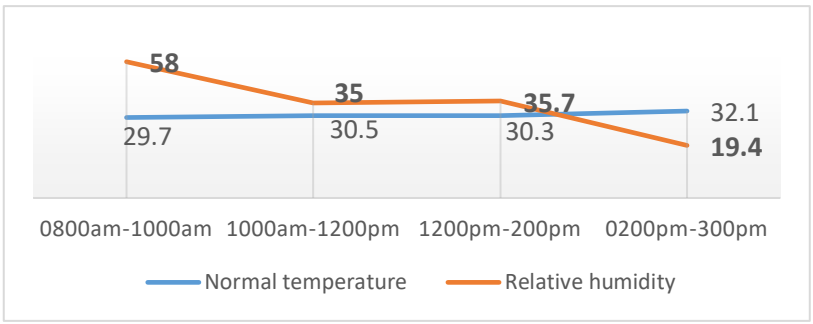
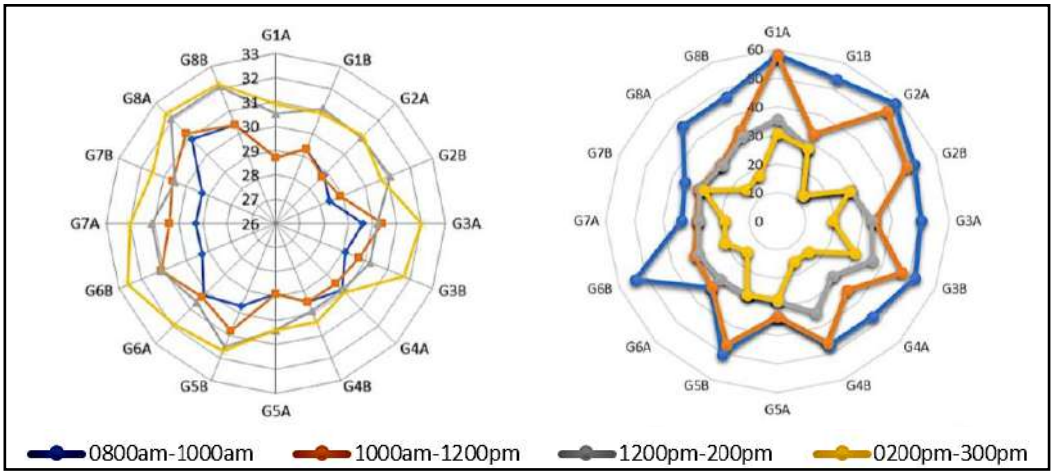


Figure 4.4 Correlation between Temperature and Relative Humidity (for High Range)

The correlation data can be seen in Figure 4.4, where it indicates that when the temperature is lower (29.7◦c), the RH % will be higher (58%) (morning session) and when the temperature is higher, the RH% will drop (evening session).



(a) Temperature (b) Relative Humidity

Figure 4.5 Result Analysis for Temperature and Relative Humidity (Low Range)

For low range readings, the temperature is recorded between 28.7◦c (morning session) to 32◦c (evening session), and relative humidity (RH) is recorded between 12.6% (afternoon session) to 58% (morning session). The correlation data can be seen in Figure 4.6, where it indicates that when the temperature is lower (28.7◦c), the RH % will be higher (58%) (morning session) and when the temperature is higher, the RH% will slightly drop (evening session).

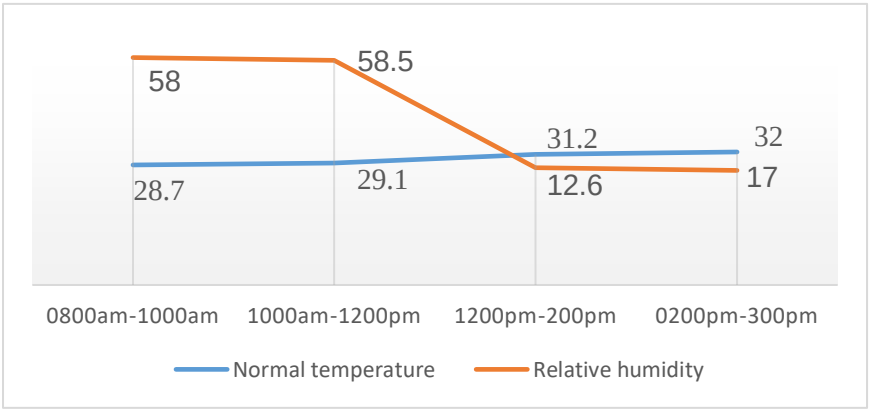


Figure 4.6 Correlation between Temperature and Relative Humidity (for Low Range)

Discussion on the Findings

From the result, it is found that, the main contributing factors of dampness issue in university's accommodation for the case study is due to the location of the rooms which mostly located next to bathrooms. It is also found that through visual inspection and BCA survey, the main reasons of the dampness issues are based on the location of sinks and showers that involves water splashing to wall surfaces due to human activities. This will increase the potential of water seeping through the capillary of building elements. Hence, with the aging of damp proof course of the buildings' element, it will lead to the occurrence of all types of dampness. Table 2 summarised the main contributing factors and types of defects occur during dampness assessment diagnosis for the case study.

Table 2 The Main Contributing Factors and Types of Defects

		Defect Profiling Grid/Code															
Methods	**Types of Dampness**	**G1A**	**G1B**	**G2A**	**G2B**	**G3A**	**G3B**	**G4A**	**G4B**	**G5A**	**G5B**	**G6A**	**G6B**	**G7A**	**G7B**	**G8A**	**G8B**
Virtual Inspection	Rising Damp	/	/	/	/	/	/	/	/	/		/	/	/		/	
	Lateral Damp	/			/	/						/	/	/			/
	Condensation Damp	/	/		/		/		/	/	/	/	/		/	/	/
BCA Survey	**Influential Factors**																
	Distance to Water Resources (Sink, Shower)						/	/	/								/
	Poor Water-Proofing (DPC)			/	/							/	/				
	Leakage (Water Seeping)		/	/	/				/	/		/		/		/	
	High Activities Involving Water (Ablution, Washing)	/						/	/							/	
	Not exposed to direct sunlight		/			/	/				/				/		
NDT Survey	**Temperature**																
	High *(Morning)*																
	Normal							/	/	/	/	/	/	/	/	/	/
	Low	/	/	/	/	/	/										
	High *(Afternoon)*												/	/	/	/	/
	Normal	/	/	/	/		/	/	/	/	/	/					
	Low					/									/	/	/
	High *(Evening)*	/	/	/	/		/	/	/	/		/	/	/			
	Normal					/					/						
	Low																
	Relative Humidity																
	High *(Morning)*	/		/		/	/	/	/	/			/		/		/
	Normal		/		/						/	/		/		/	
	Low																
	High (*Afternoon)*																
	Normal		/	/				/	/								/
	Low	/			/	/	/			/	/	/	/	/	/	/	
	High *(Evening)*																
	Normal							/	/								
	Low	/	/	/	/	/	/			/	/	/	/	/	/	/	/
Total Marks		10	10	9	11	9	10	9	11	9	8	10	10	9	8	10	9

From Table 2, it is found that grid G2B and G4B have achieved highest marks among all grid which indicates that these zones need immediate maintenance action plan. The table shows that, for all types of dampness, G2B has all types of dampness based on the virtual inspection, which are Rising Damp, Lateral Damp and Condensation Damp. Meanwhile, G4B has two (2) types of dampness in that zone. It also found that from all three types of dampness in this building, the highest occurrence of dampness comes from Rising Damp with 13 frequencies, followed by Condensation Damp with 12 frequencies and Lateral Damp with 7 frequencies.

Through BCA survey, it is found that the most influential factors for dampness occurrence comes from the issue of leakage in the building, with 8 frequencies to areas of G1B, G2A, G2B, G4B, G5A, G6A, G7A and G8A. This is followed by the location factors of each related room that is not facing directly to the sunlight, which leading to accumulation of high humidity in the area of G1B, G3A, G3B, G5B and G7B.

Through NDT Survey, with the aid of thermal imager, it is found that most of the grid zone do not have high temperature in the morning, which leads to higher relative humidity (RH)% during morning session. This is the main justification on the accumulation of dampness issues in the building which also influence by the leakage issues and the location issues gained from the BCA survey. During evening session, almost all zones have higher room temperature, which leading to lower RH%. Thus, this session is recognised as "a drying period" for the zone. However, issue will arise if during the evening session, rains occurs which may increase the RH% content in the room.

Conclusion

This study will give advantages to many stakeholders in the university, especially the maintenance department of the university, building users, staffs and students. It helps to identify defects that associated with dampness and the contributing factors involved on the occurrence of these defects based on certain period of time. For the university's management, it will allow a holistic solution on reducing maintenance cost of the building and improve the maintenance performance procedures by following a proper guideline in controlling the issue of excessive humidity in university's accommodation.

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Evaluation of Geoid Model in Johor Region Using Global Geopotential Models and GPS Levelling Data

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Abstract
Global Geopotential Models (GGM) can be described as mathematical functions that represent the gravitational potential of the Earth. GGMs contribute significant value and also enhance global geoid undulation data by providing data from satellite gravity missions such as Gravity Field and Steady-State Ocean Circulation Explore (GOCE), Gravity Recovery and Climate Experiment (GRACE), Laser Geodynamics Satellites (LAGEOS) and Challenging Minisatellite Payload (CHAMP). Currently, the best fit GGM for a local region is assumed to be EGM2008. However, variations in the degree value also affect local precise geoid modelling. This study evaluates the best fit GGM that statistically matches geometric geoids from GPS levelling data in the Johor region. In most applications, due to the wide use of Global Navigation Satellite Systems (GNSS), orthometric height can be calculated by adding Global Positioning System (GPS)-derived height (ellipsoidal height) to precisely geoid undulations model information. An evaluation has been made between geoid undulations derived from different GGMs from 2012 to 2017 and GPS levelling data provided by the Department of Survey and Mapping Malaysia. The differences in geoid height and Root Mean Square Error (RMSE) between the gravimetric geoids from GGMs and GPS levelling data were computed. In this study, the result shows the lowest RMSE was EIGEN-6C3stat (0.35370 m) for combined missions and HUST-Grace2016s (0.35592 m) for satellite only missions. The statistical analysis clearly shows that XGM2016 and HUST-Grace2016s are the best fit for geoid undulations in the Johor region. Thus, GGM can help the development of new and precise local geoids for the Johor region in Malaysia.

Introduction

Geoids can be interpreted as a level surface and an equipotential surface of the Earth's gravity field that approximates mean sea level. Geoid surfaces are undulated and act perpendicular to gravity at all points. In general, geoids are physical reference surfaces that are important for geodetic computations and can be identified using gravity measurements (Chymyrov and Bekturov, 2019; Jalal et al., 2019).

Gravimetric geoid models are widely used since they provide very high resolution and accuracy (Pa'Suya et al., 2018; Pa'Suya et al., 2019). In order to compute the gravimetric geoid, the presence of short, medium, and long wavelengths are important to ensure the accuracy of the gravimetric geoid. The geoid model is divided into three components: long wavelengths derived from global geopotential model data, medium wavelengths acquired from airborne gravity data, and short wavelengths obtained from terrestrial data (Forsberg, 1984; Heliani and Hidayat, 2016; Srimanee et al., 2020).

Global Geopotential Models (GGM) can be represented as a mathematical function close to the real gravity potential of the Earth using spherical harmonic expansions (Barthelmes, 2014). The

International Center for Global Earth Models (ICGEM) has released numerous GGMs every year (http://icgem.gfz-potsdam.de).

Geoid height can be extracted from the International Center for Global Earth Model (ICGEM). Generally, there are two types of GGMs, combined mission GGM and satellite only GGM, used for geoid model determination (Yazid et al., 2016). Evaluation of global geoids can be conducted by comparing current GGMs with satellite only GGMs and new combined GGMs from 2012 to 2017. The most appropriate GGM can be used to determine precise geoids for a local area. The current status of GGM in the state of Johor in Peninsular Malaysia shows there is no comprehensive analysis on the accuracy of GGMs in the Southern region, which depends only on EGM 1996 and EGM 2008. According to the current global evaluation, EGM 2008 is the best fit GGM for a combined solution (Yazid et al., 2016). After all, for the determination of a localized geoid model, the results from the global evaluation should not be used directly as a suitable GGM model (Kiamehr, 2006). Variations in degree value also affect the local geoid modelling. Figure 1 displays a spectral comparison of EGM 2008, which is compared to the most recent combined model.

Methodology

The study area (Figure 2) is defined between latitude 1 ºN to 4 ºN and longitude 101 ºE to 105ºE. Geoid model assessment for this study focuses on Johor, Malaysia.

In this paper, the accuracy of GGMs were evaluated with GPS levelling data provided by the geodesy section, Department of Survey and Mapping Malaysia (DSMM). GPS levelling techniques simply involve the derivation of ellipsoidal heights from the Global Positioning System and orthometric heights from the levelling process. Ideally, to obtain absolute geoid height, a station should have a known height above the ellipsoid and orthometric height (Zhang, 1997). However, this approach requires a mean sea level height.

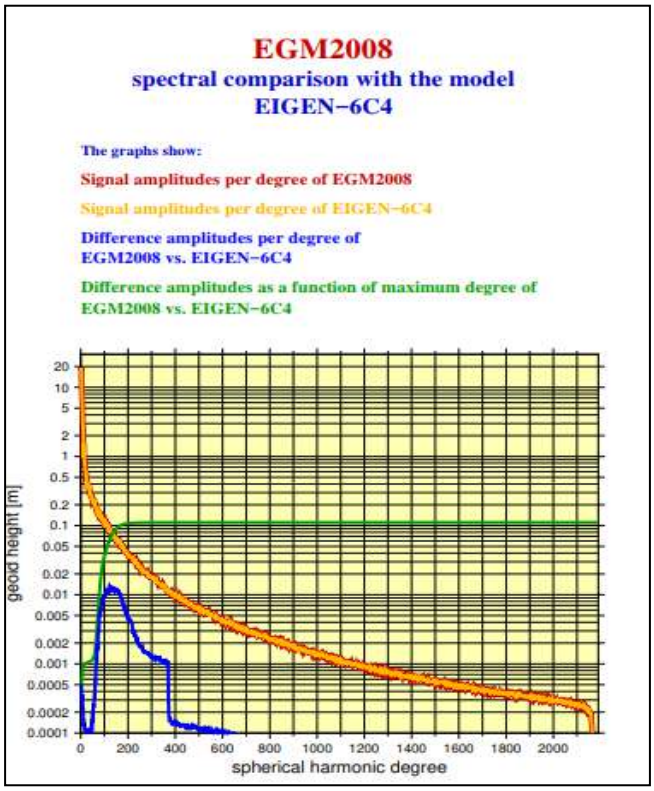

Figure 1: Spectral Comparison of EGM 2008 with the recent combined model EIGEN-6C4 (ICGEM, 2015)

This study attempts to evaluate the best possible Global Geopotential Models (GGM) for assessment of land geoid models in a regional area. The assessments include computing the RMSE value of geodetic monuments in Johor. The GGM with the lowest RMSE was selected as the best geoid model for the Johor region.

