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Analytical Hierarchy Process for Selecting the Locations for Vegetable Vendors

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Abstract: Choosing the right location is crucial for the success of any business, and this holds true worldwide. While there has been extensive research on location selection for any business setup, very limited study has been done to identify suitable locations for vegetable vendors, particularly in urban areas. To address this gap, present study aims to establish a methodology to identify the most suitable locations for vegetable vendors in urban area using the Analytical Hierarchy Process (AHP). AHP establishes the criteria and attributes for identifying the best locations for vegetable vendors in the present study. From the existing literature, four criteria and eleven attributes were selected. The relative relevance of these criteria and attributes are determined using AHP. Findings of the present study, established that accessibility, environment, infrastructure, and population are the crucial aspects to be considered while predicting suitable locations for vegetable vendors. The findings of this study will provide significant insights to urban planners, municipal officials, and development authorities for identifying or anticipating the appropriate locations for vegetable vendors in urban areas.

Keywords: *Analytical Hierarchy Process (AHP), vegetable vendor, location, criteria*

1. Introduction

Consuming vegetables is an economical way to obtain the necessary nutrients [1]. Nevertheless, the significance of vegetable consumption with regards to dietary habits is influenced by culture [1]. In India, the vegetable industry is considered important by farmers, consumers, and vendors [2]. Most Indians consume vegetables with rice, which is the country's main staple food. According to the Household Consumption of Various Goods and Services report [2], perishable goods such as milk, milk products, and vegetables are the most commonly consumed. Vegetables can be purchased at shopping malls, convenience stores, local markets, and from street vendors. They also play an important role in urban areas of many developing countries [3].

Street vegetable vendors (SVVs) who sell vegetables on the street use mobile trucks, carts, and other temporary setups to offer their goods and services to the public [4]. These vendors strive to maintain good customer relations by providing high-quality products, and they tend to establish themselves in busy locations to sustain their business [4], [5].

Street vending is a challenging occupation that involves intense competition for customers, fluctuating prices of goods, and difficulty in securing suitable locations. It is often associated with issues such as overcrowding, traffic, pollution, and improper waste disposal [6], [7]. Furthermore, street vendors have limited access to basic facilities such as toilets and drinking water [8]. Unfortunately, the government fails to recognize the vital role that street vendors plays in advancing the economic and social welfare of urban populations [9].

A suitable location is one of the most important factors for vegetable vendors to consider in urban environments, as it can offer them with access to basic amenities and regular access to potential clients [10]. Few studies have characterised the geographic behaviour of SVVs, particularly in the Indian context [7], [11]–[16]. According to Widjajanti (2016) [17], the positioning of street vendors are mostly found to be in between educational and residential landuses. These places experience significant amount of movement of community members residing in nearby locality as well as the floating population like office workers, shop visitors etc, Rajkumar and Jacob (2010) [13], emphasize the importance of smart location choices for street vendors in order to maximize the vending activities [13].

Although there are existing business models [16], [18] for vegetable vendors, any such model to identify suitable locations inconclusive, particularly for SVVs due to the lack of research on the subject [19]. Therefore, further studies are necessary to gain a better understanding of the location preferences of vegetable vendors. The present research seeks to establish appropriate criteria and attributes for identifying favorable locations for vegetable vendors through the use of the mathematical tool i.e. Analytical Hierarchy Process (AHP) model.

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2. Literature Study

The theory of facility placement was introduced in 1909, through the work of Weber [20]. This theory aimed to reduce costs by determining the most efficient location for facilities. Over time, many other models and ideas were developed, each with its own set of criteria for optimal facility placement [21]. To determine the best location for retail stores, various approaches like mathematical and scientific programming have been utilized, as described by Aikens, (1985) [11].

Understanding how to attract customers is crucial for the growth of any business [22]. The location of a business can have a significant impact on its effectiveness [23]. Location theories have been studied since the 1960s to help businesses select suitable locales for different markets. According to Verma & Mishra (2021) [24], vendors tend to position themselves in locations that meet the daily demands and requirements of their consumers [24].

In a study conducted by Bhowmik in 2005 [25], the prevalence of street vending in various Asian countries was analyzed, including Bangladesh, Sri Lanka, Thailand, Singapore, Malaysia, the Philippines, Vietnam, Cambodia, South Korea, and India. Additionally, Bhowmik (2003) [26], focused on seven Indian cities, namely Mumbai, Ahmedabad, Kolkata, Imphal, Patna, and Bhubaneswar, revealing that licenses for street vending are provided in all municipalities except Kolkata.

