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COMPARISON BETWEEN PREFERENCE OF SWIFTLET HOUSING DESIGN AND CHARACTERISTICS BY RANCHERS IN SABAH AND SARAWAK

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Abstract:

For the past few years, demand for health and beauty products has been high, including bird nests, which has led to the thriving of Malaysia's swiftlet ranching industry. Hence, the macro parameters related to swiftlet housing characteristics and designs owned by swiftlet ranchers in Sabah and Sarawak were identified. The size of the house, placement of the bird entrance, house orientation, flooring, and location were observed. The descriptive data were analyzed by using ANOVA ($p<0.05$) and the interaction between variables was determined by using Chi-square regression via SPSS 25.0. The number of swiftlet houses in Sabah was identified as higher than in Sarawak. 57% of the swiftlet houses are in the agricultural area, and 41% of the swiftlet houses are in the forest area. 37% of the chosen orientation by a rancher in Sabah was in the directions of east to west and north to south. This data was significantly different compared to Sarawak as 25% of the houses in Sarawak were constructed from southeast to northwest by the ranchers. The two-floor design was most preferred by the ranchers in Sabah and Sarawak with a total of 43% respectively, followed by a three-floor design at 27% in Sabah and 34% in Sarawak. The size of the swiftlet buildings preferred by ranchers in Sabah and Sarawak was small, with a length and width below 10 feet. Meanwhile, there is no significant difference ($p>0.05$) in terms of bird entrance, placement, and measurement of the swiftlet houses. Several improvements are needed to reduce the limitation, such as widening the distribution of survey locations or in quantitative aspects, such as edible bird nest production among farmers.

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Swiftlets Farming, Swiftlet House, Sabah, Sarawak

Introduction

Swiftlets are small, winged animals from the Apodidae family that breed throughout Southeast Asia and the South Pacific region (Lim and Cranbrook, 2002; Munirahet al. 2018). The Greek word, 'apous', signifies 'without feet', which alludes to the swiftlets' short legs and hesitance to settle intentionally on the ground (Merikle, 1998). Additionally, they also perch vertically on the surfaces or their nesting planks (Ibrahim et al. 2009; Hamid, Wahab, Hosna, Kamruzzaman, & Hasanat, 2021). They are small in size with body loads between 6 to 40 g and are predominantly found in Southeast Asian nations, such as from Andaman to Nicobar Island, from the Indian Ocean to the waterfront areas of Malaysia, Thailand, Vietnam, Palawan Island in the Philippines, and the south-eastern part of China.

Among the numerous swiftlet species, only a certain species can produce consumable Edible Bird Nest (EBN) from the discharged salivation during the rearing season. There are 24 species of swiftlets recorded in the world, which are separated into four genera, namely Aerodramus (echolocatingswiftlets), Hydrochous, Schoutedenapus and Collocalia(non-echolocatingswiftlets) (Ibrahim et al. 2009; Azaharet al. 2014). Regarding the Aerodramus family, A. fuciphagus, A.maximus, A. germani and A. unicolour are the four distinct types of swiftlets that make up this genus. It was discovered that White-nest Swiftlets (A. fuciphagus) and Black-nest Swiftlets (A.maximus) are among the several species known to be able to produce EBN (Lim and Cranbrook, 2002; Qi and Abdul, 2016). Even though most consumable EBN distributed in Southeast Asia are derived from the three prevalent types of cavern swiftlets - A. fuciphagus, A. maximus and C. esculent, the five most common species of swiftlets found in Malaysia and Borneo Island are Hydrochousgigas, Collocalia esculent (white belly swifts), Cypsiurusbalasiensis (Asian palm swift), A.fuciphagus and A.maximus.

