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Rehabilitation of the Traditional Dwellings: A Strategy for Alleviating Housing Dilemma

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ABSTRACT

Ancient cities have a great cultural heritage in which the residential buildings form a proportion of up to 60%. These cities are characterised by meeting living population needs. However, the socio-economic and cultural developments occurred in the Palestinian society prompted many residents to abandon their traditional homes as they did not respond to the renewable community needs. The research aims to highlight the systematic rehabilitation of the heritage houses in Hebron old city (as a case study), and measure the satisfaction level of the residents through survey questionnaire. The research finds that traditional housing can meet the modern requirements through rehabilitation and achieves high degree of people's satisfaction.

Keywords: *Rehabilitation, Traditional Dwellings, Housing Dilemma, Hebron*

INTRODUCTION

Since the arrival of the Palestinian national authority, in line with the Oslo Accord, 1.5 million refugees came back after diaspora. Then a big quandary in Palestine has arisen with respect to housing problems (Hammer, 2009). The problem has exacerbated after 1994 due to various reasons: The population increase in the West Bank and Gaza Strip is doubling every 25 years (PCBS, 2010); the shortage of acreage for housing use; the

expansion of Israeli settlements. These factors led to crucial situation and high population density, which has attained in some vicinities 6913 people/ km2 (Ibid).

Nevertheless, the recovery of old vicinities is disregarded under the ruse of expenditure, inadequate experience, and not fulfilling the present requirements as the focus are normally on overcoming the housing dilemma by forming new buildings and cities. Yet the case of the old city of Hebron proved that it is capable of solving most of the crisis and that it accommodated in excess of 800 families at a minimum cost, considering the future needs of the inhabitants.

LITERATURE REVIEW

Many believe that rehabilitation of heritage residential districts needs copious amounts of money and efforts and yield few returns (Brebbia & Binda, 2011; Rizzo & Mignosa, 2013). In the light of this conviction, many countries develop new residential areas at the expense of agricultural land, and neglect the heritage residential districts. However we should look to a rehabilitation concept broader of material and moral, because it serves multiple benefits (a lot of references): (1). Afford the housing, upgrade and improve its conditions, which is considered the direct instantiation of the State's interest and move the population and their settlement activities, also proceed the construction wheel, (2). Conserve the heritage houses and benefit from them in affording the housing that will support the development and save money, (3). Rehabilitation changes the city features and assist in the implementation of housing plans, (4). Reduce the competition for land, especially with farmers, (5). Avoid turning the farmers into the city, and worsening the housing crisis (Aubert, Marcom, Oliva, & Segui, 2014; Omar & Syed-Fadzil, 2011).

Humanitarian Requirements at the Level of City and Housing in Arab Countries

Humanitarian needs of today and yesterday should be considered so as to implement a policy of restoration as a strategy for overcoming the housing dilemma. The degree and amount of receptive events for these needs differ between one community as shown in Table 1 and Table 2.

Table 1: Humanitarian needs for districts and neighborhoods

Requirements	**Previously**	**Recently**
Accommodation	residential tower house for extended family	Residential houses, villas, apartments for separated families
Work	Market, field, service buildings, army, (few administrative)	Trade, industry, agriculture, administration, military, education, health, services
Comfort	Orchards, squares, plenary	Cultural buildings, recreational areas, tourist areas, green areas, public service buildings
Transportation	streets with Primitive means (donkeys, mules, camels)	Streets with modern transport
Services	Hammams and souks	Social, cultural, health, educational
Requirements for pre-school	Koranic schools in (Jame'e) grand mosque	Nursery, Kindergarten
Education	Mosque and Islamic schools	Schools, colleges
Health services	Exorcism, cupping (old Arab medicine) in house doctor	Health centers, dispensaries, primary health care centers, hospitals
Social services	mosque	Social and cultural centers
Business services	Souks	Markets, shops, business centers
Social Activities	Squares, mosques	Squares, piazzas, public centers
Green areas	Orchards	Public parks and small gardens distributed to the general plan
Cultural services	mosque	Cultural centers, public libraries, theaters
religious aspects	mosque, Jame'e	mosque, Jame'e
Parking	------	Designated parking
Children's play areas	Squares, fields	Squares, parks and some of the buildings earmarked for children (schools)
Places strengthens social relations	Squares, mosques, souks	Squares, mosques, markets, social and cultural centers and institutions

Table 2: Humanitarian needs for the houses

Human requirements	Spaces provided by the traditional house	Spaces provided by the modern house
movement Spaces	Courtyard entrance, entrance hall Distribution (vestibule), the distribution of motion in the lounge decks, stairs (staircase)	The movement of the vehicle: car parking with service. Population movement: patio, halls
Economic and service spaces	Livestock Stable and granaries, a space dedicated to the beasts and feed, fattening sheep barn, storage rooms, toilets …etc.	Kitchen, stores, lounge with dining, Maid room, laundry and clothes room
Living and recreational space	Room (Diwan) for talking and discussion, intermediate rooms used for living and daily activities for the whole family	Family sitting room, reception room with W.C., Office room specified for the House owner
Resting and sleeping spaces	Bedrooms are mostly rectangular differentiated in the area, and distributed in the middle and upper floors	Guest bedroom, bedrooms for boys and girls, master bedroom with private bathroom
Economic productivity spaces	Confined only in residential buildings adjacent to the souks or which lies on the their edges, and have their own external doors to serve, which is in the form of shops	nothing

METHODOLOGY

The researchers follow several methodologies to achieve the goal; (1)- inductive approach to know the reality of housing in heritage cities, predict the future of these cities, and identify the contemporary needs, (2)- descriptive analytical approach to explain the case study, benefit from the advantages, avoid disadvantages, and try to disseminate the experiment, (3)- Survey questionnaire to find out the satisfaction degree of the inhabitants about their houses after 10 years of rehabilitation.

Hebron Old City (case study)

Hebron is proclaimed as one of the oldest and most sacred cities in Palestine. Situated 32km south of Jerusalem, Hebron is an important centre for three of the world's great religions; Islam, Judaism and Christianity (Platt, 2012). Hence, it was listed in the tentative list of UNESCO's World

Heritage Site on 2nd April 2012. Thousand and five hundred of Hebron's total population of 126,000 reside in the old town, according to 1997 survey. Before the military invasion, the population of the old town totaled 10000 in 1967. The outcome of Israeli's policy that hinders people from residing there caused a severe decrease in the population with the departure of 35% of the households there. The owners and tenants were forced away by these events from the old town, which still keeps 99% of its old buildings (Ibid).

It was vital to attain numerous goals through the immediate restoration of the town; to overcome the ever-growing housing dilemma there, to thwart the pressure from the Israeli government to vacate the old town, and to avert becoming a bull's-eye for Israeli settlements. It is proposed that this be achieved by creating the old town to be inhabitable once more with an aggressive programme of restoration that would elevate the residences up to existing standards of living. This is meant to motivate the coming back of the previous inhabitants and other people who are displaced currently. This is to be achieved by taking into account the value of the old town and its worth as ethnic property. The project commenced in two parts of the town. It encompasses the recovery and restoration of the current residences and separates bigger houses into smaller apartments which can be utilised by various families while at the same time, offering the fullest possible solitude. (Thomas, 2010)

The number of apartment units that had been built was 800 units. The two or three-story buildings, which do not follow to any planned volumetric, but demonstrate an organic development perpendicularly, are sub-separated in each case as the particular building permits. There are normally two or more spaces expanding to the small courtyards; numerous stairs rise from the courtyards to the levels on top, offering entry to small groups of rooms. To the extended family, this is vital, as open cooking areas and amenities are not present in each unit. The rooms are not so big; a star vaulted residing area is around 24-30 m^2. This means that the wedded son of a family inhabits an area of 70-90 m^2, consisting of a half-open ventilation space and sometimes, a reduced storing area (Ibid). Running water services are constructed in the half-open areas if they are spacious enough; if not, a smaller room is separated between the WC, shower, and the kitchenette. In cases where there were already such changes, they were retained if they were not unpleasant.

The buildings do not pose extreme construction issues. Cement mortar covers small cracks in the wall or vault surfaces. The wall is demolished and done once more (scucio-cucio technique) when a big structural fissure is discovered in a wall. Metal ties are placed into the parallel features when there is a severe opening in the floor and walls. This results in noticeable pyramidal caps on both end walls. The technology of constructing a cross or star vault is complicated and hence circumvented. In several instances, these open areas are on two floors, making stairs the sustained from below with strengthened concrete arches instead of being mended or redone.

Figure 1: The existing and proposed urban profile of Hebron Old Town
Source: (Marchettini, Brebbia, Pulselli, & Bastianoni, 2014)

Recipients of the Programme

The project profited the whole town of Hebron because the revival of the old centre accommodated housing for more than 800 families, restored the town and assured the Palestinian presence in it. The owners and the renters make up the dwellings' users. "Owners" mean in excess of fifty people for every building; a single room possessed by some members of a

bigger family (Irving, 2011). This numerous ownership design functions associate directly to the usage and separation of the clusters. Also associated to this design is the variety in the quantity of open areas and the floor built-up of the inhabited units. The buildings are separated into smaller leasing units when there are excessive members of the binuclear family still residing there or who are prepared to come back. There are some cases where the part owners residing in the houses will pay some lease to other part owners, at the conclusion of five years. In instances where there is a chief landlord residing in the house and there is no issue within the family, his binuclear family utilises the entire building the way it was customarily used.

The landlords are permitted to use their houses as solitary private houses if the houses are not very big. At the moment of choice, it is logical to presume that this also relies on the ownership arrangement. Houses that have excessive landlords normally end up being utilised by renters if the members of the family circle cannot come to an agreement to permit one or two basic families to reside there. To lease a property, the concurrence of 51% of the landlords is sufficient enough. In the choice to separate a building, landlords of the houses are given precedence. The proportion of landlords to renters is 2:1; this indicates that the ancestral quarter of Hebron remain populated by 67% of those who possess property there (Seraj Al-Deen, 2007). With the aid of a questionnaire distributed by Muhawi and Amiry (2008), the renters were selected from among the applicants. Applicants were normally lesser paid government staffs, armed forces, or employees. Favoured were young marrieds with small children. For the initial five years, the renters did not pay any lease, after which point, lease at current prices was to be settled if they intend to reside in their houses. To assure this, a contract was engaged with the renter presuming that a lease of USD 3500 per year was to be settled if the requirements of the contract were not met. For every month at zero cost, each unit was provided with 100 KW electricity and 8 m^3 water (Nigro & Taha, 2006).

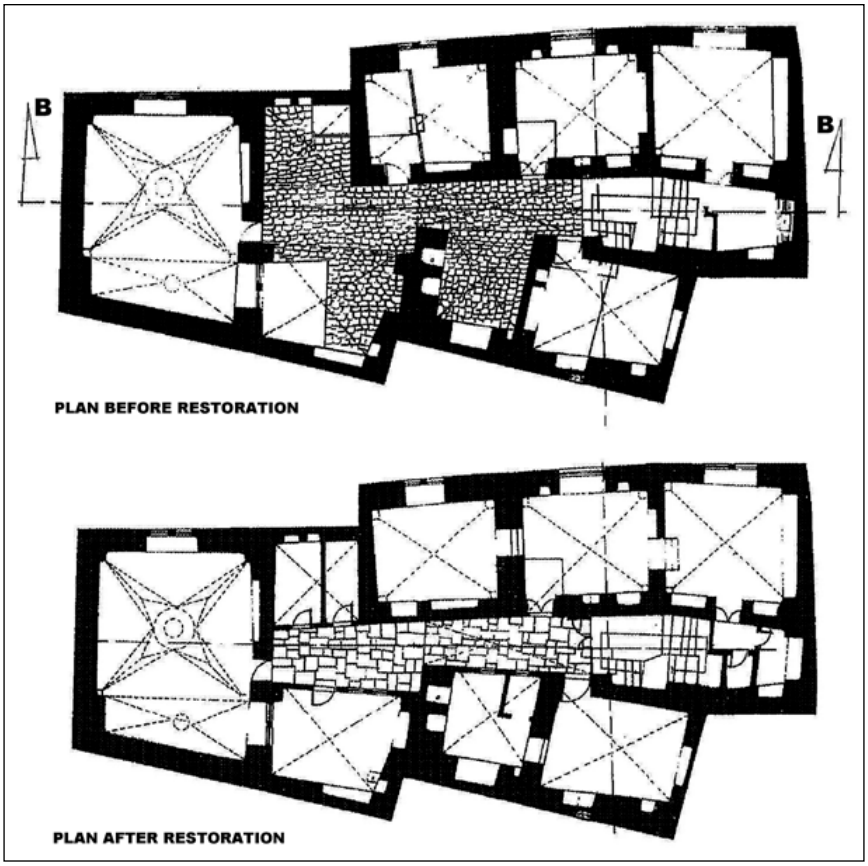

Figure 2: House entrance before and after rehabilitation.
Source: (De Cesari, 2009)

Reaction to Project

The researcher had the chance to converse with many of the renters and landlords. Even though some indicated a need for additional rooms, none of the renters had serious complaints. As their houses were refurbished, they had basic facilities, and were residing contentedly; nearly all of the landlords were satisfied. These are the key aspects in persuading the other landlords to come back to the old town. When the project was concluded in 2002, the researcher disbursed a questionnaire to an arbitrary sample of dwellers of homes that had been restored. This was to measure the contentment with

the new houses, and later, repeat the exact questionnaire in 2012 (i.e. after 10 years), and the outcomes were as follows:

The sample was 125 houses that represent 15.6% from the 800 houses had been rehabilitated; the respondents were 94 persons (75.2%). The distribution began in 21/10/2013 and continued for three days. The percentages of the samples from diverse age groups were: 15-20 years (1.9%), 21-30 years (8.1%), 31-40 years (35.6%), 41-50 years (34.4%), 51-60 years (13.2%) and more (6.8%). Males constitute 89% of the samples whilst 11% are females. The family constituents were made up of young married couples only (7.1%), single parent with children (5.6%), couples with children (53%), three generations (33.3%), and others (1%). ownership of Houses ranged from owner resided (70.1%), company (5.0%), public leased (9%), and private leased (15.9%). The tenures of occupancy were under two years (3.5%), 2–4 years (7.4%), 4–8 years (19.2%), 8–12years (50.3%), 12–18 years (4.8%), and above 18 years (14.8%). The academic level of the Head of the family ranged from uneducated (15.5%), lower than high school (26.8%), bachelor (47%), master (8.3%) and PhD (2.4%). Typical daily income for the inhabitants; below 10$ (10.6%), from (10-25$) (39.4%), from (25-50$) (28.7%), from (50-100$) (13.4%), and above 100$ (7.9%).