Figure 2: Map of the study area (Modified from Google Earth, 2017)

Global Geopotential Model (GGM)

In general, GGM can be classified into two categories:

Satellite-only GGMs are acquired from satellite-based gravity observations from CHAMP, GOCE, and GRACE, or a combination of other satellite missions such as Laser Geodynamic Satellites (LAGEOS) (Yazid *et al.* 2016). According to Featherstone and Rummel (2002), the accuracy of satellite-only GGMs is weak at the higher coefficient degrees due to power decay of the gravitational field with altitude, less precise modelling of non-Earth gravity field induced satellite motion such as third body influences and atmospheric drag, incomplete tracking of satellite orbits using ground stations, and poor coverage of global gravity field samples.

Combined GGMs can be defined as the combination of satellite-only GGMs, terrestrial gravity data, gravity anomalies from satellite altimetry, airborne gravimeters, topography, and bathymetry. The combination of all gravity data can minimize the limitations of higher degree expansion. Yet, terrestrial data errors remain (Sulaiman, 2016). Generally, terrestrial gravity data is better fit with combined GGMs than satellite-only models. In addition, these combinations can lead towards the determination of the best approximation of the Earth's gravitational field (Sadiq & Ahmad 2009).

Table 1 and 2 show the list of combined and satellite-only models of GGMs respectively starting from 2012 to 2017 that was used in this study. GGM can be represented as the best mathematical model that describes the gravitational potential in a spectral domain using spherical harmonic expansions. Generally, in GGM, a set of fully normalized spherical harmonic coefficients are compressed into computations. Each geopotential model consists of the mass of the earth (*M*), Newtonian gravitational constant (*G*), a reference radius (*R*), normal gravity on the surface of the reference ellipsoid (*γ*), fully normalized Stokes' Coefficients for each degree of *n* and order *m* ($\bar{C}_{nm}$ and $\bar{S}_{nm}$), and the standard error. Based on the provided information, gravity anomalies and geoid height in GGM can be computed using Equations 1 and 2 are used (Sulaiman, 2016).

$$\Delta g_{ggm} = \frac{GM}{r^2} \sum_{n=2}^{m} \left(\frac{a}{r}\right)^n (-1) \sum_{m=0}^{n} (\bar{C}_{nm} \cos m\lambda + \bar{S}_{nm} \sin m\lambda)\, \bar{P}_{nm} (\cos\theta) \quad (1)$$

(1)

$$\Delta N_{ggm} = \frac{GM}{r\gamma} \sum_{n=2}^{m} \left(\frac{a}{r}\right)^n (-1) \sum_{m=0}^{n} (\bar{C}_{nm} \cos m\lambda + \bar{S}_{nm} \sin m\lambda)\, \bar{P}_{nm} (\cos\theta) \quad (2)$$

(2)

Table 1: Combined models

No	Model	Year	Degree	Data Sources
1	XGM2016	2017	719	A, G, S(Goco05s)
2	ITU_GGC16	2016	280	Grace, Goce
3	EIGEN-6S4 (v2)	2016	300	Grace, Goce, Lageous
4	GOCO05c	2016	720	GOCO05s, A, G, S
5	GGM05C	2015	360	A, G, S(Goce), S(Grace)
6	GECO	2015	2190	EGM2008, S(Goce)
7	GGM05G	2015	240	S(Goce), S(Grace)
8	GOCO05s	2015	280	GOCO-S, S
9	EIGEN-6C4	2014	2190	A, G, S(Goce), S(Grace), S(Lageos)
10	GO_CONS_GCF_2_DIR_R5	2014	300	Grace, Goce, Lageous
11	GOGRA04S	2014	230	Grace, Goce
12	EIGEN-6S2	2014	260	Grace, Goce, Lageous
13	EIGEN-6C3stat	2014	1949	A, G, S(Goce), S(Grace), S(Lageous)
14	GOGRA02S	2013	230	Grace, Goce
15	GO_CONS_GCF_2_DIR_R4	2013	260	Grace, Goce, Lageous
16	EIGEN-6C2	2012	1949	A, G, S(Goce), S(Grace), S(Lageos)
17	GAO2012	2012	360	A, G, S(Goce), S(Grace)
18	DGM-1S	2012	250	Grace, Goce
19	GOCO03s	2012	250	Grace, Goce
20	EGM2008	2008	2190	A, G, S(Grace)
21	EGM96	1996	360	A, EGM96S, G

Table 2: Satellite-only models

No	**Model**	**Year**	**Degree**	**Data Sources**
1	IfE_GOCE05s	2017	250	Goce
2	GO_CONS_GCF_2_SPW_R5	2017	330	Goce
3	Tongji-Grace02s	2017	180	Grace
4	NULP-02s	2017	250	Goce
5	HUST-Grace2016s	2016	160	Grace
6	ITU_GRACE16	2016	180	Grace
7	GO_CONS_GCF_2_SPW_R4	2014	280	Goce
8	ITSG-Grace2014s	2014	200	Grace
9	ITSG-Grace2014k	2014	200	Grace
10	GO_CONS_GCF_2_TIM_R5	2014	280	Goce
11	JYY_GOCE04S	2014	230	Goce
12	GGM05S	2014	180	Grace
13	Tongji-GRACE01	2013	160	Grace
14	JYY_GOCE02S	2013	230	Goce
15	ULux_CHAMP2013s	2013	120	Champ
16	ITG-Goce02	2013	240	Goce
17	GO_CONS_GCF_2_TIM_R4	2013	250	Goce

Each GGM in Table 1 and 2 was downloaded from ICGEM website provide the website address for a 1° x 1° grid and extracted using Global Mapper version 13 software. This software can extract data based on elevation grids from 3D point data.

When selecting the most suitable GGM for precise local geoids, selection criteria are generally based on what GGM is the closest fit to the geoid undulations from GPS levelling data.

The determination of the best fit GGM for a local area is required to compare derived gravimetric geoid from GGMs with GPS levelling data. Therefore, the best fit GGM is decided based on the lowest RMS from the geoid undulation residual. The residual from geoid undulations was computed using Equation 3.

$$\Delta N_{residual} = N_{GGM} - N_{gps} \quad (3)$$

where $\Delta N_{residual}$ is the geoid undulation residual, N_{GGM} is the gravimetric geoid from GGM, and N_{gps} is the geometric geoid from GPS levelling. N_{gps} is derived from the ellipsoidal height from GPS observations and the orthometric height from GPS levelling points. This derivation can be shown as Equation 4.

$$N_{gps} = h_{gps} - H_{MSL} \quad (4)$$

then, the Root Mean Square Error (RMSE) for a different $\Delta N_{residual}$ is computed based on Equation 5:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(N_{GGM} - N_{Geometric})^2}{n}} \quad (5)$$

where *n* = the total number of stations. Thus, the lowest RMS error for the assessment of N_{GGM} with N_{gps} shows the best fit GGM for Johor.

2.2. Local Precise Geoid (MyGEOID)

The local precise gravimetric geoid model (MyGEOID) is constructed using R-C-R methods. (Nordin, *et al.*, 2005). The gravimetric geoid, $NGrav$ can be computed by determining the long and medium-wavelength contributions of $NEGM$ from the global geopotential model (GGM), part of the remaining medium-wavelength effect of $N\Delta g$ from the short wavelength, and terrestrial gravity data associated with height information Nh from a digital elevation model (DEM). This gravimetric geoid is represented by the following relationship:

$$NGrav = NEGM + N\Delta g + Nh \quad (6)$$

However, the basic theory for the first-order approximation of Molodensky's method was originally introduced by M.S Molodensk developed for a 10-centimetre geoid model in quasi-geoid modelling (Molodensky *et. al.,* 1962; Ulontu, 2009). Figure 3 shows the final gravimetric geoid undulation for Peninsular Malaysia. Figure 4 represent the gravimetric geoid for Johor and Table 3 presents the statistical analysis of MyGEOID.

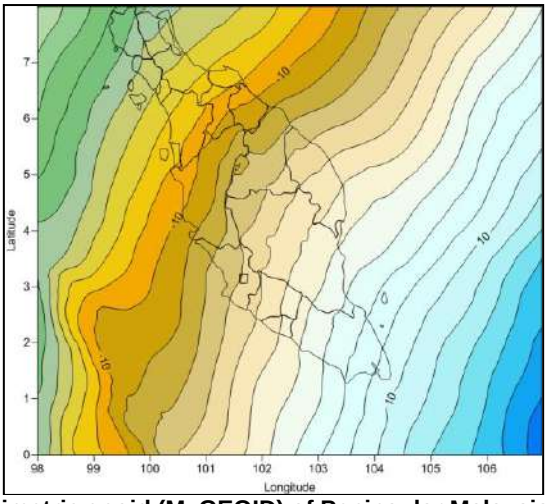

Figure 3: Existing gravimetric geoid (MyGEOID) of Peninsular Malaysia (Sulaiman *et al.* 2013)

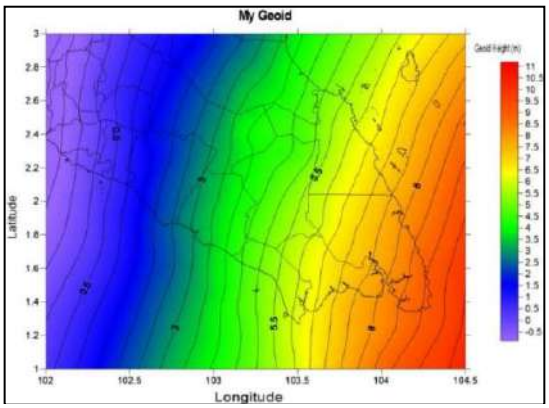

Figure 4: Gravimetric geoid (MyGEOID) of Johor region (the color code represents the geoid undulation for Johor)

Table 3: Statistical analysis of gravimetric geoid (MyGEOID)

	Minimum (m)	Maximum (m)	Mean (m)	Standard Deviation (m)
N_{Grav}	1.400	9.089	5.101	1.999

GPS Levelling

Gravimetric geoids from GGM were evaluated using GPS levelling data from DSMM. The assessments were computed point by point using 46 stations from around Johor. The closest fit GGM to the GPS levelling data acts as the best geoid model for Johor region. Table 4 shows the mean sea level height for GPS levelling points in the Johor region.

Table 4: Mean Sea Level height (H_{MSL}) of GPS levelling points

	Station Name	Lat (°)	Lon (°)	Ellipsoidal height, h (m)	Hmsl (m)	N_{gps}, Geometrical Geoid (m)
1	GP15	2.064909	102.556900	4.604	1.959	2.645
2	GP16	2.131209	102.734200	36.916	33.473	3.443
3	GP43	2.601636	103.779200	11.811	4.986	6.825
4	GP44	2.474653	103.066000	56.276	51.874	4.402
5	GP47	2.388669	102.933700	51.814	47.858	3.956
6	GP48	1.976078	102.934000	165.371	160.992	4.379
7	GP49	1.626056	103.200400	7.980	1.951	6.029
8	GP50	1.547497	103.395800	10.730	3.810	6.920
9	GP51	1.633985	103.667200	43.351	35.525	7.826
10	GP52	1.369832	104.267900	68.553	58.723	9.830
11	GP53	1.804248	103.897600	32.473	23.997	8.476
12	GP54	1.925474	104.094500	13.523	4.655	8.868
13	GP55	2.079800	103.889400	37.387	29.329	8.058
14	GP56	2.391582	103.873300	12.203	4.680	7.523
15	GP58	2.121680	103.427900	78.270	72.099	6.171
16	GP59	1.973504	103.228200	45.819	40.153	5.666
17	GP60	1.884510	103.398900	62.592	56.054	6.538
18	GP61	2.189069	103.192800	42.460	37.318	5.142
19	GP84	1.857513	102.942200	7.742	3.154	4.588
20	GP85	1.908766	102.736300	5.547	1.883	3.664
21	GP90	1.930477	104.114100	11.428	2.469	8.959
22	GP91	1.879292	103.692100	26.949	19.554	7.395
23	J416	1.461806	103.773358	11.935	3.424	8.511
24	STN8	2.064920	102.556900	4.005	2.020	1.985
25	STN9	2.131220	102.734200	36.230	33.530	2.700
26	STN21	2.601650	103.779200	11.177	5.040	6.137
27	STN22	2.474660	103.066000	55.652	51.930	3.722
28	STN23	2.388680	102.933700	51.184	47.920	3.264
29	STN24	1.976090	102.934000	164.754	161.050	3.704
30	STN25	1.626070	103.200400	7.364	2.010	5.354
31	STN26	1.547510	103.395800	10.122	3.870	6.252
32	STN27	1.634000	103.667200	42.704	35.580	7.124
33	STN28	1.804260	103.897600	31.829	24.060	7.769
34	STN29	1.925480	104.094500	12.877	4.710	8.167
35	STN30	2.079810	103.889400	36.748	29.390	7.358
36	STN31	2.391590	103.873300	11.570	4.740	6.830
37	STN32	2.121690	103.427900	77.624	72.160	5.464
38	STN33	1.973510	103.228200	45.183	40.210	4.973
39	STN34	1.884520	103.398900	61.954	56.110	5.844
40	STN35	2.189080	103.192800	41.831	37.380	4.451

41	STN36	1.857520	102.942100	7.127	3.210	3.917
42	STN37	1.908780	102.736300	4.932	1.940	2.992
43	STN39	1.930490	104.114100	10.786	2.530	8.256
44	STN40	1.879300	103.692100	26.304	19.610	6.694
45	STN46	1.461820	103.773300	11.295	3.480	7.815
46	STN47	1.461820	103.773350	11.293	3.420	7.873

A mean sea level height benchmark for Peninsular Malaysia was transferred using precise levelling data from tide gauges in Port Klang after more than 10 years of observation (1984-1993). From the nearest benchmark, height was transferred to GPS levelling points as Table 4. From mean sea level height at GPS levelling points and ellipsoidal height from GPS observations, geometrical geoids were derived as mentioned in Equation 4, Section 2.1. Figure 5 shows the distribution of GPS levelling points in Johor.

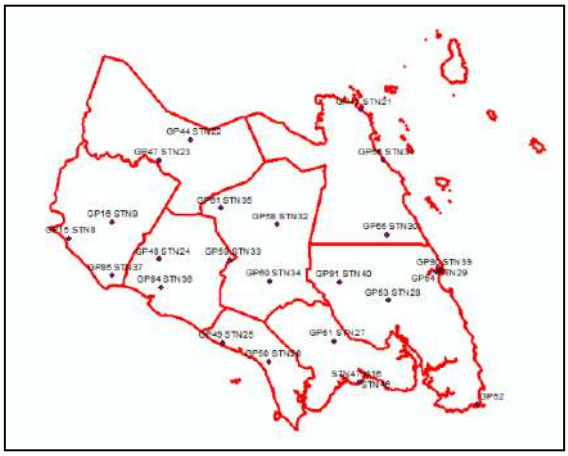

Figure 5: Distribution of GPS Levelling Points in Johor

Results and discussion

Geometrical Geoid from GPS Levelling

Using Equation 4, geometrical geoids were calculated and tabulated as shown in Table 3. Figure 6 displays a map of geometrical geoids from GPS levelling points and Table 5 displays the statistical analysis of geometrical geoids using GPS levelling.