Swiftlet houses are constructed artificially to resemble the swiftlets' natural habitat to roost for swiftlet farming. For this purpose, the important details regarding the natural habitat of swiftlets have been used for the improvement of the breeding environment in the house. Man-made swiftlet houses resemble cave-like environments to encourage the swiftlets to build nests inside the house. Swiftlet houses are commonly built near the coast or far inland to create suitable conditions for swiftlet farming. Several elements such as light intensity, temperature, air velocity and humidity are controlled and optimized to create an appropriate living environment for the swiftlets (Qi and Abdul, 2016; Ul Hosna, Islam, & Hamid, 2021).

Borneo, a giant island consisting of Indonesia Kalimantan, Brunei, Sabah, and Sarawak, are currently the world's most important source of wild edible nests. Most abundant in Borneo is the builder of the commercially inferior 'black nest' known as Black Nest Swiftlets. The exploitation of nests from the local representative, which is the White-bellied Swiftlet is a recent innovation in Borneo (Lim and Cranbrook, 2014). At present, the activity of swiftlet ranching is performed inside a building that resembles a cave-like environment to provide alternative nesting sites to lure the swiftlets (Koon, 2011; Vaiappuriet al. 2012). To achieve a conducive environment, the housing design needs to be taken into consideration to optimize

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the production of edible bird nests. Thus, this study aims to determine the preference of swiftlet housing characteristics by ranchers specifically in East Malaysia.

Literature Reviews

According to Mursidah, Lahjie, Masjaya, & Rayadin, (2022) The demand for swiftlet nests continues to rise, and the prices are rather high, attracting an increasing number of people interested in swiftlet farming. The study went on to say that there would be a 15% rise in operational expenses and a 30% drop in benefits. The results revealed that Swiftlet production in Kota Bangun District is still financially viable even if operational costs increase by 15% or benefits decline by 30%, or if both increases in operational costs and decreases in benefits occur concurrently.

Another study by Ibrahim et al., (2018) shows that, the abundance of food supplies and the favourable environment in South East Asia are the primary reasons for swiftlets to move to Malaysia. The EBN industry should leverage on this criterion to accelerate its expansion. The current demand for EBN products, particularly health items, will elevate the industry to one of the most promising in the near future. Similarly, research by Susanto & Nainggolan, (2021) identified that, the current worldwide output of this nest is estimated to be $5 billion USD per year. Meanwhile, the price of raw nest from farmers in Indonesia ranges from Rp.10 million (USD 715) to Rp30 million (USD 2.143) per kilogramme in export operations.

Suarni, Asriati, Masnan, and Fitriani (2019) conducted a research to encourage the local people of Belawa sub-district, Wajo regency, South Sulawesi, to join in the edible bird's nest industry. Where study shows that, edible-nest swiftlet farming has become popular among the local agricultural community, especially since the issuance of MUI Fatwa No. 2 of 2012, which addresses the lawful consumption of edible bird's nests as well as the lawful swiftlet farming in Islam, along with several requirements, including that the birds not be tortured during the process. The findings show that the prospective profits of the business, frequent agricultural crop failures, and the permit to consume bird's nest based on Islamic law, as well as the permit to farm the bird based on Islamic business ethics, are the factors motivating people to engage in the edible bird's industry.

El Sheikha's study (2021) discusses edible bird's nest and provides an overview as follows: (1) eatable bird's nest as an add new functionality strategic food product, (2) quality issues associated with edible bird's nest, including implications that the site of acquisition of the edible bird's nest has food safety implications, (3) existing regulations and geo-tracking approaches to ensure the quality and safety of edible bird's nest, with a special focus on polymerase chain reaction-denamination.

I, Rahman, Jelani, & Yaacob, (2021) study has discovered and created a list of ecological and environmental criteria for the effective production of edible bird nest swiftlets. EBN production was much greater in swiftlet homes with acceptable habitat and environmental conditions, according to the findings. Only adequate habitat and environmental circumstances in swiftlet house management may ensure a fruitful and lucrative ranching endeavour swiflet.