Table 3: The Measurement of Satisfaction Using the Most Five Important Factors

Criterion		2002			2012		
		Satisfied	Neutral	Dissatisfied	Satisfied	Neutral	Dissatisfied
House Design	Space	73.2%	8.7%	18.1%	69.9%	10.1%	20.0%
	Area	75.0%	6.9%	18.1%	68.7%	11.5%	19.8%
	No. of rooms	69.3%	13.9%	16.8%	60.1%	18.0%	21.9%
	rooms Arrangement	77.9%	4.5%	17.6%	75.0%	12.2%	12.8%
	Ease of housework	74.6%	9.0%	16.4%	70.4%	1.9%	27.7%

Average		74.0%	8.6%	17.4%	68.8%	10.7%	20.4%
Safety	Disasters	53.0%	7.0%	40.0%	65.8%	4.7%	29.5%
	Criminals	88.8%	2.9%	8.3%	87.0%	7.8%	5.2%
	Cleanliness of air	69.9%	16.6%	13.5%	61.6%	25.0%	13.4%
	Noise/ vibration/odor	80.5%	17.2%	2.3%	70.8%	6.6%	22.6%
	Nature Abundance	67.7%	9.9%	22.4%	67.3%	0.0%	32.7%
Average		72.0%	10.7%	17.3%	70.5%	8.8%	20.7%
Convenience	Transportation	68.2%	18.3%	13.5%	68.0%	17.0%	15.0%
	Shopping	65.0%	13.9%	21.1%	75.8%	13.0%	11.2%
	Commuting	71.0%	18.8%	10.2%	81.9%	6.6%	11.5%
	Welfare Facilities	67.9%	9.0%	23.1%	78.1%	19.4%	2.5%
	Accessibility	80.4%	11.1%	8.5%	75.0%	10.9%	14.1%
Average		70.5%	14.2%	15.3%	75.8%	13.4%	10.9%
Climate performance	Ventilation	73.4%	20.7%	5.9%	68.5%	18.8%	12.7%
	Lighting	69.1%	21.1%	9.8%	71.0%	2.9%	26.1%
	Heating and cooling	66.0%	22.0%	12.0%	60.9%	14.1%	25.0%
	Cleanliness	80.8%	14.8%	4.4%	70.1%	9.6%	20.3%
	Beauty	73.9%	19.8%	6.3%	64.0%	11.0%	25.0%
Average		72.6%	19.7%	7.7%	66.9%	11.3%	21.8%
Social factors	Relation in house	85.5%	5.6%	8.9%	71.0%	12.0%	17.0%
	Neighbors relation	81.0%	5.3%	13.7%	68.8%	10.0%	21.2%
	Gardens	69.0%	3.0%	28.0%	57.9%	9.9%	32.2%
	children Playground	71.0%	12.6%	16.4%	66.6%	17.0%	16.4%
	Cost	70.7%	13.8%	15.5%	80.7%	9.7%	9.6%
Average		75.4%	8.1%	16.5%	69.0%	11.7%	19.3%
Overall satisfaction rate		72.9%	12.3%	14.8%	70.2%	11.2%	18.6%

RESULTS AND DISCUSSION

When studying and examining the earlier table, it showed that the degree of general contentment for the population was commendable in 2002 because they were part of the involvement in planning, observation and support. However, because a number of neighbourhood inhabitants had transformed and they were not part of the involvement in the project, this degree reduced somewhat after 10 years. We discovered that the populace contented tremendously on the rooms' condition and their disbursement; and vicinities where an earlier questionnaire had been disbursed to them before the project execution. Also, their views and needs were taken into consideration for the planning of housing, but in the last questionnaire (2012) the satisfaction has decreased because of the need for more rooms and areas, this is confirmed by the report of Palestinian Central Bureau of Statistics (2010) which indicates that the "average number of rooms in the housing unit in the Palestinian Territory is 3.6 and the average housing density in the Palestinian Territory in general is 1.6 person per room". It had previously been a tremendous quandary for the inhabitants with respect to the safety factor, chiefly, assaults of Israeli settlers and army. For instance; during the restoration of the city, work was halted 103 times and 416 workers were detained (Elnokaly & Elseragy, 2013). However, these assaults had decreased in 2012 due to the presence of such political answers, while the situation based on the crimes were less in 2002 because the character of the tribal-led population of most city inhabitants as well as rituals and cultures prevented any attacks.

However, lately, communal associations have reduced and many outsiders are residing in neighbourhoods which have further lowered the level of safety. Accessibility has grown with the passing of time and there is simplicity in movement and transportation concerning comfort; this is what the high rate of population contentment indicated, which surpassed three quarters. A vital role in enticing people to reside in the old city is the environmental aspects, but the drastic weather alterations decreased the competency of houses. That is the reason why the percentage fell from 79.6% to 68.7% in a period of 10 years. Palestinian society is integrally intelligible with respect to social aspects but the political and economic situations lower these at times, and lastly for the expenditure, the inhabitants (mainly the renters) pay equal amounts since the conclusion of the project in 2002

and thus far, in spite of the tremendous land costs, growth in the demand for housing, and the high expenditure of living; i.e. The survey's results of PCBS (2010) indicated that the average monthly rent paid for a housing unit in the Palestinian Territory was USD 400 and the residents have still paid USD 3500 yearly. This is what results in the inhabitants' contentment degree on cost increase in which they find it extremely appropriate compared to other aspects.

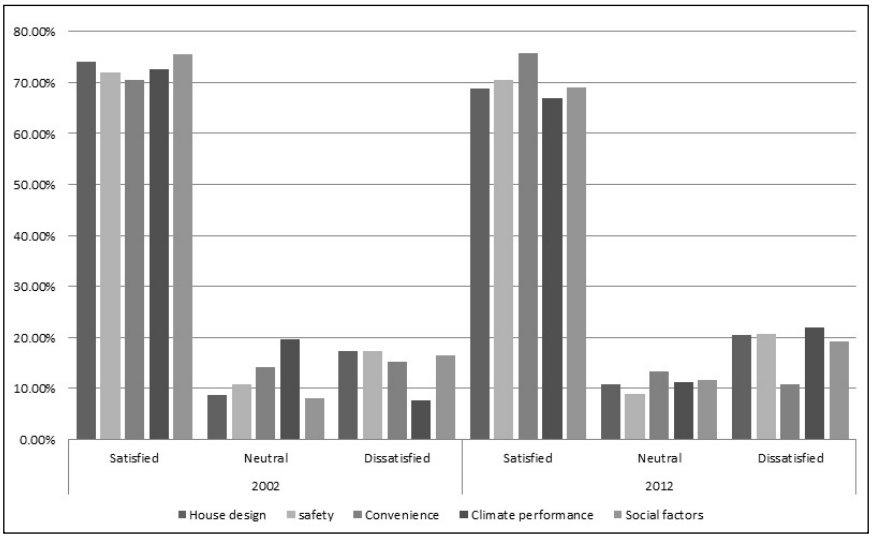

Figure 3: Comparison of the percentage of housing satisfaction between 2002 and 2012

CONCLUSIONS

If we can apply the Hebron project throughout Palestine, it will surely deliver extraordinary outcomes in the housing area and offer a great answer in the housing dilemma, particularly, there are based on Riwaq (2007) 50,320 historic buildings in Palestine, almost half of the historic buildings are either empty or only partly being used; 4,447 buildings (8.84% of the total) were partially used and 18,216 buildings (36.20%) were empty. The housing crisis should be dealt with effectively so as not to worsen and become a major dilemma difficult to resolve, especially in light of increasing population

growth and lack of land; by way of example, not exhaustive enumeration, the findings of PCBS (2010) for Housing Conditions Survey shows that 71.6% of households in the Palestinian Territory need to build new housing units during the next 10 years, which prompts us to ring the alarm bell.

The experience of the rebuilding of the old city of Hebron surpassed the domestic level to locate for answers which possess a vital symbolic quality; hence the domestic public had been involved competently, and in the process aiding the nearly overwhelming environment into a wonderful communal open area, and the architectural exercise turned out to be a philosophical and communal social activity. Some delicate problems, for instance: acreage, proprietorship, personality and ethnic and ancestral consciousness were essential to be confronted. This explains, in spite of the break of 10 years on the project, a high overall contentment rate was observed of the residents (70.2%) from their homes. The significance of the rehabilitation policy for housing buildings lies not only in restoration, but also in giving back those buildings to their landowners and afford them the freedom to dispose of or how to utilise them within a particular system for lease to accommodate the proportion of renters to landlords.

The experience of Hebron, as mentioned in the report of the Committee for the Aga Khan award, is taken as excellent in that it signifies leaving the usual flairs and tendencies in restoration and the potential to regain communal open areas within a deteriorated surrounding, together with the labours and involvement of the populace that have survived under the Israeli blockade. The project won Aga Khan Award in 1998, Yasser Arafat Prize for Achievement at 2008, and the World Habitat Award in 2013.

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Properties of Traditional Clay Roof Tiles Manufacture in Kelantan, Peninsular Malaysia

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ABSTRACT

The industry of traditional clay plain tiles, Singgora tiles, has been established in Kelantan for almost a century. However, the studies conducted in this field are insufficient. The purpose of this study is to test the properties of existing Singgora tiles to find out whether they satisfy the standard requirement. The tests of dimension measurement, surface quality, water absorption and flexural were done. The relative percentage constituent mineral and microstructure of Singgora tiles were measured by using XRD and SEM technique respectively. The physical test shows the length and thickness of Singgora tiles is not satisfied the standard. In addition, most of the samples have the defect on the surface and high water absorption. It is found that the strength of Singgora tiles is lower than the minimum requirement of standard. The presence of high percentage of quartz is observed in the mineral phase of Singgora tiles and the SEM analysis proved the incompletes vitrification among their microstructures.

Keywords: *Tile, Conservation, Roofing, Singgora, Malay House*

INTRODUCTION

A roof is an essential covering that is placed on top of the building. The basic purpose of roof is to provide protection for the structure, fabric, occupant and content of the building (Harvey, 1972). According to Abdul & Wan (2002), in selecting the materials for building, high priority should

be given to the strength of material. Therefore, the strength of roof is vitally important and a faulty of roof such as leakage will allow the penetration of rainwater into the building thus becomes a source of problem to other structures (Feilden, 2003).

A Singgora tile (Figure 1) is a roof covering for old building which commonly found predominantly in Kelantan and Terengganu. It is become highly important as a roofing material of conservation for repairing, replacing or even reconstructing them totally. It can last for up to 150 years and used traditionally in dwellings, palaces and community centers (Hanafi, 1996). Singgora tiles is the most distinctive and decorative historic roofing materials because of their great features in shape and colour. The colour is pale orange which imparts the natural hue to the building. In terms of aesthetic value, Singgora tiles form a unique look, like fish scales, when arranged in the roof framework (Killmann et al., 1994). Singgora tile has formed a symbol of identity to the Malaysian traditional architecture. One of the famous buildings that used Singgora tiles is Jahar Palace in Kelantan which built in 1887 (Nasir, 1979).

Figure 1: Singgora tiles

The history of the manufacture of Singgora tiles in this country is obscure because there is no proper record of their existence. However, many scholars believed the industry is originated from the south of Thailand (Adit, 1994; Salinger, 1997) which was a part of the Malay Kingdom in the past. The similarity found in the roofs of buildings in East Coast of Malaysia and Southern Thailand show a strong trade links and good relationship between them in the past. Singgora tiles become an important component in the

history of Malaysia which presents the influence of Thailand architecture to the building in Kelantan and Terengganu.

