EXPERIENCE, IMPACT AND NEEDS RELATED TO URBAN HEAT ISLAND PHENOMENON IN INDUSTRIAL AREAS

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ABSTRACT

Many urban and suburban areas experience higher temperatures than their outlying rural surroundings. This difference in temperature is what constitutes an Urban Heat Island (UHI). UHIs result from man-made modifications of the natural environment. The replacement of vegetation, soil and water with concrete, brick, asphalt and metal reduces evapotranspiration, increases the storage and transfer of sensible heat and decreases air movement. Problems that are associated with the urban heat island phenomenon include atmospheric pollution, increased morbidity and mortality, a decreased thermal comfort and an increase in energy consumption. For these reasons, it is desirable to mitigate the UHI effect. Models and tools to predict the effect of UHI mitigation measures can assist the urban planner to incorporate these in urban design. A number of numerical (simulations) and empirical (observational) models have been constructed to date. Empirical models are most likely to be of use to urban planners. However, such a model does not yet exist for Asian country such as Malaysia. As a test bed for a potential, more comprehensive study in the future, the aim of this research is to empirically investigate the experience, impact and needs related to urban heat island phenomenon at industrial area, in terms of land use characteristics, of urban environments in Malaysia (Mont Kiara, Raja Chulan and Setia Alam). Firstly, in order to be able to select relevant data on which the analyses will be conducted, an inventory of UHI mitigation measures has been provided. Mitigation measures of interest have been divided in two categories: vegetation (urban parks and gardens, street trees, green roofs and walls), open water (rivers, ponds, lakes and fountains), built form (low building density and street design that promotes ventilation), material (high albedo materials and porous paving) and anthropogenic sources (improved thermal insulation

of buildings and car-free zones). Secondly, the required data has been gathered UHI data has been retrieved from the scientific literature. Three studies, corresponding to three locations, were found to be of use in the analyses.

With objective to compile all the information related to basic background, workplace information, workers attitude and experience towards urban heat island, impact and needs to mitigate and improve the precaution and preventive action related to urban heat island phenomenon.

Quantitative and qualitative questionnaire used to get the information at selected places stated in scope of works. The interviews conducted will be record in questionnaire and all data will be analyzed by using SPSS (Statistical Package for Social Sciences) software.

Data obtained then will be discussed in discussion chapter. Discussion, limitation and conclusion from the research conducted will follow up by further recommendation and future action.

ABSTRAK

Banyak kawasan bandar dan subbandar mengalami suhu yang lebih tinggi berbanding kawasan luar bandar sekitarnya. Perbezaan suhu inilah yang dikenali sebagai Pulau Haba Bandar (Urban Heat Island, UHI). Pulau Haba Bandar ini hasil daripada pengubahsuaian buatan manusia terhadap persekitaran semula jadi. Tumbuhan hijau, tanah dan air yang diganti dengan konkrit, batu-bata, aspal dan besi logam mengurangkan sejat-transpirasi (evapotranspiration), meningkatkan penyimpanan dan pemindahan haba dan mengurangkan pergerakan udara. Masalah yang dikaitkan dengan fenomena pulau haba bandar termasuklah pencemaran atmosfera, pertambahan morbiditi dan mortaliti, kurang udara nyaman dan peningkatan dalam penggunaan tenaga. Atas sebab-sebab ini, adalah perlu untuk membendung akibat-akibat daripada UHI ini. Model dan alat yang dapat meramal pembendungan akibat UHI ini boleh membantu para perancang bandar untuk menerapkannya ke dalam rekabentuk bandar. Beberapa model angka (simulasi) dan empirik (pencerapan) telah diperbuat sehingga masa kini. Model empirik nampaknya lebih berguna kepada para perancang bandar. Namun, model seperti itu belum wujud lagi untuk negara Asia seperti Malaysia. Sebagai satu medan kajian yang berpotensi dan lebih komprehensif pada masa depan, matlamat kajian ini ialah untuk menyiasat, secara empirik, pengalaman, impak, dan keperluan yang berkaitan dengan fenomena pulau haba bandar di kawasan perindustrian dalam persekitaran bandar di Malaysia, dalam erti kata ciri-ciri penggunaan tanahnya (Mont Kiara, Raja Chulan dan Setia Alam). Pertamanya, untuk berjaya memilih data yang relevan dengan analisis yang akan dijalankan, sejumlah ikhtiar pembendungan UHI telah disenaraikan. Ikhtiar pembendungan yang disenaraikan telah dibahagi kepada dua kategori: tumbuhan (taman dalam bandar, pokok tepi jalan, atap dan dinding hijau), air terbuka (sungai, kolam, tasik dan mata air), bentuk binaan

(kepadatan bangunan yang rendah dan rekabentuk jalan yang menggalakkan pengudaraan), bahan (bahan beralbedo tinggi dan turap poros) dan sumber antropogenik (tebatan haba bangunan yang baik dan zon bebas-kereta). Keduanya, data yang diperlukan yang telah dikumpul. Data UHI telah dikutip daripada karya saintifik. Tiga kajian, merujuk kepada tiga lokasi, telah didapai berguna untuk analisis ini.

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I would also like to thank the experts and respondents who were involved in the survey for this research project titled *EXPERIENCE, IMPACT AND NEEDS RELATED TO URBAN HEAT ISLAND PHENOMENON IN INDUSTRIAL AREAS*. The survey could not been completed without their active participation and fruitful input.

Lastly, I would like to express my gratitude to my parents and friends who have been my pillars of strength and supported me throughout my years of study. This small accomplishment of mine could not have been done without them being there and backing me up. Thank you.

Alias Bin Ismail *2017*

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LIST OF SYMBOLS AND ABBREVIATIONS

AIHA	:	American Industrial Hygiene Association
ALARP	:	As Low As Practicable
ALOHA	:	Area Locations of Hazardous Atmospheres
API	:	American Petroleum Institute
BLEVE	:	Boiling Liquid Expanding Vapour Explosion
CCPS	:	Center for Chemical Process Safety
CNG	:	Compress Natural Gas
CODO	:	Company Owned Dealer Operated
CO_2	:	Carbon Dioxide
DODO	:	Dealer Owned Dealer Operated
DOE	:	Department of Environment
DOSH	:	Department of Occupational Safety and Health
LEL	:	Lower Explosive Limits
LOC	:	Level Of Concern
LOPA	:	Layer of Protection Analysis
OHSAS	:	Occupational Health and Safety Assessment Series
PHA	:	Process Hazard Analysis
QRA	:	Quantitative Risk Assessment
RON	:	Research Octane Number
SCE	:	Safety Critical Equipment
SIL	:	Safety Integrity Level
SPSS	:	Statistical Package for the Social Sciences
UHI	:	Urban Heat Island

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Urban planning guides the orderly development of settlements. Urban climatology is a vital aspect of urban planning. It is concerned with the study of the climate effect of urban areas and the application of the knowledge acquired to the better planning and design of cities (Mills, 2014): understanding the microclimates between buildings helps the urban planner to manipulate these spaces in order to create better environments for humans ("<The Impact of Urban Heat Island.pdf>,"). The need for climate-sensitive urban design is also stressed by Carmona, Tiesdell, Heath & Oc (2010), who regard (climatic) comfort as a prerequisite for successful places. Various studies show that comfortable microclimates increase the number of people present in an urban space (Nasrollahi, Hatami, & Taleghani, 2017) and that both too cold and too warm conditions have a negative influence on the emotional state of people (Eliasson, Knez, Westerberg, Thorsson, & Lindberg, 2007). It is known that urban climates differ from rural climates. In this context, one of the most studied phenomena is the Urban Heat Island (UHI) effect: the phenomenon that many urban and suburban areas experience elevated temperatures compared to their outlying rural surroundings (Shamsipour Ali Akbar1, 2013). Urban heat islands may be observed both at the surface (surface heat islands, SHI) and in the atmosphere in and above the city (atmospheric heat islands). The latter type may be sub-divided into canopy-layer heat islands (CLHI) and boundary-layer heat islands (BLHI). The CLHI is observed in the layer of air closest to the surface in cities, extending upwards to approximately the

mean building height. The BLHI forms a dome of warmer air that extends downwind of the city. In contrast to the surface UHI, the atmospheric UHI is mainly a nocturnal phenomenon; it is often weak during the day and becomes more pronounced after sunset (van Hove et al., 2015).

1.2 OBJECTIVES

This research was conducted to study about the worker experience, impact and needs on urban heat island phenomenon.

It has objectives as stated below:

- To determine workers' basic workers background & building information where they work.
- To determine the workers' basic knowledge & experience with heat, impact of urban heat island.
- To investigate the impact of urban heat island to workers (physical health, psychological health & social behavioral)
- To conduct & determine the workers' needs for facing the urban heat island situation in terms of transportation aspect, increases of vegetation (internal & external) and also the material use in the building, methods of spreading out the UHI information & communication and green urban landscape promotion around the building.