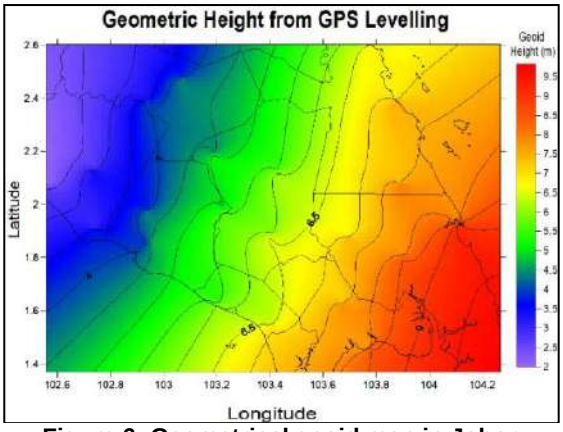

Figure 6: Geometrical geoid map in Johor

Table 5: Statistical analysis of geometrical geoid from GPS levelling

Unit:m	N_{gps}
Minimum	1.985
Maximum	9.83
Mean	5.967
Standard Deviation	1.999

Global Geopotential Models (GGMs)

Gravimetric geoids from GGMs were extracted for the Johor region as 0.01667 º by 0.01667º, which is equal to a 1' x 1' regular grid. These extractions are important for evaluating geoid undulations from GPS Levelling data and GGMs. Figure 8 illustrates six (6) models from satellite only models and Table 6 shows the statistical analysis of satellite only models from 2012 to 2017.

The statistical analysis of satellite only models is displayed in Table 6. Based on the table, the standard deviation of satellite only models ranges between 1.722m to 2.624m. According to this analysis, GGM05S shows the lowest standard deviation value and categorised at the first rank order. However, ITSG-Grace2014s shows the highest standard deviation value among satellite-only GGM models and categorised at the 17 ranking order Table 7 shows the statistical analysis of the combined mission model and Figure 9 displays six (6) models from combined satellite missions model over the study period.

Based on the statistical analysis of the combined mission model, standard deviation represents ranged from 1.868m to 2.065m. Where, GOGRAS02S showed the lowest standard deviation value and categorised at the first ranking order, followed by GOGRA04S in second place. The highest standard deviation value is GECO with 2.065m and categorised at the 21-ranking order.

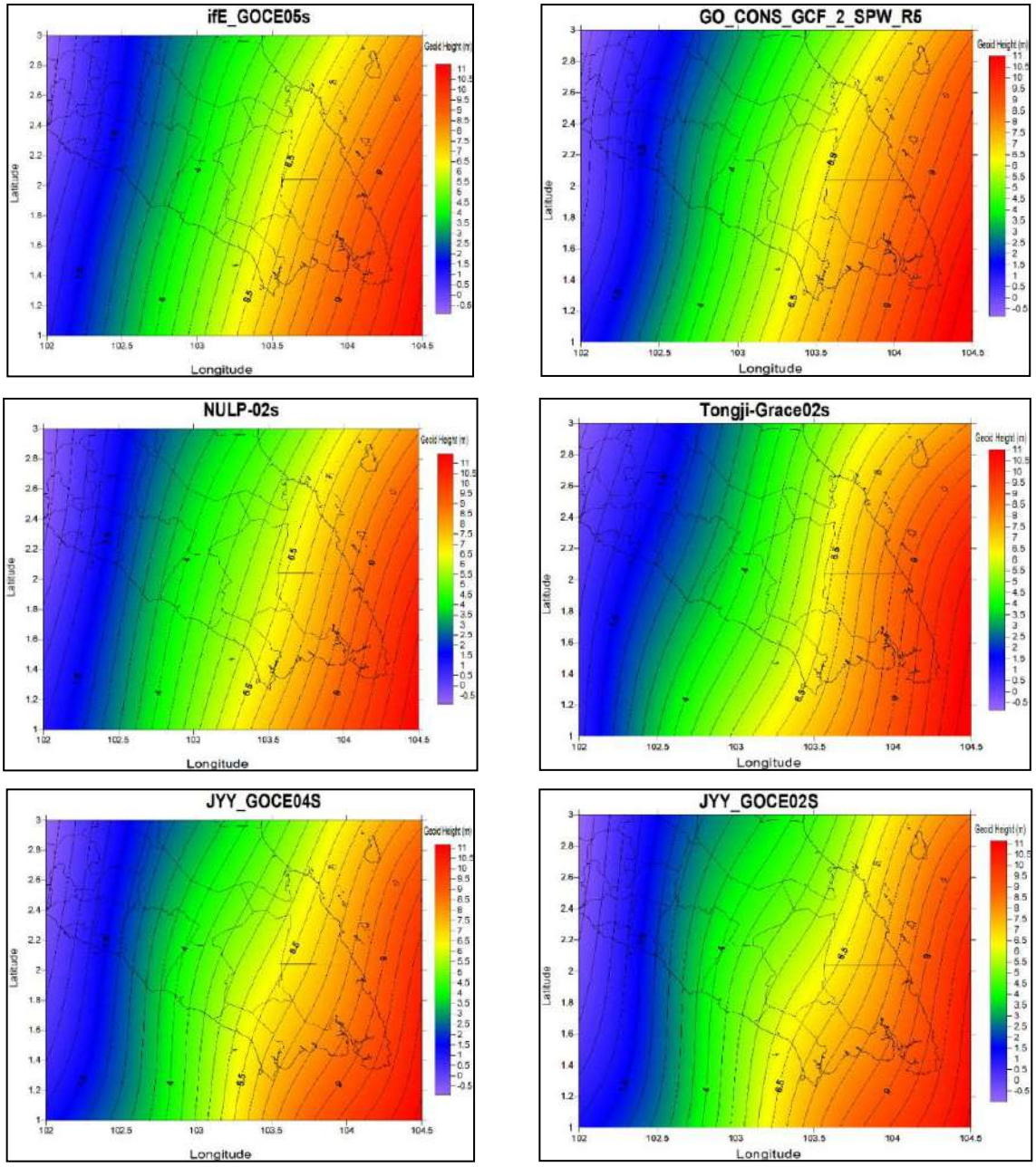

Figure 8: Satellite-only models [Unit: Meters]

Table 6. Statistical analysis of satellite-only models from GGM

Model	Minimum (m)	Maximum (m)	Mean (m)	Standard Deviation (m)	Rank
GGM05S	2.419	9.726	5.798	1.722	1
ITU_GRACE16	2.636	10.709	4.633	1.809	2
JYY_GOCE02S	2.376	9.852	5.936	1.870	3
JYY_GOCE04S	2.357	9.819	5.947	1.888	4
GO_CONS_GCF_2_TIM_R5	2.274	10.253	5.944	1.962	5
GO_CONS_GCF_2_TIM_R4	2.293	10.196	5.904	1.980	6
ITG-Goce02	2.359	10.169	5.874	1.984	7
NULP-02s	2.349	10.237	5.909	1.986	8
GO_CONS_GCF_2_SPW_R4	2.291	10.205	5.963	1.996	9
ULux_CHAMP2013s	2.430	10.051	6.259	2.012	10
GO_CONS_GCF_2_SPW_R5	2.311	10.208	5.930	2.015	11
HUST-Grace2016s	2.273	9.869	5.954	2.042	12
IfE_GOCE05s	2.239	10.090	5.912	2.097	13
Tongji-GRACE01	2.347	10.134	5.888	2.113	14
Tongji-Grace02s	2.291	10.150	5.782	2.161	15
ITSG-Grace2014k	2.267	10.397	5.879	2.239	16
ITSG-Grace2014s	1.574	10.742	5.370	2.624	17

Table 7: Statistical analysis of combined mission models from GGM

Model	Minimum (m)	Maximum (m)	Mean (m)	Standard Deviation (m)	Rank
GOGRA02S	2.382	9.855	5.946	1.868	1
GOGRA04S	2.359	9.822	5.953	1.889	2
GAO2012	2.300	10.117	5.914	1.947	3
EIGEN-6S2	2.300	10.116	5.933	1.947	4
GO_CONS_GCF_2_DIR_R4	2.300	10.117	5.934	1.947	5
ITU_GGC16	2.271	10.255	5.942	1.963	6
GOCO05s	2.289	10.243	5.953	1.964	7
GOCO03s	2.380	10.232	5.911	1.973	8
EGM96	2.313	9.959	5.853	1.978	9
EIGEN-6C3stat	2.248	9.950	5.959	2.004	10
GOCO05c	2.260	10.037	5.991	2.014	11
EIGEN-6S4 (v2)	2.312	10.197	5.947	2.021	12
GO_CONS_GCF_2_DIR_R5	2.311	10.197	5.946	2.021	13
EIGEN-6C2	2.233	9.940	5.962	2.021	14
EGM2008	2.292	9.988	5.991	2.022	15
XGM2016	2.286	10.010	5.976	2.024	16
EIGEN-6C4	2.236	9.996	5.972	2.028	17
GGM05C	2.328	10.115	5.931	2.028	18
DGM-1S	2.290	10.244	5.902	2.032	19
GGM05G	2.325	9.997	5.882	2.061	20
GECO	2.235	10.031	5.974	2.065	21

Comparisons of geoid between GGMs and GPS Levelling Data

In this paper, geoid height was derived from a geopotential model and evaluated using geometric geoids from GPS levelling data. The best fit geoid model was selected that had the lowest RMSE in the geoid height residual statistical analysis. A total of 46 GPS monument records from the Department Survey and Mapping Malaysia were compared with gravimetric geoids from GGM.

The differences in geoid height for each GGM are explained in Figure 10 (the differences of GGM data with GPS Levelling data (Satellite-only models)) and 11 (the differences of GGM data with GPS Levelling data (Combined models)). Where, these assessments were done using statistical analysis.

The result from geoid height statistical analysis using selected GGM data and GPS levelling data is represented in Table 8 and 9. The range value of RMSE for satellite only GGMs was 0.35592m to 2.61129m. For combined mission GGMs, the range value was 0.35370m to 0.39299m. From this analysis, EIGEN-6C3stat had the lowest RMSE value of 0.35370m for the combined models. For the satellite-only models, HUST-Grace2016s had the smallest RMSE value of 0.35592m.

Table 8: Statistical analysis for each satellite-only models GGM compared to GPS levelling data

Model	Minimum (m)	Maximum (m)	Mean (m)	RMSE (m)	Rank
HUST-Grace2016s	2.273	9.869	6.000	0.35592	1
GO_CONS_GCF_2_SPW_R5	2.311	10.208	5.973	0.36217	2
JYY_GOCE04S	2.357	9.819	5.991	0.36238	3
GO_CONS_GCF_2_SPW_R4	2.291	10.205	6.007	0.36377	4
GO_CONS_GCF_2_TIM_R5	2.274	10.253	5.989	0.36484	5
GO_CONS_GCF_2_TIM_R4	2.293	10.196	5.946	0.37898	6
JYY_GOCE02S	2.376	9.852	5.980	0.38054	7
IfE_GOCE05s	2.239	10.090	5.959	0.38249	8
NULP-02s	2.349	10.237	5.951	0.38744	9
Tongji-GRACE01	2.347	10.134	5.936	0.40129	10
ITG-Goce02	2.359	10.169	5.915	0.40515	11
Tongji-Grace02s	2.291	10.150	5.823	0.50899	12
ITSG-Grace2014k	2.267	10.397	5.924	0.52307	13
GGM05S	2.419	9.726	5.827	0.53079	14
ULux_CHAMP2013s	2.430	10.051	6.290	0.64281	15
ITSG-Grace2014s	1.574	10.742	5.425	1.09118	16
ITU_GRACE16	2.636	10.709	4.620	2.61129	17

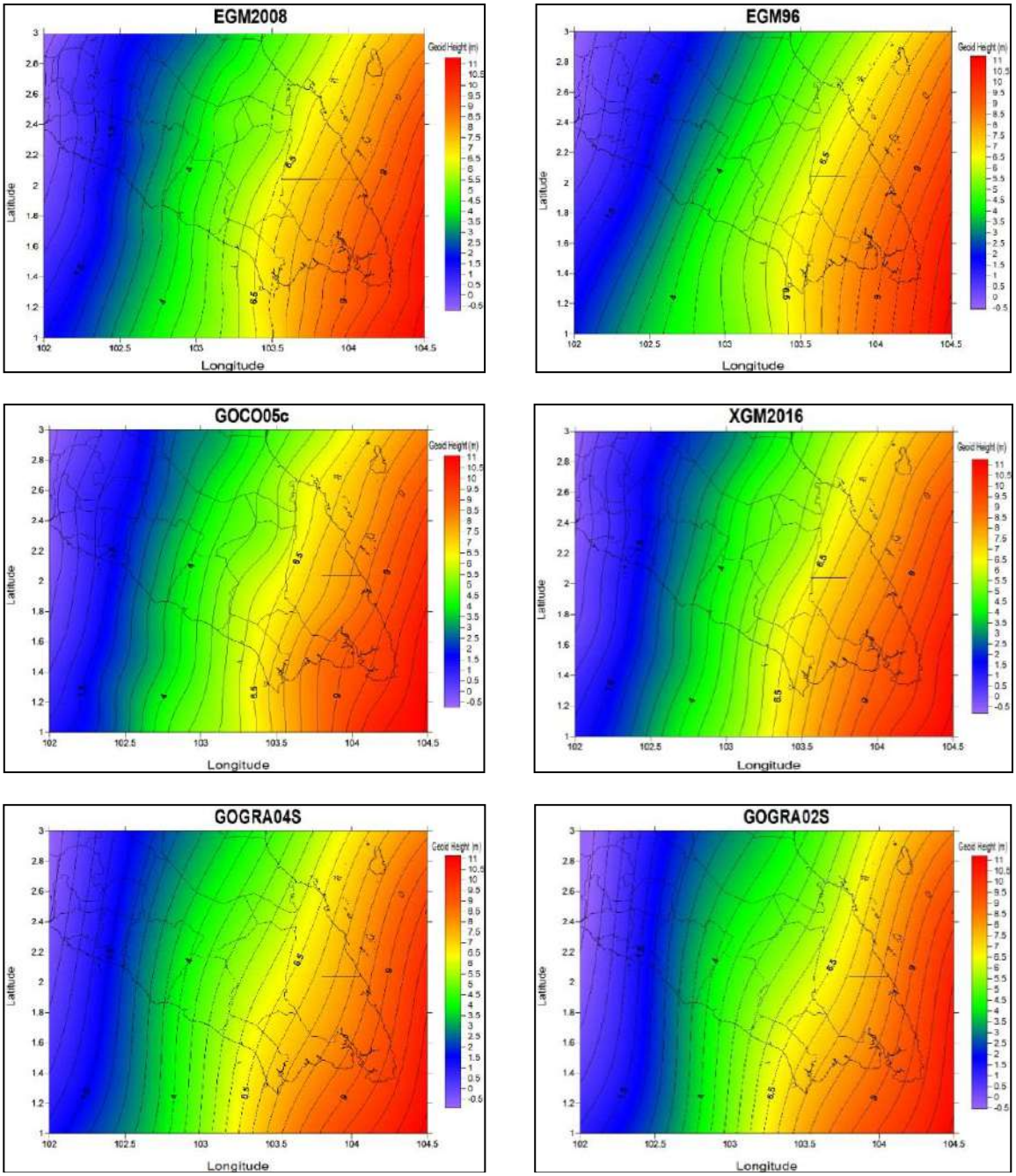

Figure 9. Combined mission models [Unit: Meters]