In 2008, Dimas [27] conducted a study on the history of street vending and claimed that street vendors pose a significant challenge for urban authorities. Their study suggested that urban decision-makers need to change their mindset and adopt management practices from around the world to tackle this issue [27].

There are also studies like Adhikari (2011) [28], that suggests the importance of street vending in the social-economic development of developing nations by creating job opportunities, boosting production, and generating revenue. Adhikari also pointed that vendors can earn more money by investing less in their business. Harendra and Rajesh (2020) [29], further elaborated on the economic growth policies for informal sectors and their socio-economic conditions.

Banerjee (2014) [30], conducted a study on the financial situation of street vendors and found that a significant portion of these vendors belongs to low-income family background and face financial constraints due to poverty. This limits their ability to invest in their businesses and make a decent income. In a study by Bhatt et al. (2018) [31], the researchers examined the roadside location settings, the items being sold to consumers, and the social status of those who purchase goods from roadside vendors. Tigari et al. (2020) [4], on the other hand, presented the revenue and expenditure patterns of SVVs in Davangere. It was found that people are increasingly buying vegetables from street vendors because of the superior quality.

Numerous studies have explored the socio-economic circumstances of street and vegetable vendors, including the obstacles they encounter on a daily basis, their living expenses [5], education level [32], and the level of women's participation [33]–[35]. Despite this, there is a scarcity of research on identifying the preferences and criteria for locations of vegetable vendors. This research aims to establish the attributes and criteria for selecting suitable locations for vegetable vendors in urban areas. Various methods were employed to calculate the weights, but the multiple criteria decision-making method (MCDM) proved to be the most effective in distinguishing appropriate sites for vegetable vendors [36], [37].

The MCDM model has emerged as a valuable tool for resolving decision-making problems, not just in business but in various contexts. It enables a comprehensive evaluation of available information and considers all possible alternatives, minimizing the risk of flawed conclusions [38]. Decision-making, however, can be a challenging task due to several obstacles. In business site selection, decision-making is particularly critical because the wrong choice can lead to financial ruin [39]. Hence, it is crucial to choose carefully. Saaty's AHP technique, proposed in 1977 [40], has been widely used in practical decision-making over the last few decades. This technique has proved useful in diverse contexts and has significantly contributed to research in MCDM. Therefore, this paper aims to elaborate on the MCDM model and Saaty's AHP technique, highlighting their importance in decision-making and their applications in various fields.

The paper will provide a comprehensive review of the literature concerning MCDM and AHP, their theoretical backgrounds, and their practical applications. Additionally, the paper will explore the limitations, challenges, and future research directions of the MCDM model and AHP technique.

3. Material and Method

Figure 1 provides a concise overview of the research methodology utilized in this study. In the study, optimal locations for vegetable vendors were identified through the application of the AHP method. A systematic workflow approach utilizing AHP was outlined, which proved to be effective for decision-making processes involving multiple quantitative criteria that can be structured hierarchically. It was concluded that AHP is a comprehensive tool for most decision-making scenarios [41].

3.1 Sampling and Data Collection

For this study, the purposive sampling technique was utilized. Purposive sampling, also known as judgment sampling, involves intentionally selecting participants based on their specific qualities. This non-random technique does not require any underlying theories or specific number of participants [42], [43].

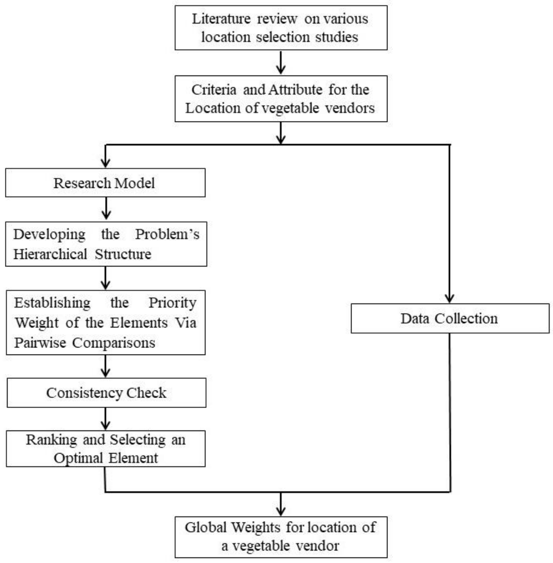

Fig. 1. Research Methodology for Decision Support Process

Source: (Authors, 2023)