Singgora tiles are produced using clay that is moulded and then burnt in a kiln. This handmade tile is manufactured in such a way that their surface is more textured, the size is less uniform but perhaps more attractive colour. Singgora tiles are sustainable product which has the thermal mass characteristic to help the building react to temperature variations throughout the day. During peak temperature, Singgora tiles will absorb the heat, rather than transfer it to the living space. This keeps the interior of the home comfortable during peak temperature hours. At night, the absorbed heat is released, keeping the home to stay warm. Nevertheless, Singgora tiles help to improve building comfort and reduce the demands for peak energy. In addition, the Singgora tiles are installed to allow greater airflow between the tile and the roof batten. Thus, the insulating properties of the roof are improved.

Nowadays, most of the demand for Singgora tiles is to repair the damage of roofs in old buildings. The decline of this material today is affected by changing housing style. Singgora tiles failed to cope with the present housing style make them started to seem obsolete, old-fashioned and impractical. Besides, the emergent of modern material and the inferior quality of the product itself have drive down their market. Nevertheless, the decreased in consumer demand becomes the factor to the decline of Singgora tiles industry. Unlike other craft industries, such as Sayong pottery in Perak, this industry is at risk as there is only one factory which has survived until today.

Little attention has been given to the studies on Singgora tiles attributed to the limited information on this industry. In year 1991, Ministry of Housing and Local Government in Malaysia at that time has listed Singgora tiles as one of the neglected traditional building material (USM, 1991). The history of Singgora tiles is described by Adit (1994) and Salinger (1997). The production of Singgora tiles is well documented (Hanafi, 1996) and little has been published on the improvements that can be made to the product's quality (Shamsu, 2013; Zulkarnian & Siti Norlizaiha, 2013). This paper is intended to assess the standard of the Singgora tiles which is available in the market at present. The results of this study may be useful to point the way for further research in improving the production of Singgora tiles.

METHODOLOGY

The samples were collected from the regular production of Singgora tiles located at Bachok, Kelantan. Sample and data collection were done based on these area because they are the sole supplier of Singgora tiles in Malaysia. In order to check whether the existing roof tiles are up to the standards, mainly four tests were done including dimension check, surface quality, water absorption and flexural strength. In addition, the XRD and SEM analysis were also conducted to determine the mineral and textural property of Singgora tiles.

Dimension Measurement

The vernier caliper and micrometer were used to measure the length, width and thickness of Singgora tiles, to the nearest 0.2mm. The test was conducted according to BS EN ISO 10545-2: 1997 (Section 2). The samples were measured according to the dimension line as shown in the Figure 2. For each sample, the average dimension of the width, length and samples was the average of four measurements. For thickness measurement, four lines was draw across the uneven surface of Singgora tiles at a distance of 0.125, 0.375, 0.625 and 0.875 times the length of the samples (measured from the end). Based on those lines, the thickness was measured at the thickest point on each line.

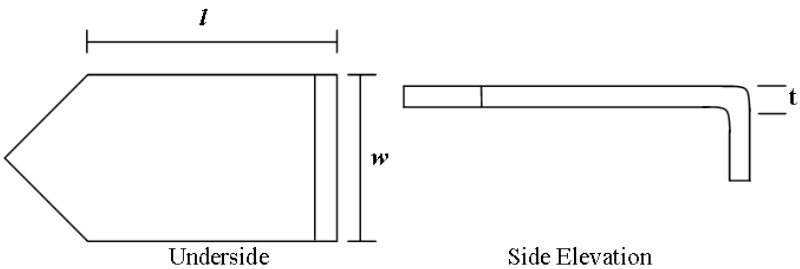


Figure 2: The dimension line of a selected sample

Surface Quality

The surface quality of fired Singgora tiles was observed with the naked eyes at a distance of 30cm to 40cm, under normal lighting as described by BS EN 1304 (2005). In addition, the surface was also observed using microscope Olympus SZX7 to get a better view of defect. The defects found were classified according to the terminology of defect in BS EN 1304:2005 and BS EN 14411:2006. The defect was measured using vernier caliper to the nearest 0.2mm.

Water Absorption

The method used to determine the water absorption was according to BS EN ISO 10545-3: 1997. The laboratory equipments used were digital balance (capacity of 4200g and sensitive to 0.01g), heater, distilled water, iron wire, thermometer and damp cloth. Five pieces of specimen were tested. The samples were brought to a constant weight by drying with oven Carbolite PF 30. The samples were dried at temperature 110±5°C for 24 hours till constant mass was reached, which the different between two successive weighed at two hours interval showed an increment of loss less than 0.2% of the last previously determined weight of specimen.

The percentage of water absorption of Singgora tiles was determined by placed the tile in distilled water. The samples were completely immersed and do not touch the bottom and others sample. The container was heated with a heater and soaked for four hours at boiling point. After that, the samples were left cooling for four hours immersed in water. Once the tiles were removed from the beaker, excess water in the surface was removed using damp cloth. The percentage of water absorption is expressed in the formula;

$$Percentage\ of\ water\ absorption = \frac{W_2 - W_1}{W_1}\ x\ 100 \quad \text{.....(1)}$$

Where W_1=the mass of dry tile; W_2=the mass of wet tile

Flexural Strength

The strength test was carried out according to ASTM C1167-03 (Section 6.3). Five specimens of Singgora tiles were tested. Each piece was cut to a dimension of 110mm length and 70mm width to fix the length of cylindrical rod of Instron 4469 machine. The selected span size was 75mm, based on the nominal gauge between the batten when installed at frameworks of roof as stated by Hanafi (1996). The specimens were prepared using dry method test. They were dried at temperature 110±5°C for 24 hours till constant mass reached where the different between two successive weighing at two hours interval showed an increment of loss not greater than 0.2% of the last previously determined weight of specimen. The samples were tested not later than 2 hours reached the room temperature. The equation used to calculate the modulus of rupture is;

$$Flexural\ Strength = \frac{3FL}{2bh^2} \quad \text{.....(2)}$$

Where F=breaking load (N); L=span between two rods support (mm); b=width of specimens (mm); h=minimum thickness of the test specimens, measured after the test, along the broken edge.

The accepted results were only considered the samples that break within the central position of length equivalent to the diameter of the central rod. The break sample that has a dark area, steely appearance and sharply delineated from the surrounding normal colour (also known as black heart or black core) was accepted.

Mineralogical and Textural Analysis

A mineralogical analysis of fired samples was carried out by using X-ray diffraction analysis. The machine used was X-Ray Diffractometer D5000. The Scanning Electron Microscopy (SEM) analysis was used to study the textural property of the Singgora tiles by using Scanning Electron Microscope FEI Quanta 200F. The samples, which have a good quality of surface, were cut to a dimension of 1cm length and 1cm width.

RESULTS AND DISCUSSION

Dimension Measurement

Figure 3 to 5 shows the deviation of length, width, and thickness of Singgora tiles from the mean value. There is no work size of length specified by the manufacturer. Therefore, the average dimension of ten samples, which is a total of 40 measurements, is considered as work size in the experiment.

According to the BS EN 14411:2006 (Annex F), the deviation of length and width of tiles shall fall within ±2.0% of the work size while the thickness is within ±10.0%. The work size of length, width and thickness of Singgora tiles are 208.32mm, 163.78mm and 6.75mm respectively. Only 20% of the length and 10 % of thickness are meeting the standard requirement. Overall, although the width of all samples is within the allowable deviation, the samples are considered did not satisfy the standard. The reason of failure is their length and thickness is not fulfilling the minimum requirement of deviation. The variation in the dimensions of green tiles is contributed by the variation size of mould to shape the tiles. In fact, good tiles should be consistent in size and only vary within allowable tolerance to avoid the different joint sizes and to ensure the proper installation and smooth flow of water.

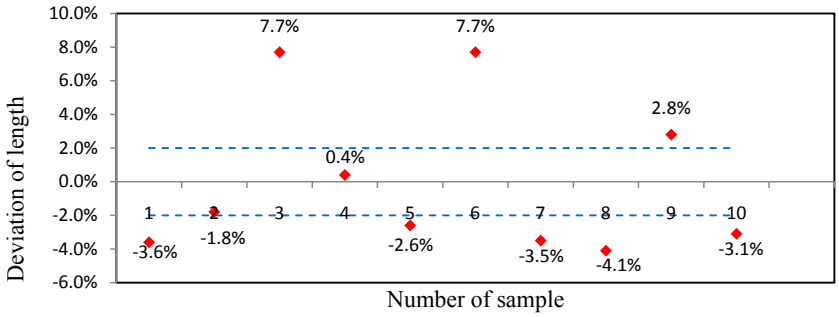


Figure 3: The deviation of length from the average value

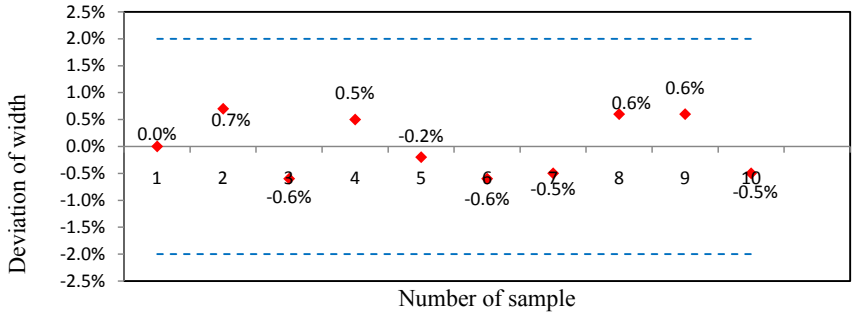


Figure 4: The deviation of width from the average value

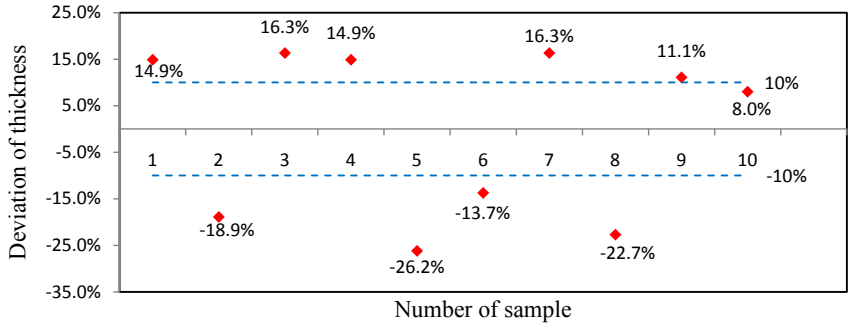


Figure 5: The deviation of thickness from the average value

Surface Quality

According to EN 14411:2006, 95% of the ceramic tile surface shall be free from visible defects that would impair the appearance of a major area of tiles. On the other hand, ASTM C1167-03 (Sec. 5.2) describes that the tile that has good quality shall be free of defects, deficiencies or bloating, because it would interfere the proper laying of tiles. The surface quality of Singgora tiles are depends on the surface defect. The surface failure of Singgora tiles are described in the Table 1.

Table 1: Surface quality of Singgora tiles

Surface fault	No. of Sample									
	1*	2*	3	4	5	6	7	8	9*	10
Crack *(BS EN 1304:2005)*	√		√							
Pit *(BS EN 1304:2005)*			√						√	
Chip *(BS EN 1304:2005)*		√								
Unevenness *(BS EN 14411:2006)*						√				
Rough Edge *(BS EN 14411:2006)*	√	√		√	√	√	√	√	√	√
Impurities					√					
% of visible defect	6	6	4	2	4	4	2	2	7	2

* Does not satisfy BS EN 1411:2006 requirement

Thirty percent of the samples did not fulfill the requirement of BS EN 1411:2006 because the defect on their surface is more than 5%. Most of the defect that occurs on the product is rough edge or an unintentional irregularity along the edge of a tile. The common part of tiles that has this type of defect is along the edge of hook. Besides, 20% of the samples have crack and pit. The crack is not running throughout the entire thickness of the product while pit is a fraction of material detached from the body of the product on the visible surface of the product with a mean dimension of over 7mm. In addition, 10% of the samples have the defect of chip, impurities and unintentional depression in the surface of a tile or also known as unevenness.

Figure 6 presents the view of defect under the microscope. Figure 6 (a) shows the presents of tiny pit and hairline crack in the surface of Singgora tiles. Besides that, the pore and impurities are also observed as shown in the Figure 6 (b) and 6 (c) respectively. This defects that occur on the product might be contributed by the fault of equipment or human during production.

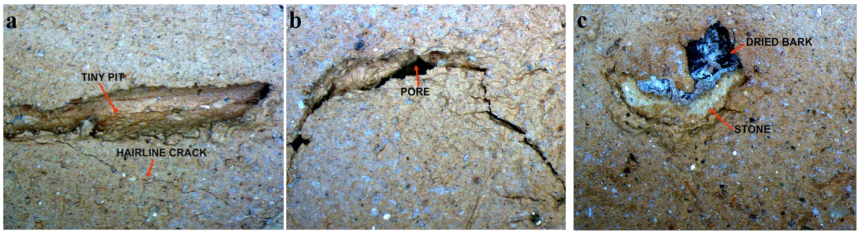


Figure 6: The defect on the surface of Singgora tiles (0.8x magnifications)

Water Absorption

The percentage of water absorption of Singgora tiles is recorded as 22.0%. Singgora tiles are categorized into the Group III, where the water absorption is greater than 10% as prescribed in BS EN 14411 (2006). Under this category, this ceramic tile is considered to have high water absorption with porous body.