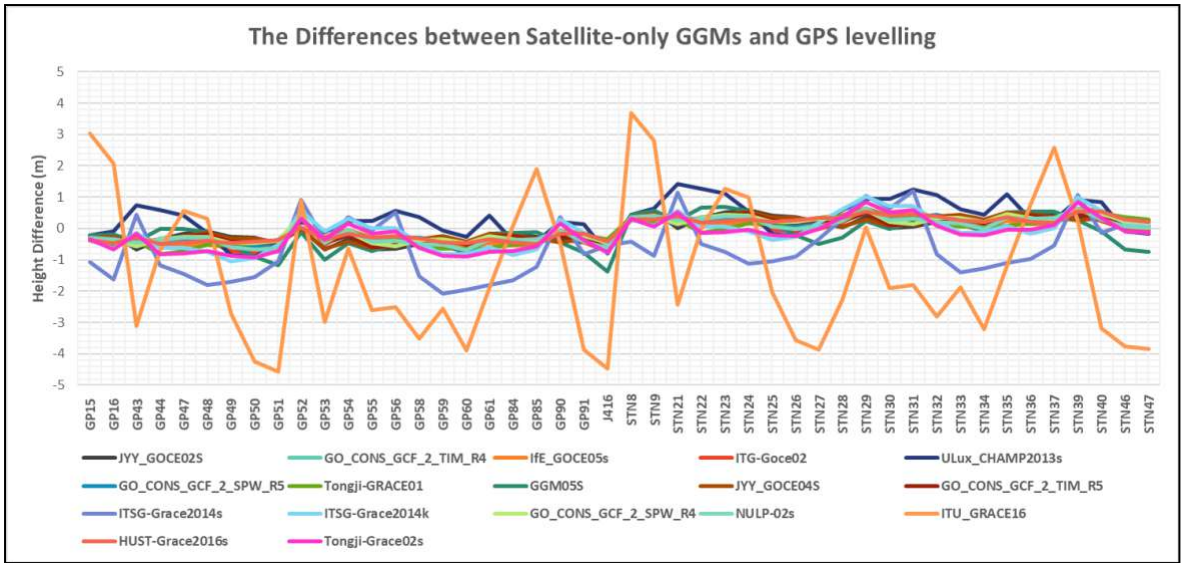

Figure 10: The differences of GGM data with GPS Levelling data (Satellite-only models)

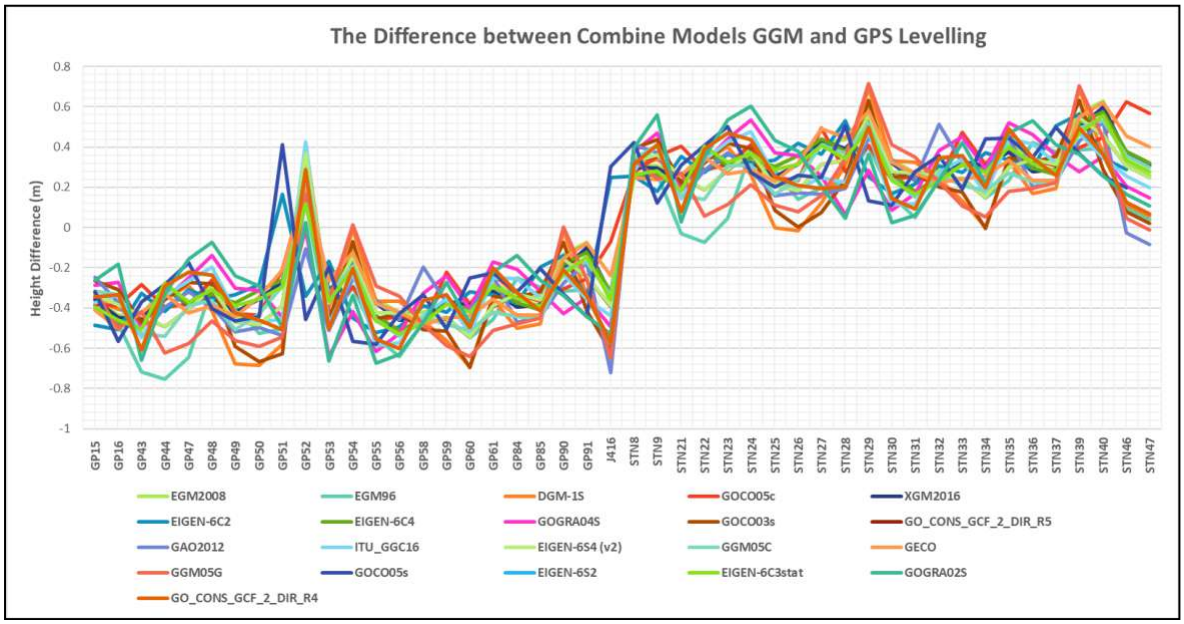

Figure 11: The differences of GGM data with GPS Levelling data (Combined models)

Table 9: Statistical analysis for each combined mission models GGM compared to GPS levelling data

Model	Minimum (m)	Maximum (m)	Mean (m)	RMSE (m)	Rank
EIGEN-6C3stat	2.248	9.950	6.006	0.35370	1
XGM2016	2.286	10.010	6.023	0.35378	2
EIGEN-6C2	2.233	9.940	6.009	0.35601	3
EGM2008	2.292	9.988	6.037	0.35692	4
EIGEN-6C4	2.236	9.996	6.019	0.35703	5
EIGEN-6S4 (v2)	2.312	10.197	5.993	0.35953	6
GO_CONS_GCF_2_DIR_R5	2.311	10.197	5.992	0.35962	7
GOGRA04S	2.359	9.822	5.997	0.36208	8
GOCO05c	2.260	10.037	5.897	0.36309	9
GGM05C	2.328	10.115	5.979	0.36412	10
GECO	2.235	10.031	6.022	0.36414	11
ITU_GGC16	2.271	10.255	5.987	0.36498	12
GOCO05s	2.289	10.243	5.998	0.36528	13
GAO2012	2.300	10.117	5.977	0.36589	14
GO_CONS_GCF_2_DIR_R4	2.300	10.117	5.977	0.36661	15
EIGEN-6S2	2.300	10.116	5.976	0.36670	16
GOGRA02S	2.382	9.855	5.989	0.38082	17
EGM96	2.313	9.959	5.897	0.38526	18
GOCO03s	2.380	10.232	5.953	0.38651	19
DGM-1S	2.290	10.244	5.946	0.39229	20
GGM05G	2.325	9.997	5.924	0.39299	21

By referring to Figure 10 and 11, we can see differences in geoid height between GGMs and GPS levelling data. From the statistical analysis in Table 8 and 9, the minimum, maximum, mean, and RMSE for each GGM was tabulated.

According to Table 8, the statistical analysis of satellite-only models showed the smallest RMSE value was 0.35592m. The development of HUST-Grace2016s was done using a modified dynamic approach with approximately 13 years of GRACE data published by JPL and kinematic orbits and released by ITSG (Zhou *et al.,* 2016). ITU_GRACE16 showed the largest RMSE value of 2.61129m. This is because its errors increase with larger degree values, making it is not recommended for use beyond 130 degrees without smoothing (Akyilmaz *et al.,* 2016).

From the statistical analysis in Table 9, EIGEN-6C3stat showed the smallest RMSE value of 0.35370m, followed by XGM2016 and EIGEN-6C2. EIGEN-6C3stat is using the GOCE direct approach and known as the newest high resolution global combined gravity field model that contains terrestrial, GRACE, GOCE and LAGEOS data with maximal degree of 1949.

This study shows that HUST-Grace2016s and EIGEN-6C3stat are the best fit GGM for the Johor region. This study also disproved the assumption that EGM 2008 was the best fit GGM for the Johor region.

Conclusion

The development of physical geodes has led to the determination of precise regional geoid models that can aid authorities and research activities. A precise local geoid model can be used to replace conventional height determination from faster GNSS measurements. From this assessment, the accuracy of GGM with GPS levelling data showed important information for determining the best fit GGM for the Johor region. The results show that the most suitable GGM in comparison to GPS levelling data were HUST-Grace2016s and EIGEN-6C3stat, as they had the smallest RMSE value.

Therefore, it can be concluded that HUST-Grace2016s and EIGEN-6C3stat are the best combination of GGM and GPS levelling data for Johor. It is highly recommended that the assessment of GGM with GPS levelling data is done to support the selection of precise local geoids for the Johor region.

Acknowledgment

Appreciation is given to the Department of Survey and Mapping Malaysia (DSMM) for the GPS levelling data in Johor. The authors would like to acknowledge ICGEM for providing open access GGM data. We are grateful to the Ministry of Education Malaysia and Universiti Teknologi Malaysia under the Research University Grant (RUG) Tier 2, Vote Number: Q.J130000.2652.16J88.

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Implications of Macroeconomic Factors on Non-Performing Property Loans: Case of Malaysia

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Abstract

The failure of a real estate finance system had been long feared by all policy makers and financial institutions globally. The largest threat to the stability of a sound real estate finance system is the rise of non-performing property loans. Volatile macroeconomic conditions had been one of the prevailing theories of a significant and major contributor to the downfall of financial systems, calling attention of economists and researchers to look into its triggers and monitoring its movements to regulate and formulate better policies. Hence, this research aims to analyze and study the implications of major macroeconomic factors in affecting non-performing property loans in Malaysia. There are eleven (11) Macroeconomic Factors that were studied in this research, namely Gross Domestic Product, Consumer Price Index, Producer Price Index, Unemployment, Percapita Income, Housing Prices, Average Interest Lending Rates, Trade Balances, Foreign Direct Investments, Sale Taxes and Service Taxes. Utilizing a multivariate regression analysis, the multivariate regression analysis reduced the macroeconomic factors to 6 significant factors. It was found that Gross Domestic Product, Housing Prices, Average Lending Interest Rates, Foreign Direct Investments, Percapita Income and Service Taxes significantly affect non-performing property loans in Malaysia. GDP possesses a strong coefficient correlation and significant negative relationship with property NPLs. Foreign Direct Investments, Service Taxes and Housing Prices were found to be significant and negatively affect property NPLs in the country. At the same time, Housing Prices and Service Taxes while significantly negative with property NPLs, both possess weak impacts on property NPLs. Percapita Income and Average Lending Interest Rates were found to be significantly positive and possess fair impact towards property NPLs.

Keywords: Non-Performing Property Loans, Macroeconomic Factors, Time Series Multivariate Regression Analysis Analysis

Introduction

Rising number of non-performing loans bring forth impending doom for the financial system, which had been found to cause systemic economic crises (Agnello, 2011). As financial institutions struggle with non-performing loans (NPLs), they face credit illiquidity (Hou, 2007). A systemic phenomenon of credit illiquidity caused by macroeconomic factors will cause a group or all financial institutions within a country to collapse, leading to a systemic banking crisis (Valencia, 2018; Hou, 2007).

A systemic banking crisis is a situation where a country's corporate and financial sectors experience a rising number of NPLs, with corporations and financial institutions face great difficulties repaying their debt obligations on time (Campbell, 2007; Beck, 2006). This had prompted economists and researchers to look into the factors that cause NPL to prevent such economic crises (Valencia, 2018, Grauwe, 2008). In seeking for the roots of NPL causes, they found that uncontrollable levels of Non-Performing Loans are caused by adverse Macroeconomic conditions that plays a role in bringing economies of both developed and developing countries to their knees (Demirguç-Kunt, 1998; Llewellyn, 2002).

In Malaysia alone, NPLs had continued to rise persistently for the past several years. The volume of the Malaysian non-performing property loans (NPPLs) had been rising since 2014. In order to manage the occurrence of the rising of such non-performing loans, it is necessary to find and understand the root Macroeconomic causes that condition these NPPLs in Malaysia. Such analysis is essential because it can provide signs of alarm by understanding the implications of Macroeconomic factors on non-performing loans to help regulatory authorities and financial institutions to take measures to prevent a possible crisis (Agnello, 2011). One of the foremost important methods in controlling and managing NPPLs is through macroeconomic surveillance (Fendi, Sawalha, & Shamieh, 2017). Macroeconomic surveillance of NPLs aims to mitigate the impact of systemic shocks by identifying macroeconomic and financial risks that could lead to a large number of financial institutions becoming insolvent or significant disruptions to vital parts of the economy (Reinhart, 2010). Macroeconomic risks can include interest rate risk, inflation risk, unemployment and reducing national income levels. Mitigating such risks is a key part of macroeconomic surveillance, thus improving the stability of the financial system and the overall economy in order to control the rise of NPPLs. Regulators are required to be updated with the riskiness position and the true level of safety and soundness of the macroeconomic conditions and identify any problem occurs a s early as possible, to prepare for sudden adverse incidents (Summers, 2000). Reinhart and Rogoff (2010) pointed out that the surveillance of NPLs can be used to mark the beginning of a banking crisis (Reinhart, 2010).

Literature Review

Macroeconomic Surveillance and Monitoring in Strategic Monetary Policy Making

Due to the dynamic evolution of macroeconomic conditions, researchers, economists, regulators and central banks are concerned with the channelling of accurate and prudent monetary policies in addressing the problem of NPLs (ESRB, 2019). Monetary policies are crucial in prevention of an economic crisis (Glickman, 2014). While monetary policy can affect every sector of the economy and mitigate NPLs, it is also true that conditions of various sectors of the economy affect the implementation of monetary policy (Shrestha, 2008). Therefore, central banks need to properly assess the existing situation and monitor carefully each and every development taking place in the economy for credible monetary policy management. This calls for the need of Macroeconomic Surveillance in determination of monetary policy (Shrestha, 2008). Shrestha (2008) define the objectives of macroeconomic surveillance as the process of monitoring closely the macroeconomic developments in the economy, identifying the interlinkages between various economic variables, and make projections of likely future scenarios. Based on the information on the current state of the economy and the likely future developments, appropriate measures can be recommended to achieve monetary policy objectives consistent with various macroeconomic goals (Shresta, 2008; Fendi, Sawalha, & Shamieh, 2017). Moreover, accurate identification of problems in each and every sector can help avert the economy from crises. The adaptation of monetary policy formulation is similar in many countries where it requires an assessment of economic problems and identification of a set of policy instruments to achieve the desired outcomes consistent with the broad macroeconomic goals. This necessitates a competent surveillance system capable of analyzing the macroeconomic developments, preparing consistent

projections of the major sectorial accounts, and proposing appropriate policy measures (Shrestha, 2008).