CHAPTER 2

LITERATURE REVIEW

2.1 FACTORS CONTRIBUTING TO THE UHI (URBAN HEAT ISLAND) EFFECT

The factors that affect the intensity of the urban heat island have been accommodated in the categories ‘urban form’ and ‘urban function’ (Mills, 2014). In addition, (Rovers, 2016), distinguish the category ‘weather and geographic location’. The building density, properties of urban materials and the reduced amount of vegetation in urban areas are of interest in the category of urban form. Solar energy gets trapped in between buildings due to multiple reflection and absorption, which reduces the urban albedo and increases the amount of heat stored in the urban fabric (Rovers, 2016). The emission of long-wave radiation to the sky is low due to the reduced sky-view factor (SVF) in urban areas (Levermore, Parkinson, Lee, Laycock, & Lindley, 2017), thereby inhibiting the rate of cooling after sunset. Furthermore, wind speeds in urban areas are often strongly reduced (Guattari, Evangelisti, & Balaras, 2018), impairing ventilation cooling. Materials commonly used in the urban environment, such as concrete and asphalt, have a low albedo (Jandaghian, Touchaei, & Akbari, 2017) and a large thermal capacity and conductivity (van Hove et al., 2015), which intensify the UHI effect. Furthermore, urban areas generally have extensive impervious surfaces. In combination with efficient drainage, this results in a decrease in surface moisture available for evaporation, and hence to higher temperatures (van Hove et al., 2015). Similarly, the reduced amount of vegetation in urban areas leads to a decrease in transpiration, thereby contributing to the UHI effect (Yang, Qian, Song, & Zheng, 2016). For these reasons, high-density urban

development is often associated with large UHI intensities (Guattari et al., 2018), however, note that recent studies have reached the paradoxical conclusions that not only dense city configurations, but also urban sprawling can result in more intense UHIs. Urban sprawl can exacerbate UHIs since it results in more land clearances, impervious surfaces and excess heat generated per capita when compared to higher density development (Lemonsu, Viguié, Daniel, & Masson, 2015). In the category urban function, the anthropogenic emissions of waste heat and water vapor are of interest (Mills, 2014). (Shahmohamadi, Che-Ani, Maulud, Tawil, & Abdullah, 2011) differentiates energy consumption from the associated emission of both sensible heat and moisture. Sensible anthropogenic heat emission can be directly through tailpipes, chimneys and air-conditioning or heating equipment, or indirectly by conduction through a building envelope and then convection and radiation into the urban environment. Heat removed from buildings exhausted through evaporative cooling equipment, and the chemical reactions that occur in the combustion of hydrocarbon fuels in motorized vehicles are sources of anthropogenic moisture. Finally, weather, in particular wind and cloud cover, affects the intensity of heat islands. Heat island magnitudes are largest under calm and clear weather conditions (van Hove et al., 2015). Geographic location dictates the regional climate and topography of the area in which the city is situated. Regional or local weather influences, such as local wind systems, may impact heat islands (Phelan et al., 2015).

2.2 PROBLEMS ASSOCIATED WITH THE UHI (URBAN HEAT ISLAND) PHENOMENON

Problems that are associated with the UHI phenomenon include atmospheric pollution, increased morbidity and mortality, a decreased thermal comfort and an increase in energy consumption.

Many studies have focused on the association between the UHI phenomenon and air pollution. Elevated temperatures facilitate the chemical reactions of nitrogen oxides (NOX) and volatile organic compounds (VOC) into ozone (O3) (Yadav, Sharma, Peshin, & Masiwal, 2017). Ozone is one of the main components of urban smog (Yadav et al., 2017) and high concentrations of ozone aggravate asthma and other respiratory conditions (Levermore et al., 2017). Apart from the adverse health effects caused by air pollution (Phelan et al., 2015), heat-related illnesses such as heat strokes or heat exhaustion are of major concern (Phelan et al., 2015). The heat wave that hit Chicago, Illinois in 1995 is believed to have caused between 550 and 800 heat-related deaths (Onwuchekwa, 2003). In Europe, the summer of 2003 was particularly hot. Estimates of the cumulative heat-related deaths of sixteen European countries range from 27,000 to 70,000 (Robine et al., 2008). Energy consumption contributes to the UHI effect (section 1.1.1). In turn, higher urban temperatures lead to an increase in energy consumption for cooling and air-conditioning, particularly during summer (O'Malley, Piroozfarb, Farr, & Gates, 2014), as thermal comfort in many commercial and residential buildings is tried to be maintained. However, the heating load during winter is likely to be reduced as a result of the UHI effect (Wang & Bielicki, 2018). For the reasons outlined above, it is desirable to mitigate the UHI effect. Furthermore, due to climate change (and associated heat waves) and urbanization, the problems associated with the UHI

phenomenon are likely to worsen (Baklanov, Molina, & Gauss, 2016). On the other hand, although cities are known to be large sources of greenhouse gas emissions (Christopher A. Kennedy & Sebastian Carney, 2009), the effect of the UHI on global warming is believed to be small (Jacobson & Ten Hoeve, 2012).

Models and tools to predict the effect of mitigation measures can assist the urban planner to incorporate these in urban design, considering that the urban form is largely responsible for the UHI (section 1.1.1). The following sections will therefore focus on past efforts to establish models and tools to predict the heat island intensities of urban areas. These are categorized in numerical models and empirical models: numerical models simulate urban energy balance fluxes through the parameterization of urban surface processes, whereas empirical models attempt to reveal the linkage between the UHI and various descriptive factors of urban areas (Debbage & Shepherd, 2015).

2.3 WHAT ARE THE IMPACTS OF URBAN HEAT ISLANDS?

Urban heat islands (UHIs) have the potential to become one of the largest problems associated with the urbanisation and industrialisation of human civilisation, as the increased temperatures associated with UHIs tend to exacerbate the threats to human health posed by thermal stress. As a result, the UHI has been a central theme among climatologists, and is well documented in many metropolitan areas around the world (Enete, 1 Awuh, & and Ikekpeazu, 2014).

The IPCC reports that incidences of heat waves increased towards the end of the 20th Century and are projected to continue to increase in frequency, intensity and duration worldwide (IPCC, 2007). The actual impacts of urban climate change and heat

islands depend on the characteristics of local climates. Exposure to excessively warm weather is a global threat to human health and well-being. Most UHI impact studies relate UHI impacts on human health on hot days. Heat related illness includes: heat stress, heat cramps, heat syncope, heat edema, heat exhaustion and heat stroke (Grubenhoff, du Ford, & Roosevelt, 2007).

Studies of heat waves and mortality in Shanghai, China (Dian-Xiu, Ji-Fu, Zheng-Hong, You-Fei, & Rong-Jun, 2014) and in the USA (Uejio et al., 2011) demonstrate that days with increased temperatures or periods of extended high temperatures have increased heat-related mortality. More deaths are attributed to heat in temperate climates than in warm climates because people in temperate zones are less acclimatized to high temperatures (Vaneckova et al., 2011). Climatically diverse cities, such as Toronto, Canada and Sao Paolo, Brazil report excess mortality attributable to extreme heat (Harlan, Brazel, Prashad, Stefanov, & Larsen, 2006). Notable recent events include the heat waves of 2003, which killed an estimated 35,000 Europeans in two weeks (Harlan et al., 2006) and more than 1,900 people in India (Harlan et al., 2006).

UHI also has impacts on water availability and safety, as lower water levels and warmer water temperatures in a drinking water source can increase the risk of contamination. Since higher water temperatures decrease the dissolved oxygen level, water will require additional treatment to be used as drinking water. Because urban development often involves expanding paved or concrete areas at the expense of green space, it can result in increased flooding and run-off during a storm. Increased run-off can carry contaminants such as oil, chemicals and microbes into drinking water sources, with implications for public health. Additionally, the development of homes using

individual groundwater wells and septic tanks can potentially result in an increase in nutrients in surface water or contamination of groundwater due to septic effluent.

The direct impact of climate change on water resources concerns the availability of water supply due to increasing temperature and precipitation variability. Warmer temperatures may lead to increased demand by water utility customers while the water supply is limited. Moreover, increased water temperature affects water quality due to the increased use of disinfectant for killing germs ("<The Impact of Urban Heat Island.pdf>," ; Moyer & Hawkins, 2017). Projections show that the heat differential between urban centers and surrounding areas will grow wider in the future, increasing the relative health risks for poor and vulnerable populations who reside in cities. Analyzing the risks and understanding the spatial variations in vulnerability, as this study does, will allow policymakers to develop adaptation responses tailored to the needs of certain communities and different sorts of risk.

The related between above impact will created a new impact which is related to health impact to human. The symptom like eye irritation, diarrhea, anxiety and other health impact will affect the life cycle of workers. The numbers of cases due to related disease increase and affect the industries activity totally. Productivity decrease, defect of product increase and it will contribute of the waste and loss to the industries and government. This health impact becomes more serious when new virus and disease occur. The cost for the treatment become high, the population growth affected and will totally create a lot of troubles to all parties in future.