Reseaerchers have idenitified the legal issues and the impact of swift housing on local communities along with the profit, and technological development of firming. The swiftlet agricultural homes were governed by the Street, Drainage, and Building Act of 1974 and the

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Local Authority Act of 1976. Nonetheless, the swiftlet farming house had an impact on both the good and bad societies. The impact of swiftlet farming homes on local communities demonstrated the necessity for swiftlet farming houses to be regulated. In a word, swiftlet farming house law is necessary to limit the swiftlet farming house in order to enable the expansion of this business while protecting the communities. Good legislation and administration, it appears, may absolutely avoid the negative consequences on communities. (Md. Yassin, Masram, Shafii, Yahya, & Shareh Musa, 2020; Hamid, Wahab, Hosna, Hasanat, & Kamruzzaman, 2020).

Aside from these drawbacks, experts have recognised the EBN's good aspects. In the laboratory, it has been discovered that EBN is an excellent alternative meal for preventive and therapeutic agent against Influenza A virus infection. For the past ten years, well-designed in-vitro and in-vivo studies have been used to explain EBN's antiviral activities. The researcher went on to say that EBN is a treasured Chinese food that has been thought to have a well-being effect in various ways for thousands of years. Another possibility to examine when claiming the positive impact of EBN or another natural product is bioactive ingredient validation (Akmal, Intan-Shameha, Ajat, & Ideris, 2017).

A recent research by Yaacob, Khairy, Munirah, Nabilah, & Zulhazman, (2021), identified and established a list of ecological and environmental parameters for the successful ranching of edible bird nest swiftlets. In swiftlet homes with acceptable habitat and environmental conditions, EBN production was much greater. Only proper habitat and environmental circumstances can be guaranteed in swiftlet house management to be productive and lucrative ranching endeavour swiflet.

Based on the previous literature studies, current study has focuses on comparison between preference of swiftlet housing design and characteristics by ranchers in Sabah and Sarawak, Malaysia. As Malaysia is one of the major country fro swiftlet housing and firming. Previous research focuses on profit, technology development, law and community, temperatures and place selection, medical benefits and motivating to adopt swiftlet firming. However, current study will idenitify the preference of swiftlet housing design and characteristics of swiftlet housing by ranchers. As this area is still a missing point in swiftlet research field, apecifically in Malaysia region.

Materials and Methods

Data Collection

Seven parameters were observed in this study, namely location, state, district, flooring, orientation, placement of bird entrance, and size of the swiftlet houses. The samples were selected randomly along the course of the main road. A total number of 192 random samples was recorded, consisting of 91 data collected from both Sabah and Sarawak states. This study's observation was done using just the naked eye. To avoid any mistakes throughout the observation procedure, no physical impediment was assured. The observations in this study were designed based on the preferences of the stakeholders. An interview was conducted to gather information about their preferences for the swiftlet house design. The orientation of the swiftlet houses was measured by using a digital compass.

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The Location

The sample collection was taken in the main cities, ranging from Tawau, Sabah, to Lundu, Sarawak, with a total travel distance of 1644 km. The locations for this study were specifically chosen because of their easy road access. Besides, the locations that were chosen to provide geographical differences for this study. The identification of swiftlet houses was made at a distance of around 100 m from the observation spot of the main road during the daytime.

Figure 1: Travel Distance Along The Main Road From Tawau, Sabah To Lundu, Sarawak With The Locations Pinned Showing The Observation Spots Of Swiftlets Houses.

Statistical Analysis

The descriptive data obtained in this study were analyzed by using ANOVA ($p<0.05$) and interaction between variables was determined by using Chi-square regression via SPSS 25.0. table 1 shows the detailed analysis and further study will discuss accordingly about the analysis findings.