Macroeconomic Determinants and Their Relationship

The relationship between the macroeconomic environment and the NPLs has been studied in the literature relating the phases of the business cycle with banking stability. Among factors cited by the literature as significant determinants, there are: interest rates, economic growth as represented by the gross domestic product, inflation, housing prices, taxes, income, unemployment, foreign trade and foreign exchanges.

Many of the studies shows that economic output or economic growth is favorable to an increase in revenues and a decrease in financial distress. As a result, economic which is represented by either real GDP or GNI growth are found to be negatively associated with the NPL (Mazreku, 2018; Muthami, 2016; Klein, 2013; Salas and Saurina 2002; Fofack, 2005; Khemraj and Pasha, 2009; Dash and Kabra, 2010). The justification provided in the empirical literature of this association is that higher positive level of real economic growth in the measurement of Gross National Income habitually entails a higher level of income (Erdogdu, 2016). This improves the capacity of the borrower to pay its debts and contributes to reduce bad debts. When there is a downturn in the economy as reflected by GNI, the level of bad debts will likely increase.

Interest rates, another form of Macroeconomic Factor also affects also the amount of bad debt in the case of floating interest rate. This implies that the effect of interest rates should be positive, and therefore, an increase in the debt caused by the increase in payments of interest rates would cause a rise of non-performing loans (Erdogdu, 2016; Mehmood, 2013; Dash, 2011; Bofondi and Ropele, 2011; Rinaldi, 2006; Fofack, 2005; Khemraj & Pasha, 2009;). Many of the previous empirical studies showed that interest rate had been significant in affecting NPLs, despite the passage of different macroeconomic environment. The effects of interest rates on rising NPLs can be explained by higher costs of borrowing, and that higher interest rates reduces the capacity of loan repayments (Vandel, 1993).

Inflation had shown to produce contrary effects on NPLs. While inflation had been found to affect interest rates, it may improve the ability of borrowers to pay off the remaining balance due to the diminishing value of the debt (Beck et al, 2013). However, other studies tend to support the inference where interest rates, has a positive relationship with the NPLs (Mazreku, 2018; Klein, 2013; Dash, 2011; Julia, 2010; Rinaldi, 2006; Gambera, 2000). High interests' rates resulted in high levels of non-performing loans. The literature suggests that in general, during the long run, loan contracts adjust to inflation, which is captured by the interest rates and thus, reduces the risks of non-performing loans.

Unemployment would tend to correspond directly with non-performing loans in a positive relationship. Existing studies showed that increases in the unemployment rate curtail the present and future purchasing power of households and are commonly associated with a decrease in the production

of goods and services (Mazreku et al, 2018; Klein, 2013; Bošnjak, et al, 2013; Bofondi, 2011). High levels of unemployment would cause the inability of borrowers to repay their loans or debts. Specifically, unemployment is one of the biggest cause of mortgage defaults as people receiving job seekers allowance see a fall in disposable income and may no longer be able to afford repayments (Dimitrios P. Louzis, 2010).

Income could potentially represent the spending power of consumers and possesses a negative relationship with the non-performing property loans (Warue, 2013; Rinaldi, 2006; Khemraj, 2002). Ability of consumers to repay and serve their loans can be represented by the per capita income (Warue, 2013). The per capita income would correspond negatively as the higher the income of the consumers, the easier it is to serve the loans. However, in Malaysia, Zainol (2018) found that income levels were insignificant in relate to NPLs.

Housing prices had also shown to show some significant relationship with NPLs, especially in the Asian region (Wan, 2018: Khaled, 2016). The increase of housing prices that affected the increase of NPLs was suggested to be caused by either speculative activity, an increase in difficulty of repayment, decreasing housing investment and a drop in profit of housing developers (Wallison, 2009; Khaled, 2016).

Foreign Direct Investments and Foreign External Trade were found to be another macroeconomic determinant of NPLs. Trade imbalances and a withdrawal or reduction of foreign direct investments were linked to leakages in capital flow, causing a depreciation in the currency, which impacted the NPLs negatively or positively (Sandrovschi, 2014). Depending on the type of the dominancy in the commercial trade, either export or import status, we introduce different hypotheses for the exchange rate specifications (Javinsloo, 2013). In case of the dominant export countries, an appreciation of the domestic currency will lead to an increase of NPL ratio on the fact that agents exporting abroad have higher chances to gain during the depreciation of the exchange rate to meet their debt payments faster (Jovic, 2016; Kuzucu, 2019; Javinsloo, 2013).

Taxation is also another factor that may cause rising NPLs. Multiple studies showed that tax rates charged by financial institutions were absorbed into the loan repayments of debtors (Khan, 2018; Nurja, 2016; Wallison, 2009). Aside to this, it is also suggested that taxes had been known to affect household and business owner's ability to repay their property loans (Wallison, 2009; Khan, 2018).

The relationship between the macroeconomic environment and loan quality has been investigated in many other literatures, linking the macroeconomic conditions with NPLs. Malik, Shah and Siddiqui (2012) suggested that a rise in NPL portfolios of banks is mutual in all those economies where banking professionals and economic monitors containing regulators lack the understanding of systemic risks and macroeconomic effects affecting non-performing loans (Malik, 2012). The nature of Macroeconomic Determinants' impact upon non-performing loans is ever-changing, and economists

worldwide continuously monitor and try to chart financial modeling to anticipate its effects in the past, and understand more how it possibly affects the non-performing loans in the future. This had formed the basis of monetary policy strategy as macroeconomic surveillance allows regulatory authorities to better understand the dynamics of macroeconomic impact has on NPLs. The macroeconomic factors affecting non-performing property loans in Malaysia is required to be determined to provide a bigger view of its impact in better credit risk control.

Non-performing loans are dangerous not only for the economy of one country but also for the whole world as we have seen the financial crisis created by these loans in Europe, the US, East Asian countries, America and Sub-Saharan Africa, so this is the need of the era to identify the factors responsible for non-performing loans; as researchers believe that once we identify these factors then we can make policies to prevent any future happenings of these loans. This study aims to serve this cause, to formulate a model to study the relationships between the macroeconomic factors and non-performing loans in detail towards influencing market sentiments in the real estate finance system. The result of this literature review had enabled the selection of crucial macroeconomic factors to be tested, which hereby includes Inflation (CPI & PPI), Interest Rates (ALR), Economic growth (GDP), unemployment (EMP), income (GNI Percapita), housing prices (HPI), taxes (SERT & SALT), foreign trade (TB) and foreign direct investments (FDI) as follows:

Symbol	Dependent Variable	Related Literature	Source	Expected Sign	Frequency
GNI	Gross National Percapita Income	Zainol (2018), Warue (2013), Rinaldi (2006), Khemraj (2002) ,Gambera (2000)	BNM	-ve/+ve	Quarterly
HPI	Housing Price Index	Ok, et al (2019), Wan (2018), Khaled (2016), Wallison (2009)	JPPH	-ve/+ve	Quarterly
ALR	Average Lending Interest Rates	Zainol (2018), Erdogdu (2016), Javinsloo (2013), Mehmood (2013), Louzis (2012), Okpugie (2009), Rinaldi (2006) ,Hoggarth (2005), Greenwalt (1976)	BNM	+ve	Quarterly
GDP	Gross Domestic Product	Mustafa (2019), Zainol (2018), Kuzucu (2019), Khan (2018), Mazreku (2018), Erdogdu (2016), Klein (2013), Greenwalt (1976)	BNM	-ve	Quarterly
CPI	Consumer Price Index	Mustafa (2019), Zainol (2018), Khan (2018), Mazreku (2018), IMF (2016), Klein (2013), Hoggarth (2005), Greenwalt (1976)	BNM	-ve/+ve	Quarterly
EMP	Unemployment Rates	Mustafa (2019), Khan (2018), Mazreku (2018), Klein (2013), Gambera (2000), Bofondi (2013), Louzis (2010).	BNM	+ve	Quarterly

PPI	Producer Price Index	Mustafa (2019), Zainol (2018), Khan (2018), Mazreku (2018), IMF (2016), Klein (2013), Hoggarth (2005), Greenwalt (1976)	BNM	-ve/+ve	Quarterly
SALT	Sale Taxes	Khan (2018), Nurja (2016), Domm (2017), Wallison (2009)	BNM	+ve	Quarterly
SERT	Service Taxes	Khan (2018), Nurja (2016), Domm (2017), Wallison (2009)	BNM	+ve	Quarterly
FX	Foreign Direct Investments	Kuzucu (2019), Jovic (2016), Javinsloo (2013)	BNM	-ve	Quarterly
TB	Trade Balances	Kuzucu (2019), Jovic (2016), Javinsloo (2013)	BNM	-ve	Quarterly

Figure 1: Summary of Literature Review on Macroeconomic Factors and Relevant Items Affecting NPPLs

As shown in Figure 1 above, the description of the independent variables are elaborated, together with their expected impact and frequencies. The following chapter discusses the methodology of this research.

Research Methodology

Introduction

The collection of data involves extraction of key economic indicators and info from Central Bank of Malaysia and the National Property Information Center (NAPIC). Besides, data are also extracted from thesis, journals, papers, conference proceedings and other secondary sources. These information are then grouped together to be analyzed. Data analysis involves quantitative approach method. Quantitative experimental design such as regression of time series data had been adopted universally by economists and researchers worldwide as it is the most appropriate and accurate way of researching into time series data such as macroeconomic factors and non-performing property loans. This can be seen by various economists in analysing macroeconomic factors and non-performing loans using multivariate regression analyses both in Malaysia (Mustafa, 2019; Zainol, 2018) and other countries and regions (Khan, 2018; Muthami, 2016; Mazreku, 2018; Erdogdu, 2016; Khaled, 2016, IMF, 2016)

Sampling Design

As to June 2019, there are a total of 57 financial institutions in Malaysia. There are currently 26 Commercial Banks, 16 Islamic Banks, 2 International Islamic Banks, 11 Investment Banks and 2 Special Financial Institutions (Bank Negara Malaysia, 2018). These institutions all provide loans in property purchases, and are the originators of loan in Malaysia. Accordingly, this study focuses on all types of financial institutions that provide property loans in Malaysia. The Malaysian economy weathered through the global financial crisis in 2009-2010, and subsequently, the NPLs had been decreasing from 2009 to 2014, before increasing from 2015 to 2017. This particular time frame had been interesting for macroeconomic surveillance research where it provides the perfect time frame as

to what conditions the increase of NPLs in a relatively stable economy. Thus, this study takes into account the observations of macroeconomic factors during the period of post global financial crisis in 2009 until 2017, where the increment of NPLs had been observed for the first time in almost a decade from 2015 onwards. The selection criteria are hence, it takes into account the NPPLs in the whole country, of all the financial institutions that provide property loans to Malaysians, and the time series period from 2009 to 2017, which covers a total of 36 quarterly data of observations, spanning 9 years.

Data Analysis Quantitative Methods

Unit Root Tests

In order to test the data collected for time series regression purpose, it is important to ensure the Macroeconomic Data collected are stationary in nature. This is to ensure the spuriousity is ruled out and ensure the data is suitable for the computation of time series regression analysis.

For stationary data, the $|\beta| < 1$, and the **β** with a lesser value of 1 eventually exerts a downward pressure onto the βX_{t-1}, affecting the variable or observation **X** to return back to 0. Thus, the formula for a stationary data can be denoted as follows:

$$X_t = \beta X_{t-1} + E_t$$

Where **X** = the observed variable, t = time, **β** = rho/coefficient on a time trend, **E** = a particular error. As for non-stationary data, the $|\beta| = 0$, then it would meant that there is a unit root. There is no role of **β** in exerting downward pressures onto the βX_{t-1}, affecting the variable or observation X to return back to 0. Thus, the formula for a non-stationary data can be denoted as follows:

$$X_t = X_{t-1} + E_t$$

Where X = the observed variable, t = time, E = a particular error. Therefore:

Should **β** = 0, it has a Unit Root, denoting the data is Non-Stationary

Should **β** ≠ 0, it has no Unit Root, denoting the data is Stationary. In other words, the data is stochastic, and is a random sample of time series observations.

In order to determine whether the data is stationary or non-stationary, the Dickey Fuller Test is conducted for this purpose.

Multivariate Regression Analysis

In multivariate regression analysis, the variation of the independent variables in the dependent variable is accounted synchronically. Multivariate regression analysis model is formulated as in the following:-

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + e$$

Where,

***y* =** Dependent Variable

x = Independent Variable

***β* =** Parameter

***e* =** Constant Error

The assumptions of a multivariate regression analysis are normal distribution, linearity, freedom from extreme values and no multiple ties between independent variables. In ensuring the robustness of the multivariate regression analysis, this study also engages multiple tests to ensure the robustness of the model formed, which include testing for stationary data for suitability of time series analysis, auto-correlation tests to ensure the model formed has no issues of autocorrelation, and multicollinearity tests to ensure there is no issues of multicollinearity within its variables.

Autocorrelation

Autocorrelation is the cross-correlation of a signal with itself and it is a systematic pattern in the errors that can be either attracting or repealing autocorrelation. Informally, it is the correspondence between observations as a function of the time separation between them. James Durbin and Geoffrey Watson (1950) came out a Durbin-Watson statistic which to detect the presence of autocorrelation in the residuals from a regression analysis (Durbin, 1950). If $\mathbf{e_t}$ is the residual associated with the observation at time t, then the test statistic is :-

$$\boldsymbol{d} = \frac{\sum_{\boldsymbol{t=2}}^{\boldsymbol{T}} \ (\boldsymbol{e_t} - \ \boldsymbol{e_{t-1}})^2}{\sum_{\boldsymbol{t=1}}^{\boldsymbol{T}} \ \boldsymbol{e_t^2}}$$

Since d is approximately equal to 2(1-r) and it always lie between 0 and 4, where r is the sample autocorrelation of the residuals, d = 2 indicates no autocorrelation. In addition, if the Durbin–Watson statistic is substantially less than 2, there is evidence of positive serial correlation. As a rough rule of thumb, if Durbin–Watson is less than 1.0, there may be cause for alarm. Small values of d (d<2) indicate successive error terms are, on average, close in value to one another, or positively correlated. On the other hand, if d > 2, it is a successive error terms, on average which much different in value to one another, i.e., negatively correlated.

