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Social Network Analysis on Knowledge Sharing in Swiftlet Ranching Industry in Gua Musang

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Abstract
This paper utilizes social network analysis to identify key stakeholders in Gua Musang's Swiftlet Ranching industry, focusing on knowledge shari ng in ranch management. The study underscores the pivotal role of government agencies as information distributors, revealing a modest 39.92% centralization closeness in knowledge sharing among stakeholders. Recognizing these influential stakeholders is crucial for implementing effective policies and information dissemination, essential for the industry's success and increased edible bird's nest production.

Keywords: Swiftlets; Social Network Analysis; Knowledge Sharing; Edible Birds Nest

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1.0Introduction
Malaysia recognizes Edible Bird's Nest (EBN) as a pivotal industry in its Economic Transformation Program, poised to contribute over RM1 billion to the gross national income. Ranking as the world's second-largest EBN producer, Malaysia exported 56.54 metric tonnes valued at RM1.2 billion in 2022, with a growing demand of 80 metric tonnes annually from China alone (The Ministry of Agriculture and Food Industries, 2022). Initially harvested from caves in locations like Gomantong and Niah, the surge in demand led to the flourishing business of purpose-built swiftlet ranching in the late 1990s. These ranches, designed to mimic natural swiftlet habitats, have become instrumental in meeting market needs, reflecting a significant shift from cave harvesting practices (Alpandi et al., 2022).

The high number of swiftlets ranching, leading to a year-on-year rise in Edible Birds Nest (EBN) production, is a testament to the beguiling market demand. On 2021, there are 16,731 swiftlet ranching has been registered under Department Veterinary Services (DVS). However, the industry faces a major hurdle where 70 per cent to 80 per cent of swiftlet ranches are regarded as inefficient since it's failed to achieve 1.36kg of the nest after one year of operation due to a lack of understanding and knowledge in the management of swiftlet ranching (Ya'acob et al., 2022). Knowledge has been catered as important tools to help rancher enhance the management of swiftlet ranching and boost the production of EBN and movement towards sustainable development of Swiftlet ranching industry (Alpandi et al., 2022). Swiftlet ranching is really needing proper management to make sure the birds attracted to the house to build the nest. The

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right chooses of sound amplifier to attract the birds to lure the house, the mist to make sure suitable humidity to avoid nest to fragile, the colour inside the building since the birds don't like sun light during breeding, the plank to facilitate the birds which not perch due to their leg structure and many more. Not many ranchers known about this specific feature in ranching house which can attract more birds and boost the production. The objective of this research is to mapping out the social network of Swiftlet Ranching in Gua Musang to capture the main stakeholders that can play an important role in knowledge sharing regarding the management of Swiftlet Ranching in Gua Musang.

2.0 Literature Review

Social Network Analysis (SNA) employs mathematical tools to systematically explore networks, comprised of vertices (e.g., individuals) connected through edges or ties (e.g., friendship). This approach utilizes network metrics to discern key actors, subgroupings (network clusters), and overall network structures, such as density (Hansen et al., 2020; Knoke and Yang, 2019).

Numerous studies have leveraged SNA across diverse domains. Bright et al. (2021) applied SNA to examine groups involved in illicit activities like drug trafficking and terrorism. Conversely, Faas and Jones (2017) utilized SNA to probe human behavior and relationships in disaster contexts, illustrating its potential utility in understanding complex human-environment dynamics.

Despite its applicability in various fields, research utilizing SNA in agriculture remains scarce. Ya'acob et al. (2022) highlighted inefficiencies in swiftlet ranching, attributing them to a lack of understanding and knowledge management. Alpandi et al. (2022) Alpandi et al., (2022) in their research also mentioned knowledge management on switlet ranch playing main role to make swiftlet ranching can attract more birds to build the nest. From here SNA can be used to see the knowledge sharing network pattern and who is the main stakeholder in sharing knowledge on management of Swiftlet ranch.