According to Dan et al. (2009), the pore dimension and distribution is influenced by the quality of raw clay, the amount of water, the presence of additives or impurities in the raw clay, and the firing temperature. He adds the percentage of water absorption will determine the capacity of the fluid to be stored and circulated within the product, which lead to deterioration and decrease the mechanical strength. The higher water absorption of clay product will trap more water which promoting the growth of moss and ficus.

Flexural Strength

Figure 7 displays the bending strength of Singgora tiles. The average strength of Singgors tiles is 4.90 N/mm^2. It is worth mentioning that this value is less than the minimum typical strength of roof tile, 8.00N/mm^2, as described by ASM (Kuhn et al., 2000) and BS EN 14411 (2006). The experimental data for each sample is unevenly distributed. The regular production of Singgora tiles has a high value of standard deviation which is ±1.26 N/mm^2. Therefore, the Singgora tile is considered as unreliable product.

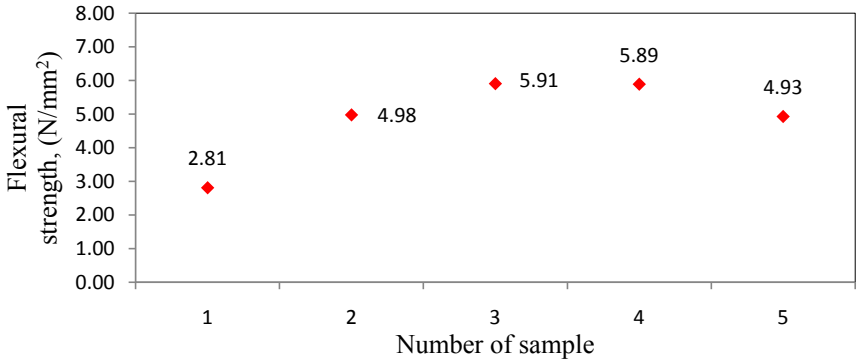


Figure 7: The flexural strength of Singgora tiles

Sidjanin et al. (2007) notes that the mechanical properties of roofing tiles are influenced by their microstructure; which vary based on the mineral composition of clay and the firing temperature. In term of mineral composition, the variation of compressive strength is due to the difference in the mineralogy properties of clay (Manoharan et al., 2011). Through firing, the compressive strength is improved by decreasing the porosity and reducing the formation of crack in the fired clay (Monteiro & Vieira, 2004). It is not surprising the value of flexural strength of Singgora tiles is low since their percentage of water absorption is high.

The variation of strength among the samples of Singgora tiles is contributed by technique to fire the product. The kiln used in the small scale industry of Singgora tiles is inefficient and consuming large fuel quantities. It has produces a varied quality of product which depends on the location of the tiles in the kiln. The tiles that fired near to the source of fire is burnt hard whereas those fired at the top is burnt soft.

The high standard deviation among the sample is also contributed by the presents of impurities inside the fired body. After the test was conducted, it was observed that there was a tiny pit and black heart along the broken edge of samples (Figure 8). Black heart is generally owing to the reduction of iron minerals during the firing process (ASTM C1167-03). The pin hole, or pore, is formed when the organic impurities is burned out. The burnt impurities during firing have left the pore inside the body of tiles. The pore

is correlated well with the strength of the product because high porosity will contribute to the low strength of ceramic (Van Vlack, 1964).

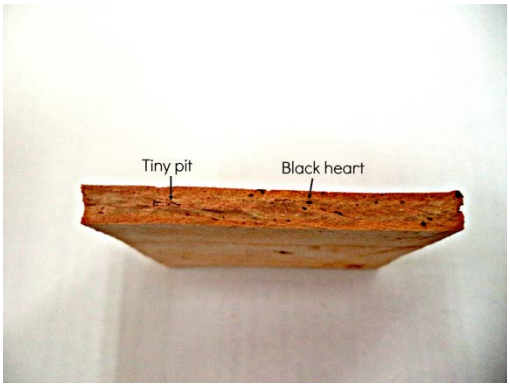


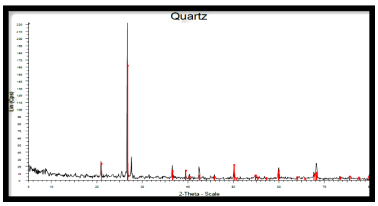
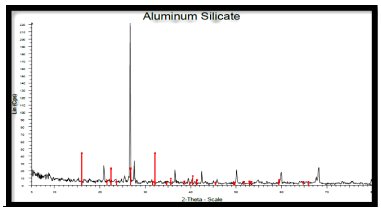
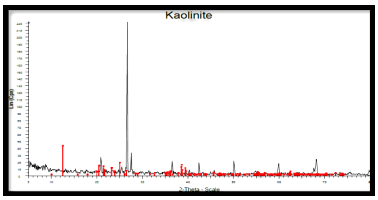
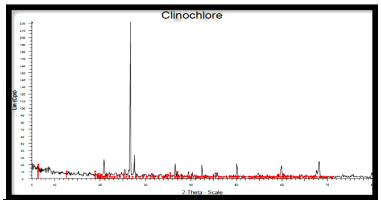
Figure 8: Broken edge of Singgora tiles

Mineralogical Properties

Table 2 displays the percentage of kaolinite, illite, quartz and chlorite in Singgora tiles. The XRD results show that the quartz is the most common mineral phases of Singgora tiles. Besides, the Singgora tiles also consist of illite and kaolinite, with minor amounts of chlorite.

According to Brown and Gallagher, (2003), in the deposit of clay, there are several elements presence in the clay including the accessory mineral, impurities and the most important is clay mineral, which constitute less than 35% clay deposit and categorised by similarity in crystal structure. They add the type and amount of these elements will determine the composition and property of clay. Ash et al. (1982) notes the essential clay mineral for brick and tile making are; kaolinite because of their good sintering, illite which can produce plasticity, and quartz which act as stabiliser.

Table 2: Mineral composition of Singgora tiles

Mineral Phase	Reflection	Peak (Å)	Wt. %	XRD Pattern
Quartz	011	26.640	71.97	
Illite	110	15.841 & 32.066	18.90	
Kaolinite	001	12.402	18.76	
Chlorite	002	6.247	8.10	

Textural Evolution

Figure 9 shows the textural surface of the Singgora tiles. The image of surface is taken at 3000x magnification which according to Elssner et al., (1999), this magnification will make the scanning electron monograph possible to easily recognise and determine grain size, shape and distribution. The image shows the microstructure of a porous body and the vitrification of the ceramic particles was incompletes. It makes the tiles being more

porous and easily absorbs the moisture. This SEM result is consistent with the high water absorption of Singgora tiles.

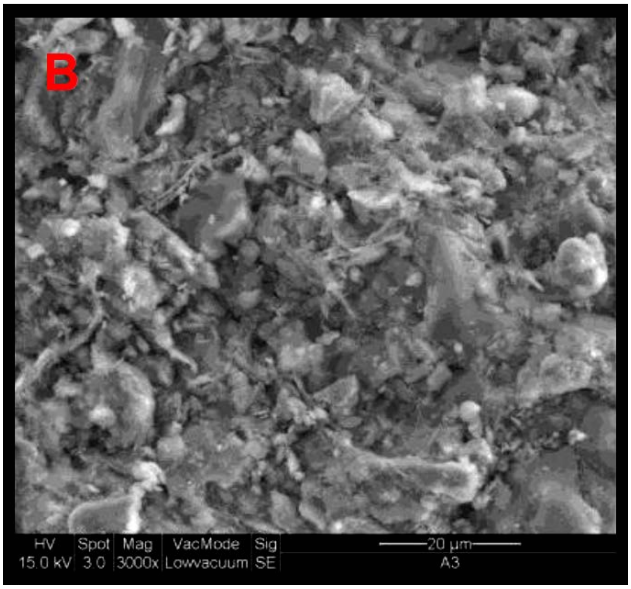


Figure 9: The surface of Singgora tiles

A successful firing of clay body is achieved when their strength and degree of vitrification is develop without deforming (Fraser, 2000). According to Cultrone et al., (2004), the vitrification of clay product can be clearly detected when the samples are fired at temperature between 900 and 1000ºC. Bernasconi et al., (2011) notes that firing duration is the key parameter to promote the vitrification, which increasing in firing time will decrease the water absorption. As mentioned earlier, the traditional kiln is used to fire the Singgora tiles in the factory. The used of this primitive kiln may not achieve the temperature 900ºC or the shorter firing time has lead to the failure of the product to achieve vitrification.

CONCLUSION

The properties of Singgora tiles existing in Kelantan are less than the standard requirement for clay roof tiles in terms of dimension, surface quality, water absorption and flexural strength. Study found that size of Singgora tiles is non-uniform where the variation of length and thickness is high. In term of the quality of surface, a lot of defects are found especially unintentional irregularity along the edge of a tile. Singgora tiles also have high water absorption and porous body. Furthermore, the flexural strength of Singgora tiles did not satisfy the minimum requirement of typical strength of roofing tiles. The abundance of quartz is observed in mineral phase of Singgora tiles. The textural analysis has proved the high water absorption of the product where the microstructure of the tiles body is porous and the vitrification of particles is incomplete. Further research to improve the quality of Singgora tiles is necessary because this material is important for the conservation and maintenance work, and newly construction of traditional building.

ACKNOWLEDGEMENT

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Assessment on Slope Mapping using Airborne Laser Scanning and Terrestrial Laser Scanning

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ABSTRACT

This study is about the evaluating the differences of two techniques of Airborne Laser Scanning (ALS) and Terrestrial Laser Scanning (TLS), by carried out an assessment on slope mapping. This study is carried by assessing the Digital Terrain Model (DTM) of a slope in Habu, Cameron Highland Pahang. The further slope assessment is done based on the difference slope class using slope map and slope aspect by ALS technique and TLS technique. These two techniques of data collection provide a three-dimensional data point. However, since both techniques is operating in a different platform where the ALS is a kind of data collection from the air platform while TLS is only based on the ground surface, there might be a slight differences in data production even though the use of the same slope is controlled. Hence, at the end of this study, the differences between these two data collection of ALS and TLS could be compared.

Keywords: *Airborne Laser Scanning, Terrestrial Laser Scanning, Digital Terrain Model, Slope Mapping.*

INTRODUCTION

The slope mapping is a topographic map showing changes in elevation on a highly detailed level. There are many ways to gather data and information for slope mapping. Airborne Laser Scanner and Terrestrial Laser Scanner are among the best two instruments for data collection in slope mapping

studies. Slope mapping is normally been used to evaluate particular site and to visualise the surface of earth at slope area.

Airborne Laser Scanning (ALS) is the laser scanner systems are installed in an airplane for the purpose of measuring the height or elevation of the terrain. The system is fully automatic method from the very beginning of flight planning, data acquisition and the generation of digital terrain model. ALS is operated with the principle of laser (Ruijin Ma, 2005). It can determine the distance to the Earth's surface by measuring the time-of-flight of a short flash of infrared laser radiation, by emitting laser pulses which travel to the surface. The distance is obtained by taking the speed of the light (Wehr and Lorh,1999). Accuracy can be defined how closely the measured values are believed to the true values. In ALS, the accuracy is based on the elevation of the data points, where the ALS produced about 5-15cm for vertical (Z) accuracy and the horizontal (X and Y) accuracy is 30-50cm (Baltsavias, 1999). With these two accuracies, ALS data can obtain precise topographic features.

ALS has the specialty in less time consuming for processing with about 12 hours needed for acquisition of 1000km^2 and 24 hours for processing the generation of DEM of the same area, 1000km^2. Besides, ALS is known as weather and light friendly as the data collection is not affected by the sun inclination and at night or even during bad weather (Frank et al., 2013). The ALS is proven to have the minimum cost for the data collection to complete the job by considering the speed, accuracy and density data (Veneziano et al., 2002). ALS could provide DEM for topographic and bathymetric survey in shoreline mapping. Shoreline mapping used LiDAR points of topo-bathy and then transformed to tidal datum using specific software (eg : VDatum software), followed by creating shoreline contour from DEM and presented in the graphics (White, 2011). In urban modelling, the ALS could help in the process of modelling the building forms by attempting to fit standardised building types to the residual data points after an estimated bare earth terrain surface has been removed (Zhou, 2012).

Terrestrial Laser Scanning (TLS) is a ground base device that used to scan at a range of scales from very small objects to very large monuments. The scanner scans an object's surface recording shape and produced XYZ points. Same as ALS, TLS is also used the principle of laser in data

collection. The distance and direction of the laser beam are measured, and processed to produce 3D coordinates. Accuracy of the TLS could be said that 1: 10,000 which is stand for 1mm accuracy for 10m range (Pfeifer et al., 2014). TLS produced a very high-density data where the distance between adjacent measured points can be up to several tenth of a millimetre which provides information on every detail of the object.

The advantages of using TLS method is that its data acquisition's rate is very high resolution and about up to several thousand points per second. The precision is high since it can detect even in centimetre length. The possibility to get the data on subvertical or overhanging rock wall is very high due to the high sensitivity of the scanner. Nowadays, TLS is widely been use in various field such in power industry where the raw data (point cloud) could create 3D models and topographic maps. While in mine survey, TLS data could be used to compute quantities of earthwork, DTM and 3D of quarries and pits. The applications of TLS in hydrotechnic field also can be found while measuring the different hydrotechnic structures (Fryskowska *et al.,* 2009). It can measure the navigation of lock gates which consists of two parts and are fastened in two bearing positioned on vertical line. Its measurements cover the measurement for gates form, the measurement for determination and measuring the gate deformation. TLS is also could be used in the reconstruction of 3D tree stem model of plant. The TLS is said could automatically reconstruct tree stem models and it is the step towards virtual forest scene generation. The TLS technique could provide valuable data on canopy structure. It works like the scanner scan the trees from 20 or 21 different positions and the 3D- point cloud of every tree was translated into a point cloud grid with defined distances between the data points to standardise the spatial resolution data (Kelbe *et al.,* 2014).

