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# Perception of Green Roof Users with Their Mental Well-Being

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**Abstract.** Green roofs have grown popular in developing nations as an additional green space in a city when most of the land is being considered for new building construction but it has received less attention in Malaysia. Green roofs are also publicly accessible which provides a pleasant experience in recreational places that can relieve stress and soothe mind. Thus, this paper aims to determine the level of awareness of green roof adaptation among residents in high-rise residential buildings, as well as to investigate the relationship between intensive green roofs and mental health among residents in green residential buildings. . It began by studying the literature on prior research, then collected data from a survey questionnaire on the target population. Statistical Package for Social Science (SPSS) version 27 will use to record and analyse the results of this study's attempt to address the subject. According to the findings of the studies, the majority of residents are aware of the characteristics of an intensive green roof that influence their feelings. A minority of residents have mental health issues and they prefer five personal controls to keep their minds healthy based on their feelings. The essential conclusion is that a green roof may help in ensuring the preservation of a healthy mental state.

## 1. Introduction

Environmental crises including global warming, local climate change, deforestation, air pollution, energy scarcity, and natural disasters, in tandem with a variety of socioeconomic problems, prevail in many cities [1] [2]. Due to rapid urbanization growth, the city's green space is dwindling, while the city's new construction features are increasing. Thus, create a space where those with expertise in the building trade may grow plants or other landscaping elements on the building's roof and wall facades. Two innovative ways to promote sustainability are green roofs and green walls [3]. A climate change mitigation strategy that incorporates urban greening also includes green roofs. It provides an efficient method for tackling environmental problems, as well as a novel response to the limitation of urban space and an improvement in the standard of living for people [4]. Extensive green roofs, intensive green roofs and semi-intensive green roofs are the three types of green roofs. These classifications are based on the depth, components, and maintenance requirements [5]. Based on the survey, the common green roof in Malaysia is intensive green roofs account for 77.5 % whereas extensive green roofs (22.5 %) are uncommon in the country [6].

Due to a shortage of vacant land, high-rise residential buildings commonly include green roofs in their design. In order to make the most of the limited space accessible, the podium, parking area, and rooftop are mostly provided with a garden and other attractions [7]. Based on survey done by Syumi in 2013, residential buildings are the most implemented with green roofs (46.7%), followed by commercial (43.3%) and institutional buildings (10%) in Malaysia [6]. Many professionals installed green roofs on buildings because they believe that today's generation lack awareness and appreciation for public



vegetation. Residents may demand a sense of ownership by having a garden that is accessible within a few minutes' walk of their dwellings [6].

Although Malaysia does not directly offer incentives to encourage the use of green roofs, this feature has been added as one of the requirements for the Green Building Index (GBI) and Malaysia Carbon Reduction and Environmental Sustainability Tool (MyCREST), the latter two of which serve as a part of the Building Environmental Index (BEI). Green roofs are classified as a contribution to sustainable site planning and management in the GBI (SM12). If their buildings have green roofs, they will receive two points. While green roofs are a part of the evaluation in MyCREST for preserving the natural ecology of landscape features. Green roofs help to reduce carbon emissions by storing carbon in the ground [8].

Generally, researchers noted that green roofs offer a variety of perks, including aesthetic, ecological, technological, and cost-effective benefits. [9]. Based on the survey by S. R. A. Rahman in 2013, green roofs are useful as an alternative green area in a metropolis when most of the land is being explore for new building development according to urban planners [6]. They believe green roof might serve as a leisure space for urban folk. Green roofs provide a pleasant environment for tenants and residents of surrounding structures. When they are available to the public, they may also provide relaxation and recreation, helping to relieve tension and soothe the mind. There is mounting evidence that visual and physical interaction with natural greenery has significant mental health benefits as well as an overall sense of well-being. Living or green roofs might improve contact and allow a roof space for more efficient use, which is fine [10].

This benefit seeks to advance environmental policies and energy, among others towards specific objectives. The following objectives stand out: to identify the level of awareness of green roof adaptation among residences in high-rise residential building and to investigate the relationship between intensive green roofs and mental health among the residents in the green residential building. The study focused on the level of awareness for green roof adaptation and the improvement of mental health among the residents with the intensive green roof in green residential building at Nusajaya, Iskandar Malaysia. Given the vast scope of the objectives, a survey for the level of awareness of green roof adaptation and improvement of mental health among residents with intensive green roofs in green residential buildings will be conducted through questionnaires to collect data for analysis.

According to the study, the majority of residences are aware of the aspects of an extensive green roof that affect their emotions. Additionally, there are five (5) personal controls that minor residents want to utilise in order to maintain their mental health in line with their feelings. The key finding is that having a green roof might support mental wellness. As a result, the research we carried out presented green roof residents with a more comprehensive understanding of their mental health.

## 2. Literature Review

In order to become sustainable cities or low-carbon eco-cities with resilient housing, multiple towns have developed policies that aim to achieve it while using fewer resources overall [11]. There have been proposed and some implemented multi-sectional sustainability initiatives, such as city forests for urban greening [12], sponge cities for urban flooding mitigation [13], sustainable transportation systems to reduce the adverse consequences of public transit [14], and sustainable building for the eco-friendly segment [15]. The green roof concept, utilizing rooftops as alternative sites for planting vegetation, was brought by the loss of open spaces and the urge for greening [16].