CHAPTER THREE

METHODOLOGY

3.1 STUDY LOCATION

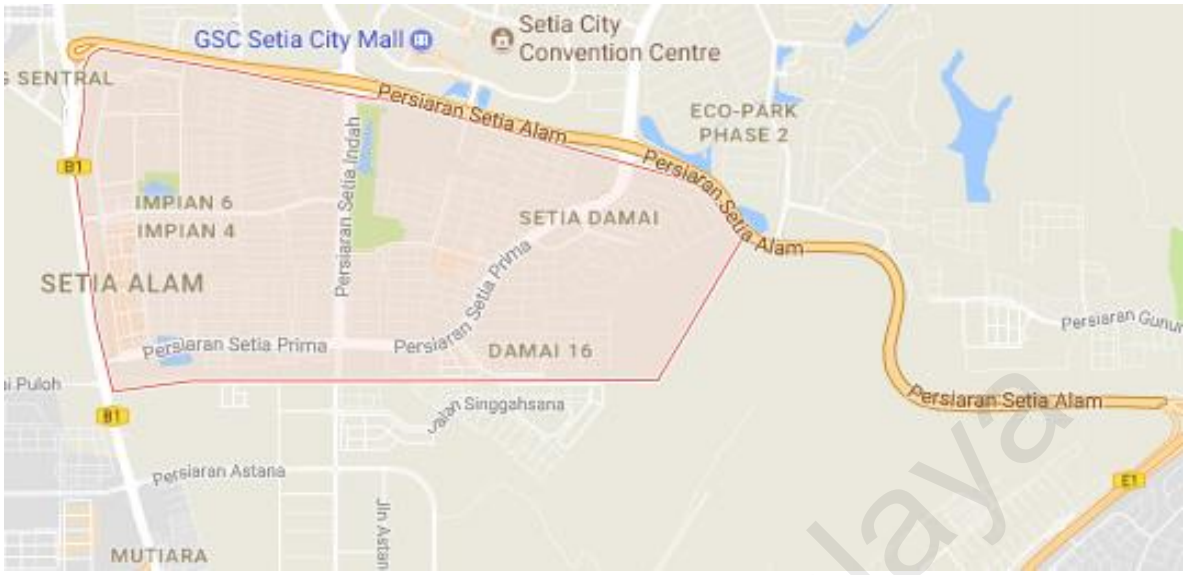
Area of study was in Mont Kiara, which is an affluent township northwest of the city centre of Kuala Lumpur, Malaysia, in the constituency of Segambut; Raja Chulan which is currently (since 1982) named after Raja Sir Chulan, Raja di Hilir Perak, the first Malay unofficial member of the Federal Council (1924–1933), formerly named after Sir Frederick Aloysius Weld (1823–1891), Governor of the Straits Settlements and Setia Alam which is a new township located in Shah Alam, Selangor, Malaysia. It is accessible via Setia Alam Highway from the New Klang Valley Expressway (NKVE) since the interchange was opened on 14 July 2006. Setia Alam is also accessible from the Federal Highway and Klang via Jalan Meru. This township is developed by SP Setia Berhad Group. Setia Alam is an integrated development spanning over 4,000 acres (16 km2) of land. It falls under the jurisdiction of the Shah Alam City Council (MBSA) which had placed restrictions on the establishment of entertainment outlets such as pubs, discos and lottery business.

Figure 3.1 Study Locations (Mont Kiara, Raja Chulan and Setia Alam)

MONT KIARA

RAJA CHULAN

SETIA ALAM



3.2 STUDY POPULATION

Subject was limited to the workers of the factories within the industrial area stated. These subjects worked in various types of factories in Mont Kiara, Raja Chulan and Setia Alam performing all kind of duties required based on the type of factory they work for.

3.2.1 Sample Size

In this research, 1050 eligible participants were targeted in responding to the questionnaires distributed by interviewer. Each area will be allocate 350 respondent each and target industries will be focused on.

3.2.2 Inclusion Criteria

From the research study, the inclusion criteria in selecting the subjects are to be followed as below:

a) Targeted respondents include manufacturing and service workers.

b) Both female and male gender.

d) District area within Mont Kiara, Jalan Raja Chulan and Setia Alam only.

3.2.3 Exclusion Criteria

The exclusion criteria, on the other hand, are enlisted below:

a) Workers outside the targeted area.
b) Workers outside the targeted industries.
c) Workers less than 1 year working experience.

3.3 SURVEY AND QUESTIONNAIRE

Survey and questionnaire was conducted to collect information i.e. experience, impact and needs assessment in relation to urban heat island phenomenon in industry areas by factory workers.

Questionnaire was designed deliberately for subjects' easy understanding with the aid of surveyor. The questionnaire form consists of five sections: General information; Building Information; Experience of urban heat island phenomenon; Personal health impact of urban heat island phenomenon; and community needs assessment. The selection of subject was done by conducting face-to-face questionnaire and all were recorded anonymously. Subject was required to select the best answer from options given for all questions and all were record anonymously.

General information like age and gender were registered. Ethnicity and their education level were also taken in consideration as it may be one of the factors that can affect understanding on occupational health at workplace individually.

Next, subjects were required to clarify on statement regarding the experience related to heat island phenomenon at the workplace and the impact to them. Finally, the needs assessment recorded to analyze workers needs as response to the heat exposure phenomenon.(Refer attachment 1 : Research Questionnaire)

3.4 STATISTICAL ANALYSIS

Data collected will be compiled using SPSS software (Statistical Package for Social Sciences), version 24.0. Starting process with descriptive analysis; to organize and analyze data. Then, Correlation test using Spearman's Rank Order Correlation will be

conducted to determine the percentage respondent information (background, building information, experience, effect to health & needs to face the situation) associated to total adverse health symptoms experienced.

CHAPTER FOUR

RESULT

4.1 DEMOGRAPHIC DATA

Based on survey carried out among 1050 respondents who are working within the targeted area, a demographic table including variables like age, gender, ethnicity, education level, industry background and duration of working experience are tabulated as shown in Table 4.1.

Table 4.1 Demographic Data of Respondents (General Information)

	Variables	Count (n)	Percentage (%)
Age Group	21 - 30	703	67
	31 - 40	240	22.9
	41 - 50	90	8.6
	51 - 70	17	1.6
Gender	Male	484	46.1
	Female	566	53.9
Ethnicity	Malay	536	51
	Chinese	354	33.7
	Indian	149	14.2
	Others	11	1.0
Educational Level	University	602	57.3
	Others	476	42.7
Industry Background	Manufacturing	61	5.8
	Servicing	978	93.1
Duration Working Experience	4 – 6 Years	920	87.6
	Others	130	12.4

As refer to Table 4.2, for building information, most of the respondents working in high rise buildings such as shop lots, which are less than 5 storey. The percentage of the respondents who work in this type of building is 42.5%, high rise building which is more than 5 stories is 37.2 % (n=391) and landed building is 20.3% (n=213). For ventilation system used in their workplace, air conditioning system contributes 56% (n=588), using only fans is 6.7% and usage of both systems for their workplace ventilation is 36.2% (n=380).

Table 4.2 Demographic Data of Respondents (Building Information)

	Variables	Count (n)	Percentage (%)
Type of Building	Landed Building	213	20.3
	High Rise (< 5 storeys)	446	42
	High Rise (> 5 storeys)	391	37.2
Building HVAC	Air-conditioning	588	56
	Fan	70	6.7
	AC + Fan	380	36.2
Staff in Building	< 19 workers	453	43.1
	20 – 100	422	40.2
	101 – 200	162	15.4
	200 above	12	1.1
Mode of Transport	Car	538	51.2
	Motorcycle	297	28.3
	Public Transport	186	17.7
	Others	29	2.6

For the number of workers working in the same building with respondent, it is divided by 4 categories. The organization which is have above 200 workers is 1.1% (n = > 200 workers), less than 200 workers but above 101 workers is 15.4% (n = 162), less than 100 workers but above 20 workers, 40.2% (n = 422) and less than 19 workers is 43.1%, (n = 453).

For the transportation to work place, almost 51.2 % (n = 538) respondent use a car to go to workplace. 2nd highest transportation used is motorcycle which is 28.3% (n = 297) followed by public transport 17.7% (n = 186) & others 2.6% (n = 29).

4.2 EXPERIENCE OF URBAN HEAT ISLAND PHENOMENON

UHIs have the potential to directly influence the health and welfare of urban residents. Within the United States alone, an average of 1,000 people dies each year due to extreme heat. As UHIs are characterized by increased temperature, they can potentially increase the magnitude and duration of heat waves within cities. Research has found that the mortality rate during a heat wave increases exponentially with the maximum temperature, an effect that is exacerbated by the UHI. The nighttime effect of UHIs can be particularly harmful during a heat wave, as it deprives urban residents of the cool relief found in rural areas during the night.

Research in the United States suggests that the relationship between extreme temperature and mortality varies by location. Heat is more likely to increase the risk of mortality in cities in the northern part of the country than in the southern regions of the country. For example, when Chicago, Denver, or New York experience unusually hot summertime temperatures, elevated levels of illness and death are predicted. In contrast, parts of the country which are mild to hot all year-round have a lower public health risk from excessive heat. Research shows that residents of southern cities, such as Miami, Tampa, Los Angeles, and Phoenix, tend to be acclimated to hot weather conditions and therefore less vulnerable to heat related deaths. However, people in the United States appear to be adapting to hotter temperatures further north each decade. However, this might be due to better infrastructure, more modern building design, and better public awareness.

As stated in the table 4.3, almost 90% of respondent is aware about the Urban Heat Island phenomenon. They noticed that the climate change affect their activity and lifestyle. Only 7.5% (n = 72) respondent didn't know due to inability to understand the climate change and 2.5% (n = 26) was not aware about the situation.