In Malaysia, there are many landslide incidents which involve slope area. The slope needs to be monitored in order to prevent any major problem happen in future. The monitoring of slope required high resolution data to determine the condition of slope during landslide incident. Therefore, the study will investigate the high-end technology using ALS and TLS for slope mapping application. A specific study of slope attribute of each slope classes will be conducted to determine the different product from ALS and TLS.

STUDY AREA

The site area for this study is in Habu, Cameron Highland. The study area is only limited with dimension of 100 m height by 180 m width. This site is selected for this study is due to the condition of the area that has many slopes. Some of the slope had undergone slides for several times. Since the slides occurred, the slopes are now being under supervision and several studies had been carried out. Figure 1 shows the condition of slope of the site area.

Figure 1: Slope condition of site area of Habu (Source: Google earth map)

METHODOLOGY

Figure 2 resembles the phases that involved in this study. There are five phases altogether. The first phase is about the preliminary study. Generally, preliminary study is done by carried out some research about previous study on related topics. The previous study is based on the journal, conference

paper and thesis. The second phase is data acquisition. This study consists of two sources of data acquisition, which are from ALS and TLS. The ALS data is capture from a scanner in a flight of airborne while the TLS is obtaining from a scanner on the ground of survey work. The third phase is data processing. There are two software used for this phase. The fourth phase of this study is the gaining the result outcome. The expected outcome for both data is a slope map and aspect map, which are generated using DTM. The result of slope map and aspect map will be analysed on the data analysis section of the last phase for this study based on their attribute and classes.

ALS Data Capture

ALS data is provided by a private company that offers ALS services. The data came with the resolution of 50cm point and it is a filtered data and already in the form of Digital Terrain Model (DTM).

TLS Data Capture

TLS data is captured with the Topcon Geodetic Laser Scanner-1500, as shown in Figure 3.2. It is a scanner with built in digital camera. The advantages of this scanner is it is a high-speed scanner with the data collection of emitting the laser beam up till 30,000 points per second which is ten times faster than the previous invention of scanner model and this results that the higher density point clouds can be captured in a shorter time. Besides, it produces clean and ultra-low-noise scan data which can produce a very finest textured of scanned objects. It also provides the data collection in a wide and long range of 500m in range and a very accurate scanner with 4mm distance accuracy at every distance of 150m. Last but not least, this scanner requires ScanMaster Software for powerful Data Processing.

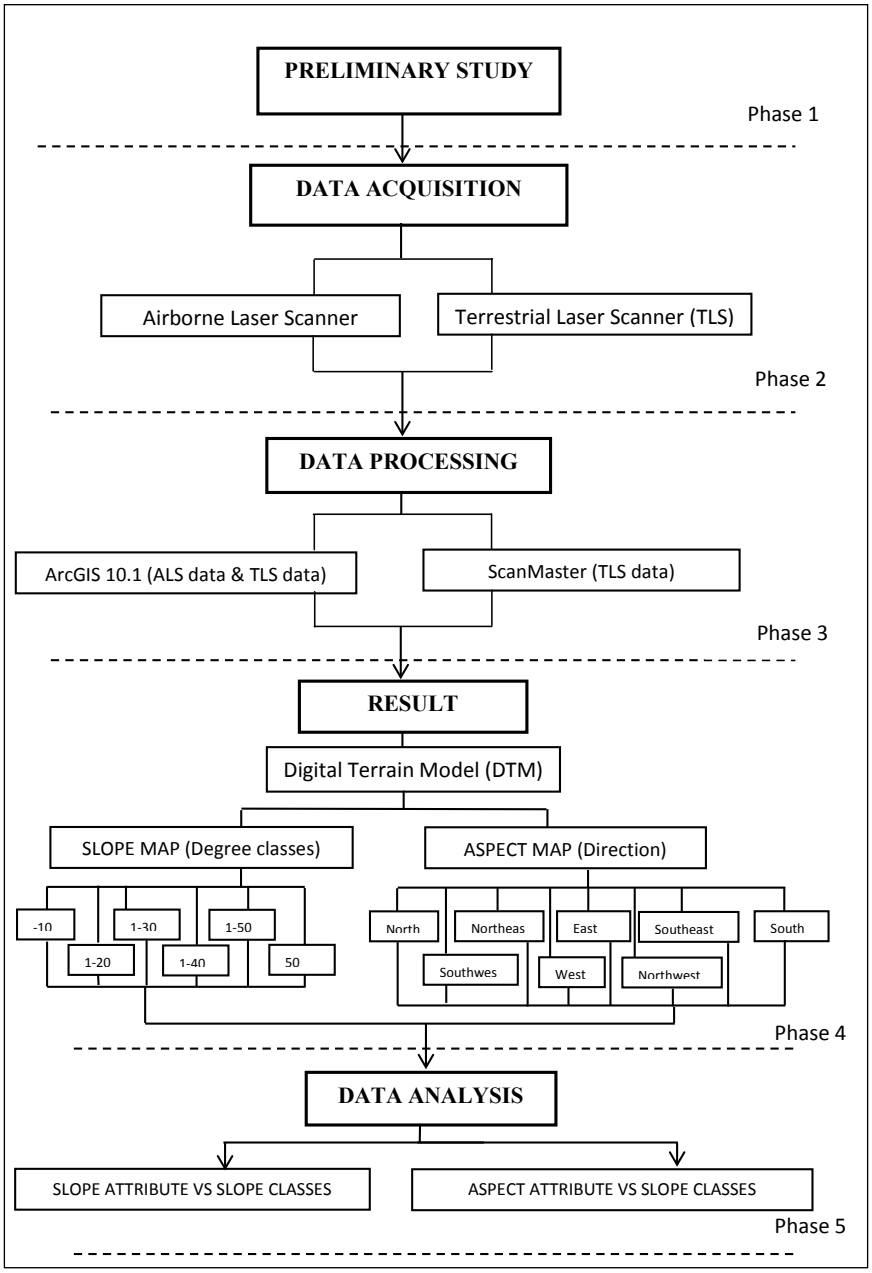

Figure 2: Methodology Flowchart

RESULTS AND ANALYSIS

The data of both scanners are processed until the formation of Digital terrain Model (DTM) which is known as a model to represent the earth surface in digital form. Then, the slope map and aspect map are generated from the DTM. Further analysis is carried out regarding the slope map and aspect map and their attribute against each class for both laser scanners.

Slope Map Analysis

The slope map is produced as in figure 3 from the DTM using ArcGIS 10.1 software. The slope is calculated by the differences between vertical distance to the horizontal distance and the comparison can be expressed in three forms of as an angle, a percentage or as a ratio. For this study, the comparison is made in the form of percentage of slope degree. The generation of slope map for both laser scanners are classified into six classes according to their slope degree within the classes range of 0-10°, 11-20°, 21-30°, 31-40°, 41-50° and >50°. The slope map is then represented in the form line graph in order to ease the process of analysing (Figure 4).

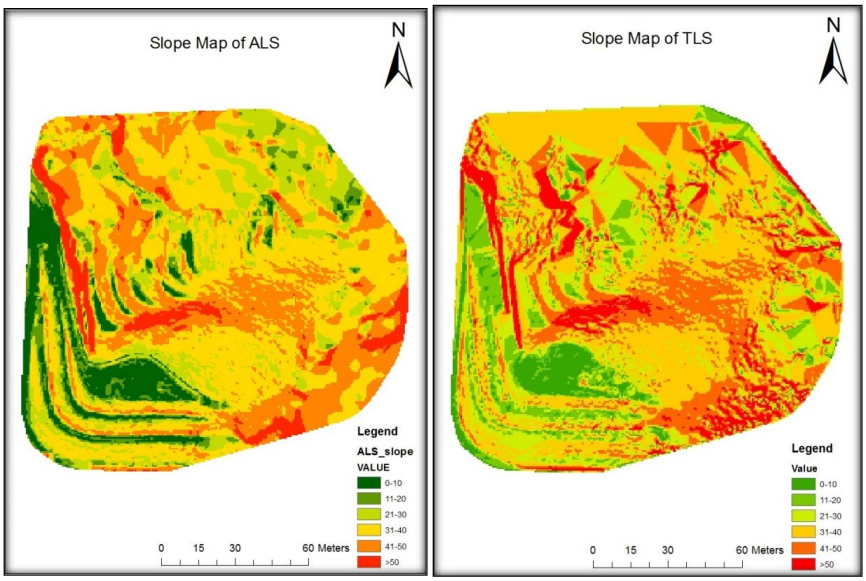

Figure 3: The slope map for both scanner of ALS and TLS

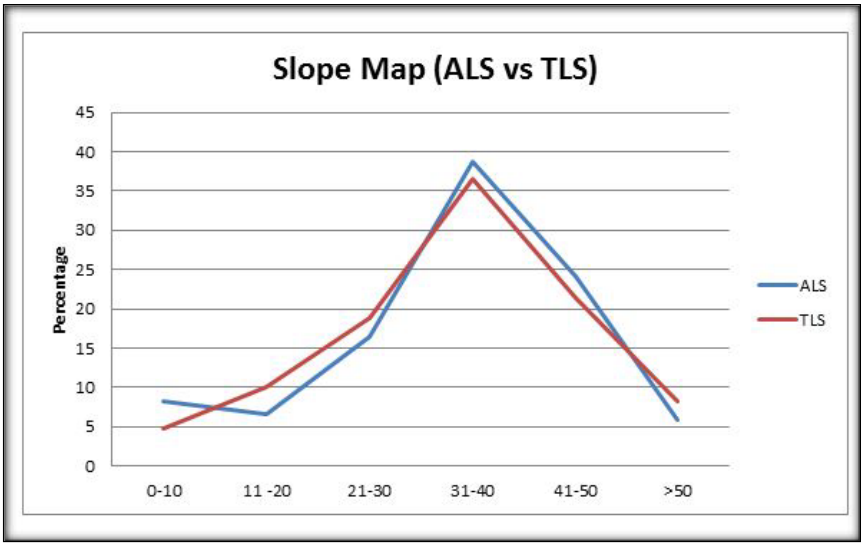

Figure 4: The graph of slope map

Aspect Map Analysis

Figure 5 shows the aspect map of Habu for both scanners and from the figure 6, the ALS data has highest percentage of slope direction compare to TLS data in the direction of Southwest while TLS data has higher percentage in West direction. Since ALS data is able to detect more points at lower-slide area, we can conclude that the Southwest area of the study area has less slide compare to the West area, where in West area the TLS detects such a higher percentage of slope degree.

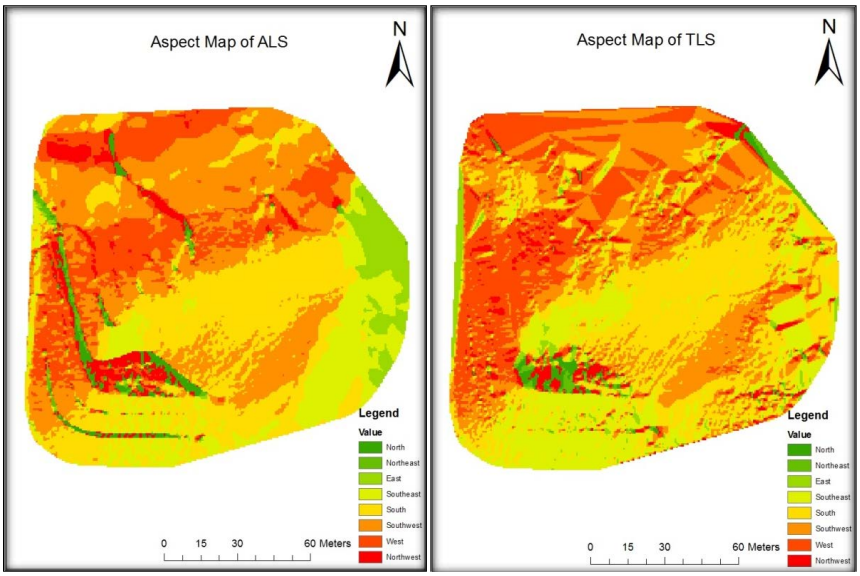

Figure 5: The aspect map for both scanner of ALS and TLS

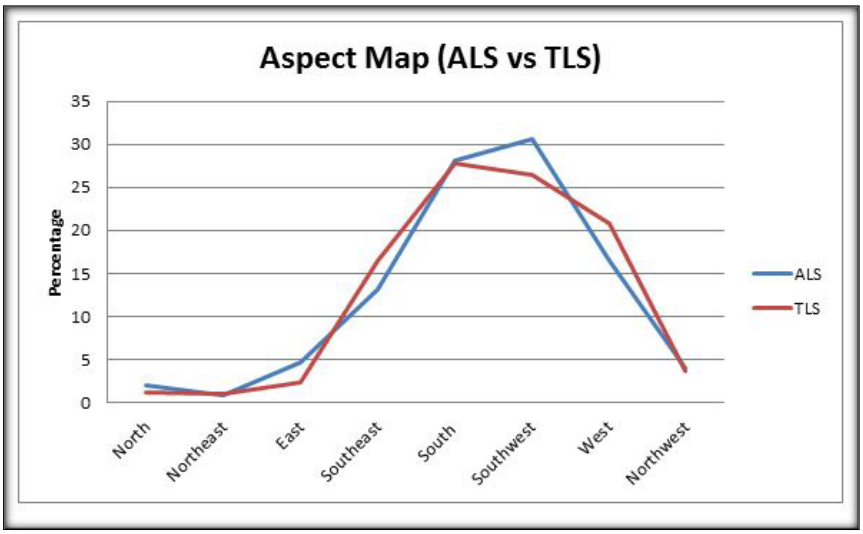

Figure 6: The graph of aspect map

CONCLUSION

ALS data has less ability to scan point data slope with high gradient but still, ALS technique is considered as one of the most accurate data collection as compare to any photogrammetry technique. The ALS data has specialisation in covering the wide area during scanning process, plus it is one of the active remote sensing sensor that could be operate during night time, however the night time work operation might has barrier in terms of navigation issue with satellite system. Meanwhile for TLS, differ from ALS, it is able to scan slope data with high gradient. This indicates that TLS data produced better slope map compare to ALS data as it contains detail result. TLS is also well-known as an accurate data collection and could been applied in various field.