Instead, the researcher determines the information needed and seeks out individuals who have the necessary knowledge or experience to provide it [42]. The process includes identifying and selecting individuals or groups who possess expertise and knowledge in a specific area of interest [44]. In the paper of Chen (2006) [45] , the questionnaire survey was designed and delivered to 50 academic related associations. The responses included 35 samples, for a response rate of 70 percent. This study was conducted with the involvement of 60 academicians and experts, categorized into 6 groups from different cities across India. With a response rate of 75%, 45 of the 60 experts who were approached responded to our questions. Respondents were required to assess the relative performance of a variety of characteristics for the ultimate objective of selecting a location for vegetable vendors. In response to the question, "In terms of roadside dumping and road type, which is more significant?" the relative position scaling was given equal weight (see Table 1). Table 3 is the primary questionnaire design for pairwise comparison assessment. After pairwise comparisons were implemented, the pairwise matrix was constructed. In addition, all data were compared using the pairwise approach. Depending on the availability of the experts, both online and offline Google forms were used to collect the primary datasets.

3.2 Questionnaire Development

Table 1. The primary questionnaire design: Efficient criteria and pairwise assessment.

Factor	**Factor weighting score**																	**Factor**
	More important than								**Equal**	**Less important than**								
L1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**L2**
L2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**L3**
L3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**L1**

Source: [29]

3.3 Data Analysis Methodology

1. A detailed description of the problem

To begin, it is important to thoroughly examine any relevant literature and consult with experts [23]. This will help to clearly define the decision problem (goal), as well as any multiple criteria and attributes involved, as depicted in Figure 2.

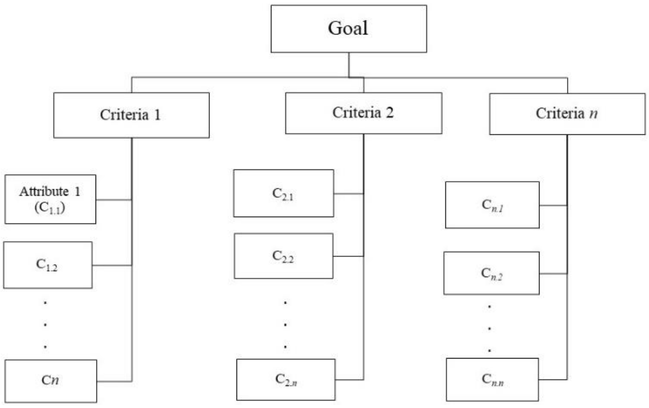

Fig. 2. AHP hierarchy structure

Source: (Authors, 2023)

2. Developing the Problem's Hierarchical Structure

The problem is partitioned into criteria for which each possible attribute (sub-criteria) is hierarchically categorised at several levels [38]. Each criterion is separated into its own attributes that are organised at the same level [40], [46], [47]. The objective is represented by the highest degree of hierarchy in the decision-making process (i.e., problem). The next level is comprised of a series of decision criteria used to solve the problem. The attributes are then stated under the appropriate judgement criteria [23].

3. Establishing the Priority Weight of the Elements Via Pairwise Comparisons

Pairwise comparison is a technique used to determine the importance of different items, such as criteria and attributes, within a hierarchy [47]. Decision-makers evaluate the importance of each item at each level by comparing them in pairs wise on their own experience and expertise [38]. In the study of Ho (2008) [38], at the second level, the criteria are compared with each other, and at the third level, attributes are compared with the respective attribute [38].

To calculate the weights associated with each item, decision-makers are given a survey questionnaire in the form of a pairwise comparison matrix within the hierarchical framework [48], [49]. The weight of each factor is measured using Saaty's scale, as shown in Table 2 of the pairwise comparison given in equation 1.

For a detailed explanation of the AHP process, refer to Taherdoost Hamed (2017) [48], research article.

$$\lambda_{max} = \frac{1}{n} = \sum_{i=1}^{n} \frac{(Aw)i}{\omega_i} \quad (1)$$

n = Comparison number of factors

A = Pairwise comparison matrices

i = 1,2,3……..n

w = Eigen vector

λ_{max} = Maximal eigenvalue

Table 2. The 9-point intensity scale of relative weight (importance or well-being)

The intensity of Relative Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another.
5	Essential or strong importance	Experience and judgment strongly favor one activity over another.
7	Demonstrated importance	Activity is strongly favored, and its dominance is demonstrated in practice.

9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between the two adjacent judgments	When a compromise is needed.