According to Sakti et al. (2020), knowledge sharing involves interpersonal communication for transmitting knowledge, impacting overall industry network performance (Ozkan-Canbolat et al., 2016). Van Waveren (2017) further defines knowledge sharing as the strategic transfer of knowledge within and between units, highlighting its importance in human resource management. This process encompasses various entities such as business partners, stakeholders, and departments (Spraggon et al., 2012).

SNA delves into relationship patterns within networks, with nodes representing stakeholders or agencies capable of decision-making (Kumari, 2019). Ties encompass diverse forms of interactions, including friendship, knowledge transfer, and competition (Bodin et al., 2006; Borgatti & Li, 2009; Kim et al., 2011). At the network level, metrics like density and centralization offer insights into network cohesion and hierarchy.

In summary, SNA offers a systematic framework for understanding network dynamics and knowledge sharing patterns, with potential applications spanning diverse sectors including agriculture. By leveraging SNA methodologies, researchers can unravel intricate relationships and inform strategies for enhancing industry sustainability and performance.

3.0 Methodology

The social network study requires the identification of actors or stakeholders involved in the swiftlet ranching network in Gua Musang, by defining the ties or relationships between two or more actors and setting the network boundary. The actors included those involved ties in the knowledge sharing regarding the management of swiftlet ranching base on the questionnaire. In this study, the actors are defined as respondents that belong to a certain category of stakeholders such as Government agencies (DVS), ranchers, consultants, and researchers. These actors have a stake in EBN ranching and will be affected by any policies or law implemented. An individual, even though lacking in formal mandate to govern, can be included as an actor in an SNA of swiftlet ranching as they are involved in knowledge sharing regarding how to manage swiftlet ranch. These actors fall into several stakeholder categories depending on their functions. In this research 150 stakeholders' sample has been interviewed by using snow ball sampling method.

SNA views social relationships, in terms of network theory, consisting of nodes and ties (also called edges, links, or connections). Nodes are individual actors within the networks, and ties are the relationships between the actors in this research cater knowledge sharing. The resulting graph-based structures are often very complex. There can be many kinds of ties between the nodes. The matrices are used in linking the ties of stakeholders with each other. There is a number inside the matrix cells that represent the presence or absence of ties. For example, if A has a relationship on knowledge sharing regarding management swiftlet ranching with B, then the number of ties between them is 1 and if A has no social relationship on knowledge sharing regarding management swiftlet ranching with C, the number of ties between them be 0. The matrix cells of the relationship between A and A will be placed as non-existent. Table 1 will show the example of matrix data of a relationship of stakeholders. In the contact of this research, the relationship among the stakeholder (node, actor) is knowledge sharing regarding the management of swiftlet ranching.

Table 1: Social network analysis data entry

	A	B	C	D
A	-	1	0	1
B	1	-	1	1
C	0	1	-	1
D	1	1	1	-

Questionnaire answer must be entered in table sheet like Table 1 and later UCINET and Net Draw software was then used to compute how the relationship looks like based on the matrix data. Based on example Figure 1 is the simple result will come out where the result shows that stakeholders A and C have no relationship with each other while stakeholders B and D know everyone inside the network. Each relationship is unique and can be a relationship based on friendship, advice, conflict, or simple interaction. SNA can uncover the structure of the network and identify which stakeholders are more central and how this network is clustered together. For example, from the table 1 stakeholders B and D have the highest number of ties (knowledge sharing regarding the management of swiftlet ranching) and therefore, a higher influence inside the network than stakeholders A and C.