Table 4.3 Demographic Data of Respondents (Experience of UHI phenomenon)

	Variables	Count (n)	Percentage (%)
Awareness	Aware	945	90
	Not aware	26	2.5
	Don't know	72	6.9
Experience	Temperature Increase	1027	97.8
	Raining Pattern Change	902	85.9
	Wind Pattern Altered	528	50.3
	Water Decreased	1011	96.3
	Haze Increased	1008	96.0
	Air Pollution Amplified	979	93.2

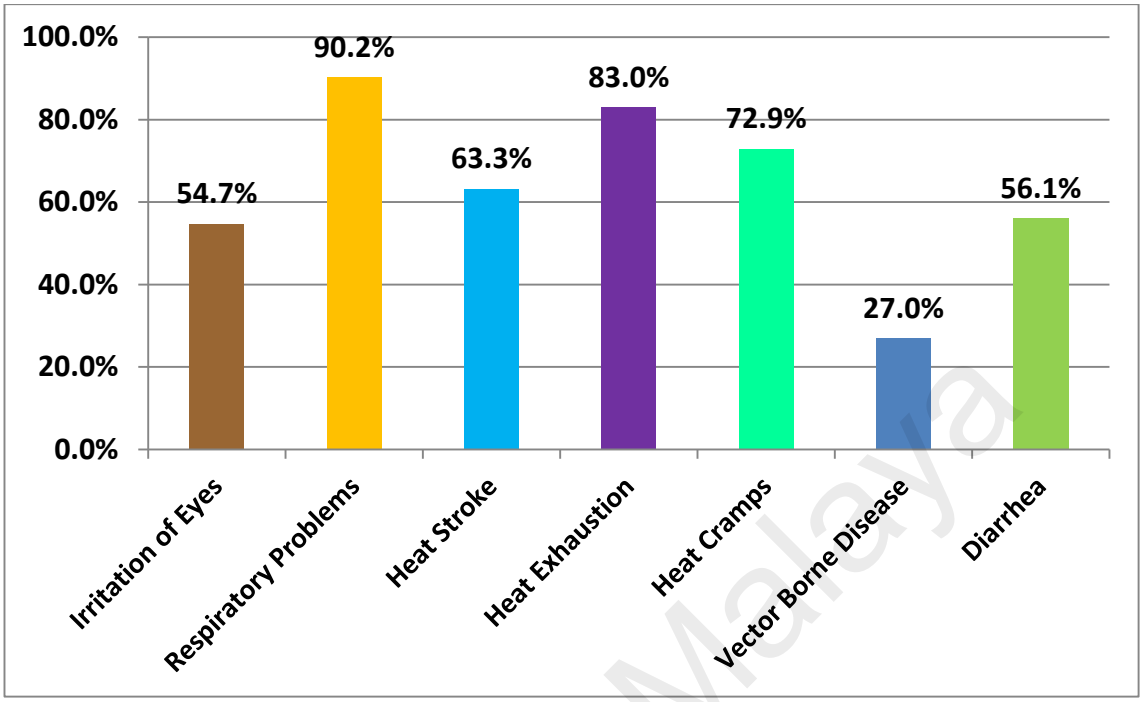
Most of the respondents agree that surrounding temperature increases due to UHI (Urban Heat Island) phenomenon. Almost 97.8% (n = 1027) of respondents agree about one of the effects of UHI phenomenon. 85.9% (n = 902) agreed that the raining pattern is changed which is not the same previously when rainfall is usually associated to raining season. The change of the raining pattern is caused by altered wind pattern which is agreed by 50.3% of respondents (n = 528). The water supply received by residential areas is also decreased due to the effect of UHI. This is agreed by 96.3% of respondents (n = 1011) and supported by increasing of haze incident this year which was agreed by 96% of respondents (n = 1008). It also caused the number of air pollution to be amplified which was noted by 93.2% of respondents (n = 979).

Urban heat islands also had an impact to personal physical health and it was shown in this analysis. As refer to Table 4.4, the impact of UHI Phenomenon is included eye irritation, respiratory problem, heat stroke, heat exhaustion, heat cramps, vector borne disease and diarrhea. 90.2% (n = 947) of respondents agreed that respiratory problem is the highest health impact effect from UHI. Followed by heat exhaustion 83% (n = 872), heat cramps 72.9% (n = 765), heat stroke 63.3% (n=665), and diarrhea 56.1% (n = 588). Eye irritation is also the impact cause by UHI. 54.7% (n=573) respondent agreed and 27% (n = 283) from 1050 respondent agreed that vector borne disease is the lowest physical impact effect from UHI phenomenon.

Table 4.4 Demographic Data of Respondents (Personal Health Impact of UHI phenomenon)

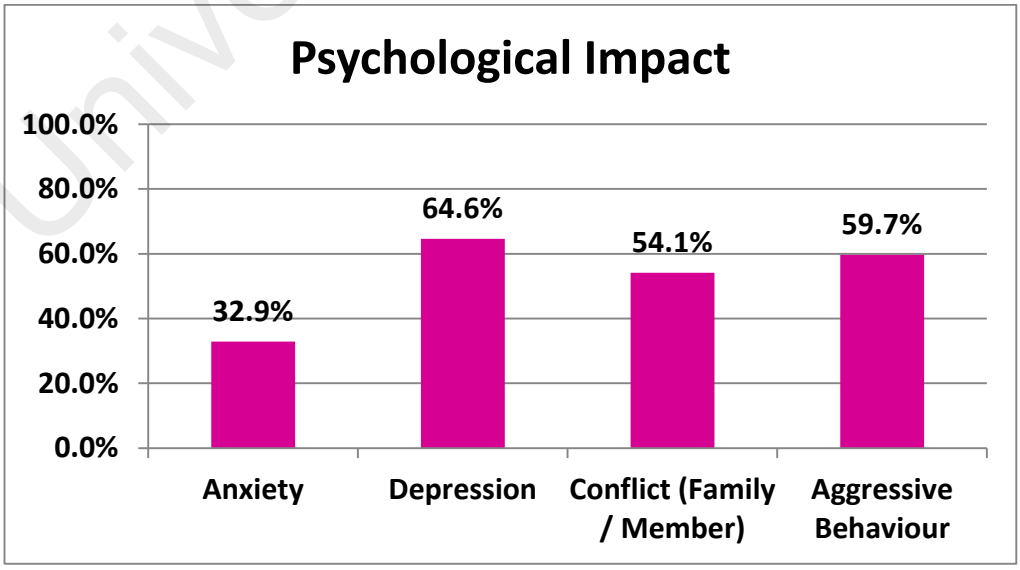
	Variable	Count (n)	Percentage (%)
Physical Impact	Eye Irritation	573	54.7
	Respiratory Problem	947	90.2
	Heat Stroke	665	63.3
	Heat Exhaustion	872	83
	Heat Cramps	765	72.9
	Vector Borne Disease	283	27
	Diarrhea	588	56.1
Psychological Impact	Anxiety	345	32.9
	Depression	678	64.6
	Family Conflict	567	54
	Aggressive Behavior	626	59.7
Social Impact	Decrease Mingling	635	60.5
	Reduce Outdoor Activity	951	90.6
	Skip work/school	599	57

Figure 4.1 : Personal Health Impact of UHI (percentage of respondent experience)



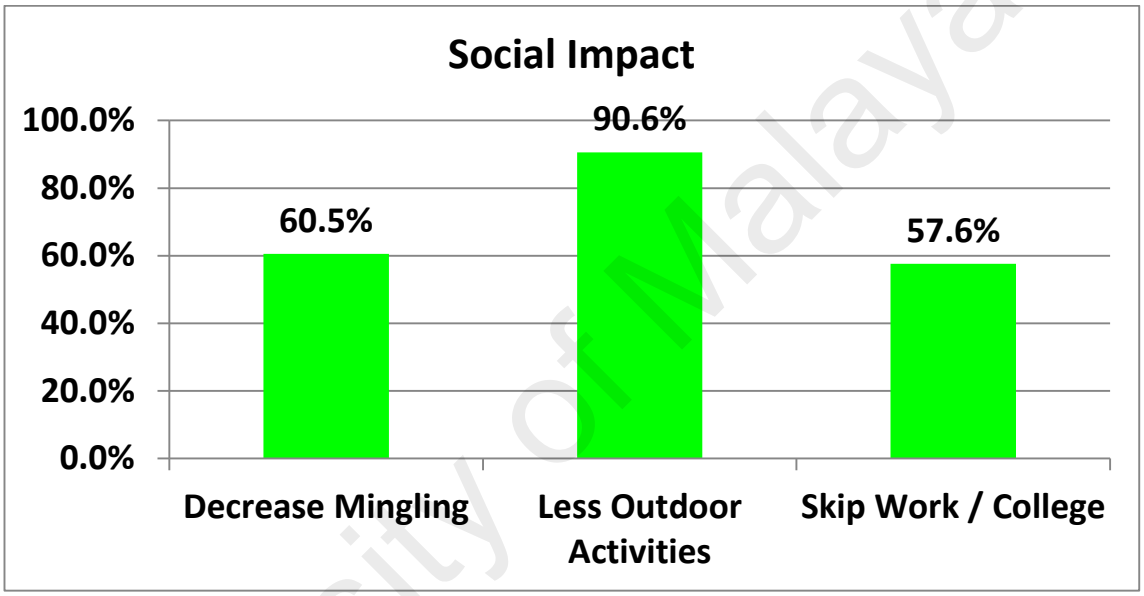
For psychological impact, the respondent agreed that depression is the highest impact due to urban heat island phenomenon (64.6%, n = 678) followed by aggressive behavior 59.7%, family conflict (54%, n = 567) and anxiety 32.9% (n = 345) respondent.

Figure 4.2 : Psychological Impact of UHI (percentage of respondent experience)



For social impact due to urban heat island phenomenon, 90.6% (n = 951) of respondents reduce their outdoor activity, 60.5% (n = 635) noted decreased mingling and 57% (n = 599) skipped work/school. The number of respondents are not affected in terms of social impact due to this phenomenon is quite impressive. They made up less than 50% of respondents and they noted having to struggle to face this situation.