Source: [40], [41], [49]

4. Consistency Check

Saaty, (1990) [50], proposed using both the consistency index (CI) and the consistency relation (CR) to determine the consistency of comparison matrices, wherein the terms CI and CR are determined:

$$CI = (\lambda_{max}-n)/(n-1) \quad (2)$$

$$CR = CI/ \quad (3)$$

Using the set of pairwise comparison matrices, all relative weights that represent the relative impact of a group of elements on a single element are combined in the final phase of the AHP. AHP also computes a consistency index (or inconsistency ratio) to demonstrate the consistency of the judgement. In addition, λ_{max} denotes the greatest eigenvalue of the comparison matrix given by Saaty (1990) [50], where n is the matrix's order. In the preceding equation (3), RI represents a random index based on Table 3, where n represents the order of the matrix [51]. The consistency check is conducted to ensure that the survey data are consistent, which is denoted by the number ≤ 0.1 [41], [49], [52].

Table 3. The value of the Random Consistency Index

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: [50][52]

4. Ranking and Selecting an Optimal Element

In the final step of the AHP, the relative weights of distinct domains are aggregated to determine the global weights. Here, "global weights for each element (i.e., attribute or alternative) are produced from the second level down by multiplying relative weights by the corresponding criterion (or alternative) in the level above and adding them for each element based on the criterion (alternative) it affects" [53]. Consequently, the found global priorities are applied to the final ranking of the criteria, attributes, and options, as well as the selection of the optimal option for each criterion, attribute, and option.

5. Results and Findings

In this study, a hierarchical structure was used to arrange the model's criteria and attributes, and binary benchmarking matrices were built for each of them. Each criterion was compared to itself, resulting in a continuous 1 on the diagonal of the comparison matrix in Table 4, Table 5, Table 6 and Table 7.

Global weights were also calculated by solving another matrix, using the comparison matrix of the criteria outlined in Table 4 to determine the weight of each criterion. After reviewing the outcome of the calculations, the evaluator found it to be less than 0.1.

Table 4. Pairwise comparison matrix of the criteria

Criteria	Access	Environment	Infrastructure	Population	Weight (w_c)	Consistency ratio
Access	1.00	0.50	3.00	0.25	0.16	0.098<0.1 Matrix is consistent
Environment		1.00	5.00	0.50	0.30	
Infrastructure			1.00	0.33	0.09	
Population				1.00	0.45	

Source: (Authors, 2023)

A comparison matrix of access, environment, and infrastructure attributes are shown in Table 5, Table 6, and Table 7 below. In contrast, the additional matrices were solved for the global weight calculation.

Table 5. Pairwise comparison matrix for the attribute of access

Criteria	Roadside dumping	Type of road	Accessibility	Street lights	Weight (w_a)	Consistency ratio
Roadside dumping	1.00	0.14	1.00	0.20	0.07	0.090 <0.1 Matrix is consistent
Type of road		1.00	5.00	0.50	0.36	
Accessibility			1.00	0.17	0.07	
Street lights				1.00	0.49	

Source: (Authors, 2023)

Table 6. Pairwise comparison matrix for the attribute of the environment

Criteria	Landuse	Water Supply	Waste Disposal	Weight (w_a)	Consistency ratio
Landuse	1.00	9.00	3.00	0.67	0.090< 0.1 Matrix is consistent
Water Supply		1.00	0.20	0.06	
Waste Disposal			1.00	0.27	

Source: (Authors, 2023)

Table 7. Pairwise comparison matrix for the attribute of infrastructure

Criteria	Type of Parking	Drainage	Parking Space	Weight (w_a)	Consistency ratio
Type of Parking	1.00	7.00	0.25	0.30	0.098< 0.1 Matrix is consistent
Drainage		1.00	0.14	0.07	
Parking Space			1.00	0.64	

Source: (Authors, 2023)

The present study analyzes the consistency ratio of all criteria and attributes with the input of 45 experts. The mean values were considered for the final consistency ratio. The consistency ratio value for access was found to be 0.090, for environment 0.098, and for infrastructure 0.097. As the criterion of the population only had one attribute, the consistency ratio could not be defined. The overall consistency ratio for the criteria was 0.098, indicating that the data are consistent since the values were <0.1.

Table 8. Consistency ratio table for the criteria

Level	Consistency ratio	Consistency test
Goal Criteria	0.098	Accepted (<0.1)
Access	0.090	Accepted (<0.1)
Environment	0.098	Accepted (<0.1)
Infrastructure	0.097	Accepted (<0.1)

Source: (Authors, 2023)

Choosing the right criteria and attributes is crucial when selecting an ideal location for vegetable vendors. Access, environment, infrastructure, and population are key factors that must be considered. It is essential to take into account the international literature when selecting and evaluating criteria for any city.