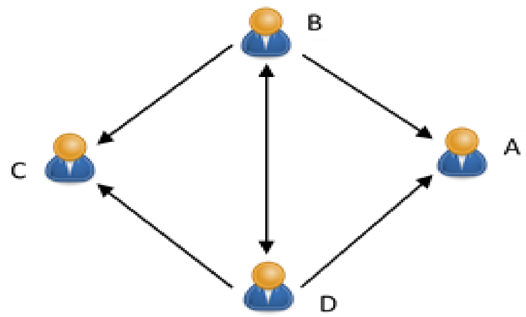

Fig. 1: Kind of ties among stakeholders

In the following Table 1 some useful notions will be illustrated through a simple example on the way SNA approach works. The network SN = <V/E> is described by a set V of n vertices and a set E of m edges and is assumed to be a connected, undirected and unweight graph. The SNA study undertaken involves the computation of several measures in order to find the important stakeholder in knowledge sharing ties regarding the management of swiftlet ranching. This study will measure:

3.1 Network centralization

Centralization is where one or a few of the actors hold most ties with each other in the network. The network links them to other actors that are not connected to each other. All of this result will be obtained after we run UCINET and Net Draw software based on the matrix data that we get from the questionnaire. Centralization is helpful in the initial phase of forming groups and building support for collective action (Crona and Bodin, 2006). However, such a centralized network is disadvantageous for long-term planning and finding solutions to a problem because when relying on only a few actors, the network becomes highly vulnerable to shock. It would also be difficult for the network to grow because other actors become highly dependent on the main actor(s) with strong ties to give the commands and, hence, they would not take their own initiative. A similar concept to centralization is centrality. The centrality concepts refer to the position of actors in a network that can affect how resources and information circulate and is exchanged in the whole network. The two types of centrality measurements used in this study are degree centrality and betweenness centrality.

3.2 Degree centrality

Degree centrality is one of the most common types of centrality methods used by research to analyze network data. It is defined as the number of ties for every single node in the network by using the questionnaire. Degree centrality usually means how the network flows from one node to another (Figure 2). There are two types of degrees: indegree and outdegree. Indegree counts the number of ties coming to the node and based on the questionnaire "Who is the person you refer and share knowledge regarding the management of swiftlet ranching?", the word "refer" showing the indegree where the actor go into another actor seeking the knowledge, while outdegree counts the ties that go out to other nodes which word "share" in the questionnaire are more appropriate to explain the actor willing to give their knowledge to others. Degree centrality usually will be used to see the relationship between friends or the flow of advice from one actor to another. Figure 2 shows nodes 3 and 5 have the highest degree, which is 4.

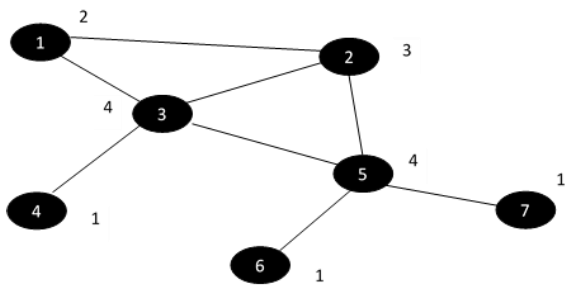

Fig. 2: Degree Centrality Illustrated.

Degree centrality for individual nodes provides the number of their direct links and helps identify leaders who have the (almost) highest number of links within the network. Group degree centrality represents the number of nodes outside the group that are linked to the elements of the group. The normalized node degree centrality and group degree centrality in each social network (SN) are computed as follows:

$\boldsymbol{C_D^{SN}(i)} = \frac{\boldsymbol{d(i)}}{\boldsymbol{n-1}}$ for normalized node (node i) and
$\boldsymbol{C_D^{SN}(i)} = \frac{\boldsymbol{|N(G)|}}{\boldsymbol{n-|G|}}$ for a group node (node G)
Where n is the number of nodes in the network SN, d(i) is the degree (number of edges) of node i, and N(G) is the set of nodes, which do not belong to group G but are adjacent to an element of the group.

3.3 Betweenness centrality
Betweenness centrality refers to how an actor occupies a between position on many pairs of other actors, who are disconnected in the network (Figure 3). Actors that hold a high betweenness centrality are important in long term management planning because they can perform a broker role in bringing together disconnected actors of the network. Figure 3 reveals that Actor no. 5 holds the high betweenness centrality in the network with the value 1.