Parameters		**State**		**Chi- square**	
		Sabah	**Sarawak**	**Calculated**	**Tabulated**
Location area	Agriculture	52	28	23.571*	9.49
	Forest	15	37		
	Urban	3	8		
	Coastal	7	1		
	Residential area	14	17		
Orientation of swiftlets building	E-W	34	7	69.334*	14.07
	W-E	4	3		
	N-S	34	6		
	S-N	1	6		
	NE- SW	2	19		

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	SE- NW	5	23		
	SW- NE	5	14		
	NW- SE	3	13		
Bird Entrance placement	N	34	5	69.334*	14.07
	S	2	7		
	E	34	8		
	W	4	3		
	NE	4	17		
	NW	6	15		
	SE	5	21		
	SW	2	15		
Number of floor	1	24	14	3.890	9.49
	2	39	34		
	3	25	27		
	4	2	4		
	5	1	0		
Length	1 m- 10.9 m	74	88	19.475*	5.99
	11 m- 20.9 m	14	3		
	>21 m	3	0		
Width	1 m- 10.9 m	33	40	11.687*	5.99
	11 m- 20.9 m	34	46		
	>21 m	24	5		

Table 1: Percentages of swiftlet houses in Sabah and Sarawak

NOTE*E- East; W- West; N- North; S- South; NW- Northwest; NE- Northeast; SW- Southwest; SE- Southeast
*Significant at (p>0.05)

Results

Different parameters were observed in the state of Sabah and Sarawak to study the preference for swiftlet house designs.

District

The percentages of 91 swiftlet houses were identified as study samples in Sabah and Sarawak, respectively. A total number of 18 districts from Sabah and 9 districts from Sarawak were involved. The district with the highest number of swiftlet houses encountered was Mukah, Sarawak, with a total of 33 houses identified in the district. The detailed results are shown in Figure 2.

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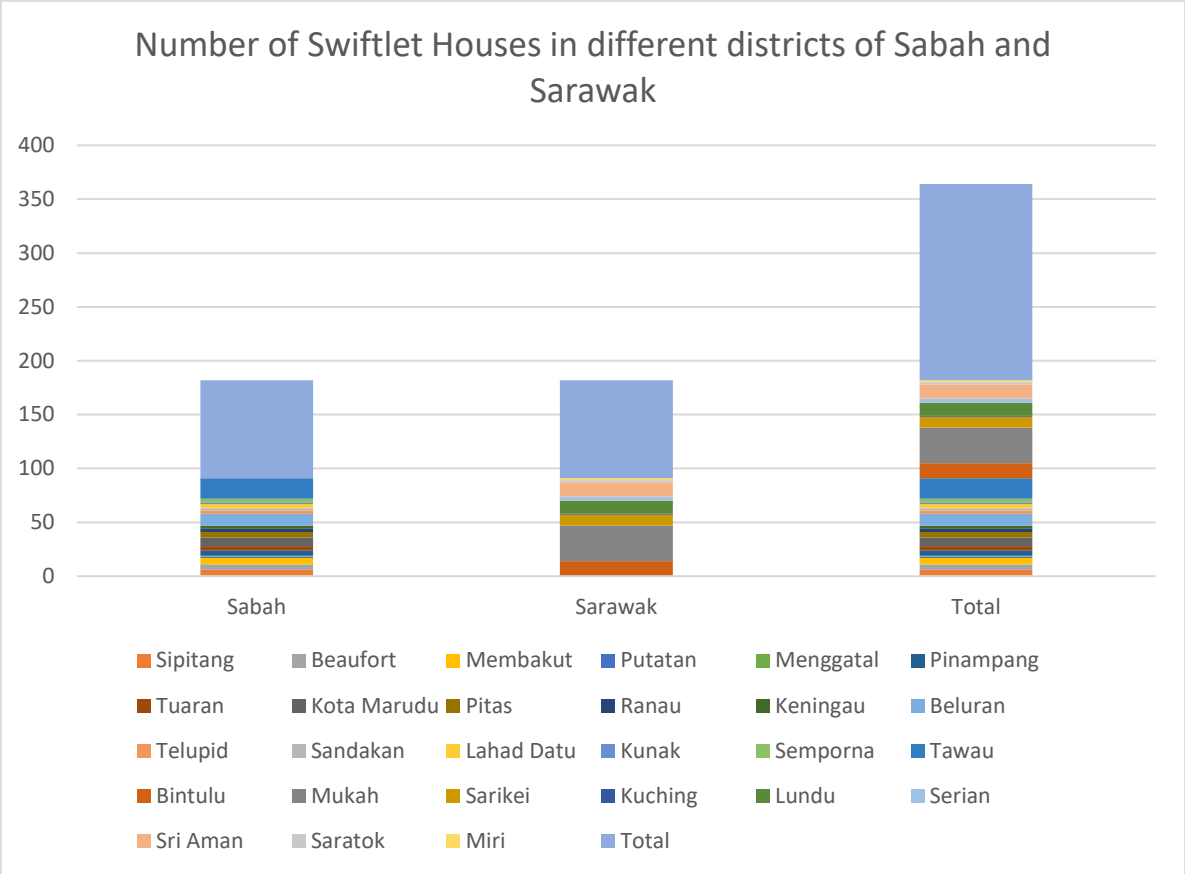