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The Practice of Life Cycle Cost in Malaysia Construction Industry: A Review

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ABSTRACT

Life cycle cost (LCC) is a concept and practices that seem ambiguously understood in the construction industry in Malaysia. This paper reports on the initial phase of the study and its results. The initial study was carried out through the literature review on LCC in general and focuses on the application of LCC in Malaysia. The main focus on this study is to identify the current practice and the enhancement of the LCC in construction projects. There are six (6) practitioners in construction industry that been interviewed in related to the research study. The outcome of this research shows that most of the practitioners are aware on the term and concepts of the LCC but did not apply in their construction projects. There are few challenges are listed and their opinions on the solution to solve the lack of application LCC. The paper also identifies the elements cost and evaluation method used in developing the LCC plan.

Keywords: *Construction Industry, Life Cycle Costing, Maintenance*

INTRODUCTION

Life cycle cost was originally introduced in the mid-1990s in United States for procurement all types and purchases for the Department of Defense (Raymond J. Cole & Sterner, 2000). It involves the systematic consideration of all related cost and revenues connected with the ownership and acquisition of an asset (Gluch & Baumann, 2003; Raymond J. Cole & Sterner, 2000).

Not until much later, life cycle cost started to be used in United Kingdom (UK). The definition of this term is the costs involving the operating and purchasing of an asset. It is also known as ultimate cost, whole life costing or total cost analysis (Ashworth & Hogg, 2000).

In Malaysia, life cycle cost concepts and practices are seemed to be unrecognised and lack of knowledge for the practitioners in the construction industry (Noor Azizah & Zainal Abidin, 2012). Previous research stated that techniques for life cycle cost were seldom applied even though most developers and consultants aware of the terms and practice of it (Mazlan, 2010; Mohamed, Karim, Nor, & Kho, 2007). They only concentrate on the initial cost but very seldom take into consideration the future cost for example operation, maintenance, replacement when they proposed the development or building facilities (Mohd Fairullazi & Khairuddin Abdul, 2011).

Moreover, life cycle cost was applied to facilitate the agencies to identify the unnecessary cost, maximizing the cost saving in the building and optimise the overall life cycle cost to obtain the standard qualities demanded. Life cycle cost is implemented in value management in Malaysia introduced by University Teknologi Malaysia as a common technique for choosing the most cost effectiveness among the alternatives for the purpose of quality, cost saving, profitability and other criteria to meet the client requirements (Mat, 2010). According to Mohd Fairullazi (2012), there is no evidence found in the literature to support large number of people had knowledge on the life cycle cost did practiced the LCC techniques to evaluate total ownership cost of the building project in Malaysia construction industry.

LIFE CYCLE COST

Definition of Life Cycle Cost

Generally, life cycle cost is known as a valuable approach to compare the building designs alternative that enhance the operational cost benefits to be evaluated against any increasing initial cost (Raymond J. Cole & Sterner, 2000). Historically, life cycle cost is described by construction and building standard ISO15686 as a method which allows comparative cost assessments

to be created over certain period of time, taking into consideration all economic aspects both capital costs and future maintenance and operation cost (Gluch & Baumann, 2003).

The basic idea of the construction project life cycle cost management is developed from the traditional process of cost management in deficiencies and defects. The overall cost of project management usually concentrate in the construction project cost, while ignoring the costs operations, maintenance costs and the cost of the abandoned project at the end of project life (Li, Zhu, & Zhu, 2012). Generally, the production cost is the main cost factor in construction and often set to the minimum, which does not important in improving the lifetime performance of buildings. However, a higher production cost might reduce the total life cycle cost (CABA, 2004; Levander, Schade, & Stehn, 2007).

According to Li and Zhu (2012), once the project put into use, the operating and maintenance cost is greater than the project's construction cost usually in 5-10 times. In the life cycle cost theory, the project economic evaluation will be taken into consideration the whole life period of the construction costs, using operating, maintenance costs and wasting cost. These will lead to choose the best investment method, to enhance the good quality of project and achieve minimum of cost target and to achieve the most economical in the project construction (Li et al., 2012).

Section 707 of Executive Order 13123 defines life cycle cost as "… the sum of present values of investment costs, capital costs, energy costs, operating costs, maintenance costs, and disposal costs over life-time of the project, product or measure." Flanagan and Jewell (2005) define the LCC as an exercise that is carried out to evaluate the effectiveness of many different solutions in order to determine the best option.

Fuller (2005) identifies the LCC analysis is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and disposing of a project are considered important to a decision. The LCC method takes into consideration the initial costs which are capital investment costs, purchase, installation cost, capital replacement costs, financing costs and any resale or disposal cost over the lifetime of the project, product or measure (Flanagan & Jewell, 2005; Fuller, 2005; Li et al., 2012).

The economic evaluation which is known as life cycle cost has become the framework for measurement by the researchers in the past two decades (Flanagan & Jewell, 2005; John R Kelly, 2009; Kishk et al., 2003). Owner, occupants and organisation have common interest in improving the lifetime quality and cost effectiveness of buildings. There are several terms used such as "cost in use", "life cycle cost", "whole life costing" and "whole life appraisal". According to Flanagan and Jewell (2005), the terminology has changed over the years from "cost in use" to "life cycle costing" and further to "whole life appraisal". ISO Standard 15686 (2005) makes a difference between the "whole life costing" and "life cycle cost" which is the whole life costing covering wide range of analysis that include external cost and future cost of a building (Korytarova & Hromadka, 2010). Although the terms used are interchangeably, the life cycle cost is used equivalent to whole life costing/appraisal and the term life cycle cost is better known term used in the practice today (Levander et al., 2007; Mohd Fairullazi & Khairuddin Abdul, 2011).

Flanagan & Jewell (2005) and Ayob & Rashid (2011) stated that the older resources might refer the term as cost in use, changing over the year to the life cycle cost and further to whole life costing / appraisal for better represent concept. Different terms are actually interchangeably among them. Table 1 shows the definitions of life cycle cost by the organisations and researchers.

Table 1 : The definitions of the life cycle cost according to the organization and researchers

Organisations / Researchers	Definitions of Life Cycle Cost (LCC)
Section 707 of Executive Order 13123	Life cycle cost is the total of present values of capital costs, investment costs, energy costs, installation costs, operation cost, maintenance costs, and disposal costs over the life time of product or project.
Australian government document (Treasury, 2000)	Life cycle cost is the sum of cost during its life time with design, planning, support and acquisition costs and any other costs directly to having the project.

Royal Institution of Chartered Surveyors (2001)	Life cycle cost of an asset over its operating life which is the initial capital cost, occupation costs, operating costs, maintenance costs and the benefit of the refurbishment or disposal of the asset at the end of its life.
(El-Haram, Marenjak, & Horner, 2002)	Life cycle cost is a technique for identifying and evaluating all the costs in money terms direct and indirect including designing, building and facility management of a building throughout its service life with the disposal or refurbishment cost.
(Sirin, 2007)	Life cycle cost is the method of identifying and documenting the initial cost and external future cost of the development project during the lifetime of the building.

Economics Evaluation Method

Life cycle cost is an economic method to evaluate the life cycle cost effectiveness in which all costs form arising, operating, maintaining and disposing of a project in order to determine the best decision. There are many types of method that used in the calculations of life cycle cost depend on the data available. Some of the economic evaluation methods are shown in Table 2. Most of the researchers are agreed that the net present value (NPV) method is the mostly common method used in the analysis of life cycle cost.

Table 2 : The economic evaluation methods

Economic Evaluation Methods	Descriptions	Advantages	Disadvantages
Simple Payback	• The number of years required to return the initial investment cost (1,2,3) • The shortest pay-back time is the most profitable investment (1) • Used in rough estimation or only as the screening tools (1,2)	• Quick and easy calculation • Easy to interpret	• Does not use discounted cash flows thus, ignores the time value of money (2) • Does not take into inflation or interest (1)

Economic Evaluation Methods	Descriptions	Advantages	Disadvantages
Net Present Value (NPV)	• Traditional method specific to the net present value of the investment from the present value of the benefit project (9) • Present value of cash flows minus the present value of cost (3) • If the result of NPV is positive, so it is useful to invest (4,5,6) • Most commonly techniques used in the construction industry (1,7,8,9)	• Use the time value of money into account (1) • Uses all available data (1,7)	• Not suitable if comparing the alternatives which have different life lengths (1) • Difficult to interpret (1,7)
Internal Rate of Return (IRR)	• Discount rate that makes the estimated NPV of an investment equal to zero • Compare the profitability of investment (4) • To determine the average rate return to the condition that the values equal to zero at the initial point of time (5,10) • Highest IRR is the best option (5,10)	• Results are presented in percent form which is easy to interpret (1)	• Need trial and error procedure (1)

Notes:
1. (Flanagan & Jewell, 2005)
2. (Fuller, 2005)
3. (Davis Langdon, 2005)
4. (Buys, Bendewald, & Tupper, 2011)
5. (Levander et al., 2007)
6. (Noor & Eves, 2010)
7. (Kishk et al., 2003)
8. (Noor Azizah & Zainal Abidin, 2012)
9. (Wong, Li, & Wang, 2005)
10. (ISO/DIS, 2004)

Life Cycle Cost Application

Life cycle cost is able to assist in the effective management completed buildings and projects also being able to select the choice between alternatives. Rum and Akasah (2012) propose the integrated life cycle design as the method that integrates the design, construction, maintenance, management, and operation of buildings into the comprehensive life time engineering. The life cycle cost can be implementing in various areas such as in the intelligent building, sustainable building, facility management, value management and others.

(a) Life Cycle Cost in the Sustainable Building

Sustainable building is known as a building that is planned, constructed and effectively managed by the occupants where the service life of building preserves the environment, ecological performance requirement, able to meet the capabilities and needs of future generation (Siti Hamisah, Fathoni, & Jamaludin, 2005). The advantages of a sustainable building are increasing energy saving, usage of recycled materials and reduced the emission of toxic substances (Mohd Fairullazi & Khairuddin Abdul, 2011). Even though the progress of the sustainable building is widely explored and it's essential to balance total economic cost, ecological performance and social life in Malaysia, there is no standard technique has been formulated to calculate the life cycle cost of a sustainable building.

(b) Life Cycle Cost in the Value Management

Value Management analysis used the life cycle cost as the common technique to the lowest cost among the options for the purpose of eliminating the unnecessary cost (Mat, 2010; Mazlan, 2010). The other performance criteria to meet the client's requirements also are evaluated through value management process such as quality, safety, reliability, fitness for purpose, maintainability, aesthetics, technology and increasing the cost savings (Abdul Lateef A & Olanrewaju, 2013).

(c) Life Cycle Cost in the Facility Management

The application of life cycle cost in the facility management is still new in Malaysia. According to the Tenth Malaysia Plan (2011-2015), the government encourages life cycle cost technique to become as a part of development culture in maintaining and preserving the asset in holistic manner and efficient (Mohd Fairullazi & Khairuddin Abdul, 2011).

(d) Life Cycle Cost in the Public Private Partnership Programme

Public Private Partnership (PPP) is a new procurement approach in Malaysia that refers to a working relationship between government and private organisation. The aim of this programme is to achieve the common goal in the public infrastructure and services (Mohd Fairullazi & Khairuddin Abdul, 2011). PPP programme concentrates on the life cycle cost, private sector innovation, service approach, and management skills for the long-term relationship between public and private division to gain value of money. However, this programme is still new in Malaysia and the implementation of life cycle cost is still limited.

OPERATION AND MAINTENANCE

According to BS 3811, maintenance is defined as the combinations of all technical and related administrative actions intended to retain an item in or restore it to a state in which it can perform a building in its original state so that it continues to reserve its function and purpose in life cycle of a building (Oh, 2006).