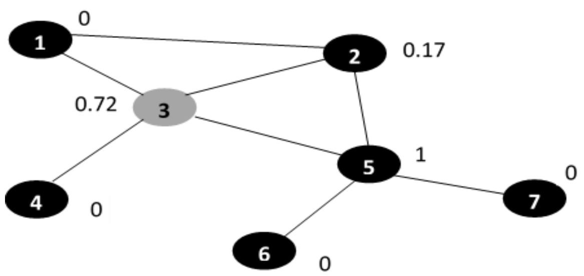

Fig. 3: Betweenness Centrality Illustrated

This allows the network more diversity resulting in new ideas flowing inside it (Bodin et al,2006; Prell, 2011). However, it also allows the actors that hold the broker position to feel torn when there are conflicts with different elements of the network and feel forced to take sides (Krackhardt, 1992). Betweenness centrality also expresses the amount of the flow control that a node (or a group of vertices) possesses over the interactions of other nodes in the network. It is high for mediators (or brokers) which are nodes that act as intermediaries between other nodes or as joints between communities. The betweenness centrality indicator is computed as follows:

$\boldsymbol{C_B^{SN}(i)} = \frac{\boldsymbol{2 \times \sum_{i \neq j \neq k} \frac{p_{jk(i)}}{p_{jk}}}}{\boldsymbol{(n-1)(n-2)}}$ for node i and
$\boldsymbol{C_B^{SN}(G)} = \frac{\boldsymbol{2 \times \sum_{j<k} \frac{p_{jk(G)}}{p_{jk}}}}{\boldsymbol{(n-|G|)(n-|G|-1)}}$ for a group of G nodes

where p_{jk} is the number of shortest paths between nodes j and k and $p_{jk(i)}$ (resp. $p_{jk(G)}$is the number of shortest paths between nodes j and k that cross node i(resp. G). For the SNA, answers to the questionnaire were placed in a datasheet by following the SNA data entry system. UCINET and Net Draw software were then used to compute the SNA measurements of network cohesion, network centralization and reciprocity, as well as in drawing the network maps.

Selecting the right stakeholders for social network analysis poses challenges due to unclear boundaries. Carrington (2005) proposed snowball sampling, wherein initial stakeholders were interviewed, each recommending another for interviews. This continued until no new actors emerged, defining the network's scope. Sandstrom and Rova (2010) advocate for sampling mirroring the actual population in network studies, prioritizing it over expert-driven sampling. Scott (2000) notes that observational data collection for an entire network is time-consuming, suggesting a comprehensive interviewing approach to capture the social relationship aspect and establish the network structure efficiently

This research still has limitations which this research has been conducted with limited boundaries setup just within Gua Musang only. The data can be collected more than just stakeholder involved in Gua Musang and it will represent more stakeholders in industry including inside and outside of the country. However, based on this research the collection of data only set limit in Gua Musang only due to time consuming and wide network.

4.0 Finding and discussion
The study commences with a comprehensive stakeholder analysis aimed at identifying key stakeholders within the swiftlet ranching industry. These stakeholders were queried regarding their connections to other industry actors, focusing on those involved or impacted by knowledge dissemination regarding swiftlet ranching management in Gua Musang. The inclusion of these stakeholders is paramount as they serve as conduits for disseminating best practices to inefficient ranchers, thus contributing to industry enhancement.

Data collected from the questionnaire responses were compiled into a standardized datasheet, adhering to the Social Network Analysis (SNA) data entry protocol. Analysis of the gathered data was conducted using UCINET and NetDraw software. Field surveys employing a standardized questionnaire facilitated data collection, with subsequent analysis performed utilizing UCINET and NetDraw software. The resultant findings revealed distinct stakeholder groups within the Edible Bird's Nest (EBN) ranching industry in Gua Musang, predominantly comprising government agencies, ranchers, and consultants.

Visualization of the EBN ranching industry network in Gua Musang was achieved through Figures 4, offering a graphical representation of the identified stakeholder groups. This visualization aids in comprehending the interconnections and dynamics within the swiftlet ranching ecosystem, providing valuable insights for stakeholders and policymakers to foster collaboration and drive industry improvement initiatives.