### 2.1. Green Roof

Green Roof, also known as an eco-roof, a living roof, or a roof garden, is a multi-tiered building installed on rooftops. It is well renowned for enhancing the built environment by installing a green roofing system, which is a sustainable and long-term solution [18]. To solve significant urban difficulties and further increase conservation, it is imperative to look at how green roof installation works in practise. From a global context, the green roof industry began in Germany in the early 1970s and in Central and Western Europe in the mid-1980s. Singapore, Eastern Europe, and the United States were among the

first to implement the green roof system in the early 2000s, whereas Hong Kong, Manila, and China did not develop green roofs until the mid-2000s [19].

## 2.2. Classification of Green Roof

Extensive green roofs, intensive green roofs, and semi-intensive green roofs are the three distinct forms of green roofs. These categories are influenced by the depth, components, and maintenance requirements [5]. There are two types of green roofs in Malaysia: intensive and extensive. According to the data, intensive green roofs are the most prevalent type of green roof in Malaysia (93 responses, or 77.5 percent), whereas extensive green roofs (27 responses, or 22.5 percent) are less common [6].

**2.2.1. Extensive Green Roof.** The extensive green roof is a simpler, lighter, thinner type of green roof that is typically appropriate for lightweight structures. On extensive green roofs, a substrate layer with a maximum depth of approximately 150 mm and plant and vegetable life is common [20]. The vegetation possibilities are more limited than on an intense green roof, where the plants used are frequently tiny plants, sedum, shrubs, and bushes that require minimal maintenance and can self-generate. It typically only requires a shallow substrate of 15 cm or less [6]. Extensive green roofs are best suited to roofs with limited load bearing capability and locations that are not intended for use as roof gardens. Compared to semi-intensive or intense green roofs, the expenses are lower. It is ideal for less demanding and low-growing species of plants despite the mineral substrate layer's shallow depth and inadequate nutrients [21]. Based on Abdul Rahman in 2013, extensive green roofs are less expensive to install and maintain than intensive green roofs. In most cases, this form of green roof is only accessible for maintenance needs, hence it is rarely open to the public [6]. This system is not intended for public access and was created primarily for aesthetic and lead to environmental [22]. It may also be used on roofs with a pitch of up to 30 degrees [23].

**2.2.2. Semi-Intensive Green Roof.** In terms of demands, semi-intensive green roofs fall somewhere between extensive and intensive green roof systems, according to the International Green Roof Association in 2009. This type of green roof weighs heavier and needs more upkeep than the extensive green roof, which also costs extra to maintain. While tall-growing shrubs and trees are still insufficient, a deeper substrate level offers more design options, including the ability to plant a variety of grasses, herbaceous perennials, and shrubs like lavender [24].

**2.2.3. Intensive Green Roof.** Intensive green roofs tend to be referred as roof gardens. Buildings that are robust enough to sustain extra weight may feature intensive green roofs, often known as rooftop gardens [20]. According to Abdul Rahman in 2013, there are more roof gardens than large green roofs in Malaysia. Intensive green roofs are heavier and stronger than regular green roofs, making them ideal for subterranean garages and huge buildings. As a result of its weight, the system needs special support from the building [6]. On the other hand, it requires a deeper base with a minimum depth of 15 cm and offers a range of vegetation including trees, big shrubs and bushes, and other appealing plant species like the rooftop garden. According to researchers, it may occasionally be furnished with extra facilities like paths, benches, playgrounds, or even ponds. Since the extensive green roof itself is completely furnished with all the amenities of a park or traditional garden, the general public is usually welcome to visit it. The only difference is that the garden is positioned on the building structure which is roof and makes it unique. Intensive green roofs are being created to be publicly accessible [22]. Hence, pathways, benches, playgrounds, and even ponds may be built as roof features. Due to the frequent requirement for rigorous maintenance involving specialized labor, it requires periodic garden maintenance and a proper watering system, which makes it expensive to build and maintain [25]. There are no limitations on creativity or design, but the system build-up must be taken into consideration and the chosen plant populations must coexist peacefully. More attention is needed for intensive green roofs than for extensive ones, and they need constant fertilizer and watering [24].

### 2.3. Benefit of Green Roof

In the last quarter of the 20th century, the idea of green roofs in urban areas for environmental reasons seems to be growing popularity. People are extremely aware of environmental issues. On certain places, the use of green roofs in buildings has been promoted as a means of boosting the urban environment [26]. Urban heat island mitigation [9], runoff management [27], energy reduction [28], carbon sequestration [29], significantly improved job prospects [30], and civic beauty [31] are just a few of the advantages of green roof that have been thoroughly documented for fostering a sustainable and healthy way for cities and residents.

According to research done by Rowe in 2011, while green roofs are useful in decreasing pollution, more effort is needed to overcome technical limitations such as plant selection, planting substrate development, and grey water utilisation as well as related economic and political obstacles [16]. The high initial and maintenance expenses, as well as roof leakage, are the primary difficulties of green roofing. Green roof structures can significantly decrease urban floods, minimize energy costs, and enhance environmental performance [17]. Thus, the benefit of horizontal green technologies under the three categories of environmental, social, and economic advantages [26].