Figure 4.3 : Social Impact of UHI (percentage of respondent experience)

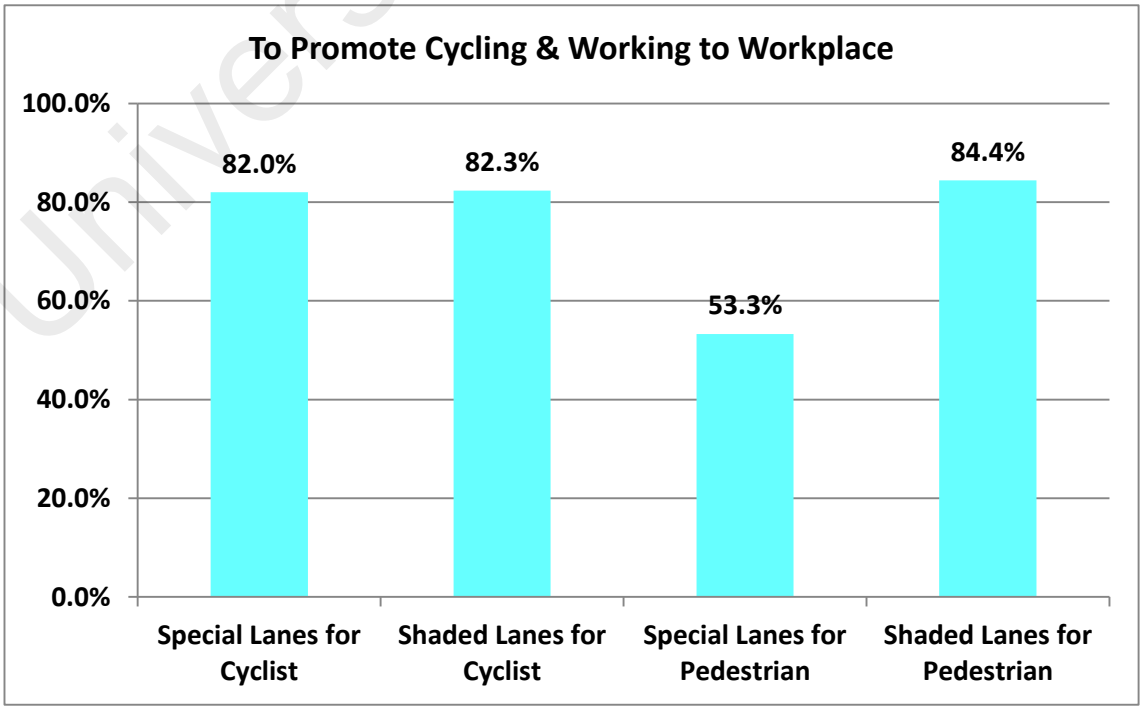


To support the green house campaign, walking and cycling activities should be encouraged among industry workers. As refer to table 4.5, cycling promotion program, 59.9% (n = 629) informed that the facility i.e. special lanes for bicycles are not enough and need to be increased. Only 11% (n = 115) of respondents are satisfied about the facility near their workplace. 22.1% (n = 232) of respondents clarified that they don't have that facility at their workplace and required it. Only 7% (n = 74) of respondents feel that they have no need for the facility to be near their workplace.

Table 4.5 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – Promote Cycling & Walking

Variables		Count (n)	Percentage (%)
Special Lanes for Bicycle	Have (Enough)	115	11.0
	Have (Not Enough)	629	59.9
	Don't have (Need)	232	22.1
	Don't have (No Need)	74	7.0
Shaded Bicycle Lanes	Have (Enough)	111	10.6
	Have (Not Enough)	176	16.8
	Don't have (Need)	688	65.5
	Don't have (No Need)	75	7.1
Lanes for Pedestrian	Have (Enough)	456	43.4
	Have (Not Enough)	349	33.2
	Don't have (Need)	211	20.1
	Don't have (No Need)	34	3.2
Shaded Pedestrian Lanes	Have (Enough)	129	12.3
	Have (Not Enough)	254	24.2
	Don't Have (Need)	632	60.2
	Don't have (No Need)	35	3.3

Figure 4.4 : Percentage of Respondent needs : Related to promote cycling and walking to workplace.



For shaded bicycle lanes, almost 27% of respondents realize that they knew that the facility is near their workplace while 16.8% (n = 176) of respondents believe that the number of those facilities need to be increased and 10.6% (n = 111) mention that it is sufficient. Almost 72.6% respondent claim that they didn't see the shaded bicycle lanes near their work place while 65.5% of the respondents need the facility, another 75 respondents (7.1%) don't want it.

For the pedestrian lanes, almost 43.4% (n = 456) of respondents agree that it is sufficient. Another 33.2% (n = 349) mentions that the facility is not enough and needs to be added. 20.1% (n = 211) of respondents claim that they don't see this facility near their workplace and required it. Only 3.2% (n = 34) of respondents claim that they don't want this facility.

For the shaded pedestrian lanes, 60.2% (n = 632) respondent mention that facility is limited near their workplace. They agreed that the shaded pedestrian lanes will encourage people to walk to their workplace. 24.2% (n = 254) of respondents informed that the facility is provided at their work place but they need more. Another 12.3% (n = 129) responded and informed that the facilities are enough and sufficient. Only 3.3% (n = 35) of respondents don't need that facility.

For workers who commute using public transports, a number of criteria were listed for respondents to get their feedback. One of the criteria is having public transport routes which cover all main areas from working areas to activity center like workplace, shopping complex or recreational park. As shown in table 4.6, 43.9% (n = 461) of respondents claim that they are satisfied with the current public transport routes while another 32.9% (n = 345) informed that the routes are still insufficient. 22.1% (n = 232) of respondents informed that the routes are not many and insufficient while another 1%

(n = 11) of respondents didn't have this problem and are satisfied with the current routes.

Table 4.6 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – To encourage public transport

	Variables	Count (n)	Percentage (%)
Routes Cover All Main Areas	Have (Enough)	461	43.9
	Have (Not Enough)	345	32.9
	Don't have (Need)	232	22.1
	Don't have (No Need)	11	1.0
Station near to workplace (Walking Distance)	Have (Enough)	132	12.6
	Have (Not Enough)	656	62.5
	Don't have (Need)	251	23.9
	Don't have (No Need)	11	1.0
Station near to activity center	Have (Enough)	130	12.4
	Have (Not Enough)	645	61.4
	Don't have (Need)	262	25
	Don't have (No Need)	13	1.2
Short Time Waiting Interval	Have (Enough)	160	15.2
	Have (Not Enough)	616	58.7
	Don't have (Need)	255	24.3
	Don't have (No Need)	19	1.8

For the public transport stations which are near to the workplace (walking distance), 62.5% (n = 656) of respondents need that facility to be increased. Only 12.6% (n = 132) of respondents are satisfied with the distance of the public transport station. Another 24.9% of respondents mention that the station is too far from their workplace while 23.9% (n = 251) needs that station to be near and 1% (n = 11) of respondents don't require public transports.

Another criterion that respondents choose in this analysis is the closeness of activity centers (within walking distance) to public transport stations. 73.8% of respondents agreed about it where 12.4% (n = 132) is satisfied with the distance, while another 61.4% (n = 645) of respondents want the numbers of station to increase. 25% (n = 262) of respondents claim that they didn't have that kind of station available and need it and another 1.2% (n = 13) of respondents don't want this facility.

For public transport service with short time intervals, number of respondent agreed is 73.9% where 15.2% (n = 160) respondent satisfy with the frequent interval and another 58.7% (n = 616) respondent still need the time to be improve. Another 24.3% (n = 255) respondent don't have this experience and required this criterion and only 1.8% (n = 19) respondent don't have any problem and satisfied with this interval time.

The table 4.7 shows the community needs assessment related to increasing the number of vegetation inside building which can reduce the effect of urban heat island. For buildings, they have created small landscape areas for planting vegetation inside them. 36.2% (n = 380) of respondents inform that their workplace has indoor plants and are sufficient while only 26.7% (n = 280) of respondents need that implementation in their workplace to be increased. Another 26.7 % (n = 280) of respondents mention they have no indoor plants in their workplace and need to have them if possible while 10.5% (n = 110) of respondents think that plants are unnecessary.

Table 4.7 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – To Increase Vegetation (Internal: Inside Building / Workplace)

	Variables	Count (n)	Percentage (%)
Indoor Plants Inside Building	Have (Enough)	380	36.2
	Have (Not Enough)	280	26.7
	Don't Have (Need)	280	26.7
	Don't Have (No Need)	110	10.5
Nature-based Landscape	Have (Enough)	45	4.3
	Have (Not Enough)	466	44.4
	Don't Have (Need)	432	41.2
	Don't Have (No Need)	106	10.1
Mini Garden Outside / Balcony	Have (Enough)	44	4.2
	Have (Not Enough)	420	40
	Don't Have (Need)	512	48.8
	Don't Have (No Need)	73	7.0

For nature-based landscape, 44.4% (n = 466) of respondents agreed that their workplace have those areas but are still inadequate. Only 4.3% (n = 45) of respondents agreed that nature-based landscape in their work place is sufficient. For respondents who clarify having no nature-based landscape in their workplace, almost 41.2% (n = 432) said that they have no nature-based landscape and need to implement it if applicable and 10.1% (n = 106) said that there is no need to have that area.

48.8% (n = 512) of workers respond that mini garden outside or in the balcony area is not sufficient and need to increase the implementation. 7% (n = 73) of workers agreed that they have no need for that area of vegetation. 44.2% of other respondents mention they have that area where 44 workers (4.2%) said what they have is enough while the rest 40% (n = 420) agreed that the implementation still not enough and need to be added.

6 criteria are chosen for respondents to select as shown in Table 4.8. One of those criteria is vegetation planting around the workplace building. 67.3% (n = 705) of respondents recognize that they have no vegetation plant around the building and they agreed to have it while only 28.7% (n = 294) clarified that they have vegetation planted around the workplace building. 5.2% (n = 55) of respondents are satisfied and 23.5% (n = 246) of respondent claim the needs to improve. Another 4% (n = 42) of respondents doesn't have and doesn't need vegetation plant around the workplace building.