Figure 2: Comparison of Tabulated and Calculated Chi-Square Values

*Results were significant as the calculated chi-square value (182.00) was higher than tabulated chi-square value (38.89).

Location Area

The results showed that most of the observed swiftlet houses were located in the agricultural and forest areas. In Sabah, 57% of the houses were built in the agricultural area while 41% were constructed in the forest area. The least number of houses were built in the seaside area, with only 8% of the total number of houses being located there. In Sarawak, the forest area made up the largest proportion of the swiftlet houses built; 41% of the houses were built in that domain, while 31% of the houses were constructed in the agricultural area. In the residential area, 19% of houses were located, with an addition of 9% of houses situated in the urban area, and 1% of houses were established in the seaside area.

Orientation of Swiftlets Building

According to the obtained data, East to West and North to South directions were the most preferred building orientations for the swiftlet houses, with 38% and 38%, respectively. The least preferred orientation was Northern East with 0% in Sarawak and 2% for the Northeast to Southwest orientation in Sabah. Based on the data, Sarawak was the major contributor to the building orientation of Southeast to Northwest. It was noted that 25% of the swiftlet houses were built with this orientation.

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Bird Entrance Placement

Based on the collected data, most of the bird entrance placement was at the north and east side of the building with 34% in total, respectively, while the least preferred placement was at the south position with 2% and followed by the west side at 3%. However, there is no distinct difference between the preferred bird entrance placement in Sabah and Sarawak.

Number of Floors

It was noted that a two-floor house was the most preferred design with 43% of the identified houses being built with this feature in both Sabah and Sarawak states. The building with a three-floor design was the second-most preferred by the swiftlet ranchers as 34% and 27% of the swiftlet houses were built with this particular design in Sarawak and Sabah, respectively. Swiftlet houses built with only one floor were preferred by 26% of swiftlet ranchers in Sabah and 18% in Sarawak while only a scant few constructed swiftlet houses with a four-floor and five-floor design. The least preferred flooring design chosen by the farmer was the building with a four-floor and five-floor design.

Length and Width

It was observed that the length of swiftlet houses between 1m to 10.9m was most preferred in this study. Based on the data, 37% of swiftlet houses were designed in this range of length in Sabah while 51% of the houses in Sarawak used this range of length. In terms of the width of the swiftlet houses, most of the ranchers preferred a width ranging from 1 m to 10.9 m in both states, followed by 1m to 10.9m.

Discussion

Data were collected along the route from Tawau, Sabah to Lundu, Sarawak, mostly within the vicinity of the main city. 91 swiftlet houses were identified as study samples in Sabah and Sarawak, respectively. The total number of districts involved in this study was 27, made up of 18 districts from Sabah and 9 districts from Sarawak. The district with the highest number of swiftlet houses encountered was Mukah, Sarawak, with a total of 33 houses identified in the district.