The AHP model was used to calculate the local weights for both criteria and attributes, as shown in Table 4, Table 5, Table 6 and Table 7 for each expert. The local weights of criteria and attributes are represented in Table 9 (e.g., W_1 and $W_{1.2}$). The global weights were determined by multiplying the local weights W_1 and $W_{1.2}$.

Table 9. Overall weights of criteria and attributes for identifying locations for vegetable vendors

Criteria	**Local Score (W_1)**	**Attributes**	**Local Score ($W_{1.2}$)**	**Global Weights W_3**	**Ranking**
Access (C_1)	0.215	Roadside Dumping ($C_{1.1}$)	0.053	0.011	10
		Type of Road ($C_{1.2}$)	0.330	0.071	5
		Accessibility ($C_{1.3}$)	0.383	0.082	3
		Street Light ($C_{1.4}$)	0.235	0.050	8
Environment (C_2)	0.293	Landuse ($C_{2.1}$)	0.559	0.163	2
		Water Supply ($C_{2.2}$)	0.184	0.054	7
		Waste Disposal ($C_{2.3}$)	0.257	0.075	4
Infrastructure (C_3)	0.109	Type of Parking ($C_{3.1}$)	0.268	0.029	9
		Drainage ($C_{3.2}$)	0.084	0.009	11

		Parking Space ($C_{3.3}$)	0.648	0.070	6
Population (C_4)	0.384	Population Count ($C_{4.1}$)	1	0.384	1
Total	1			1	

Source: (Authors, 2023)

The weights explained in Table 4, Table 5, Table 6 and Table 7 are based on one pairwise comparison matrix, while 44 other matrices were similarly solved to derive the global weights described in Table 9. The ranking was conducted based on the global weights, with population count being the most important attribute at 0.384.

The second highest attribute was 0.163, followed by accessibility at 0.082. Additional attributes, in order of importance, were waste disposal (0.075), type of road (0.071), parking space (0.070), drainage (0.054), street lights (0.050), and type of parking (0.029). The least important attributes were identified as roadside dumping (0.011) and water supply (0.009). These criteria and attributes are crucial in identifying suitable locations for vegetable vendors.

Based on the findings in Table 9, attribute ranking is determined by multiplying local scores of criteria with local scores of attributes. Population criteria has the highest weight of 0.384, which when multiplied with the weight of population count attribute, results in the highest-ranking weight. Other attributes were also ranked and global weights were calculated accordingly.

The second highest local score criteria was found to be environment, with a weight of 0.293, and when multiplied with landuse, it resulted in the second highest global weight with a ranking of 2. The local score of the criteria plays a crucial role in the ranking and global weight calculation, leading to changes in the attribute hierarchy.

6. Conclusion

The aim of this study was to determine the criteria and attributes that street vegetable vendors take into account when selecting their location using the AHP method. The findings of the study indicate that population is the most crucial factor for location selection. Since vendors anticipate a high volume of visitors, they prefer to establish their presence in densely populated areas where they expect to generate more revenue.

The present study emphasizes the importance of selecting the appropriate weights for the criteria, as the suitability of location selection varies depending on the weight assigned. The contribution of this study is significant because, it intersects all the appropriate criteria and attributes for location selection, unlike previous research.

Apart from population density, the second most important factor identified was environment, followed by access and infrastructure. It was also observed that changes in certain criteria can impact the location of street vegetable vendors. Although the present study only addresses a minor portion of the research. Informal sector, planners or administrators can use the model to identify suitable locations using appropriate criteria and attributes for vegetable vendors specifically in urban areas.

Future research areas can explore the use of reliable and efficient technologies such as Geographic Information System (GIS), Artificial Intelligence, Global Positioning System (GPS), Machine Learning, Neural Networks, and Analog Approach for the location identification of vegetable vendors.

Author contributions

Sushmita1 Chakraborty1: Conceptualization, Methodology, Software, Field study**,** Data curation, Writing-Original draft preparation, Software, Validation., Field study. **Dr. Abir2 Bandyopadhyay2:** Visualization, Investigation, Reviewing and Editing. **Dr. Swasti3 Sthapak3:** Reviewing and Editing.