*2.3.1. Benefits to Environmental.* The first benefit in this section is Urban Heat Island (UHI) mitigation where Heat islands arise because of numerous circumstances including an increase in the amount of paved, built-over and hard-surface areas, a reduction in evaporating surfaces, a lack of green vegetation, and reduced cooling due to building shelter. The plants on green roofs can create evapotranspiration, which will lessen the heat island effect by humidifying and cooling the air. This impact raises the night temperature in the heart of the city in metropolitan area [9]. Green roofs are thought to be a good way to reduce the urban island effect in cities without pursuing excessively land [32]. According to reference A. Shahrudin, a green roof may reduce ambient air temperature by up to 1.5°C over the span of a day, with the effect being slightly stronger on non-rainy days (1.6°C) than rainy days (<1.5°C) [33].

Secondly, a further advantage of the green roof is stormwater management. By minimising storm water runoff, green roofs help the environment. [34]. Green roofs serve as porous surfaces that controls and regulates stormwater as they are one of the most effective ways to manage flooding issues in densely populated metropolitan areas. It may be used as a stormwater management strategy at the site level. They could extend the time it takes for water to depart from an area approximately up to three hours while decreasing the rate of overflow by 65 percent [35]. With a green roof area of around 645 m<sup>2</sup> and a soil depth of roughly 15 cm, an overall rainfall of 8.9 mm is considered a threshold value for the green roof to store rainwater. The author found that in a Malaysian climate, a green roof with a comparable configuration might minimize water runoff by 84 percent each event and achieve 51 percent total volumetric retention [36]. According to Musa et al., the green roof model absorbed 17 to 48 percent of storm water flow after rainfall [37].

Next, the advantages of good air quality for instance, plants have historically been employed in cities to filter out air pollutants and greenhouse gases such particulate matter, carbon dioxide, nitrogen dioxide, carbon monoxide, and sulphur dioxide. Photosynthesis is a process in which plants absorb CO<sub>2</sub> emissions and produce oxygen, resulting in cleaner air and lower CO<sub>2</sub> emissions [38]. Green roofs can help to reduce air pollution depending on the depth of the soil and the plants used. In a cap-and-trade scheme, a green roof can be used as a carbon sink to keep carbon emissions under control [35]. Green roofs act as natural air filters, absorbing dust and purifying the air [39]. Up to 4% of heavy metal, the green roof might capture city dust.

*2.3.2. Benefit to Economic.* Depending on the depth of the soil and the plants used, green roofs can contribute to the reduction of air pollution. A green roof can be used as a carbon sink in a cap-and-trade system to limit carbon emissions. [32]. Horizontal plants are a good solution for reducing cooling energy demand and boosting building energy efficiency because of their capacity to lower temperature [40]. Through shade, insulation, evapotranspiration, and increased thermal mass, a green roof can help reduce energy usage [41].

Moreover, Green roofs would increase the property's value from an economics perspective. It provides a social benefit to the neighbourhoods and adds value to the units that face the green roofs. Excellent greenery increases a property's worth by 6 to 15 percent, according to research done in the United States and the United Kingdom [42]. An extensive green roof system may add 2 to 5 percent, while an intensive green roof system may add 5 to 8 percent, according to a subsequent study on the benefits of green roofs for buildings [43]. In order to pursue greater financial success, developers and owners should be inspired by the green roof system.

*2.3.3. Benefit to Social.* Green roofs provide habitat for the growth of vegetation and trees as it bring aesthetical value. Different types of plants can be used to create rooftop gardens that are attractive and offer unique recreational areas for city dwellers [31]. Green roofs also cover unattractive rooftop amenities that obstruct the view, particularly for tenants and employees in high-rise buildings who frequently gaze down on a huge expanse of pavement, tiles, and chillers on flat rooftops [42].

Plants have a good influence on those who work or live in their vicinity. According to a study, employee productivity exceeds expectations in workplaces with visible greenery compared to buildings with less social surroundings. Humans find urban plants and those near structures to be more attractive than those in rural locations [44]. Roofs can provide wildlife habitats for rare or endangered species [45]. According to General Service Administration in 2011, green roofs can also give leisure space with the feeling that everything is fine. When they are available to the public, they may also provide relaxation and recreation, helping to relieve tension and soothe the mind [46]. Given the high value placed on land at street level in urban areas, green roofs offer more secluded, less polluted, and less noisy places for informal enjoyment [42]. Green roofs would bring delight by allowing the landscape to define the area and provide a backdrop for outdoor leisure activities among city dwellers. This is especially important for the less able-bodied (elderly, handicapped, and children), as well as those who cannot afford the time or money to go far and rely on close-by relaxation venues [42].