Multicollinearity Test

In this research, multicollinearity issue will be solved before stepwise regression method is performed in order to select the correct model which consists of the useful X variables. In multiple regressions, independent (X) variables tend to have multicollinearity. When two X variables are highly correlated, they both convey essentially the same information. In this case, neither may contribute significantly to the model after the other one is included. But together they contribute a lot. If you removed both variables from the model, the fit would be much worse. So the overall model fits the data well, but neither X variable makes a significant contribution when it is added to your model last. When this happens, the X variables are collinear and the results show multicollinearity. In other words, the greater the multicollinearity, the greater the standard errors in the data. Confidence intervals for coefficients tend to be very wide and t-statistics tend to be very small once high multicollinearity is present. Coefficients will have to be larger in order to be statistically significant, i.e. it will be harder to reject the null hypothesis when multicollinearity is present. In a regression model, there will be a high variance explained (R2). The higher the R 2 , the better the model is. However, parameter estimates are all inflated if collinearity exists, probably the variance, standard error. In this research, Variance inflation factor (VIF), which is common way for detecting multicollinearity, will be used to find out the

possible X variables to be thrown out, which a general rule is that the VIF should not exceed 10 (Hair Jr, 1995). Mathematically speaking, the VIF option in the regression procedure can be interpreted in the following ways:

VIF = 1/(1-R-square)

Results and Discussions

Augmented Dickey Fuller Unit Root Test

The results of the Augmented Dickey Fuller Unit Root Test, tested for level, 1st Difference and 2nd Difference respectively when necessary to ensure the t-stat is higher than the 5% Critical Value to reject the hypothesis of the existence of a unit root, rendering the variable stationary and suitable to be used for Time Series Regression. The Unit Root Test is conducted based on a lags from 0 to 4, with automatic selection as accoding to the Akaike Information Criteria (AIC). It had been a common acceptance where monthly time series data would involve lags up to 12, while quarterly data lags up to 4. Since the time series data used in this research is on a quarterly basis, lags from 0 to 4 were used to test for the unit root tests respectively as below:

Symbol	Lags based on AIC, Max. Lags of 4)	Transformed Variables	t-Statistic	5% Critical Value	Prob.	Unit Root
GNI	0	GNI – Level	-3.4684	-3.544	0.0587	I(0)
HPI	2	HPI – Level	-4.3717	-3.622	0.0809	I(0)
ALR	4	ALR – Level	-3.5751	-3.575	0.0945	I(0)
GDP	0	GDP – Level	-4.1086	-3.544	0.0139	I(0)
D(CPI)	4	First Difference of CPI	-5.917	-2.951	0.0000	I(1)
D(EMP)	4	First Difference of EMP	-6.635	-2.951	0.0000	I(1)
PPI	1	PPI – Level	-3.4629	-3.548	0.0598	I(0)
D(SALT)	4	First Difference of SALT	-5.569	-3.548	0.0000	I(1)
SERT	1	First Difference of SERT	-3.705	-3.544	0.0352	I(0)
FX	1	FDI – Level	-4.9472	-3.544	0.0017	I(0)
TB	0	TB - Level	-5.0320	-3.204	0.0013	I(0)
NPL	3	NPL – Level	-4.412	-3.456	0.0166	I(0)

Figure 2: Augmented Dicker-Fuller Unit-Root Test (Intercept with Trend)

The above results for unit root test showed that the calculated absolute t-statistic is less than the absolute value of the critical value at various differences to adjust for stationary with a confidence level of 90% ($p<0.10$). Therefore, the null hypothesis of individual variables being non stationary is accepted at the respective Levels and Differences. With the above results, the study can then proceed with multicollinearity tests.

Multivariate Regression Results

Model Formed and Accuracy

A multivariate regression was run to predict Non-Performing Loans against 11 other independent variables: Gross National Income (GNI), House Price Index (HPI), Average Lending Rate (ALR), Gross

Domestic Product (GDP), Consumer Price Index (DCPI), Unemployment Rate (DEMP), Producer's Price Index (PPI), Sales Taxes (DSALT), Trade Balances (TB), Services Taxes (SERT) and Foreign Direct Investments in Malaysia (FX). These variables statistically significantly predicted F(6, 35), $p < 0.05$, R2 5= 0.9451. All six variables added statistically significantly to the prediction, $p < 0.05$. The Final Model Summary for the multivariate Regression can be seen as follow:

NPL = 0.918244015381*GNI - 0.0180613164433*HPI + 0.11506231484*ALR - 1.42066215361*GDP - 0.00758875822441*D(CPI) + 0.023643636358*D(EMP) - 0.0011114542503*PPI + 0.000204144031692*D(SALT) - 0.000447966300857*SERT - 0.00912396475216*FX + 1.15108769343e-06*TB + 0.703792095399

Where:

NPL = Non-performing Property Loans in Malaysia
GNI = Gross National Percapita Income
HP I = House Price Index in Malaysia
ALR = Average Lending Interest Rates
GDP = Gross Domestic Product
CPI = Consumer Price Index
EMP = Unemployment
PPI = Producer Price Index
SALT = Sales Taxes
SERT = Service Taxes
FX = Foreign Direct Investments
TB = Trade Balances

Coefficients & Statistically Significant

The final model's coefficients formed is selected and shown as below:

Variable	Coefficient	Prob.	Direction of the Macroeconomic Implication on NPL
GNI	0.942226	0.0005	Significantly Positive
HPI	-0.018194	0.0032	Significantly Negative
ALR	0.117483	0.0237	Significantly Positive
GDP	-1.448273	0.0000	Significantly Negative
FX	-0.009301	0.0037	Significantly Negative
SERT	-0.000446	0.0622	Significantly Negative
D(CPI)	-0.010274	0.6065	Insignificantly Negative
D(EMP)	0.025041	0.5491	Insignificantly Positive
PPI	-0.000787	0.7612	Insignificantly Negative
D(SALT)	0.000185	0.4187	Insignificantly Positive
TB	1.150000	0.7563	Insignificantly Positive

Figure 3: Coefficients Correlations of the Variables

Based on the Coefficients Correlations of the Variables shown in Figure 3, GNI, HPI, ALR, GDP, FX and SERT were found to significantly impacted Non-Performing Loans from 2009 to 2017. This is

non-spurious as spuriosity had been ruled out in the Dickey Fuller Test for stationary. The significance of both negative co-efficient variables are statistically significantly different to zero, as shown in the "Sig" column where both are less than $p < 0.10$. The graphs in the following pages show the correlation between macroeconomic factors and NPPLs.

Autocorrelation Results

Autocorrelation of the samples have been tested using EViews. At 5% significant level and with 10 independent variables together with 32 data observations after adjustments, the lower critical value (dL) is 0.8360 and upper critical value (dU) is 2.2030 based on Durbin-Watson table.

Model Summary Diagnostics	Value
Durbin Watson Statistic	1.4974

Figure 4: Durbin Watson Statistic of the Multivariate Regression Model

Based on the results from EViews as shown in Figure 4, the Durbin-Watson for the regression model is 1.4976 which falls between the dL of 0.769 and dU of 2.306 at 5% significant level. This shows that there is an absence of serial autocorrelation. With this result, we reject the hypothesis that there is presence of serial autocorrelation in the regression model. Therefore, parameter estimates from the model formed is stable, efficient and suitable for policy simulation.

Multicollinearity Test Results

Tolerance and VIF for each variable has been examined. Low values indicate high multivariate correlation, since for each independent variable, Tolerance = 1 – R2 , where R2 is the coefficient of determination for the regression of that variable on all remaining independent variables. And, the Variance Inflation Factor (VIF) is 1/Tolerance which it shows the number of times the variance of the corresponding parameter estimate is increased due to multicollinearity as compared to as it would be if there was no multicollinearity.

Symbol	Coefficient Variance	Uncentered VIF
GNI	0.075353	141.8036
HPI	4.23E-05	3.162330
ALR	0.003151	2.341917
GDP	0.109253	134.5955
D(CPI)	0.000521	1.782403
D(EMP)	0.002322	1.331162
PPI	8.35E-06	2.579588
D(SALT)	6.39E-08	2.119008
SERT	7.06E-08	2.649728
FX	8.39E-06	1.609889
C	0.250622	NA

Figure 5: Coefficient Variance of the Multivariate Regression Model

Figure 5 shows the standard errors for the parameter of variables are less than 9. Values of VIF exceeding 9 are often regarded as indicating multicollinearity as mentioned in Chapter 3 (BNM 1997-2018). With all these results, we may conclude that multicollinearity exists between GNI and GDP (being more than 9 in VIF values). This is however, expected as gross national income and gross domestic product are closely correlated. The relationship between GNI and GDP is correlated as both are similar

indicators, which will be discussed in the discussions chapter. However, other independent variables were found to have no issues of correlation with one another, having a VIF value of only 1 to 3, less than the accepted value of 9.

Conclusion

Empirical evidence had showed that there several significant variables consisting of GNI, GDP, HPI, ALR, SERT, and FX that impacted non-performing property loans in Malaysia as the multivariate Regression analysis was done successfully. The model formed is robust as it shows high prediction accuracy, with a significant R-square value of 0.9451, showing that the regression model has a high level of prediction as it exceeds 0.5, or 50% in its level of prediction at a confidence interval of 94.51% of the variability of the NPPLs. Moreover, the model formed also does not have any issues in autocorrelation, having a rational Durbin Watson Stat value of 1.4974 which is well within the lower and upper boundary of the Durbin Watson Table at 5% significance level. Therefore, there is an absence of autocorrelation, and the parameter estimates from the model formed is stable and efficient for policy simulation. Lastly, the model formed also did not have serious issues with multicollinearity. The VIF values of the model showed that aside to GNI and GDP which has presence of multicollinearity, there are no multicollinearity between all the remaining independent variables. The regression model formed was able to prove and show significant positive relationship of GNI and ALR on NPPLs, while HPI, GDP, FX and SERT were found to possess significant negative implications on NPPLs. Moreover, CPI and PPI were found to be insignificantly negative towards NPPLs, while EMP, SALT and TB were found to be insignificantly positive towards NPPLs.

A strong macroeconomic surveillance system can closely monitor the developments in the economy, identify the inter-linkages between various economic variables, and make projections of likely future scenarios. Based on the information on the current state of the economy and future likely developments, appropriate measures can be recommended to achieve monetary policy objectives consistent with various macroeconomic goals. Priority should be given to increasing and boosting the GDP of the economy at the aggregate level, expansion of economic activities and strengthening the aspects of local productivity as the first barrier of defence against rising NPPLs due to the highest significance, heavy weight of impact and negative relationship between GDP and NPPLs. An immediate focus on housing prices to ensure housing prices remain stable and to avoid speculation activities due to the significant impact of housing prices on NPPLs. Lastly, it is suggested that the increasing and pulling in of foreign funds in terms of Foreign Direct Investments, would assist in controlling the number of NPPLs in the country.

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Affordable Housing – The Literature Review

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Abstract:
Affordable housing is a program that introduced by the government to improve housing affordability which ensure every income earner group could afford houses, especially for low-income households. Affordable sustainable housing project has no clear definition so far but the concept of needs, which seeks to ensure that the essential needs of the poor are adequately met; and the need for addressing every limitation arising from the use of technology and activities of social elements affecting the environment's ability to meet the present and future needs, may to consider defining as general idea. This paper its to study the criteria of affordable housing concept to be inline by answering the term of affordable sustainable housing project. By using the latest 10 years of publication for extensive literature review methodology perhaps may contribute in enhancing the existing knowledge.

Keywords: affordable, housing, criteria

INTRODUCTION

There are different types of housing offered in the market but not all of them are affordable by everyone. Researchers had defined affordability in general as the relationship between household expenditure and income earned. However, there are argument saying that affordability is not only influenced by that, but also by the levels and distribution of house process, structure of financing cost, housing availability, employment, maintenance of the existing affordable housing stock and patterns of new construction (Nor Hanizan Sahib, 2015; Wilcox, 2003; Ludwig et al, 2002; Bramley, 1994).

Affordable housing is a program that introduced by the government to improve housing affordability which ensure every income earner group could afford houses, especially for low-income households (Xiaolong Gan et al, 2017; M.S. Suhaida et al, 2011; Azevedo et al, 2010). According to Nor Hanizan Sahib (2015), houses which having housing loans exceeding 30percent of monthly gross household income will not be counted as affordable housing as it will affect other basic needs of the owner. Other than the financial affordability, the location, quality and build-up of a house should be sufficient in order to entitled affordable housing (Cheah Su Ling et al, 2017).

Malaysia government had implemented several affordable housing programme such as Program Bantuan Rumah (PBR) and Perumahan Rakyat 1Malaysia (PR1MA) for low- and middle- income households to cope with the problem of mismatch between supply and demand of housing due to socioeconomic change, urbanization and evolving population structures (Nor Baizura Jamaluddin et al, 2016). However according to Cheah Su Ling (2017) Malaysia still facing shortage of affordable homes for the masses. Hence, it is important to have more affordable housing constructed in Malaysia.

LITERATURE REVIEW

A house is a home, building or structure that functions as a habitat for humans or other creatures. The term house includes many kinds of dwellings ranging from rudimentary huts of nomadic tribes to complex structures composed of many systems. Apart from affordable, the aspect of comfortable in is also important. According to Hamidah Ramlan et al. (2016), the definition on affordable housing is generally involved in the ability of a household to get the housing services, while specifically it involves the correlation between household income and the price or payment. Largely, the Malaysia's accommodation procedure has a principal of aim of realizing all nations, mainly the low-income group (LIG), are definite admission satisfactory and unrestricted admission to a reasonable accommodation requirement. According to Hamidah Ramlan et al. (2016), it is hoped that they seek out the country for a feasible and sustainable being settlement can be achieved throughout a suitable and well deliberate accommodation condition.

The Brundtland report defines SD as ''development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). The two key common concepts contain in the above two SD definitions are: the concept of needs, which seeks to ensure that the essential needs of the poor are adequately met; and the need for addressing every limitation arising from the use of technology and activities of social elements affecting the environment's ability to meet the present and future needs.

Based on the aforementioned two concepts, which are affordable and sustainable housing, it should adequately meet housing needs of the vulnerable households on a continuous basis, and at the same time consider the environmental limitations while meeting such needs both in the present and future in relation to the affordable techniques and sustainable components (Akanbi Olusayo Oyebanji et al., 2017). However, sustainability issues are bound to arise where appropriate measures are not adequately and properly linked together in affordable housing delivery. Therefore, clearance on defining affordable sustainable housing project truly much appreciated to make these two concept well deliver to the public as well as to the construction players the parties who deliver these concepts.

Affordable Housing – The Definition

By referring to Table 2.1, few authors state that houses will be consider affordable only when the financing of home ownership which included utilities fee, maintenance fee, taxes and insurance is less than 30% of the monthly gross household income. When the amount of house cost more than 30%, the house will not be considered as affordable housing as it will affect the other 70% of income which initially being allocate for the use of basic needs such as food, clothing, vehicles, medical financing, education, cultural needs, and even leisure time and entertainment (Nor Hanizan Sahib, 2015; B Bakhtyar et al, 2013; Barclay, E. and Betker, D, 2004; Anderson, M.L., et al, 2003).

However, some author mentions that affordable housing is the relationship between housing and people. According to Wallbaum H, et al (2011), a range between 15 to 30 years will be given for client

to obtain affordable houses. The affordability is depends on the ability and desire of client to own or buy houses. For certain client, all house is consider affordable for them; however for certain client, no housing is affordable unless it is free (Adel El Menshawy et al, 2016; A.M.J. Esruq-Labin, 2014; Abed, 2012; Yang, Z, and Shen, Y, 2008; Stoned, 2006, p.153).