Table 4.8 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – To Increase Vegetation (External: Outside Building / Workplace)

	Variables	Count (n)	Percentage (%)
Plants Around Building	Have (Enough)	55	5.2
	Have (Not Enough)	246	23.5
	Don't Have (Need)	705	67.3
	Don't Have (No Need)	42	4
Plants On Top of Roof	Have (Enough)	15	1.4
	Have (Not Enough)	76	7.2
	Don't Have (Need)	707	67.4
	Don't Have (No Need)	251	23.9
Plants at Spot (People) Area	Have (Enough)	25	2.4
	Have (Not Enough)	195	18.6
	Don't Have (Need)	341	32.5
	Don't Have (No Need)	489	46.6
Plants Along the Street	Have (Enough)	353	33.6
	Have (Not Enough)	304	29
	Don't Have (Need)	287	27.3
	Don't Have (No Need)	106	10.1
Small Garden at Workplace	Have (Enough)	39	3.7
	Have (Not Enough)	131	12.5
	Don't Have (Need)	831	79.1
	Don't Have (No Need)	49	4.7
Nearby Sport / Recreational Park	Have (Enough)	32	3
	Have (Not Enough)	568	54.1
	Don't Have (Need)	416	39.6
	Don't Have (No Need)	34	3.2

For green roof or green wall, almost 90% of respondents informed that their building didn't practice it. 67.4% (n = 707) of respondents request to have it while 23.9% (n = 251) of respondents don't want to have it. Only 8.6% of the respondents agreed that their building have the green roof and wall but only 7.2% (76) of respondents want the practice to be implemented more aggressively.

Again, for the spot area where people usually get together at workplace, the planting of vegetation around that area is also an option for the respondent. Almost 46.6% (n = 489) of respondents claim that they don't have this kind of area and don't want it while another 32.5% (n = 341) of respondents want this area to be "green". 18.6% (n = 195) informed that they have this type of area and need to increase it and 2.4% (n = 25) of respondents believe that is sufficient.

The walkways along the street also need to be planted with vegetation. 33.6% (n = 353) respondents believe that street landscape is sufficient while another 29% (n = 304) said they need to add more plants. Another 27.3% (n = 287) of respondents claim the walkway landscape is not implemented and request to have it and another 10.1% (n = 106) of respondents think that practice is not necessary at all.

To have a small garden at workplace is another option that is provided to respondents for this analysis. Almost 79.1% (n = 831) of respondents mention that they didn't see any small garden in their workplace but agreed that needs to be done. Only 4.7% (n = 49) of respondents think that it is not necessary yet. While 12.5% (n = 131) of respondents claim that their workplace has a small garden but is still insufficient. Only 3.7% (n = 39) of respondents are satisfied with the small garden in their workplace.

To stimulate the workers, and add balance in their life, the question regarding about sports or recreational park facility and distance between workplace is taken into account. Almost 54.1% (n = 568) of respondents informed that they know about the facility, but it is not near their workplace. They request to have more additional park for outdoor exercise or activities. Only 3% (n = 32) of respondents are satisfied about the facility they have near to their workplace. 42.8% of respondents claim that they didn't have this type of facility where 39.6% (n = 416) requests to build this facility and another 3.2% (n = 34) of respondents didn't want it.

The other aspect that the community needs for dealing with the urban heat island phenomenon is the suitability of material used for internal building which includes operable windows for natural air ventilation, curtain or blind and solar panel to reduce the effects of UHI. 44% (n = 462) of respondents agreed that number or operable windows and opening in their workplace is sufficient while only 21.9% (n = 230) thinks they need to have more. Refer Table 4.9, percentage of respondent needs assessment recorded.

Table 4.9 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – Usage of Suitable Building Material – Internal Building

	Variables	Count (n)	Percentage (%)
Operable Window / Opening	Have (Enough)	462	44
	Have (Not Enough)	230	21.9
	Don't Have (Need)	264	25.1
	Don't Have (No Need)	94	9
Curtain or Blind	Have (Enough)	479	45.6
	Have (Not Enough)	222	21.1
	Don't Have (Need)	319	30.4
	Don't Have (No Need)	30	2.9
Solar Panel	Have (Enough)	53	5
	Have (Not Enough)	78	7.4
	Don't Have (Need)	847	80.7
	Don't Have (No Need)	72	6.9

Other than that, 25.1 % (n = 264) of respondents mention that their workplace doesn't have sufficient opening and needs to increase the number while another 9% (n = 94) of workers believe that they have no need for that item.

For curtain and blind, 45.6 % (479) of respondents believe that the items are sufficient whereby only 21.1 % (n = 222) wants the usage of blinds or curtains to be increased in their building. 2.9% (n = 30) of workers don't think that they need those items but 30.4% (n = 319) of respondents whose workplace doesn't have any blind or curtain believe that the item would help them to reduce the effect of urban heat island.

Solar panel is the action and commitment from the government to reduce the effect of urban heat island and help to maximize usage of natural resources. But the implementation was not up to expectation due to high costs of installation and maintenance. Almost 80.7% (n = 847) of respondents realize that their workplace don't have any solar panel system and needs that facility while another 6.9% (n = 72) of workers don't think that system can provide much help. Only 5% (n = 53) of respondents informed that their building have the system and is sufficient but another 7.4% (n = 78) of workers believe that the system need to be used more in their building.

As refer to table 4.10, for the external usage of suitable building material, the respondents were given 3 categories to be chosen as answers i.e. the material used for the outside wall, the colour of the wall of own-building and the colour of wall of the surrounding buildings. For outer wall that uses solar reflective material to reduce heat absorption to respondents' workplace, almost 77.2% of respondents mention not having them, in which 38.8% (n = 407) propose to have that material and 38.4% of respondents (n = 403) mention no need to have that type of material used for outer wall of workplace

building. Only 22.9 % mention that their workplace building is built with solar reflective material where 9.9% of respondent claim it still not enough and need to increase the usage of the material.

Table 4.10 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – Usage of Suitable Building Material – External Building

	Variables	Count (n)	Percentage (%)
Outer Wall (Sun's Rays)	Have (Enough)	136	13
	Have (Not Enough)	104	9.9
	Don't Have (Need)	407	38.8
	Don't Have (No Need)	403	38.4
Light Color (Outer Wall) Own Building	Have (Enough)	263	25
	Have (Not Enough)	106	10.1
	Don't Have (Need)	613	58.4
	Don't Have (No Need)	68	6.5
Light Color (Outer Wall) Surrounding Building	Have (Enough)	250	23.8
	Have (Not Enough)	126	12
	Don't Have (Need)	611	58.2
	Don't Have (No Need)	63	6

For usage of light colour for outer wall, 58.4% (n = 613) out of 25% (n = 263) agreed that their workplace building doesn't use light colours for the walls. 10.1 % (n = 106) of respondents mention that their building is painted with light colours but is still not enough and only 6.5% say that their workplace building is not painted with light colour and have no need for it.

The same case goes for surrounding building, where 58.2% (n = 611) of respondents agreed that not many buildings surrounding their workplace use light colours and their agreed to the needs to increase the usage of light colour. Almost 250 respondents (23.8%) realise that surrounding building use a light color and they think that it is enough and sufficient while 12% (n = 126) believe that the number of buildings with the

light color for walls needs to be increased. Only 6% (n = 63) respondent didn't want to have a light color for surrounding building as their option.

For health information content provided to the public, 56.8% of respondent (n=56.8) agreed that information related to UHI causes have been given but not enough. Only 5.4% (n=57) of respondents claim that information provided to public is enough. 36.7% of respondents mention that information is not enough and needs to be provided. Refer table 4.11 shown below.

Table 4.11 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – Health Information Contents

	Variables	Count (n)	Percentage (%)
Info (UHI Causes)	Have (Enough)	57	5.4
	Have (Not Enough)	596	56.8
	Don't Have (Need)	385	36.7
	Don't Have (No Need)	12	1.1
Info (UHI Effect to Health)	Have (Enough)	377	35.9
	Have (Not Enough)	275	26.2
	Don't Have (Need)	388	37
	Don't Have (No Need)	9	0.9
Info (Measures Taken)	Have (Enough)	55	5.2
	Have (Not Enough)	264	25.1
	Don't Have (Need)	728	69.3
	Don't Have (No Need)	3	0.3

For information related to effects to health due to UHI phenomenon, 377 respondents (35.9%) agreed having enough information, 26.2% (n=275) have information but insufficient, 37% (388 of respondents mention not having and need information to be provided, and only 0.9% mention that no information related to effect to health cause by UHI is provided and does not need to be provided.

For information regarding about action taken for prevention of UHI, 69.3% (n = 728) of respondents mention that they don't have information provided to them and they

need that information to take precautionary action. 25.1% (n = 264) of respondents mention that they have information but it is not enough for them. Only 5.2% (n = 55) of respondents are satisfied by the sufficient information provided to them and 0.3% claim having no information and no need for that information regarding measures to be taken to overcome the risk of urban heat island (UHI).

To promote green urban landscape, people need proactive action to be taken by effectively using any communication channels such as mass media, social media, seminar or program which can distribute the information regarding urban heat island and how to manage it. Table 4.12 shown below about Urban Heat Island information between community and authority.