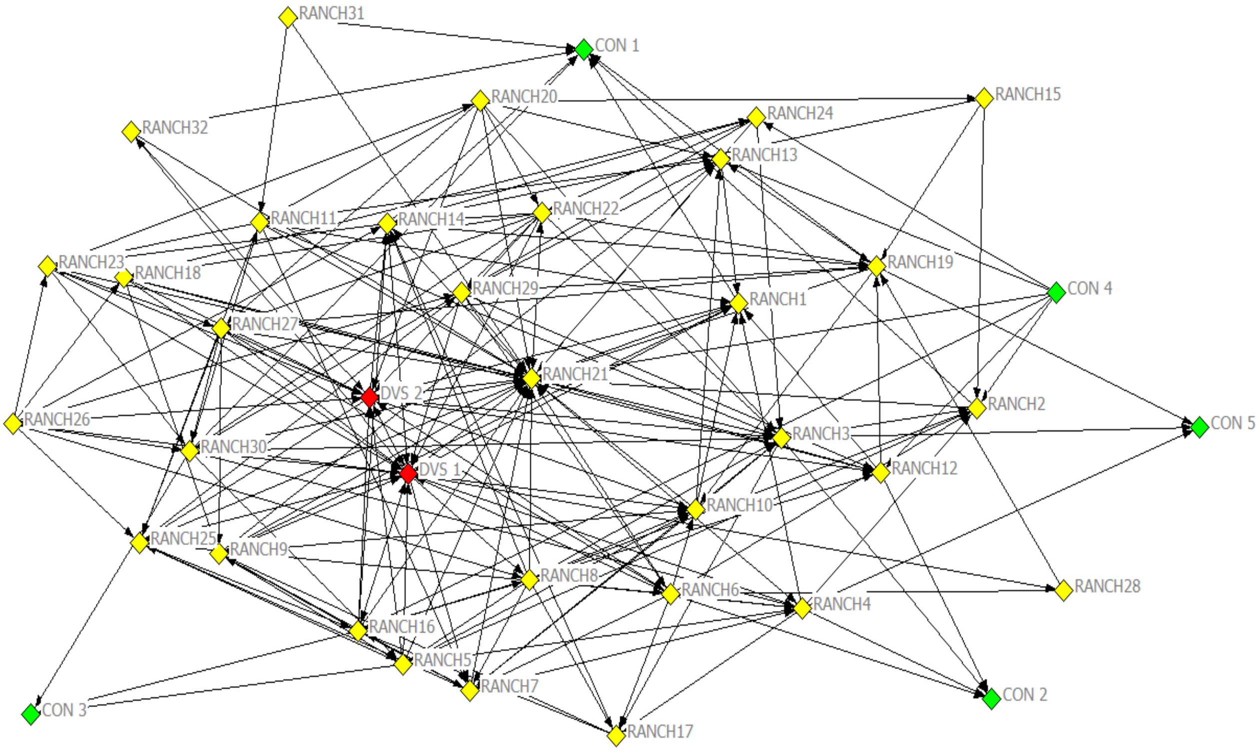

Fig. 4: EBN ranching Industry Network in Gua Musang

Stakeholders with the highest degree have a big impact on how other stakeholders behave inside the network, as they can play a role as coordinator of central knowledge. Since the actor that receives many ties may have access to and is be able to call on more resources in the network. Often labelled as third parties or deal makers among the stakeholders, they benefit from this position.

Based on SNA result In Gua Musang, the actor with the highest indegree direct ties is Rancher 21 (Table 2 and Figure 5) with the total 39 ties in the network, 28 ties or actors provided direct knowledge or information about swiftlet ranching to Rancher 21. Rancher 21 is also known as an important actor since he is regarded as a knowledge or information collector in the network. The highest outdegree score went to DVS 1. DVS 1 played the main role in providing knowledge and information relating to problems faced in managing swiftlet ranches since outdegree is the result for the question "who is most sharing" in knowledge management of swiftlet ranching.