According to Cheah Su Ling (2017), other than financial affordability, affordable housing is houses that sufficient in quality and location. Affordable housing is also a concept, which use to explain socioeconomic and development environments. It was aim to make sure that every income-earner cluster could afford the houses provided (A.M.J.Esruq-Labin, 2014).

Table 1 Definition of Affordable Housing

No.	Definition	Author, Year
1	Affordable housing is defined as housing which is sufficient in quality and location, and is not so costly that it prevents its occupants from satisfying other basic living needs.	Cheah Su Ling, 2017
2	Affordable housing can be defined as "it is a relationship between housing and people. For some people, all housing is affordable, no matter how expensive it is; for others, no housing is affordable unless it is free".	Adel El Menshawy et al, 2016; Abed, 2012; Stoned, 2006, P.153
3	Affordable housing also meant as the financing of home ownership does not exceed 30 percent of monthly gross household income.	Nor Hanizan Sahid, 2015
4	Affordable housing is a concept which is used to explain socioeconomic and development environments, which aims to confirm if housing provided for families can be afforded by each income-earner cluster, that is, low, middle, or high income-earner cluster.	A.M.J.Esruq-Labin, 2014
5	Affordable housing is a feature of housing facilities which is related to customer ability and the desire to own or buy houses.	A.M.J.Esruq-Labin, 2014; Yang, Z, and Shen, Y, 2008
6	The housing costs that consume less than 30% of a household's budget is an affordable house.	B Bakhtyar,2013 ;HUD, U.S. Department of Housing and Urban Development, 2008
7	Affordable housing can be defined as a house that a family group can acquire within a given period, which generally ranges from 15 to 30 years.	Wallbaum H, Ostermeyer Y. Salzer C and Escamilla E Z, 2011.

Table 2 shows the criteria of affordable housing from different author. There are twenty (20) criteria cover the sector of social, economic and environment. Based on table 2, resource efficient and energy efficiency are criteria that discuss by most of the researcher which six (6) authors mention it when they talk about criteria of affordable housing and sustainable housing. Follow by water efficiency which discus by five (5) authors. Other than that, four (4) authors mention about the criteria of safe, secure and healthy, and facilities and services. Affordability, sustainable site planning and management, and material efficiency had been discussed by three (3) authors. Besides, two (2) authors had mention

accessible and flexible, architecturally proper, indoor air quality, and quality management when they discuss about the criteria of affordable housing and sustainable housing. Socially and ecologically sustainable, long-lasting, generate renewable energy, innovation, loans and accommodation, grow home, appropriate technology and effective policy and legal frameworks are the criteria that discuss by either one of the authors.

Table 2 Criteria Of Affordable Sustainable Housing

Criteria / Authors	Somayeh Roshanfekr (2016)	Chau Sim Yee (2015)	Tan Teck Hong (2013)	Radzi Ismail (2013)	Mohd Wira Mohd Shafiei (2013)	A.M.J.Esruq-Labin, et.al (2014)	Akanbi Olusayo Oyebanji, et.al (2017)	**Total Referred**
Affordability	/					/	/	**3**
Socially and Ecologically Suitable	/							**1**
Accessible and Flexible	/						/	**2**
Resource Efficient	/	/	/	/	/		/	**6**
Safe, Secure and Healthy	/	/		/		/		**4**
Long-Lasting	/							**1**
Architecturally Proper	/						/	**2**
Sustainable Site Planning and Management		/		/	/			**3**
Energy Efficiency		/	/	/	/	/	/	**6**
Water Efficiency		/	/	/	/		/	**5**
Indoor Air Quality		/			/			**2**
Material Efficiency			/	/	/			**3**
Generate Renewable Energy			/					**1**
Innovation					/			**1**
Loans and Accommodations						/		**1**
Facilities and Services				/	/	/	/	**4**
Quality Management						/	/	**2**
Grow Home						/		**1**
Appropriate Technology							/	**1**
Effective Policy and Legal Frameworks							/	**1**

METHODOLOGY

Table 3 show the different year of source referred. 28 journals from year 1994 to year 2017 the latest sources had been used as references while producing this paper.

Table 3 Sources Referred

Year of published journal	Total referred
2017	2
2016	5
2015	3
2014	2
2013	4
2012	3
2011	1
2010	0
2009	0
2008	2
2007	0
2006	0
2005	1
2004	1
2003	2
2002	0
2001	0
2000	0
1999	0
1998	0
1997	0
1996	1
1995	0
1994	1
Total	28

CONCLUSION

To define thoroughly on Affordable Housing, which the housing must able to meeting an ability of the owner which in other hand afford to pay its under housing loan, where the house still within the radius of strategic location and using the quality material to build as normal conventional housing. Furthermore, all those range of criteria must able to match with the sustainability concept. The development of affordable sustainable housing its reachable, accessible and mixed development in terms of the type of housing itself to cater with the social cluster under sustainable concept. When it comes to economic cluster, its all about the cost and price of the house which the owner able to pay for the said housing price. On the environment cluster the best fact to explain it's on the material use to build the house its from low chemical content of material yet quality which may minimize the negative implication to the environment.

Affordable Housing can be achieving to implement among all construction players if the challenges factors to implement the concept can be overcome. This can be start with clear defining the concept of Affordable Housing concept itself. When the construction players have a clear concept about the affordable housing, they will only consider working on the concept as they already know about the risk of the concept.

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Potential Role of Quantity Surveyor in Shipbuilding Industry

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Abstract: Profession of Quantity Surveyor today's is wider as they getting involved in various field such as banking sector, property, interior design and it has been practicing for a long time in global. The existence of Quantity Surveyor in Malaysia also has venturing in non-construction sector which are banking sector and oil & gas industry. Furthermore, Quantity Surveying field is a combination of several disciplines such as law, economic and civil engineering. As part of Quantity Surveyor scope is focus on estimating cost, there are opportunities for Quantity Surveyor to venture in shipbuilding industry. The ship construction involved same process with building construction and it is opportunities to Quantity Surveyor to diversify their scope. This paper discusses the need to explore on diversifying the relevancies role of quantity surveyor in shipbuilding industry and the process suggests the means to identify those roles required in the shipbuilding industry. It is also argued that undertaking this heavy task cannot be accomplished without the participation of experienced of cost estimator or quantity surveyor. This research looks into the potential and future opportunities of implementing and venturing the quantity surveying services into non-construction sectors namely shipbuilding industry.

Keywords: *Role of Quantity Surveyor, shipbuilding, cost and estimating.*

Introduction

Quantity Surveyor is a part of the project team in the construction industry and provides their service related such as cost estimate, contractual matters and financial matters. Quantity Surveyor also was involved with an economy field that related to the cost planning and cost control activity. Generally, Quantity Surveyor is working on side of the client, consultant and contractor. They are having different nature of works and they are providing their services based on the employer requirement. Quantity Surveyor profession is important in construction industry because they provide services related to cost planning and cost control that can benefit to client and contractors. They also involved for the whole life span of construction project starting from feasibility study until release of the final account. Quantity surveyors also become the key information handlers on a construction project (Smith, 2004) and they also have sources of knowledge in varieties area (Wood, 2007). Within having these qualities, other than construction industries has admitted and recognize a quantity surveyor expertise.

According to Willis et al (1994) as cited in Abdul Samad, 1999, RICS has encouraged quantity surveyor to wider the opportunities in the non-construction sector where the knowledge and skill can be applied. The trend of quantity surveying practices has changed in past decades and the nature of Quantity Surveyor profession was evolutional changes over the past 20 years due to changes in market demand and development of technology (Mc Donagh, 1991). This can be supported by (Kumaraswamy & Morris,2002; Fellow, Li & Fong,2003; Wong & Fan,2013) added that the changes of quantity surveyor roles due to increase level of competition in the industry. The profession of Quantity Surveyor today's has been diversifying to the new field such as petrochemical, manufacturing, automobile, mining, telecommunication, shipping, transport

and is known as ‘Modern’ Quantity Surveyor depends on potential and relevance of his services (Abdullateef and Paul, 2015).

In order to provide their services in other industry, quantity surveyor has acquires the new area of knowledge and added the value itself. This can be supported by Pathirage and Amaratuga (2006) stressed that quantity surveyor have to acquire and operate wide range of diver skill outside the normal traditional QS role in order to compete and excel in the profession. Furthermore, QS need to check their business scene to perceive new bearing and to adjust for up and coming change in their expert practice. This implies that every profession expanding the changes in the worldwide business condition, (Marcel Frei and Jasper, 2009).

The ship construction involved the same process with building construction and it is opportunities to Quantity Surveyor to diversify their scope in this industry. Research by Abdul Samad (1999) found that they are not practicing in preparing cost planning and cost control in the shipbuilding industry that can lead the cost data unstandardized and disorganized. This paper will discuss on the possibility and future on venturing quantity surveying services into shipbuilding industry.

General Overview of Shipbuilding Industry

The shipbuilding industry in Malaysia is still growing and expected to generate income for GNI in years 2020. Malaysia Shipbuilding and Ship Repairing (MSBSR) still in develop compared to other countries and it has been recorded that Malaysia was ranked at 18th of countries (Report, 2017). The total numbers of exported vessel to other countries shown in Figure 1.

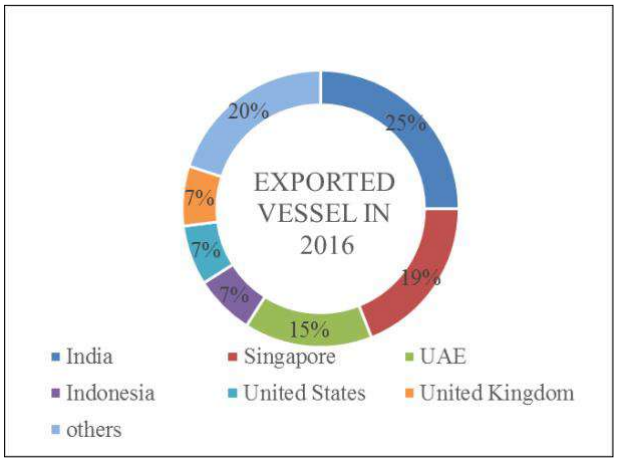

Figure 1: Total Number of vessels export to other countries Sources (MIGHT, 2017)

The building construction and shipbuilding are involved in the same process begin where the client who has a need for the facility. At the end of product in both industries is to give the best possible return and develop the life of both products. Also, in the shipbuilding industry, there has pre-contract and post-contract process same as the construction industry.

The shipbuilding industry is involved in designing, building and constructing, converting and upgrading of vessels as well as marine equipment manufacturing. The process of construct a ship has three stages which are Preliminary Work, Design and Construction and Delivery. In the stage of preliminary works, there were involved in design and application, tendering for ship building and estimated of construction. This stage has the same process within the construction industry.

The first process required for production of ship is invitation tender to shipbuilder from the ship owner. In this stage, shipyard has to prepare a proposal including the design of the ship, cost estimate and deliver time -based on the ship owner requirement. After selecting shipyard, contract between ship owner and shipyard were bound and both parties will discuss and decide the specification in detail. All the agreement and legal formalities made between the two parties involved and both parties have to fulfill the process from the beginning phases with the down payment and end with the delivery on completion and final payment (Dokkum, 2003). Despite the contract bind, there a still provision to allow for adjustment of the price during the building contract. The summaries of ship process design shown in Figure 2.

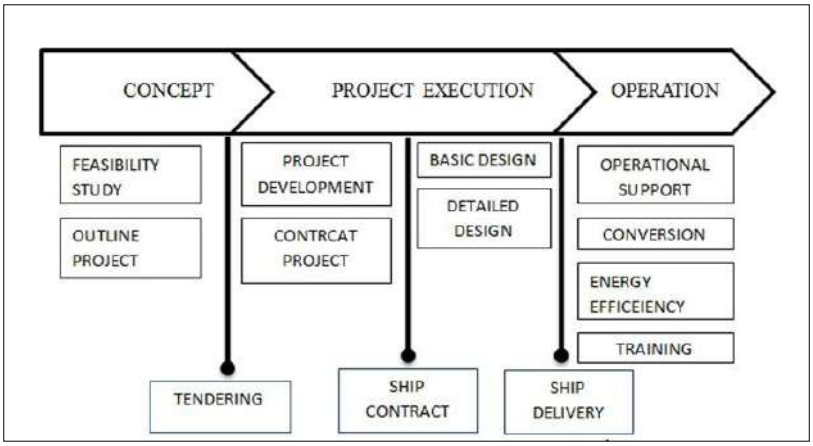

Figure 2: Ship Process Design

Sources: Eyres 2007

Generally, in shipbuilding industry, there are four main activities such as estimation of production ship, shipbuilding management, procurement in shipbuilding and life cycle cost of shipbuilding. Estimate work on ship construction is an important and crucial part to determine the total cost of a production ship. The cost of construction of ship should not have too low or too high and it has to consider on the client requirement, Miroyannis (2005). In placing more emphasis, Ross (2002) claimed that high a cost will put the shipyard out of the aggressive range and too low a gauge will cause in a money–related misfortune and conceivable liquidation. The estimating work was prepared by shipyard and they has to consider on the quality, cost and delivery expectation of client (Dokkum;2003 and Miroyannis;2005 as citied in Noor;2012). Besides that, the scope of estimation

are including building cost, labor and material cost, life cycle cost, construction cost and total ownership cost.

Constructing a ship can be seen as a complex process involving many departments of shipbuilding organization such as contract, procurement, design, management, operation. It also involves many skill of the various personnel involved and use of shipyard facilities in building a ship. All related department directly involved in the construction phase. In ship building management, the project management knowledge area is similar to the other construction industry management where it consist of the scope management for integration, scope, time, cost, quality, procurement, human resource and communication as standardizing by PMI,(Dogan, 2012 as citied in Dogan and Helvacioglu, 2017;). Kjerlsem and Emblemsvag (2014) added that project management in shipbuilding is the main concern on the activities that involved in planning, scheduling, controlling the design and tools used in order to achieve the maximum value of production ship. The industry has practiced parallel approach between Engineering, Procurement and Construction (EPC) work in order to reduce the period. This is due to a standard period of contract applied in shipbuilding, which is six to 24 months, (Dokkum, 2003). Hence, it is critically important to planning and scheduling the building of the ship within the time given by the client.

In addition, in ship construction industry, procurement department is an important department for shipyard in constructing a ship or vessel that work on of procurement activity, budget planning and material order placement (Hora, 2016). This department has responsibility on purchasing activities as per condition of contract that focuses on the factor of cost and quality of the material used in a project in to ensure the ship construct is beneficial to client and shipyard.

Furthermore, the concept of life-cycle cost in ship has similar procedure with building life cycle in estimate the life span where the data used for estimation of construction, operating and maintenance cost are through from the analysis of the existing building data, (Kneifel, 2010). The vessel can be recycled and used for 25 to 35 years and it will be demolished after the ship is total cannot operate. Therefore, this is similar to the building project, that life-cycle cost is involved with estimation of calculating cost that related to obsolescence during it service life. The summary of the main activities involved in shipbuilding industry shown in Figure 3.