Table 4.12 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – Urban Heat Island Communication

	Variables	Count (n)	Percentage (%)
Through Mass Media	Have (Enough)	46	4.4
	Have (Not Enough)	274	26.1
	Don't Have (Need)	399	38
	Don't Have (No Need)	331	31.5
Through Social Media	Have (Enough)	44	4.2
	Have (Not Enough)	586	55.8
	Don't Have (Need)	417	39.7
	Don't Have (No Need)	3	0.3
Communication at School	Have (Enough)	48	4.6
	Have (Not Enough)	563	53.6
	Don't Have (Need)	436	41.5
	Don't Have (No Need)	3	0.3
Visiting / Community Program	Have (Enough)	24	2.3
	Have (Not Enough)	522	49.7
	Don't Have (Need)	448	42.7
	Don't Have (No Need)	56	5.3

The respondents agreed that communication via mass media is not enough where 38% (n = 399) of respondents needs the relevant person or organization to take

proactive action. They also believe 55.8% (n = 586) that communication through social media such as Facebook, Twitter or Instagram is there but still needs to be improved and optimized. Almost 53.6% (n = 563) of respondents also agreed that to distribute the information about Urban Heat Island, it should begin at school and needs to be sufficient.

Another action proposed to the respondents in communicating with public regarding the urban heat island is community programs. 49.7 % (n = 522) of respondents noted the programs conducted by NGO or other parties but still needs to be increased and be more effective. Another 42.7% (n = 448) of respondents informed that community program is lacking and need more to be conducted to share the information about urban heat island.

To promote the green urban landscape, few items are taken into account where the community needs and opinion is taken such as government incentives, penalty enforcement, green roof and wall practice, and surrounding vegetation planting. Below is a table shown that the result of the survey regarding this matters.

Table 4.13 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – To promote Green Urban Landscape

	Variables	Count (n)	Percentage (%)
Government Incentive	Have (Enough)	16	1.5
	Have (Not Enough)	570	54.3
	Don't Have (Need)	414	39.4
	Don't Have (No Need)	50	4.8
Penalty Enforcement	Have (Enough)	12	1.1
	Have (Not Enough)	604	57.5
	Don't Have (Need)	394	37.5
	Don't Have (No Need)	40	3.8
Green Roof	Have (Enough)	9	0.9
	Have (Not Enough)	92	8.8
	Don't Have (Need)	834	79.4
	Don't Have (No Need)	115	11
Green Wall	Have (Enough)	11	1.0
	Have (Not Enough)	98	9.3
	Don't Have (Need)	825	78.6
	Don't Have (No Need)	116	11
Surrounding Vegetation Planting	Have (Enough)	16	1.5
	Have (Not Enough)	206	19.6
	Don't Have (Need)	791	75.3
	Don't Have (No Need)	37	3.5

The community response related to government incentives also was shocking where 54.3% (n = 570) of the respondents agreed to have that incentive but needed to prolong the scheme while only 1.5% (n = 16) are satisfied with that. Almost 39.4% (n = 414) respondent are unaware about that incentive scheme and agreed if the government provides them and only 4.8% (n = 50) of respondents don't think that incentives are necessary for them.

57.5% (n = 604) of respondents realize that penalty enforcement action for removing green areas in work place is taken and only 1.1 % (n = 12) agreed that it is sufficient. Another 37.5% (n = 394) believes that there was no penalty for removing green areas in

the workplace and needs that enforcement while another 3.8% (n = 40) doesn't think that it is necessary to implement.

For 79.4% (n = 834) of respondents, they believe that to promote green urban landscape, green roof is a good practice. Same as walls, almost 78.6% (n = 825) of respondents agreed that having green walls is also the best practice that can promote green urban landscape in the workplace. As commitment from all parties, surrounding vegetation planting is also needed to be implemented systematically to ensure the green environment not only in the workplace, but surrounding the work area too, as is the best way to promote green urban landscape. Table 4.14 below shown another method to promote green urban landscape in workplace.

Table 4.14 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – To promote Green Urban Landscape (Cont. 1)

Variables		Count (n)	Percentage (%)
Using Solar Reflective Material	Have (Enough)	25	2.4
	Have (Not Enough)	150	14.3
	Don't Have (Need)	835	79.5
	Don't Have (No Need)	40	3.8
Lighter Color Material / Painting	Have (Enough)	138	13.1
	Have (Not Enough)	115	11
	Don't Have (Need)	730	69.5
	Don't Have (No Need)	67	6.4
Developers use design strategy	Have (Enough)	31	3
	Have (Not Enough)	235	22.4
	Don't Have (Need)	762	72.6
	Don't Have (No Need)	22	2.1
Developers use South-East Orientation	Have (Enough)	28	2.7
	Have (Not Enough)	219	20.9
	Don't Have (Need)	772	73.5
	Don't Have (No Need)	31	3

Respondent also agreed that most of the building did not using solar reflective material for their building where 79.5% (n = 835) of respondents believe this is one of the action that should be taken to promote green urban landscape in their workplace. 69.5% (n = 730) of respondents agreed that most of the buildings did not use the light color material or painting which, in their point of view, is necessary to deal with this phenomenon.

The most important thing that can realize all this practice is involvement and commitment from developers. 72.6% of respondents realize that developers did not use design strategy to promote green urban landscape and they believe the rules and regulation for them to allow direct flow air in working area development is needed. They also agreed that other rules and regulation to promote green urban landscape should be enforced on developers which is to use designs with south-eastern orientation.

Table 4.15 Demographic Data of Respondents (Community Needs Assessment - UHI Phenomenon) – To promote Green Urban Landscape (Cont. 2)

	Variables	Count (n)	Percentage (%)
Enforcement (Rules: Urban Growth Limit; Congested Building	Have (Enough)	29	2.8
	Have (Not Enough)	222	21.1
	Don't Have (Need)	779	74.2
	Don't Have (No Need)	20	1.9
Enforcement (Rules: Urban Growth Limit; Congested Traffic	Have (Enough)	25	2.4
	Have (Not Enough)	218	20.8
	Don't Have (Need)	786	74.9
	Don't Have (No Need)	21	2.0
Enforcement (Rules: Urban Growth Limit; Congested People	Have (Enough)	29	2.8
	Have (Not Enough)	219	20.9
	Don't Have (Need)	784	74.7
	Don't Have (No Need)	18	1.7

Another important matter that the community needs to promote green urban landscape is enforcement of rules which is focused on control of new development

related to area which is already congested with building, congested with traffic and congested with people. For those area which are already congested with building, the respondents believe that the enforcement of rules for an urban growth limit is needed where 74.2% (n = 779) of respondents think no enforcement is implemented yet. They also believe that no enforcement of rules are practiced in areas which are congested with traffic, 74.9% (n = 786) such as Kuala Lumpur, where the development is still on going until today. In areas congested with building and traffic, it also will be congested with people where 74.7% (n= 784) of respondents need practical rules to be enforced in terms of an urban growth limit which can contribute to green urban landscape and environment developing in their workplace.

CHAPTER FIVE

DISCUSSION

5.1 DEMOGRAPHIC DATA DISTRIBUTION

Based on the results obtained from previous chapter, most of the factory workers in this study are males with an age range between 21 and 31. Most of them are married but have no children in the family to bear. Based on racial background, different races have been recorded but it was noted that 'Malay Ethnic' comprised the most population among 1050 respondents (n=539, 51.3%). It was recorded that many other races have been working in Malaysia including Bangladeshis, Indonesian, and Nepalese.

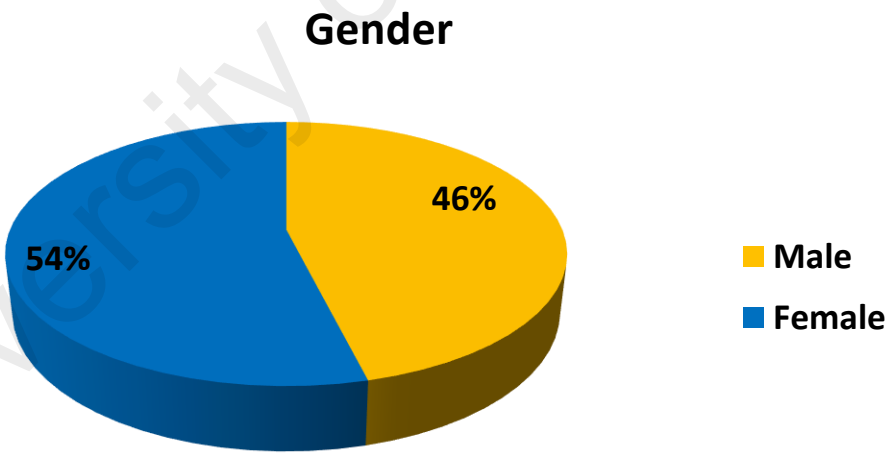


Figure 5.1 : Gender of Respondent

The percentage of the respondent is near to equivalent where 54% respondent is female while another 46% is male. This can conclude that the respondent interviewed mostly is a woman.

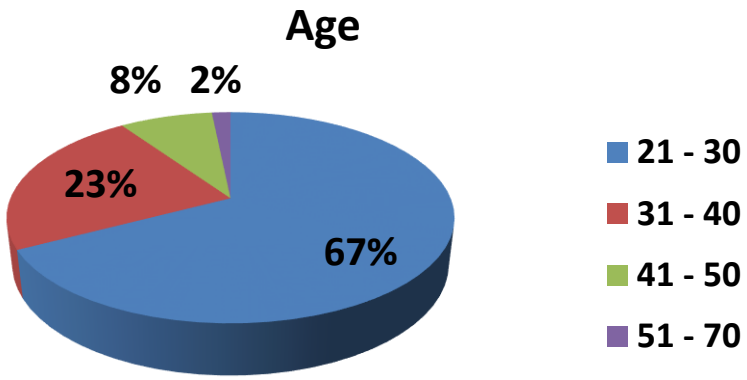


Figure 5.2: Age of Respondent

Almost 67% of respondent age is between 21 – 30 years old which can categorize by teenagers. Only 2% of the respondent is above 50 years old and some of them is already retired.