The district with the second-highest number of swiftlet houses located was Tawau, Sabah with 19 houses identified, while Kunak and Putatan in Sabah and Kuching in Sarawak were observed to have the least number of swiftlet houses along the main road. Thus, it was noted that Sarawak has more swiftlet houses built along the route, especially in the Mukah district, as compared to Sabah, with the highest number of swiftlet houses identified was in the Tawau district. This is supported by the figures from the Department of Veterinary Services in 2012 in which the number of registered swiftlet houses in Sarawak was 486, 54 houses higher than those registered in Sabah (Selvakkumar, 2013). The trend of the difference in the number of swiftlet houses continued in 2015 whereby 790 houses were recorded in Sarawak while only 584 were listed in Sabah (Fatin, 2019).

The growth of this industry in both states is due to the recognition of the economic potential of the edible bird nest by the Malaysian government. It is expected that this industry will contribute approximately RM5.2 billion to the Gross National Income in 2020. Thus, a comprehensive master plan, besides the ongoing R&D process, has been established to optimize the production of edible bird nests by introducing the industry development guidelines, as well as good production practices and industry standards (Rabu&Nazmi, 2015).

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The government has also done a lot of work to encourage farmers to get involved in swiftlet ranching. For instance, through the MyGAP certification initiative concerning the swiftlet ranching operation, 121 swiftlet houses have been certified to this date. The government has also been promoting the use of Radio Frequency Identification (RFID) tags, a machine learning tool that enables the product to be tracked from the source to the consumer to maintain the quality of the product (BIMP-EAGA, 2020).

According to the obtained data, East to West and North to South directions were the most preferred building orientations for the swiftlet houses. It was also found in a previous study that the building orientation along the east and west directions was the most preferred choice (Rania&Neveen, 2018). This may be because this orientation will reduce the susceptibility of the sidewall toward direct sunlight exposure (Ayodeji&Adedamola, 2019). As reported by Rania and Neveen (2018), building orientation is closely related to the elevation and the original geographical direction. In the building design principle, it is very crucial to consider the actual amount of sunlight exposure on the facades of the building as it may affect the thermal load, thus controlling the thermal behaviour and the amount of thermal comfort of the space.

However, in swiftlet ranching, it is important to note that all species exhibit a similar pattern of daily According to Wan et al. (2015), the bird entrance is essential to be built with the consideration of the birds' flying path as it would determine if the bird were encouraged to enter the swiftlet house. This is in line with the habits of the swiftlets, which allow them to fly directly to and from the swiftlet house activity. For instance, the swiftlets leave the colonial nesting and roosting sites at daybreak and return by dusk. On a normal day, the swiftlets would leave the roosting area as early as 6.00 a.m. The number of the emerging birds from the colonial sites would increase in a steady stream and reach its peak around 6.15 a.m. to 6.30 a.m. (Lim &Cranbrook, 2014).

Once outside the cave, the swiftlets would normally flutter and glide above the surrounding forest canopy, or meander around the edge of the forest vegetation. When the sun is above the horizon, the swiftlets move on towards the river and forage above the vegetation along the banks, only to disperse around midday. If the sunny weather persists until afternoon, the swiftlets will begin to return to the vicinity of the roosting cave as early as 4 p.m., but still soaring and swirling high in the sky, while also calling incessantly (Lim&Cranbrook, 2014).

Nevertheless, if a swiftlet house is built with an orientation that is more susceptible to prolong and direct sunlight exposure, it would increase the house temperature at nighttime. The higher temperature in the house would affect the performance and to a certain extent, might prevent the swiftlets from nesting in the house.

In addition, the wind direction is another factor to determine the placement of the bird entrance since the swiftlets fly in the direction of the wind. Thus, the door must be opened along the course of the wind as the birds would fly upwind (Wan et al. 2015). Based on the data, it could be noted that the farmers were aware of the swiftlet flying path and habit based on the design as the placement of the bird entrance was positioned either on the north or east side of the house.