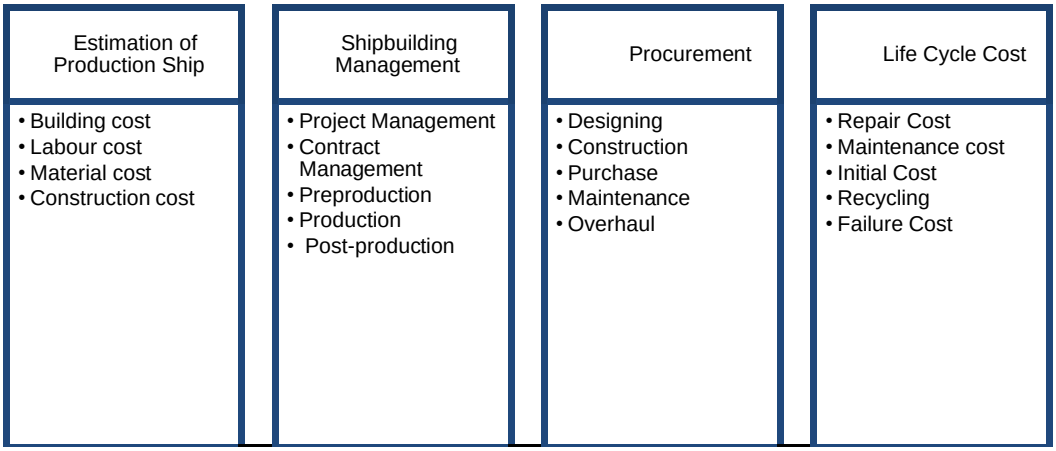

Figure 3: Main activities in shipbuilding industry.

Relevant role of Quantity Surveyor in Shipbuilding Industry

Quantity Surveyor today has to develop new expertise area and expanding their services in order to maintain and boost competitive advantage and profitability (Hasmawati & Johan, 2004) in order to compete for employment and stay competent within the market. According to Cartlidge (2011) as cited Shafie et al (2014), pointed out that, today's competitive has leads to the changed of quantity surveyor practice as they has practicing in other industry. For instance, quantity surveyor may responsible on the customer financial management including the balance sheet, profit, loss account and prepare professional reports on the value of the business (Holden, 1980; as citied in Hanid et al.,2007). Therefore, it is important for QS in evolving the nature of service along with the changes of business. In order to provide their services in other industry, quantity surveyor has acquires the new area of knowledge and added the value itself. This can be supported by Pathirage and Amaratuga (2006) stressed that quantity surveyor have to acquire and operate wide range of diver skill outside the normal traditional QS role in order to compete and excel in the profession.

In Malaysia ship's construction, the quotation and cost management matter was prepared and handle by Naval Architect or Marine Engineer and it does not standardize among the shipbuilder. However, Alia Farhana (2011), highlighted that they may lack in fundamental skill in preparing and administrating work. By hiring Quantity Surveyor in shipbuilder, they can assist in providing and preparing the Quotation, administering work, drafting contract and procuring project and materials.

Preparing Bill of Material

According to Murray (2016) bill of material is one document explained and describe on the list of raw material and component required for a construction that included data required as number, quantity, description, unit of measure and a procurement type. The role and concept of Bill of Material is similar to the Bill of Quantity that has practiced in construction industry where the bill of material

provide information in fact a detail Ship Work Breakdown Structure (SWBS),Ross et al (2001); Ross and Hazen (2002); Ross (2004), as citied in Rigo et al (2004).

Within knowledge and skill related to calculation and estimating work, Quantity surveyor is a profession that can provide services in preparing a bill of material for ship construction while it goes same function and process used. This can be supported by Hore, O'Kelly and Scully (2009) has listed the role and function of quantity surveyor and a part of it is prepare the bill of quantity and examine the bill of quantity and reporting the findings. Furthermore, Davis, P.R.; Baccarini, D (2004) urged that quantity surveyor is a right professional to prepare the bill of quantity document on behalf of the client and contractor. In addition, according to Kelly and Male (1993) as cited by Mzyece, Zulu and Nyirenda (2006), suggests that the quantity surveyor can use comparative cost and analysis method to maximize the functional of the project and also minimize the cost of production. Quantity Surveyor can provide on the financial management of a project.

Procurement

Provide information for procurement matter required that related to the completion time, contract sum, quality of materials and components, and the overall quality standard the project. A quantity surveyor able to handle procurement matters in ship construction industry because they have a specialist in procurement knowledge. This claim can be supported by (Seely, 1984) that quantity surveyor is an excellent position for procurement manager with their specialist knowledge on cost and contractual procedure, as citied in (Abd Samad, 1999).

Contractual arrangement and Legal Matter

Curnnigham, (2014) opined that quantity surveyor may perform their role as a contractual adviser, procurement experts, cost manager and cost engineer. Furthermore, in an observation- based study by O"Brien et al. (2014), the findings have shown that the role of quantity surveyor is including managing on contractual administration and financial matters. These studies have found similar result where quantity surveyor has to responsible on the contractual arrangement, (Senaratne & Sabesan, 2008). Rabie; Habib (2011), highlighted that quantity surveyor is the most suitable profession that can perform contract administration work in any related to construction work.

Cost Plan and Cost Control

Cost planning provides each level of price management during a construction project from the beginning to completion with the aim of delivering the project to satisfy the client's expectation at interval budget, required quality and delivered at the interval the united time. The importance of cost planning is to effectively strategize the value of a construction project from its inception, through the design and continuing through the entire project, (Corbett and Rowley, 1999).

In order to ensure the success of cost planning, a professional like Quantity Surveyor is responsible to provide adequacy and quality of cost and execution information. This is because, Quantity Surveyor who are

associated with taking-off exercises are maybe more suited to the cost arranging part for the most part since they are familiar with the undertaking parameters (Barrett and Stanley, 1999). According to Ashworth and Hogg, (2007) pointed out that, Quantity Surveyors are the perceived expert in the construction industry as cost and value consultant.

Life Cycle cost

Life cycle cost is referred to total cost and total life span of the project and it has implied in shipbuilding industry and is important to determine either the project constructed is value for client and identify the best method to reduce the ownership of building cost. Quantity surveyor is relevant to handle the LCC because they are primarily providing service on the planning and managing the cost of project. Therefore, quantity surveyor is the key driver to handle the life cycle cost in a project since they are providing service in advising the cost to the client and manage to balance the cost and value of a project, Chiurugwi, Udaega and Hogg (2010).

Dispute Resolution

The area knowledge on legal is applicable to apply in managing the dispute in shipbuilding industry. This can be proven where there are similar background of the process and activities involved between construction industry and shipbuilding industry.

Quantity surveyor graduate has been disclosed on legal study specific in the construction industry, land law and contract. This implies that quantity surveyor has knowledge on the legal matters that involved in construction in industry that will leads them to provide service in the legal matter, Zakaria (2003) and Nnadi and Abel (2016). Acoording to Maidin and Sulaiman (2011) stressed that, quantity surveyor graduate needs to acquire knowledge not specific to the planning and managing the cost construction industry but is has include aspect of law in their syllabus. Due to this, quantity surveyor graduate are able to meet the needs of the industry in managing the legal matters. For example, she added, the involvement of quantity surveyor in legal is beneficial to the industry when there is an issue or dispute in the profession and it is under quantity surveyor responsibility to tackle this matter. Therefore, quantity surveyor must understand and able to advice, use and apply claim adjudication and dispute resolution method since they are the main parties that have deep understanding on the whole project.

Comparison between Construction Industry (C.I) and Shipbuilding Industry (S.I)

Researcher has found the similarities and differences in these two industries. Several activities has been differentiate and illustrated in the following table; the legend of data has been listed below.

Table 1: Comparison between construction industry and shipbuilding industry.

Features and Criteria		Construction Industry	Shipbuilding Industry
Types of Tender			
Open Tender		/	/
Close Tender		/	/
Selective Tender		/	/
Project Phase			
Project Brief		/	/
Designing		/	/
Specifying		/	/
Tendering		/	/
Constructing		/	/
Maintaining		/	/
Acceptance Testing		X	/
Construction Phase			
Initiation		/	/
Planning		/	/
Construction or Project Execution		/	/
Hand Over		/	/
Operation		X	/
Project Team Involved			
Client		/	/
Consultant	Architect	/	X
	Naval Architect	X	/
	Quantity Surveyor Cost Estimator	/	/
	Marine Engineer	X	/
	Civil and Structural Engineer	/	/
	Mechanical and Electrical Engineer	/	/
Contractor		/	/
Method of Cost Estimation			
Cost Per Function Estimate		/	/
Index Number Estimate		/	X
Unit Area Cost Estimate		/	/
Unit Volume Estimate		/	X
Parameter		/	/
Panel Unit Estimate		/	X
Partial Take off		/	X
Historical Costing		X	/
Direct Analysis		X	/

Standard Ship Approach	X	/

Methodology

There are two methods adopted in gathering and collecting data for this study, which are the primary data and secondary data. The primary data refers to the data gathered from interview and the researcher has applied semi-structured interview in collecting data. Semi-structured interview is applied to achieve the objective of this research where it used to describe and explained on the main process involved in ship construction and acceptance of the industry to graduate Quantity Surveyor in venturing shipbuilding industry. It is important get respondent's view and opinions since there's no quantity surveyor in the industry. Interviews were conducted with experienced personnel involved in shipbuilding sectors. The structure of the interview was according to the standard question set out earlier at the early stage of the research. Meanwhile, secondary data was obtained from the existing sources, which is als

Analysis of Result

The findings from the interview found that quantity surveyor not yet involved in the shipbuilding industry and the respondents give good feedback for quantity surveyor to venture in shipbuilding industry. Table 2 shows the feedback from all the respondents.

From the Table 2, it can be seen that the Respondent has highlight that quantity surveyor need to have training and basic knowledge on the shipbuilding to suit themselves in this industry. Based on the answer given by respondents, quantity surveyor has opportunity to perform their role in the industry. Overall, five core potential service has been identified such as preparing bill of material, cost control management, procurement management, project management and contractual management. QSs need to strengthen themselves in these areas of knowledge in order to bridge the gap in making them 'perform' in shipbuilding industry.

Table 2: Recommendation of the respondents for Quantity Surveyor

	Annotation
Is there any QS background in Shipbuilding Industry	"There is no Quantity Surveyor background in the shipbuilding industry…" (R1, R3,R4,R5) "…. There is quantity surveyor in shipbuilding industry, and we called them as cost estimator…" (R2)
Capability of QS graduate to practice in Shipbuilding Industry	"It is good, but quantity surveyor graduate itself has to be brave in venturing the new industry." (R1) "They have possibility to venture and we are welcoming the QSs graduate to join our industry, but it must have basic knowledge on the ship or vessel construction. Also, there must get cooperation from the construction industry." (R2) "..They are recommended to venture in this industry with their skill and they need to have courage and interest to learn. They also need to have basic knowledge on engineering." (R3, R5) "… must have basic knowledge on marine engineering and basic ship knowledge to venture into this industry. They also need to know supply chain knowledge." (R4)

Potential Role of QS in the Shipbuilding Industry	"cost plan and cost control. They are possible to provide services in preparing quotation using bill of quantity format for better documentation." (R1) "…responsible on quality and quantity matters. They can involve in procurement division and consultant team division." (R2) "They are possible to have responsible on the quantity and material pricing and contract matters." (R3) "They can play their role in management team to control pricing of production ship." (R4) "They can sit in procurement team and project management team." (R5)

Discussion of Result

Evidence from literature indicated that that quantity surveyor field has cover in several other disciplines including economics, laws, accountancy, management, information technology hand construction technology (Brandon, 1990). This implies that Quantity surveyor todays are able to offer their services in other than construction industry if there has same activities and process with construction industry. Since this research aims to venturing in the profession of shipbuilding and to identify the services can be provided by quantity surveyor in the shipbuilding industry.

The results of the survey indicated that the implementation of QSs' services in shipbuilding industry is at the new stage. The types of services are identified and categorized as potential services and future services. In summary, the services offer to the industry are as shown in Table 3.The observation and interviews indicates that, QS have yet to have their role in the industry but potentially to be practiced in the future.

Table 3: Potential and Future Quantity surveyor in Shipbuilding Industry

Category of Services	Shipbuilding Industry
Potential	Cost control and Cost Planning, Procurement management, Contract Administration, Post Contract Management, Bill of Material
Future	Quality assurance, Life cycle Cost, Alternative Dispute Resolution.

Shipbuilding industry in Malaysia is still in the develop stage even it has merged around 100 year and from the observation it show less awareness among the Malaysia graduate quantity surveyor. Quantity surveyor has yet seat in Malaysia shipbuilding industry compared to other countries that has been practiced for long time. Besides that, shipbuilding and construction industry has been guided by the same organization which is CIDB where the main focus on the construction, contractor and material used. This implies that shipbuilding has similar nature with the construction industry.

Most of the respondent, highlight a QSs must have knowledge on basic science engineering to carry out their role in the industry. Researcher found that, basic engineering syllabus such as civil engineering, mechanical and electrical engineering, principle of structure has been included in the

curriculum, for QS student todays. This is advantage for QSs to matching their knowledge to market demand and also can help a quantity surveyor in provide service on the material used for the whole construction of ship in term of quality and quantity. For example, QSs student has learnt in Principle of Structure on the topic of load and forces where it is important element need to consider in the design of ship. Previous research suggested that, quantity surveyor that have specialized and expert in engineering works had been in demand and in a position to grant services in a holistic even beyond the construction industry (Olanrewaju and Anahve, 2015). Therefore, QSs are advised to gained knowledge and skill in holistic of engineering to expand the professional services in other industries.

In addition, Qs who worked with new area or new industry are advised to attend training that provided by the industry. QSs are equipped with the knowledge and training will be able to carry out the works in the future. According to Osubor (2017) urged that, a quantity surveyor can be a valuable profession when there have experienced and training on the scope of work in other industries. Therefore, in order to stimulate the market demand, quantity surveyor must acquire the skill to tackle the clients' need. In addition, Research finding shows that, all respondent giving opportunity to QSs for venturing the shipbuilding industry. However, they expected that graduate QSs must willing to learn and work hard since their knowledge and skill in the shipbuilding industry is not yet sufficient. Sit in the new industry is a bonus for QSs to expand and matching their role in order to deviate from the traditional practice. In conclusion, QSs graduate has acquire knowledge and skill and they need to prepare themselves with sufficient basic knowledge in ship design to assist the industry. This finding can be proven by Babalola (2009) exerted that quantity surveyor graded as a competent quantity surveyor where they has wide range of skill, knowledge and understanding to be practiced in an industry.

In conclusion, he professional bodies such as the Board of Quantity Surveyors Malaysia and the Royal Institution of Surveyors Malaysia play an important role in the effort of promoting quantity surveying services in shipbuilding industry such as by approaching the associates of both sectors and co-operate with them in creating and exploring more opportunities for the QSs and good way to safeguard the sustainability of the QSs in the future.

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