References

[1] M. Deliya, C. Thakor, and B. Parmar, "A Study on 'differentiator in Marketing of fresh fruits and Vegetables from Supply Chain Management Perspective,'" Journal of Research in commerce & Management, vol. 1, no. 3, 2012, [Online]. Available: www.abhinavjournal.com

[2] Government of India, "Household Consumption of Various Goods and Services in India, 2011-12," Jun. 2014. Accessed: Feb. 10, 2023. [Online]. Available: http://164.100.161.63/sites/default/files/publication_reports/Report_no558_rou68_30june14.pdf

[3] A. Jain et al., "A Comparative Study of Member Based and Non Member Based Vegetable and Fruit Vendors under Decent Work in Ahmedabad City," Imperial Journal of Interdisciplinary Research (IJIR), vol. 2, no. 4, 2016.

[4] H. Tigari and G. M. Anushree, "Income and Expenditure Pattern of Vegetable Vendors," International Journal of Commerce, vol. 8, no. 3, pp. 11–19, Jul. 2020, doi:

10.34293/commerce.v8i3.3240.

[5] H. Us, “Consumer Behavior and Attitudes in Purchasing Vegetables,” Agriculture Research & Technology , vol. 20, no. 2, 2019, doi: 10.19080/ARTOAJ.2019.20.556123.

[6] A. S. Israt and M. Adam, “From Control Street to Shared Space: A Study on The Street Hawking Activities in The Urban Public Spaces Of Dhaka City,” Asian Journal of Social Sciences & Humanities, vol. 8, no. 1, 2019.

[7] S. K. Bhowmik and D. Saha, “Street Vending in Ten Cities in India,” National Association of Street Vendors of India, no. June, pp. 1–174, Jun. 2012, [Online]. Available: http://www.streetnet.org.za/docs/research/2012/en/NASVIReport-Survey.pdf

[8] D. Kumari, A. Singh, M. Kumari, D. Sarkar, and D. Sarkar, “Street vendors of Urban Bihar: A case study of Patna Municipal Corporation Area, Bihar Geography Explore-Journal of Research for UG and PG Students Introduction,” 2012. [Online]. Available: http://www.patnawomenscollege.in/journal

[9] P. Chakraborty and S. Koley, “Socio-Economic View on Street Vendors: A Study of a Daily Market at Jamshedpur,” 2018, doi: 10.24321/2349.2872.201804.

[10] M. Panwar and V. Garg, “Issues and challenges faced by vendors on urban streets: A case of sonipat city, India,” International Journal of Engineering Technology, Management and Applied Sciences, vol. 3, 2015, [Online]. Available: https://www.researchgate.net/publication/280310189

[11] C. H. Aikens, “Facility location models for distribution planning,” Eur J Oper Res, vol. 22, pp. 263–279, 1985, doi: 10.1016/0377-2217(85)90246-2.

[12] R. Paulrajan and F. Jacob, “Business Models of Vegetable Retailers In India,” Great Lakes Herald, vol. 4, no. 1, 2009, [Online]. Available: https://www.researchgate.net/publication/235752179

[13] P. Rajkumar and F. Jacob, “Retail Logistics Practices of Indian Fresh Vegetables Market,” Asia-Pacific Business Review, vol. VI, no. 2, pp. 973–2470, 2010.

[14] S. K. Bhowmik and D. Saha, “Street Vending in Ten Cities in India,” 2012.

[15] R. Suárez-Vega, D. R. Santos-Peñate, and P. Dorta-González, “Location models and GIS tools for retail site location,” Applied Geography, vol. 35, no. 1–2, pp. 12–22, 2012, doi: 10.1016/j.apgeog.2012.04.009.

[16] X. Guo et al., “Scoping study on fruits and vegetables : results from India,” 2021.

[17] R. Widjajanti, “The Space Utilization by Street Vendors Based on the Location Characteristics in the Education Area of Tembalang, Semarang,” Procedia Soc Behav Sci, vol. 227, pp. 186–193, Jul. 2016, doi: 10.1016/j.sbspro.2016.06.061.

[18] P. Rajkumar and F. Jacob, “Business Models of Vegetable Retailers In India,” Great Lakes Herald, vol. 4, no. 1, 2010.

[19] KC Apil, G. Shrestha, R. Dahal, and S. Shrestha, “Urban Informal Sector,” 2014. [Online]. Available: https://www.researchgate.net/publication/306112043

[20] L. Ye, C. Ye, and Y. F. Chuang, “Location set covering for waste resource recycling centers in Taiwan,” Resour Conserv Recycl, vol. 55, no. 11, pp. 979–985, Sep. 2011, doi: 10.1016/j.resconrec.2011.05.007.