#### *2.4. Green Roof on High-Rise Residential Building*

Based on the survey done by S. Rafidah, residential buildings are the most prevalent building type (46.7%), whereas institutional buildings have a small number of green roof projects (10%) [6]. Many specialists installed green roofs on residential properties because they believe that today's society lack awareness and appreciation for public greenery. If a green roof is constructed for free public access, it may be abandoned and damaged as a result. Most professionals may use this notion of living as one of the considerations in including green roof systems into the design layout of a residential project. There are three different types of residential properties which are condominium, apartment, and bungalow. Condominiums are the most popular type of residential building with green roof projects (78.6%), while bungalows are the least frequent (7.1%) of installing green roof [6]. Professionals also feel that privately built green roofs are easier to manage and maintain because the costs may be delegated to condominium occupants. Another reason for this misconception is that city folks prefer to have their own garden in their houses rather than travelling to a neighbouring park. Residents may demand a sense of ownership by having a garden that is accessible within a few meters' walk of their house.

#### *2.5. Mental Health in Malaysia*

According to the World Health Organisation (WHO), mental health is a state of wellbeing in which a person is aware of their own capacity to deal with the stresses of life [47]. Depression, anxiety, and stress are all correlated with mental health. The number of people suffering from mental illnesses is on the rise. The previous ten years marked a two-fold increase in mental diseases in Malaysia, which may have been caused by unemployment, financial crises, marital problems, drug abuse, and other factors [48]. By 2020, mental illness will likely surpass heart disease as the second most prevalent health problem affecting Malaysians, according to the National Health and Morbidity Survey conducted by Malaysia's Ministry of Health (MOH) [49]. The prevalence of mental health disorders among persons aged 16 and above (29.2%) or roughly 4.2 million people. Sufferers of mental illness can have a terrible

effect on themselves and are more likely to engage in suicide conduct. Adolescents aged 16 to 19 had the highest rate of mental health disorders (34.7%), followed by those aged 20 to 24 (32.1%), and those aged 25 to 29 (30.5%) [49].

Pandemic outbreaks can harm mental health by triggering psychosis, anxiety, trauma, suicidal thoughts, chronic stress, and panic [50]. Even before the epidemic, mental health issues had quadrupled in Malaysia over the previous two decades due to a lack of awareness concerning mental disorders and the cultural stigma hooked up to mental illnesses [51]. Some people are at a higher risk for mental health disorders including depression especially when they are under a lot of stress and are separated from their family and friends as stated by Ministry of Health in 2021. If this depression is not detected and treated properly, the risk of suicide increases. According to the Royal Malaysia Police, there were 631 suicide cases recorded in 2020, rising from 609 occurrences reported in 2019. A total of 336 suicide cases has been recorded to the Royal Malaysia Police as of March 2021. Nevertheless, one of the most important factors in the worldwide burden of disease and disability is mental illness. As a result, this is a significant public health issue on a global scale [52]. All across the world, mental health issues are a major public health concern. To change the world by 2030, it became an essential component of the Sustainable Development Goals agenda.

### 2.6. Profile of Mood States

A psychological rating scale named the Profile of Mood States (POMS) was created by McNair in 1992 to evaluate instantaneous and transitory emotional states, which are feelings that endure just momentarily [53]. Researchers state that they use the POMS while assessing the psychological well-being of urban rooftop areas for their study. Poor roofing system caused a variety of psychological health effects. The POMS is a widely used tool for assessing the emotional states and psychological effects of consumers [54]. This is due to POMS, a dependable technique that is regarded as the most straightforward, efficient, and suitable to access emotional responses [55] [56]. A study conducted by researchers examined perceptions and mood changes upon seeing the four distinct rooftop photographs using the Korean version of the Profile of Mood States (K-POMS). The K-POMS had test questions that looked at how different mood states, such tension-anxiety, sadness, vigour, exhaustion, and bewilderment, fluctuate over time. The idea that rooftop vegetation may influence viewers' mood states positively and that mood states could vary depending on the vegetation design was validated by a study of the POMS data [57]. A number of emotional states are identified by POMS, including tension, depression, fatigue, confusion are belong to negative emotional states, while vigour is correlated with positive emotional states.

Tension is related to anxiety, which causes feelings of being tense, on edge, anxious, uneasy, and unsettled. While depression is characterized by dejection, which will have the emotions of unhappiness, regret for actions, sadness, blueness, hopelessness, unworthiness, discouragement, loneliness, miserableness, gloom, desperate, helpless, worthless, terrified, and guilt. Next, The Japanese subjective fatigue symptoms (2002 version), which include 25 symptoms, were used to measure fatigue. They are subdivided into five categories: drowsiness, insecurity, discomfort, soreness and fuzziness. Drowsiness includes signs of weariness such feeling tired, drowsy, needing to rest or lie down, yawning, being unmotivated, and feeling weak. Feelings of insecurity include anxiety, depression, restlessness, a short fuse, and confusion. People's discomfort includes headaches, heavy heads, low moods, daydreaming, and dizziness. Soreness where people experience arm, waist, finger, leg, and shoulder discomfort. Fuzziness when people struggle to open their eyes, experience eye tiredness, eye discomfort, dry eyes, and experience blurred vision. Moreover, confusion refers to the perplexity that individuals experience as a result of being disorganized, careless, and unclear about many issues. Vigour, the sole positive emotion, is associated with action and conveys the sensations of being outgoing, energetic, in high spirits, alert, and unburdened by anxiety or heavy obligation [53][54][57].