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Most of the swiftlet houses were located in the agricultural and forest areas. Suitable location selection to build swiftlet houses would result in a high density of birds nest production (Azahar, 2013; Rahman et al., 2020). There are several important factors required to be prioritised when selecting an appropriate location. For instance, a swiftlet house must be located far away from the industrial area. Additionally, it is also important to consider if a certain area has already been built with many swiftlet houses as this would contribute to a high population of swiftlets in the same community (Cody, 1981; Rahman et al., 2020). If a swiftlet house was built in an area that was already saturated with birds, it would make it more difficult to attract the swiftlet into the house because most of the birds would already have a birdhouse (Wan et al. 2015).

The high number of swiftlet houses located in the agricultural and forest areas may be becauseswiftlet houses should be located in areas rich in insect populations, such as paddy fields, fruit orchards, vegetable gardens, or areas close to natural water bodies such as rivers and lakes (Nutjarinet al. 2017; Rahman et al., 2020). Swiftlets forage over a range of open and forest habitats (Lim and Cranbrook, 2002; Nutjarinet al. 2017). The majority of the swiftlets' diet includes Hymenoptera (17% to 44% of the diet), Diptera (8% to 39%), Hemiptera (7% to 35%), Coleoptera (1% to 5%) and Isoptera (0% to 10%) (Viruhpintu,2002; Nutjarinet al. 2017). The most intensive foraging occurred close to the water bodies such as lakes and ponds, which could be found in the forest and agricultural areas that possess a higher density of available insect taxa from both aquatic species and terrestrial insects above the banks of the adjacent water bodies (Nutjarinet al. 2017). This is supported by Sara and Daniel's (2000) report, which states that the forest is an important source of Hymenoptera for Malaysian swiftlets.

An agricultural area such as open paddy land has a quite similar total insect biomass compared to a forest area. However, the dominant insects are Diptera and Hemiptera, which are also major swiftlet diet components (Sara and Daniel, 2000; Viruhpintu, 2000; Nutjarinet al.2017). It was also discovered that dipterans are the most abundant species in the presence of livestock (Grvebleret al. 2010; Nutjarinet al. 2017). This is consistent with this study's findings as most of the swiftlet houses in Sabah are located in agricultural areas, while in Sarawak, agricultural areas come second after the forest areas as the preferred areas by the swiftlet ranchers.

As for the residential area, not many swiftlet houses were built there since this activity would result in noise pollution as the sound system installed to attract swiftlets would create rowdy noises that disturb the surrounding residents and tourists (Duckett, 2010; Azlinaet al. 2020). For example, there was a case of an irresponsible owner that installed a high volume external sound funnel directed to the residents' dwelling for a long period, leading to several complaints from the residents regarding noise pollution (Lim, 2011; Azlinaet al. 2020).

This industry also would potentially result in air pollution due to the unpleasant odour produced by the faeces and dirt made by the swiftlets (Kurniatiet al. 2012; Azlina, 2020). There were complaints made by the residents regarding air pollution as the swiftlet house was being managed inefficiently, causing abundant bird drops and dirt around the residential area (Roselan, 2016; Azlinaet al. 2020).

Swiftlet houses in the urban area are commonly derived from shophouses. However, the construction of the swiftlet house would usually maintain the original architecture of the building as the enlargement of the building without permission is prohibited (GarisPanduan

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Pembangunan IndustriBurungWalit, 2010; Azalinaet al. 2020). The finding of this study is strongly supported by the previous statement, as in Sabah, the urban area is the least preferred location by the swiftlet ranchers.

A lower number of swiftlet houses were located in the urban areas of Sabah and Sarawak because the swiftlet foraging in the urban habitat would result in only a smaller number of prey captured since this environment is commonly known to have lower insect biomass, although it attracts flying insects when artificial lights are turned on (Perkin et al. 2013; Nutjarinet al. 2017). Thus, the foraging activity will be reduced due to the unproductive insect biomass in this particular habitat.