Operating and maintaining a building takes the biggest portion in the life cycle cost of a building (Mahdjoubi, Ahmed, & Anumba, 2004). Maintenance deals with the certain procedures, specific tasks, instructions, equipment, qualifications and resources required to control the sustainability within a specific use environment. Operation costs are used to keep track of such item as fuel, water and utility to operate the facility. The key factor is to find an optimal level of maintenance services in order to be consistent with the organisations objective of attaining minimum total cost (Oh, 2006).

Yoong (2006) stated that major expenditures on repairs is usually caused by unforeseen failure of detailing, faulty material or bad workmanship, compared by predicted overall ageing and so is almost impossible to forecast. Various variable factors contribute to the real cost of maintenance work making it very difficult to assess with the accuracy (Mahdjoubi et al., 2004).

RESEARCH METHODOLOGY

In According to Kumar (2005), literature review is one of the crucial preliminary tasks when carry out a research study. Apart of that, literature review also important to assist researcher to understand on how findings of the research fit into existing body of knowledge (Ranjit, 2005).One method of collecting data is to interview targeted respondents to gain information on the matters of interest (Uma, 2003). The purpose of conducting personal interview is to support and clarify uncertain findings from the survey (Goo, 2009). The process of validation of data ensures the credibility of the data that obtained from the case studies.

The interviews are involved the individual that have the expertise in the construction projects. There are six face-to-face interviews conducted with experience construction practitioners. There are a project manager and a director from two developer companies, a director from consultant firm, a director and two engineers from three contractor firms.

RESULTS AND DISCUSSION

All of the interviewees are given the same question related to the research study. Table 3 shows the details of the interviewees with their position, working experience and area of expertise.

Table 3: The details of interviewees

No	Position	Working Experience	Area of Expertise
A	Director	>20 years	Developer
B	Senior Project Executive	>20 years	Contractor
C	Director	>20 years	Consultant
D	Project Manager	11-15 years	Contractor
E	Project Manager	11-15 years	Developer
F	Senior Project Executive	6-10 years	Contractor

The interviews are focused on the knowledge, application and challenges of the life cycle cost in Malaysia construction industry. The findings that emerge from the interview were as follows:

(a) Knowledge and awareness on the life cycle cost

All of the interviewees are aware the importance of the life cycle cost to the construction. Some of them understand the definition and concept of the LCC but did not apply in their construction projects. They agreed that LCC can be implemented in various stages and become the most economic solution for project's whole life.

"….generally we know about the meaning and concepts of the life cycle cost"
Respondent A, B, C, D, E, F

"…we know that there are many phases to apply the life cycle cost in the construction projects such as at inception, design stage, construction and building in-use"
Respondent B, D, E, F

"…the life cycle cost highlights the economic evaluation in terms of value and time to achieve the required budget allocation"
Respondent A, C

(b) Elements cost for the development of life cycle cost

There was a common agreement in the elements cost used in the life cycle cost plan. Some of them added that the LCC is calculated with different cost depend on the stage of the project development.

> *"…there is important cost in developing the life cycle cost plan which are the initial cost, construction cost, maintenance and operation cost"*
> *Respondent A, B, C, D, E, F*
>
> *"…development cost is important in the calculation of the LCC for the projects in the inception stage"*
> *Respondent B, D, E*
>
> *"…various stage of project development lead to the usage of different elements cost"*
> *Respondent F*

(c) Most known and used evaluation method

There were variable opinions on the familiarisation of evaluation method between the respondents. But most of them agreed that net present value is the most known method in the calculation of life cycle cost.

> *"…net present value method is the most known and used in the calculation of LCC"*
> *Respondent A, B, C, D, E, F*
>
> *"…internal rate of return and simple payback are sometimes applied in their construction projects"*
> *Respondent D, E*

(d) Challenges of the application LCC in construction projects

There was a variable dissatisfaction over the application of LCC in Malaysia construction projects.

"…clearly understand the concepts of LCC but did not apply in the construction projects"
Respondent A, B, C, F

"…poor demand from the construction clients in performing life cycle cost"
Respondent C, D, E

"…most Malaysian developers have 'sell' mentality therefore the life cycle of a building is not in their development policy in the first place"
Respondent B

(e) Mitigation the problems in application of LCC

There was a general opinion on the solution to solve the problems related to the LCC application in construction projects.

"…government should play an important role in the management policy or strategy to include the LCC in every construction projects"
Respondent A, B, C, D, E, F

"…practical courses or learning on the importance of LCC to the construction clients"
Respondent C, D, E

"…difficult to identify, examine and respond on the changing cost during the whole process of construction project"
Respondent D, E, F

CONCLUSION

As such, this study briefly describes the application of LCC among the practitioners in construction industry. Most of them aware in the terms and concepts of LCC but did not apply in their construction project because of the certain problems and circumstances. Findings from this research proved that the application of LCC in construction projects is still lack and limited. The net present value is used as main evaluation method to perform the LCC. The maintenance cost of the building is one of the important elements in calculating the LCC. As a conclusion, LCC is significant to the current Malaysia construction industry as obtaining value for money. It is an economic concept of time and value of money to compare the cost that will be spent over number of years. From the application of LCC, the efficiency as well as productivity can be maximised while the maintenance cost may be minimised.

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The Evaluation of Spatial risk factors for Leptospirosis Outbreak using GIS application

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ABSTRACT

The objective of this research is to determine the factor that increase incidence of leptospirosis in Petaling district based on leptospirosis risk map (LRM). Data involves in the research is leptospirosis cases data from Selangor State Health Department The factors used to determine leptospirosis risk area namely land use, population and temperature data. The determination of leptospirosis incidence is made by produce leptospirosis distribution map (LDM). The LDM is produce using overlay method which is intersecting method. The identification of factors that increase the leptospirosis incidence is made by produce a Leptospirosis risk map (LRM). A LRM is produce using Getis-Ord Gi technique. The determination of risk area is based on several factors including land use and population factors. The used of GIS application to evaluate the health problem is one of the suitable methods compared with conventional method that made analysis based on the graphs and tables only. GIS has advantage such as can facilitate a disease data that can be accessed quickly even in large numbers, providing a dynamic system analysis and has a good technique to display, monitors and manage disease outbreak well.*

Keywords: *Leptospirosis; Geographic Information System (GIS); Risk Mapping; Spatial Modeling*

INTRODUCTION

Leptospirosis is perceived as one of the important zoonotic diseases in the world including Malaysia (Ridzlan et al, 2010). It is one of the risky viruses in Malaysia and as of late has gotten expanding consideration because of the few late occurrences that have brought about human mortality which have frightened wellbeing experts in Malaysia. The capability of leptospirosis to happen in both tropical and calm climes, and both created and creating nation has gotten boundless media consideration. Leptospirosis is an irresistible disease brought on by pathogenic spirochete microorganisms of the sort leptospira that are transmitted straightforwardly or by implication from creatures to human (i.e., a zoonotic disease) and the rodent is the real bearer (host) of the infection (Ministry of Health Malaysia, 2011). There are a few conditions that are ideal for transmission of leptospirosis, for example, supply and bearer has, flooding and waste blockage, creature human interface and human host danger variables (Ministry of Health Malaysia, 2011). For the repository and transporter has, leptospirosis has extensive variety of common rat, and non-rat supply have, for example, rats, dairy cattle, mutts, foxes, rabbits, and so forth. The creatures demonstration as transporters that can discharge expansive number of leptospirosis in their pee and in charge of the pollution of substantial and little water bodies and soil. Flooding and waste blockage may hazard variables for sullying of water bodies contaminated by creature pee. The other potential for disease builds through recreational exercises without legitimate security. The recreational ranges that poor cleanliness can pull in creature have, for example, rat, hence expands the danger of pollution of the recreational range. This is on the grounds that poor support of offices, dishonourable transfer of waste furthermore open mentality. For the human host danger figures, a few segments of the populace are more helpless to contamination, for example, those not a while ago laid open to the microorganisms in their surroundings and those with constant sickness and open skin wounds.

Geographic Information System (GIS) are automated data framework or the framework itself being create that consider catch, stockpiling, control, examination show and reporting the topographically referenced information with their data or quality information (Chang, 2014). GIS can provide effective tool to visualise the geographical data which is study area and spatial analysis of epidemiology data and environmental exposure.

The final product which is either database or thematic maps can make user interesting with the information. Since leptospirosis is a topographical and regular disease controlled by natural and social elements, land data frameworks (GIS) may be valuable to distinguish these components and to focus potential danger territory (Daniele et al, 2012). GIS may serve as fundamental for wanting to control and deal with the Leptospirosis issue. By utilising GIS consolidated with spatial examination system permit to mapping the infection, recognisable proof and appraisal of the wellbeing danger variables.

The objective of this study is to determine the incidence of leptospirosis in Petaling district, to identify the factors that increase incidence of leptospirosis in Petaling district and also to produce a leptospirosis risk map (LRM) in Petaling district. This study utilised a GIS application to integrate the locational data for the incidence of leptospirosis, along with data on land use and demography to identify areas that have potential to become risk area for these diseases. The ability to identify the probable areas for leptospirosis incidence allow for effective implementation of disease management and prevention activities.

STUDY AREA AND METHODOLOGY

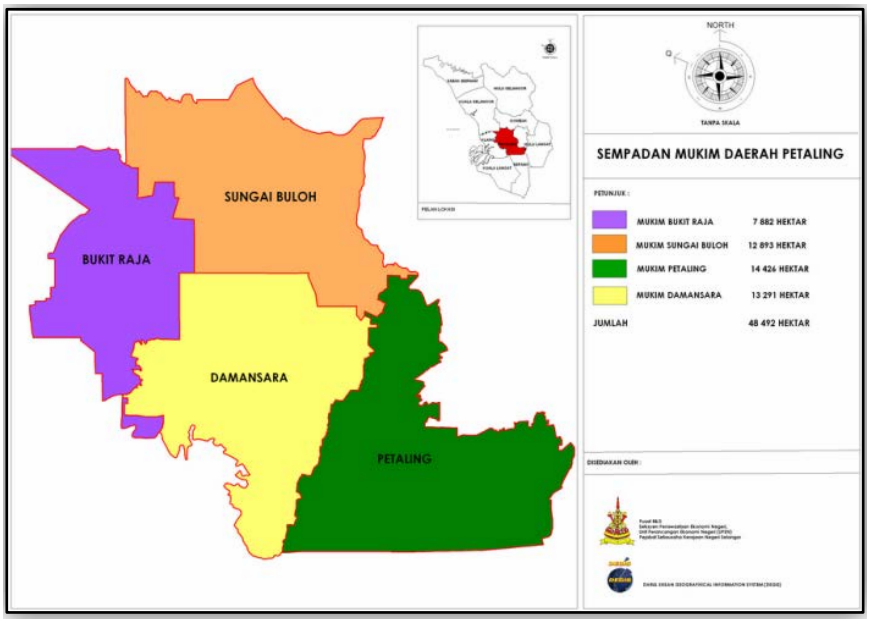

Figure 1: Petaling district

The study was carried out in the Petaling district at Selangor state. The district is selected because it is one of the highest leptospirosis incidence cases in the Selangor state. Basically, Petaling have five *mukim* which area Bukit Raja, Damansara, Sungai Buloh, Petaling and Bandar Petaling Jaya. Data involved in the study is leptospirosis cases data from Selangor State Health Department and Ministry of Health Malaysia. Another data is digital base map of Petaling district from Department of Survey and Mapping or JUPEM. For the factor to find the risk of the leptospirosis area, the data that being use is land use data, population data and temperature data. The land use data is from Town & Country Planning Department, population data is from Department of Statistics and temperature data is extract from satellite image using Landsat. Research method is simplified in Figure 2.