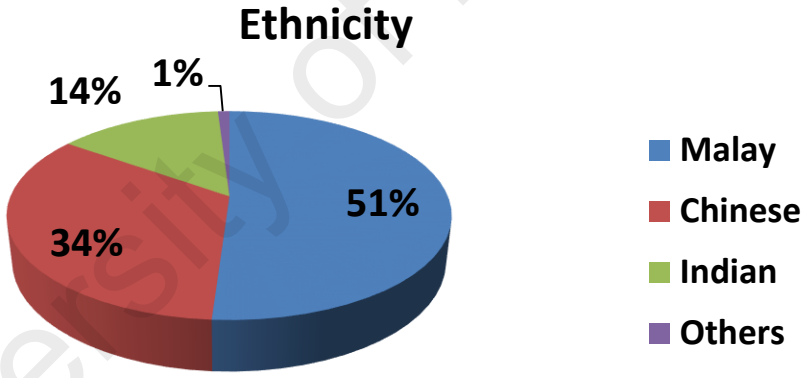


Figure 5.3: Ethnicity of Respondent

By looking at ethnicity percentage, almost 51% of respondent is Malay, while 34% is Chinese, 14% is India and 1% others. As refer to figure 5.4, most of the respondent working in Service industry where some of them need to go out and see the client or customer. From that information, conclusion about the exposure of UHI phenomenon to them is consider high and they need to ensure that prevention action taken to protect from UHI impact is sufficient.

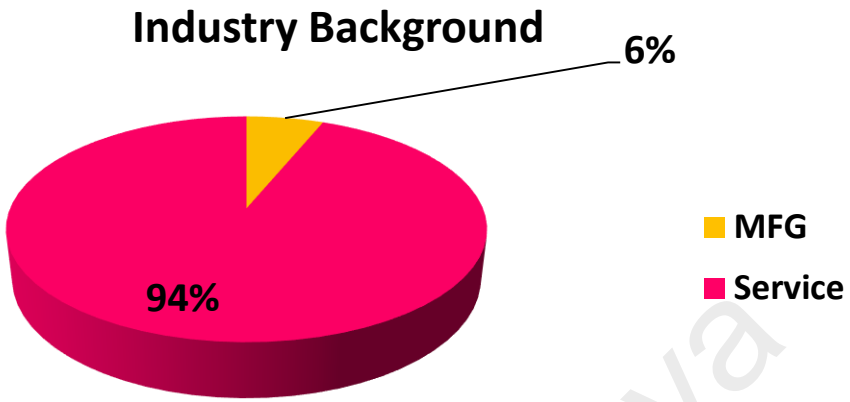


Figure 5.4: Type of Industry

Nonetheless, most of the respondents in this study have undergone proper education up to secondary level of education with some having tertiary level of education.

The level of education is vital to include in the analysis as this might affect pump attendants risk perception at work place with the knowledge they gained. It is important for them to understand the training their employers had given and conducted to them from time to time, so that the factory worker is able to understand the threat heat island phenomenon brings and protect against it.

5.2 EXPOSURE DURATION TO URBAN HEAT ISLAND PHENOMENON

This career requires working periods at an average of eight hours per day and six days per week. As factory workers work most of the time at forecourt area, it is estimated that they have been exposed to heat island phenomenon for 72 hours every week for years. Correlation analysis demonstrated association between health impacts

experience and total exposure duration in factories. According to the result shown in this study, it is noted that a positive correlation result between total working hours per day with total health impact score. This indicates that the longer the working hours, the higher the impacts of heat island phenomenon are exposed to workers therefore deteriorating their health status.

5.3 RISK PERCEPTION

Based on the result demonstrated in Chapter Four, this survey gathered important information on respondents' 'risk perception in work place'. This includes how the employees are aware of the frequencies of training and talks given by manager either on protection against exposure to impact of heat island phenomenon or ways to decrease the threat. This part enables us to find out their opinion from their point of view whether the training or supervision is sufficient.

5.4 LIMITATIONS

This study has some limitations to be considered. Firstly, the results cannot represent all population of manufacturing and office workers as this research is done in and limited to Mont Kiara, Raja Chulan and Setia Alam area only. In this cross-sectional study, casual relationship between the factors and health impacts cannot be determined. A more detailed research on blood analysis and ambient air monitoring for factory workers is suggested to further analyse the relationship between heat island phenomenon to adverse health effects.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

As conclusion, all objective projects achieved. Information about workers basic background related to age, ethnicity, industries areas and working experience gathered. The information related to type of building, type of ventilation system used, numbers of workers work at the same building and mode of transportation to workplace also collected and recorded.

For basic knowledge of the Urban Heat Island phenomenon, almost 90% of the workers aware and have an experienced related to physical impact, psychology impact and social impact to them. As mention before, all the information related to this section are collected and recorded. With 6 command climate situation given, most of the workers realized that situation happen lately. For example, surrounding temperature increases that make them feel uncomfortable and stress. If related to raining pattern changed their realized that the season is already changed and not same as before.

From investigation conducted also the UHI phenomenon affected their physical, psychological and social behavior and activity. From their experienced, the impact to workers is very crucial and serious where can cause a lot of problems and conflict. Based on the survey conducted, 1050 respondents are experiencing the impacts including fatigue and weakness, coughing, sneezing and headache indicating effects of

exposure to heat island phenomenon which are slowly deteriorating their health. As refer to health impact, almost 90% workers have a respiratory problem which can affect their performance and efficiency to work. The depression impact also is very high where above 60% workers feel stress. This is indicating that negative character, emotional can cause a lot of uncomfortable activities. For social impact, almost 90% of workers reduce their outdoor activities.

From this research also workers needs and requirement recorded in terms of transportation aspect, increases of vegetation (internal & external) and also the material use in the building, methods of spreading out the UHI information & communication and green urban landscape promotion around the building. Almost 80% request the shaded lanes for bicycle and pedestrian. They also needs that public transport station is nearby their office and also nearby recreational park or activity center. Almost 80% workers need internal vegetation like small mini garden at balcony and landscape. 90% of workers required external plantation, small garden and nearby recreational park to be implement. For the building material, most of them agreed that solar panel technology should be implementing effectively. The selection of light color paint for internal and external wall also required by workers where they feel that can help to promote the green landscape and building and also create the green environment at their workplace.

For the distribution regarding about the Urban Heat Island phenomenon, improvement in terms of method used should be effective. Almost 90% of workers needs that information should distribute by using all related media and method to indicate, educate and alert all people about the impact of heat to human, animal and

environment in future. The aggressive program and campaign should be conducted to ensure all target person get the information clearly.

As government responsibility, the enforcement, policy and requirement for promote green landscaping should be implementing and improve. Without participant from government, the effectiveness of the method to achieve the objective might be impossible. Improvement in terms of rules and regulation, guidelines and order should be revise and amend to suit the needs of the workers and environment. With cooperation between policy maker, government and industries, the main objective of green environment will be achieve and successful.

From exposure duration aspect, with their average eight working hours per day, factory workers are receiving certain level of heat island phenomenon risks every working day. Results showed that there is a significant correlation between exposure duration and adverse health impacts.

Among 1050 respondents that participated in the survey, it was shown that Coughing, Fatigue or Weakness, Headache and Sneezing are the most experienced adverse health impact.

For other symptoms like drooling, behavioral change, coordination difficulties, irritation of nose, irritation of respiratory tract et cetera are less commonly found in factory workers.

A positive correlation is acquired between employee's risk perception on hazardous workplace environment towards total health score, marking the significant relationship between their risk perception and adverse health impact due to the exposure of heat island phenomenon. From this result it is known that factory workers are well aware that they are under exposure of heat island phenomenon daily.

From the survey conducted it was found that almost all employees are well conscious of the supervision given from factory manager. Frequent training and supervision on protection against heat island phenomenon and handling on the risk is brought from time to time, however, the quality of the training is yet to be discovered. Nevertheless, major percentage of 1050 respondents agreed that their work place environment is considered to be hazardous to health.

As human power is an irreplaceable resource that is essential in future development, therefore it is critical to encourage a more proactive and secure environment for employees to improve the working condition. As such, more information shall be gathered in future researches to reduce the elevated mortality caused by the exposure to heat island phenomenon.

6.2 RECOMMENDATION

As recommendation, a lot of prevention action should be taken to minimize the impact of urban heat island whether by personal or organization. As we know the effect of the phenomenon, we need to start explore, research and implement new things and development that can help and minimize the risk and impact. Cooperation between all parties; government, private sector and industries to comply, enforced and to develop new system is very important and seriously needed to ensure the phenomenon is under control.

Development design of building before construction is the one of the important aspect that needs consideration and concern to all parties. It involved the design of building, material used, environment assessment impact and implication to surrounding area. It is very important to ensure the effectiveness of development with systematic technology and innovation would help industries growth with very minimum impact to environment. With good cooperation from all parties; developers, authority and contractor, green building created, impact to environment decrease and living ability increase. It's also encouraged more participant and student from college, university and high education institute to do more research and analysis regarding about the green technology or system and propose for implementation.

When development design establishes and enforced, the green environment easily can be achieved and become sufficient. With proper green facilities, the level of comfort ability increase, not only to internal workers but external workers also will get the impact.

From education aspect, university or college can have a specific course where the student can learn and explore new knowledge about the green technology where it can implement to industries and development. The course can be more specific and significant to implement and productive. Each knowledge from develop country such as Germany, Europe and USA where had a high technology of the green technology can be explored and shared with university or college. The knowledge and skills then can be used for help government develop the new technology, system and practices for control the risk of impact due to urban heat island. With the knowledge learn, much specialist especially in control the environment crisis would be born and help to share their knowledge to public, industries or government for support the green practice overall.

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