### *2.7. Perception/Awareness*

Perception is the process that keeps individual aware, vigilant, and observant of the environment that is going on around them [58]. People can use perception to evaluate, interpret, discriminate, and analyses their environment depending on their fundamental values in order to adapt to their surroundings [59]. Due to its various contributions to these fields, perception research has been concentrated on a range of topics including psychology, environmental issues, human development, and sustainable development. Numerous studies have discovered that demographic characteristics have an impact on how people perceive their surroundings [60]. According to Bechtel's in 1987 "Biosphere" hypothesis, social value and the constructed setting have an influence on the manner in which individuals perceive things [61]. Therefore, it is essential to raise awareness about green roofs across all classes of society to achieve sustainable development [6].

### *2.8. Previous Studies on Green Roofs towards Mental Health*

Green roofing is valuable for people's physical, mental, and overall welfare. The social advantages of the green roof system in terms of leisure, aesthetics, and psychological aspects are also vital [31]. Almost all the responders (99%) report feeling peaceful and relaxed when wandering through the rooftop garden. 96 percent of respondents said they felt very connected to nature while relaxing in the rooftop garden. The results are analogous to Ulrich's 1985 research, which discovered that having access to nature has a positive impact on conduct. Additionally, roof gardens may be useful as spaces for energy recharging and mental relaxation, offering psychological rehabilitation for those who work in tense workplaces [31]. The green roof provides areas for relaxation and enjoyment [62]. Green roofs have shown that being in contact with nature has a positive psychological effect and improves human health and happiness [63]. Plants reduced stress and weight, which was achieved by being close to green spaces. In addition, green rooftop spaces provide citizens with space for social activities [31]. Furthermore, this study supports previous research from the Netherlands' Health Council from 2004, which showed that being in touch with nature might help people recover from stress and mental exhaustion. The findings are tied to Edward Wilson's 1984 biophilia theory, which states that humans need to be connected to nature on mental, bodily, and social levels in order to feel better, even if it is through a stimulated natural setting. A study by K. Sundara Rajoo in 2021 found that exercise and nature therapy have the potential to be an form of therapeutic intervention when conducted in urban green spaces, specifically in preserving mental health during the COVID-19 crisis [64].

## **3. Methodology**

This paper employs a questionnaire survey as the primary research method to investigate the perception of green roof users with regards to their mental well-being. The questionnaire survey method was chosen for this research as it allows for the collection of data directly from the participants, providing insights into their perceptions and experiences. Specifically, the quantitative component of this research targets urban residents within the administrative jurisdiction of the Iskandar Puteri City Council.

The data for the research through quantitative method are collected by survey questionnaire with the residents of the selected green buildings in Nusajaya, Iskandar Malaysia. To achieve this objective, the target population for this research consisted of individuals who had direct access to and utilized the green roof facility. A total of 147 building occupants were identified from the population pool. Participants were approached on-site, and the purpose and procedures of the study were explained to them. Considering tolerable margin of error or a significance level of 0.05 as proposed by Taherdoost in 2017, the minimum required sample size is 107 or 100 approximately according to this method [65]. Additionally, if the data set need to be divided into several segments for comparative study, the minimum respondent of 30 people for each group is adequate based on Roscoe's guidelines in 1975 [66]. Therefore, this survey has successfully met the established minimum requirement of 100 building occupants.

For this research, the questionnaire is divided into three section that are Section A, B, C. Information, and directions for answering the questionnaire will be included in each section. The



demographic details of the respondents, including age, marital status, and level of education, are included in Section A of the questionnaire. Section B will be on the awareness of green roof for the respondent. Lastly, Part C is regarding the perception of green roof users with their mental well-being. The collected data were analysed by using the Statistical Package for Social Science (SPSS) software Version 27 and Microsoft Excel. Therefore, this analysis was presented by using frequency analysis, mean score range analysis and cross tabulation (mean) analysis.

In Section A, the questionnaire contains demographic questions asking general questions about the respondents which includes information related to gender, age, status, occupation and also household income. The purpose of these questions was to help the researcher to identify the characteristics of respondents in this survey. The demographic question will provide insight into the profile of the participants, helping to understand how different factors may influence their perceptions and experiences with green roofs.

Furthermore, in Section B of the questionnaire, the participants were asked about their perception of intensive green roofs at the high-rise residential building. They were asked to rate their level of feelings and experiences using a Likert scale. The Likert scale, a widely recognized psychometric tool, allowed participants to express their responses on a continuum, ranging from 'Strongly Disagree' to 'Strongly Agree.' This section encompassed a series of statements designed to gauge participants' emotional and psychological responses to the green roof environment. Each statement was anchored by the aforementioned response options, enabling participants to convey their nuanced perceptions and feelings toward the intensive green roof. This Likert-scale approach enabled a quantitative assessment of participants' sentiments, contributing to a more comprehensive understanding of the emotional and motivational impact of the green roof space on the high-rise residential building's occupants.