[21] A. Klose and A. Drexl, “Facility location models for distribution system design,” Eur J Oper Res, vol. 162, no. 1, pp. 4–29, Apr. 2005, doi: 10.1016/j.ejor.2003.10.031.

[22] John Henry Thompson and Evan W. Miller, Manufacturing: A Study of Industrial Location, 493rd ed., vol. 68(4). Geographical Review, 1978.

[23] R. J. Kuo, S. C. Chi, and S. S. Kao, “A decision support system for selecting convenience store location through integration of fuzzy AHP and artificial neural network,” Comput Ind, vol. 47, no. 2, 2002, [Online]. Available: https://doi.org/10.1016/S0166-3615(01)00147-6

[24] A. Verma and P. Kumar Misra, “Informal Market in Urban Setting in India: A Sociological Review,” Prizren Social Science Journal, vol. 5, no. 2, pp. 110–120, Aug. 2021, doi: 10.32936/pssj.v5i2.242.

[25] S. K. Bhowmik, “Street Vendors in Asia: A Review,” Econ Polit Wkly, 2005, Accessed: Feb. 10, 2023. [Online]. Available: https://www.wiego.org/sites/default/files/migrated/publications/files/Bhowmik-Street-Vendors-Asia.pdf

[26] S. K. Bhowmik, “Urban Responses to Street Trading: India,” Urban Research Symposium on Urban Development for Economic Growth and Poverty Reduction, World Bank, 2003, Accessed:

Feb. 10, 2023. [Online]. Available: https://learn-india.org/assets/Research/Urban-Responses-to-Street-Trading.pdf

[27] H. Dimas, “Street Vendors : Urban Problem and Economic Potential,” Economics and Development Studies, 2008.

[28] D. B. Adhikari, “Income generation in informal sector: A case study of the street vendors of Kathmandu metropolitan city,” Economic Journal of Development Issues, vol. 13, no. 2, pp. 1–14, 2011.

[29] B. Harendra and R. Sharma, “Mainstreaming of Slums and Informal Sector towards Achieving Inclusive Growth of Durgapur,” Mathematical Statistician and Engineering Applications, vol. 69, no. 1, pp. 15–28, 2020.

[30] S. Banerjee, “A study of socio-economic condition of vegetable vendors in Ranchi,” Jharkhand Journal of Social Development, vol. 7, no. 2, p. 651, 2014, Accessed: Feb. 10, 2023. [Online]. Available: https://www.academia.edu/32160115/A_STUDY_OF_SOCIO-ECONOMIC_CONDITION_OF_VEGETABLE_STREET_VENDORS_IN_RANCHI#:~:text=Their%20low%20income%2C%20double%20burden,many%20suffer%20from%20various%20infection.

[31] B. Vijaykumar Bhatt and A. Dineshchandra Jariwala, “A study of a study of street vending activities in the south east zone of Surat,” International Journal of Civil Engineering, vol. 7, no. 3, 2018, [Online]. Available: www.iaset.us

[32] R. AbuSabha, D. Namjoshi, and A. Klein, “Increasing Access and Affordability of Produce Improves Perceived Consumption of Vegetables in Low-Income Seniors,” J Am Diet Assoc, vol. 111, no. 10, pp. 1549–1555, Oct. 2011, doi: 10.1016/j.jada.2011.07.003.

[33] S. M. Trivedi, J. D. Bhatt, and C. R. Bharodia, “Social and Economic status of women vegetable vendors,” Gujarat Journal of Extension Education, vol. 31, no. 2, 2020.

[34] C. Kambara, “FDI in retail: plight of women vegetable vendors,” Indian Journal of Labour Economics, vol. 58, no. 4, pp. 677–693, 2015, doi: 10.1007/s41027-016-0041-4.

[35] S. M. Trivedi, Khunt K A, Bharodia C R, and Bhatt J D, “Performance and Problems of Women Vegetable Vendors in Saurashtra Region,” International Journal of Agriculture Sciences , vol. 11, no. 6, pp. 8157–8159, 2019, [Online]. Available: https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

[36] T. Demirel, N. Ç. Demirel, and C. Kahraman, “Multi-criteria warehouse location selection using Choquet integral,” Expert Syst Appl, vol. 37, no. 5, pp. 3943–3952, May 2010, doi: 10.1016/j.eswa.2009.11.022.

[37] S. Sipahi and M. Timor, “The analytic hierarchy process and analytic network process: An overview of applications,” Management Decision, vol. 48, no. 5. pp. 775–808, 2010. doi: 10.1108/00251741011043920.