The lowest number of swiftlet houses were located in the seaside area, with eight houses observed in Sabah while only one house was identified in Sarawak. The small number of swiftlet houses in this area is due to several factors, such as the consideration of the materials and construction techniques in coastal habitats that should be resistant to flood and wind damage, wind-driven rain, corrosion, moisture, and decay caused by sunlight, ageing, insects, chemicals, and temperature. These characteristics of the materials used during the construction of swiftlet houses would require a higher cost than those in the inland area. Additionally, a coastal building requires considerably more maintenance and repairs as compared to an inland area, which also leads to a higher building maintenance expenditure (US Department of Homeland Security, 2013). Besides that, the aerial predators should be taken into consideration when building the swiftlet house near the seaside. According to a study titled predators of swiftlets and their nests in the Andaman and Nicobar Islands, brown-hawk owls, besras, and large-billed crows are among the most common threats to swiftlets (Manchi&Sankaran, 2009). A two-floor house was the most preferred design with 43% of the identified houses being built with this feature in both Sabah and Sarawak states. The least preferred flooring design chosen by the farmer was the building with a four-floor and five-floor design. This is because the investment cost would be higher as the number of floors increases. The average investment cost for a two-storey swiftlet house with a common size of 15.24 m x 6 m x 6 m is roughly around RM294,800 to provide a breeding floor area of 186 m2 (Shahwahidet al. 2015). This supports the collected data in which most swiftlet ranchers chose a two-floor building design since the range of investment cost is at the average rate and can be considered affordable by the swiftlet ranchers.

In terms of the length and width of the swiftlet houses, most of the ranchers preferred a width ranging from 1 m to 10.9 m in both states, followed by 1m to 10.9min length. As reported by Rahman et al., (2020), a building size of 21 meters x 12 meters was identified to produce the highest number of edible bird nests, 273 nests, while the lowest number of edible bird nests were harvested in a swiftlet house with a size of 14 meters x 7 meters. This proves that the size of the swiftlet house affects the production of the edible bird nest.

Based on the data, the most preferred size was 1m to 10.9m in length and 1 m to 10.9 m in width, which was way larger than the recommended size. A larger building would provide a more comfortable setting akin to the natural habitat of the swiftlets and would likely make the swiftlets stay to breed in the houses. As reported by Wan et al. (2015), the ideal size for a swiftlet house should be at least 6 meters x 18 meters. A dimension smaller than that measurement is considered fairly small for bird nesting purposes. A small swiftlet house would

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be unconducive as it prevents the swiftlets to fly freely inside the house and thus, affecting the production of an edible birds' nest.

Moreover, the results of the study were highly significant for all the parameters discussed except the number of floors as indicated by chi-square tests (Figure I). The calculated chi-square values were higher than tabulated for location area, district, orientation, placement of bird entrance, and size of the swiftlet houses. While only for flooring the calculated value was lower than the tabulated making the result non-significant. Overall, the study was highly significant providing higher calculated values than the expected ones.

Conclusion

From this study, it was found that a higher percentage of swiftlet houses in Sabah and Sarawak are located in agricultural and forest areas. The main preference of swiftlet houses' orientation in Sabah is pointed in the direction of east to west and north to south, while it is erected in the direction of the southeast to northwest in Sarawak. In terms of the placement of the swiftlet house, the orientation, and the flooring, there is a major difference between the swiftlet housing design in Sabah and Sarawak. For the reasons stated above, there is no major change in the placement of the bird entrance, the breadth, or the length of the swiftlet dwellings. It could be concluded that most of the swiftlet ranchers in Sabah and Sarawak are well aware of the natural habitat setting of the swiftlet, considering the size chosen for most of the swiftlet houses was large to resemble the environment of the swiftlet's habitat for optimum edible bird nest production.

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