In section C of this questionnaire, the questions are made to identify the perception of occupants' mental health and the way they control themselves. For this section, participants were presented with a series of statements, each prompting them to assess the frequency of their feelings and behaviours using a scale of response options: 'Never,' 'Rarely,' 'Sometimes,' 'Often,' and 'Always.' Through this meticulous assessment of occupants' mental health perceptions and self-regulation tendencies, Section C sought to contribute a comprehensive perspective on the influence of the intensive green roof environment on the emotional and psychological aspects of the high-rise residential building's occupants.

#### 4. Results

Based on the proper analyst methods for this study, all the data and information gleaned from the questionnaire will be evaluated. To answer the objectives of this study, the analysis of the questionnaire has been divided into three parts. The first part presents the demographic background of respondents. The intensive green roofs details were discussed in the second part, while the third part discussed the results for the mental health of residents in high-rise residential building.

##### 4.1. Section A: Demographic Information

Section A of the questionnaire contains demographic questions asking general questions about the respondents that includes information related to gender, age, status, occupation and household income. The purpose of these questions was to help the researcher to identify the characteristics of respondents in this survey.

**Table 1.** Background Information of Research Participants.

Item	Description
Gender	i. Male
	ii. Female

Age	i.	Under 19
	ii.	20 – 29
	iii.	30 – 39
	iv.	40 – 49
	v.	50 – 59
	vi.	60 and above
Race	i.	Malay
	ii.	Chinese
	iii.	India
	iv.	Other
Level of Education	i.	No formal education
	ii.	SPM level or below
	iii.	STPM/ Matriculation
	iv.	Diploma/ any certificate level
	v.	Bachelor's Degree
	vi.	Master/ PhD
Occupation	i.	Government Sector
	ii.	Private Sector
	iii.	Self-Employed
	iv.	Retired
	v.	Other_____
Marital Status	i.	Single
	ii.	Married
	iii.	Widowed
	iv.	Divorced
Household Income per Month	i.	RM2,000 and below
	ii.	RM2,001 - RM4,000
	iii.	RM4,001 - RM6,000
	iv.	RM6,001 - RM8,000
	v.	RM8,001 - RM10,00
	vi.	RM10,001 and above

Thus, the results from Table 1 show that the majority of respondents who answered this form are female while the group of respondents aged 30-39 years old is the highest group who answered the questionnaire. Majority of the respondents who answered the questionnaire survey are Malays and have a Bachelor's Degree as their educational level. After the analysis process was carried out, we found that those working in the private sector became the highest respondents with a monthly income of RM6, 001 - RM8, 000 and married. The results from Table 1 have been included into this section as they would have an impact on the ability and decision-making processes of homebuyers of green roof adaptation on residential building.

#### 4.2. Section B: Likert Scale Analysis

The method of analysis used in part B of the questionnaire is Likert Scale method of Descriptive Analysis. Likert Scale Analysis method is used to achieve the first objective of the study that is to identify the level of awareness of green roof adaptation among residences in high-rise residential building. Therefore, the characteristics presented in the questionnaire will be analysed using descriptive method and subsequently using Likert scale. For this study, the Likert scale method uses a five -point

based scale. Thus, the characteristics that have been stated in this questionnaire were analysed using a centralized tendency analysis method that uses the mean score. Scale 1 represent index of No Influence, index of Limited Influence is scale 2 while scale 3 is index of Moderate Influence. Next, index of Important Influence is scale 4 and lastly scale 5 indicate the index of Very Important Influence.

In conducting analysis using Likert Scale, the determination of the index range should be determined to know the difference on range that will affect the results of future analysis. The calculation of the index value for each of these characteristics will be calculated based on the cell range of mean score plus the mean score. The calculation of the average difference between the mean score value and the index value is as follows:

$$\text{Cell Range of Mean Score} = \frac{(\text{Highest Mean Score Value} - \text{Lowest Mean Score Value})}{\text{Number of Scale}} \quad (1)$$

Based on the formula (1), the cell range for all characteristics is 0.60. The purpose of determining this value is to determine the most influence characteristics that residents' perceived green roofs. The calculation of this index value is calculated by taking the mean value of the lowest mean score and adding it to cell range value to obtain the actual range value. The mean value of the lowest score in this calculation is 1.57 while the highest is 4.55. The formula for the calculation is as follows:

$$\text{Index Value} = \text{Cell Range of Mean Score} + \text{Mean Score} \quad (2)$$

The factors can be determined by listing them according to their respective ranges. For characteristics that are in the range of mean score 1.57 to 2.18 is categorized as No Influence while mean score 2.19 - 2.80 is categorized as Limited Influence, followed by mean score 2.81 to 3.42 is categorized as Moderate Score and Important Influence mean score at 3.43 to 4.04. The last mean score 4.05 to 4.66 is categorized as Very Important Influence.