[38] W. Ho, “Integrated analytic hierarchy process and its applications - A literature review,” Eur J Oper Res, vol. 186, no. 1, pp. 211–228, Apr. 2008, doi: 10.1016/j.ejor.2007.01.004.

[39] J. Y. L. Yap, C. C. Ho, and C. Y. Ting, “Analytic hierarchy process (AHP) for business site selection,” in AIP Conference Proceedings, American Institute of Physics Inc., Sep. 2018. doi: 10.1063/1.5055553.

[40] T. L. Saaty, “A Scaling Method for Priorities in Hierarchical Structures,” J Math Psychol, vol. 15, pp. 234–281, 1977.

[41] Saaty Thomas L., The Analytic Hierarchy Process. New York: McGraw-Hill, 1980.

[42] I. Etikan, S. A. Musa, and R. S. Alkassim, “Comparison of Convenience Sampling and Purposive Sampling,” American Journal of Theoretical and Applied Statistics, vol. 5, no. 1, pp. 1–4, 2016, doi: 10.11648/j.ajtas.20160501.11.

[43] A. S. Singh and M. B. Masuku, “Sampling Techniques & Determination of Sample Size in Applied Statistics Research: An Overview,” International Journal of Economics, Commerce and Management , vol. 2, no. 11, pp. 1–22, 2014, [Online]. Available: http://ijecm.co.uk/

[44] G. Sharma, “Pros and cons of different sampling techniques,” International Journal of Applied Research, vol. 3, no. 7, pp. 749–752, 2017, [Online]. Available: www.allresearchjournal.com

[45] C. F. Chen, “Applying the analytical hierarchy process (AHP) approach to convention site selection,” J Travel Res, vol. 45, no. 2, pp. 167–174, 2006, doi: 10.1177/0047287506291593.

[46] L. Mikhailov and P. Tsvetinov, “Evaluation of services using a fuzzy analytic hierarchy process,” Applied Soft Computing Journal, vol. 5, no. 1, pp. 23–33, Dec. 2004, doi: 10.1016/j.asoc.2004.04.001.

[47] S. Sipahi and M. Timor, “The analytic hierarchy process and analytic network process: An overview of applications,” Management Decision, vol. 48, no. 5, pp. 775–808, 2010, doi:

10.1108/00251741011043920.

[48] Taherdoost Hamed, "Decision Making Using the Analytic Hierarchy Process (AHP); A Step by Step Approach," International Journal of Economics and Management Systems, 2017, [Online]. Available: http://www.iaras.org/iaras/journals/ijems

[49] N. F. Aziz, S. Sorooshian, and F. Mahmud, "MCDM-AHP Method in Decision Makings," ARPN Journal of Engineering and Applied Sciences, vol. 11, no. 11, 2016, [Online]. Available: www.arpnjournals.com

[50] T. L. Saaty, "How to make a decision: The Analytic Hierarchy Process," Eur J Oper Res, vol. 48, pp. 9–26, 1990.

[51] I. Konstantinos, T. Georgios, and A. Garyfalos, "A Decision Support System methodology for selecting wind farm installation locations using AHP and TOPSIS: Case study in Eastern Macedonia and Thrace region, Greece," Energy Policy, vol. 132, pp. 232–246, Sep. 2019, doi: 10.1016/j.enpol.2019.05.020.

[52] B. L. Golden and Q. Wang, An alternate measure of consistency. Springer, Berlin, Heidelberg, 1989. doi: https://doi.org/10.1007/978-3-642-50244-6_5.

[53] C. L. Yang, S. P. Chuang, R. H. Huang, and C. C. Tai, "Location selection based on AHP/ANP approach," 2008 IEEE International Conference on Industrial Engineering and Engineering Management, IEEM 2008, pp. 1148–1153, 2008, doi: 10.1109/IEEM.2008.4738050.

[54] Yoon, H. . (2023). A Quantitative Evaluation for Usability under Software Quality Models. International Journal on Recent and Innovation Trends in Computing and Communication, 11(3), 24–29. https://doi.org/10.17762/ijritcc.v11i3.6194

[55] Kshirsagar, D. P. R. ., Patil, D. N. N. ., & Makarand L., M. . (2022). User Profile Based on Spreading Activation Ontology Recommendation. Research Journal of Computer Systems and Engineering, 3(1), 73–77. Retrieved from https://technicaljournals.org/RJCSE/index.php/journal/article/view/45