Table 2: Top 10 indegree and outdegree stakeholders' scores in Gua Musang

Top 10 Stakeholders	**Outdegree Score**	**Top 10 Stakeholders**	**Indegree Score**
DVS 1	12	RANCH21	28
RANCH8	10	DVS 1	16
RANCH6	10	DVS 2	13
RANCH26	9	RANCH14	10
RANCH16	9	RANCH3	9
DVS 2	9	RANCH7	8
RANCH22	9	RANCH1	8
RANCH5	8	RANCH13	8
RANCH27	8	RANCH4	7
RANCH20	8	RANCH19	7

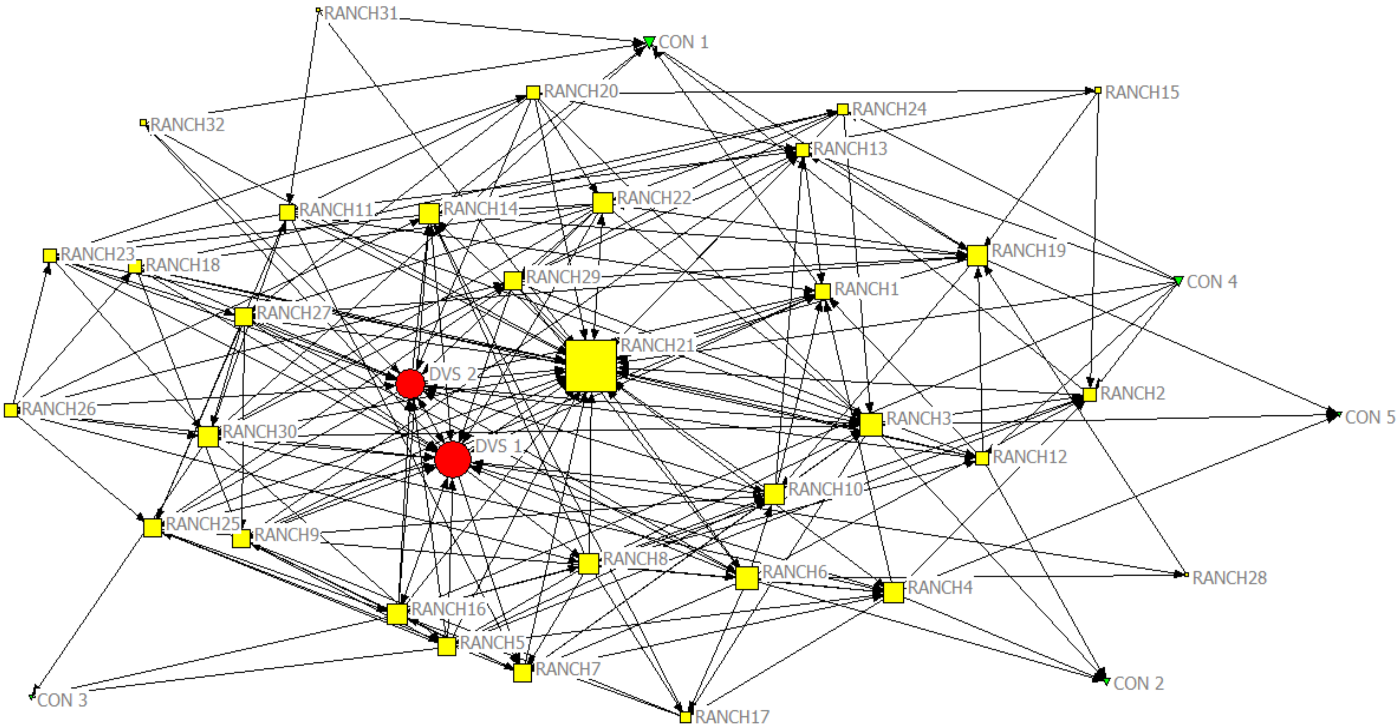

Fig. 5: Degree Centrality Mapping in Gua Musang

Table 3: Betweenness stakeholders' scores in Gua Musang

Stakeholder	Betweenness score	n ties
DVS 1	242.364	17.238
RANCH21	225.594	16.045
RANCH14	121.875	8.668
RANCH27	99.196	7.055
DVS 2	90.008	6.402
RANCH23	81.153	5.772
RANCH30	73.477	5.226
RANCH19	73.343	5.216
RANCH22	66.211	4.709
RANCH3	56.871	4.045