**Table 2.** Distribution of perceptions by significance scale.

Index	Perception of Green Roof	Mean Score
Very Important Influence	Do you think many trees and bushes on the roof will influence your feel?	4.61
	Do you think a green roof will influence you to come and do recreation regularly?	4.55
	Do you think that high-rise residential building change a normal/cement roof into green roof will influence residents' feelings?	4.42
	Do you think pavements and jogging track at the roof will influence your feel?	4.33
	Do you think when you are at the green roof will influence you to feel calm?	4.24
Important Influence	Do you think a swimming pool at the roof will influence your feel?	4.02

	Do you think when doing recreational activities on the roof will influence you to feel comfort?	3.87
Moderate Influence	Do you think when taking in air on the roof will influence you to feel motivated?	3.29
	Do you think a pond on the roof will influence your feel?	3.13
No Influence	Do you think green roof will influence you to feel threatened or dangerous?	1.57

Based on Table 2, the mean score scale that has an interval range from 4.05 to 4.66 is Very Important Influence the perception of residents living in green high-rise residential buildings. They were very aware that many trees and bushes would affect them with a total mean score of 4.61. This indirectly makes them well up on the use of green roofs will influence them to come and do recreation regularly where the mean score is 4.55. With a total mean score of 4.42 indicate that residents are enlightened that high-rise residential building should change a normal/cement roof into green roof as it will influence residents' feelings. Without exception, the intensive green roof features, namely pavements and jogging tracks are very important in influencing the residents in the awareness of the use of green roofs with a mean score of 4.33. Finally, they were also aware that a green roof would very important influence them to feel calm with a total mean score of 4.24.

Furthermore, the residents believe that the intensive green roof feature of the swimming pool was only in a significant range of important influence their feelings with a mean score of 4.02. A mean score of 3.87 follows this where residents feel comfortable to do recreational activities while on the green roof. In addition, the interval range of 2.81 to 3.42 is moderate influence. Residents of green roof buildings perceived that they feel motivated when taking in water on the roof are just moderate influence where the mean score recorded 3.29. They also noted that the pond on the roof also only moderately influenced their feelings, as the mean score was 3.13. Finally, residents of green high-rise residential buildings argued that green roofs did not affect their feelings of threatened or dangerous by proving with a mean score of only 1.57.

#### 4.3. Section C: Mean and Standard Deviation of POMS Residents.

For this study, the Likert scale method uses a five-point based scale. Thus, the characteristics that have been stated in this questionnaire were analysed using a centralized tendency analysis method that uses the mean score. Index of Never is represented by scale 1, index of Rarely by scale 2, and index of Sometimes by scale 3. Next, index of Often is scale 4 followed by scale 5 indicate the index of Always. By using the same formula (1) as stated in Section B, the cell range for all characteristics is 0.16. The purpose of determining this value is to determine the level of residents' POMS. The calculation of this index value is calculated by taking the mean value of the lowest mean score and adding it to cell range value to obtain the actual range value. The mean value of the lowest score in this calculation is 1.59 while the highest is 2.37.

The determination of these factors can be determined by listing them according to their respective ranges. For mental health that are in the range of mean score 1.59 to 1.75 is categorized as Never while mean score 1.76 to 1.92 is categorized as Rarely, followed by mean score 1.93 to 2.09 is categorized as Sometimes and Often mean score at 2.10 to 2.26. The last mean score 2.27 to 2.43 is categorized as Always.

**Table 3.** POMS Residents.

Index	POMS	N	Mean	Std. Deviation
Always	<b>Confusion:</b> Symptoms of confusion, unable to concentrate, forgetful, uncertain about things.	100	2.37	1.278
	<b>Vigour:</b> Not active, lively, energetic, cheerful, alert, and carefree.	100	2.33	1.276
	<b>Fatigué:</b> Symptoms like sleepy, lie down and rest, lack of motivation, feel weakness, and mind wandering.	100	2.27	1.173
Rarely	<b>Tension:</b> Feelings of panicky, uneasy and restless.	100	1.77	1.024
Never	<b>Depression:</b> Feelings of unhappy, sorry for things done, blue, discouraged, lonely and guilty.	100	1.59	0.780
Valid N (list wise)		100		

Based on Table 3, the result for POMS residents in the green high-rise residential building was analysed by using SPSS version 27. The majority of the population has symptoms of confusion, unable to concentrate, forgetful, uncertain about things as a mean of 2.37 (standard deviation = 1.278) and slightly different from those who feel not active, lively, energetic, cheerful, alert, and carefree where the accumulated mean is 2.33 (standard deviation = 1.276). With a mean of 2.27 (standard deviation = 1.173), residents sometimes have fatigue symptoms e.g. sleepy, lie down and rest, lack of motivation, feel weakness, and mind wandering. Most residents very rarely have feelings of panicky, uneasy and restless as the mean is 1.77 (standard deviation = 1.024) and never have feelings of unhappy, sorry for things done, blue, discouraged, lonely and guilty as the mean is 1.59 (standard deviation = 0.780).