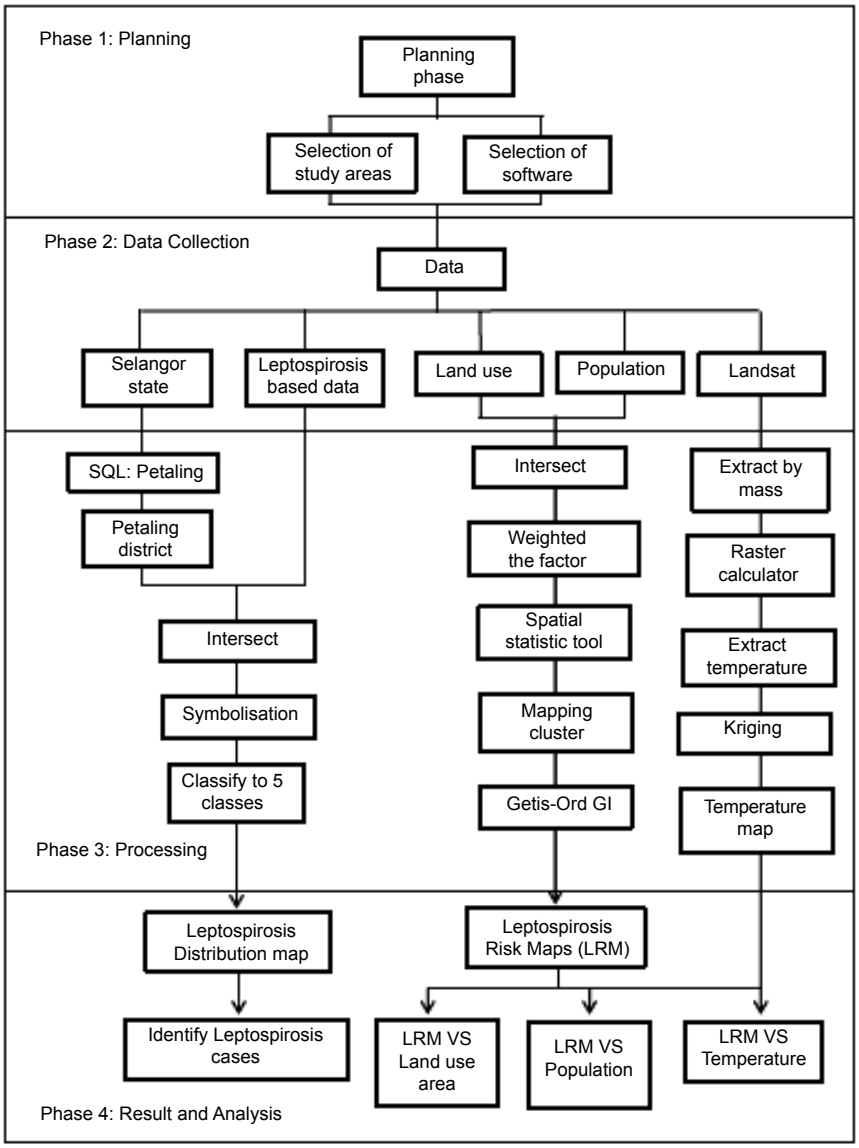

Figure 2: Research methodology

The first part of data processing is to find the temperature map. The temperature data is extract from satellite image which is Landsat 8. Then, the temperature map is produce by using kriging technique in ArcGIS software. The temperature value of the sample point is referring the temperature data from Landsat image. The second part is to find the distribution map of Leptospirosis incidence in Petaling district. By using two layer which is Petaling district and leptospirosis cases, overlay these two layer using intersect technique and then symbology and classifies the output layer into five classes. Then, select suitable colour and product the map for the distribution data. The third part is to find the risk area for leptospirosis incidence in Petaling district. In the process, there are two layers that being used which are population and land use layer. The process to find the prediction of leptospirosis risk area is using spatial statistical method which is Getis-Ord Gi* technique. The Getis-Ord Gi* will calculated the Getis-Ord Gi* statistic for each feature in a dataset and the resultant z-scores and p-values will tell where features with either high or low values cluster spatially.

RESULTS AND DISCUSSION

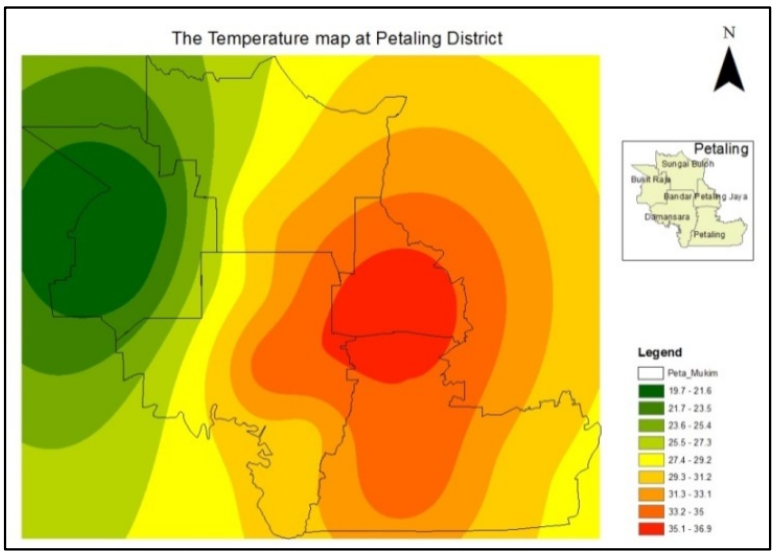

Figure 3: Temperature map

The previous study stated that the potential of leptospirosis to occur in epidemics in both tropical and temperature climes. The comparison is made between temperature area and leptospirosis risk area and the result found that the temperature at high risk area is around 20 celsius to 30 celcius. The result explains that the leptospirosis virus can be survived at mild temperature.

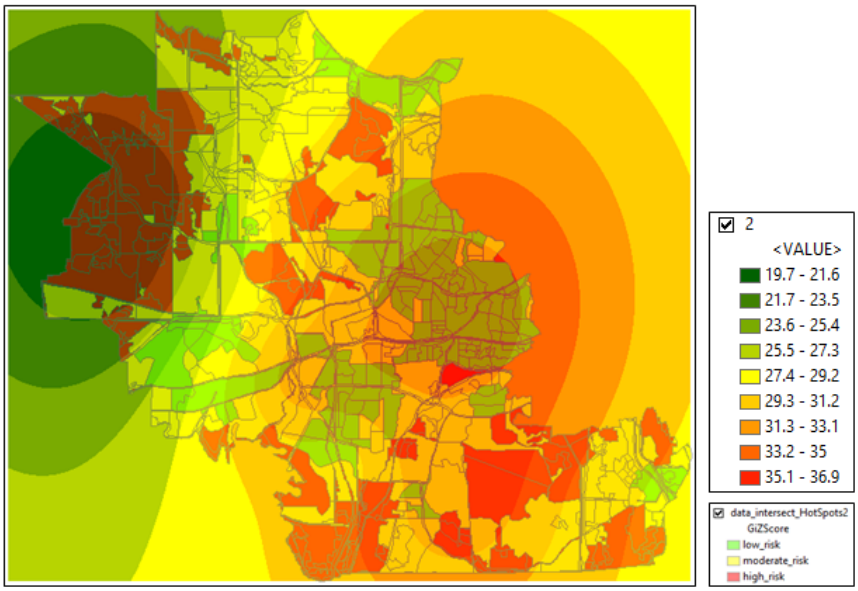

Figure 4: Comparison between temperature area with LRM

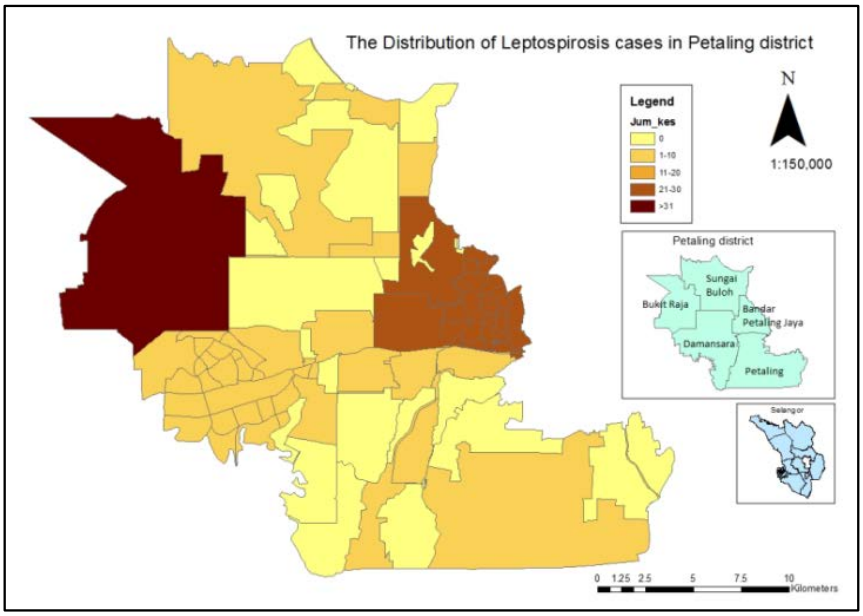

Figure 5: Leptospirosis distribution map

Based on the leptospirosis distribution map shows that the higher distribution cases that happen in Petaling district are at Bukit Raja area. Basically, the distribution of leptospirosis cases is shows using different colour display. The darker the colour display, the more cases that happen at that place. For example at Bukit Raja area, the colour that display is the darker colour because this place has more cases compare to other area. Damansara, Petaling and Sungai Buloh has display the bright colour because at these places have less cases compared to other.

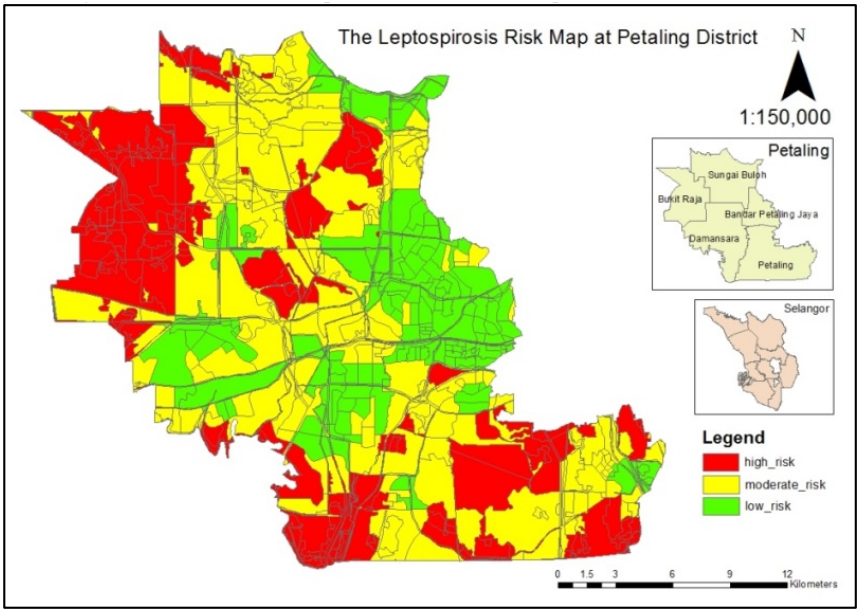

Figure 6: Leptospirosis risk map (LRM)

The leptospirosis risk map (LRM) is a creations using ArcGIS software that shows the risk area or potential area for incidence of leptospirosis will happen in Petaling district. The level of risk area for incidence of leptospirosis will be distinguished using different colour. The comparison is made between land use area and Leptospirosis risk area and the result found that the high risk area are located at agriculture area, forestry area and recreational area.The moderate risk area is located at industrial area and for the low risk area is located at residential area. The figure also shows that the agriculture area, forestry area and recreational area is contributed to the high risk area for the Leptospirosis incidence and the people that involved on that area especially at recreational area or work on that area including agriculture area and forestry area have high potential to get leptospirosis disease if the virus of the disease has on the place.

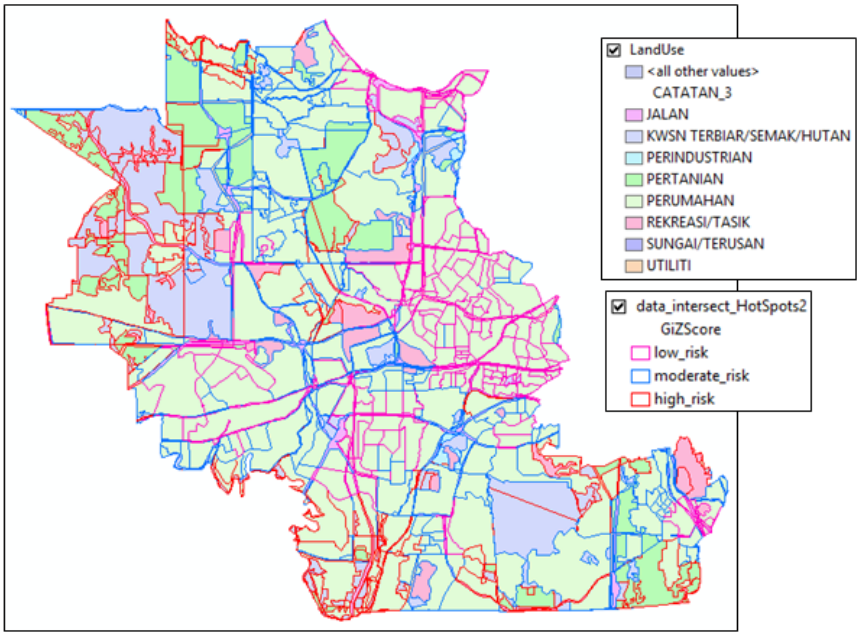

Figure 7: Comparison between land use area and LRM

The comparison is made between three ranges of population density which are 100000 populations, 300000 populations and 500000 population and the result shows that the higher population density is one of the risk factor for leptospirosis incidence will happen on that place.

CONCLUSION

Based on result and evaluation on the result show that there are certain factor that can contribute the increasing of leptospirosis incidence such as agriculture area, recreational area, forestry area and also high density population factor that contribute the increasing of leptospirosis incidence. Furthermore, the used of GIS application to evaluate the health problem is one of the suitable methods compared with conventional method that made analysis based on the graphs and tables only. Based on the study conducted, there are several suggestions which may beneficial for the further study in the future. Firstly, the study area of the research can be expanded in the

all district in Selangor state and in the whole of Peninsular Malaysia state. Secondly, use of GIS with integration with remote sensing can also be used as another method or technique to find the leptospirosis risk area. Thirdly, use additional factors such as rainfall factor and floor area factor to make the prediction of risk area is more accurate. Lastly, use other technique to predict the leptospirosis risk area. There are several technique can be used to predict the risk area including regression analysis technique such as geographically weighted regression (GWR) or ordinary least squares (OLS) and also kernel density estimation technique.

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