Actors that have a high betweenness score indicates that they are in the centre of the network. They also fall on the geodesic path between other pairs of actors in the network. Therefore, more people are depending on them to connect with other people. This betweenness actor, also known as third party or dealer, exchanges knowledge of management swiftlet ranching from one stakeholder with another stakeholder that were not connected previously. Tables 3 show that the actors with the highest scores in-betweenness in Gua Musang are DVS 1 and Rancher 21. Rancher 21 also has a high indegree centrality in Gua Musang and they know as the knowledge collectors since a lot of other actors seem to share knowledge and information regarding the problems faced and the management of swiftlet ranching with Rancher 21. Base on this result we can help the industry improve the management of swiftlet ranching by introducing these betweenness actors to be the middleman so as to relay all the knowledge and information regarding swiftlet ranching to the authorities, after which, can be disseminated aside from providing solutions to unsuccessful swiftlet ranches. DVS2 is the government agencies in Gua Musang, making them an integral part of betweenness centrality in the network. This shows that the role of government is vital to improve the management of swiftlet ranching in both areas.

Based on Table 4, the results on closeness centrality show that the industry is not open to sharing knowledge and information among stakeholders as the percentage is 39.92% in Gua Musang. However, based on the centralization degree, indegree ties are higher than outdegree in both areas indicating that they are more sharing the knowledge just inside the network (association) compared to sharing it with outside people. Base on this result we already know the pattern of knowledge sharing inside the association and their role in knowledge sharing on management of swiftlet ranching need to be highlighted to help the new ranchers and inefficient rancher to improve their management and boost the production by referring with the correct person. This situation not only can make this industry become more lucrative, but it can lower the risk of investment in this industry.

Table 4: Network level results for knowledge sharing network in Gua Musang

Network Measures	Score (Gua Musang)
Number of ties	216
Network Density	0.146
Average Degree	5.54
Average Closeness	293.87
Average Betweenness	14.66
Centralization (Degree) – outdegree	17.45%
Centralization (Degree) – indegree	60.67%
Centralization (Closeness)	39.92%
Centralization (Betweenness)	41.51%

5.0 Conclusion and recommendation

The Swiftlet Ranching industry faces significant inefficiencies ranging from 70-80% due to inadequate management and knowledge gaps. This study identifies key experts capable of providing guidance and knowledge-sharing, serving as invaluable resources for ranchers, investors, researchers, and policymakers alike. By employing Social Network Analysis (SNA), policymakers can collaborate with these experts to address challenges within the industry and establish effective Standard Operating Procedures (SOPs). Insights gleaned from SNA empower stakeholders to furnish crucial information and guidance to potential investors, thereby mitigating the risks associated with inefficient ranch construction. Despite the industry's potential for high returns with minimal bird feeding costs, the high cost of constructing Swiftlet ranches and the risks associated with improper ranch development pose significant threats to investments. Furthermore, revising SOPs based on insights from industry experts and practitioners can enhance operational efficiency. The empirical findings from this study contribute valuable knowledge, paving the way for new research avenues and facilitating the exploration of innovative insights in the field.

Paper Contribution to Related Field of Study

Through the engagement of key stakeholders, vital information and policies aimed at enhancing industry management can be channeled effectively. This inclusive approach ensures the industry's sustainability and future success. Furthermore, leveraging the expertise highlighted in the research findings can aid in refining government SOPs for the management of Swiftlet ranching**.**

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