**Table 4.** Relationship between POMS Residents and Personal Control.

POMS Factor	Vigour		Depression		Fatigué		Tension		Confusion	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
<b>Personal Control</b>										
Feel calm with the greenery of nature	3.05	1.133	1.65	0.650	2.84	1.132	3.00	0.000	4.50	0.707

Go to the park to take in the air and relax the mind	3.50	2.121	1.69	0.891	2.67	1.210	2.00	0.900	3.02	1.244
Feel positive when close to nature like trees and here the chirping of birds	2.63	1.275	2.00	1.414	2.55	1.319	1.90	1.252	2.83	1.279
Relieve stress on a green roof	2.79	1.226	1.67	0.869	2.60	1.127	1.90	1.209	2.76	1.265
Do activities such as jogging and swimming as it keep my mind healthy	2.55	1.302	1.70	0.923	3.00	1.414	2.00	0.816	3.02	1.244

Table 4 shows the results that have been generated using Cross Tabulation Analysis from SPSS version 27 based on mean and standard deviation. In this context, the POMS and factors for personal control have been put forward as the main guide to achieve a relationship between the POMS of the population and their personal control. The highest preference for residents' who are not active, lively, energetic, cheerful, alert and carefree is they like to go to the park for taking in air and relax the mind (Mean = 3.50, Std. Dev = 2.121). The second preference is they feel calm with the greenery of nature (Mean = 3.05, Std. Dev = 1.133) followed by preference of relieving stress when on a green roof (Mean = 2.79, Std. Dev = 1.226). The fourth preference is feel positive when close to nature like trees and hear the chirping of birds (Mean = 2.63, Std. Dev = 1.275), and the least preferred for residents' who are not active, lively, energetic, cheerful, alert and carefree is to do activities such as jogging and swimming because it can keep my mind healthy (Mean = 2.55, Std. Dev = 1.302).

For respondents who have the feelings of unhappy, sorry for things done, blue, discouraged, lonely and guilty, the highest preference is recorded for close to nature like trees and hear the chirping of birds will make them feel positive (Mean = 2.00, Std. Dev = 1.414). This is followed by do activities such as jogging and swimming (Mean = 1.70, Std Dev = 0.923), go to the park for taking in air and relax the mind (Mean = 1.69, Std. Dev = 0.891) and relieving stress when on a green roof (Mean = 1.67, Std. Dev = 0.869). The last preference choose by residents who have the feelings of unhappy, sorry for things done, blue, discouraged, lonely and guilty is feel calm with the greenery of nature (Mean = 1.65, Std. Dev = 0.650). Meanwhile, the highest preference of doing activities such as jogging and swimming because it can keep my mind healthy (Mean = 3.00, Std. Dev = 1.414) for residents who have the fatigue symptoms e.g. sleepy, lie down and rest, lack of motivation, feel weakness, and mind wandering. Followed by feel calm with the greenery of nature (Mean = 2.84, Std. Dev = 1.132), go to the park for taking in air and relax the mind (Mean = 2.67, Std. Dev = 1.210) and relieving stress when on a green roof (Mean = 2.60, Std. Dev = 1.127). The least preference is close to nature like trees and hear the chirping of birds will make them feel positive (Mean = 2.55, Std. Dev = 1.319) for residents who have the fatigue symptoms. For respondents who have feelings of panicky, uneasy and restless, the highest preference is feel calm with the greenery of nature (Mean = 3.00, Std. Dev = 0.000). Same amount of preference is recorded for personal control which is go to the park for taking in air and relax the mind (Mean = 2.00, Std. Dev = 0.900) and doing activities such as jogging and swimming because it can keep my mind healthy (Mean = 2.00, Std. Dev = 0.816). Both last preference are choose by residents are close to nature like trees and hear the chirping of birds will make them feel positive (Mean = 1.90, Std. Dev = 1.252) and relieving stress when on a green roof (Mean = 1.90, Std. Dev = 1.209). Last but not least, the highest preference for residents who have symptoms of confusion, unable to concentrate, forgetful, uncertain about things is feel calm with the greenery of nature (Mean = 4.50, Std. Dev = 0.707). Same

amount of preference is recorded for the second factor which is go to the park for taking in air and relax the mind and doing activities such as jogging and swimming because it can keep my mind healthy (Mean = 3.02, Std. Dev = 1.244). The next preference for residents who have symptoms of confusion, unable to concentrate, forgetful, uncertain about things is close to nature like trees and hear the chirping of birds will make them feel positive (Mean = 2.83, Std. Dev = 1.279). The last preference is relieving stress when on a green roof (Mean = 2.76, Std. Dev = 1.265).

## 5. Conclusion

The results of this study clearly show that both objectives have been successfully achieved. This has also answered questions related to the level of awareness of green roof adaptation among residents and the relationship between green roofs and residents' mental health. This study is conducted for the benefit of homebuyers and developers so that they can know in detail about the intensive green roof adaptation that will influence mental health. Therefore, this study is very useful and can be used as a reference for developers, government, and students who are in the field of property management where they can learn in detail about this intensive green roof adaptation. However, there seem to be lack of available research and studies on perception of green roof users with their mental health in Malaysia cause difficulty for the author to search for appropriate resources. It is also difficult for the researcher to have access to a wider variety of literature and samples which were useful for the research. Besides, the findings of this study were mainly based on the input and perceptions provided by the participants of the study based on their previous experiences and behaviour (via a questionnaire survey). In this study, the researchers only touched on the level of awareness of intensive green roof adaptation and the relationship between green roofs and mental health among residents in a high-rise residential building.

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