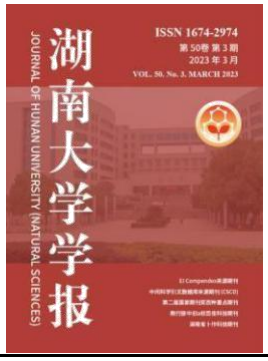

湖南大学学报（自然科学版） 第50卷第 3期
Journal of Hunan University (Natural Sciences） 2 0 2 3 年 3 月

Available online at https://jonuns.org

Vol. 50 No. 3
March 2023

Open Access Article

https://doi.org/10.55463/issn.1674-2974.50.3.3

Formation of a Tool for the Prediction of the Location of Vegetable Vendors in Raipur, Chhattisgarh

Sushmita Chakraborty, Abir Bandyopadhyay*, Swasti Sthapak*

Department of Architecture, National Institute of Technology, Raipur, India

* Corresponding authors: abandyopadhyay.arch@nitrr.ac.in, ssthapak.arch@nitrr.ac.in

Received: January 4, 2023 ▪ Review: February 1, 2023 ▪ Accepted: March 7, 2023 ▪ Published: March 31, 2023

Abstract: Vegetable vendors play an important role in the daily life of common people in urban India. It is often observed that the vegetable vendors locate themselves in certain places, which are suitable for both the vendors and buyers. Therefore, predicting their location is a significant factor in urban planning at a micro level, i.e., tier II cities. Thus, the current study formulates a model for the identification of the location of vegetable vendors in an Indian tier II city. In this paper, an attempt has been made to find a tool that would predict the location of vegetable vendors, taking the Indian city of Raipur (Chhattisgarh) as a case. Analytical Hierarchy Process and Logistic Regression methods are used to predict the location. The tool, thus, arrived and hence successfully predicted (with about 88% accuracy) the location of vegetable vendors of Raipur.

Keywords: analytical hierarchy process, location, logistic regression, prediction model, vegetable vendor.

用于预测恰蒂斯加尔邦赖布尔蔬菜供应商位置的工具的形成

摘要：菜贩在印度城市普通民众的日常生活中发挥着重要作用。人们经常观察到，蔬菜供应商将自己定位在某些地方，这些地方对供应商和买家来说都是合适的。因此，预测它们的位置是微观层面（即二线城市）城市规划的重要因素。因此，当前的研究制定了一个模型，用于识别印度二线城市蔬菜供应商的位置。在本文中，以印度城市赖布尔(恰蒂斯加尔邦)为例，试图找到一种预测蔬菜摊贩位置的工具。使用层次分析法和逻辑回归方法来预测位置。因此，该工具到达并因此成功预测（准确率约为 88%）赖布尔蔬菜供应商的位置。

关键词：层次分析法、位置、逻辑回归、预测模型、蔬菜供应商.

Introduction

A large portion of the global population today resides in urban areas; and therefore, the suitability of site selection by a vendor plays a crucial role in urban setup. Weber [1] the first to explicitly establish the location theory, aimed at minimizing the total trip distance between a warehouse and a group of spatially scattered consumers. Working & Hotelling [2] formulated the "principle of minimum differentiation" theory. About two decades later, Isard [3] revisited Weber's work [1] in his study of industrial location, land use, and related issues. This work was further

expanded by Margaret & Samuel [4].

Studying the selection of a location is a critical aspect of economic geography, regional planning, and development [6]. It may also be noted that besides other factors that typically affect the success of a business, location is an important factor. However, there have been very few studies that have explored the location behavior of Indian street vendors; and therefore, there is a need to better understand their location preferences [7, 8].

Indian cities are classified as X (tier I cities in India), Y (tier II cities in India), and Z (tier III cities in India) categories by the government, based on the population density. The study area for this research is Raipur, Chhattisgarh, which comes under the tier II category [9].

Vegetables are very important constituents of an Indian meal. Vegetable vendors play an important role in (supply chain) and serve as an important source of buying vegetables in tier II cities. In the tier I cities, the source of vegetables for a household is mostly from online delivery. Whereas in tier III cities, mostly the households have their own farms and produce. Hence, a tier II city has been taken for the study.

1. Literature Study

'Location' has been defined as placing business, facility, or group of facilities of a specific size and type within a specific area [10]. The topic “location” has received keen attention from economists, urban planners, and policymakers, as the location of any business, does affect several regional development factors [10]. Thus, location theories became an integral part of economic geography.

The location selection is a key aspect of strategic investment decisions in the behavior of street vendors that is affected by a number of variables in addition to production costs and profit. Most of these factors have been categorized in various ways. For example, location factors such as land use, drainage, parking areas, road types, accessibility, waste disposal, street light facilities, water supply, and population have all been prioritized, especially when it comes to vegetable vendors [11].

Important location factors include raw materials, transportation, markets, labor, capital, industrial energy, and community, according to the literature analysis [12, 13]. The primary objective of this study was to predict the location of vegetable vendors. To fulfill this objective, AHP (Analytical Hierarchy Process) and Logistic Regression Methods, are being used as primary tools.

2. Method

The adopted method comprises four major components: 1) selection of criteria 2) development of the Analytical Hierarchy Process (AHP) structure, 3) selection of sample size, and 4) logistic regression. For this research, the criteria and attributes of the location of vegetable vendors are selected from the literature, as well as from various experts‟ opinions.

2.1. Selection of Criteria

In this study, 110 papers were selected from the literature relating to the location of various issues. Out of these, 70 papers largely talked about issues relating to deciding a particular location, while 40 papers are related to several issues and problems that vegetable vendors face. Access, environment, market, and population are some of the primary identified criteria.

Fig. 1 illustrates the criteria selection process. To further reduce the attributes, an 'experts‟ opinion‟ was conducted (sieving process) to refine the attributes further. The experts' opinions were averaged using a 7-point Likert scale. Notably, the average value was allowed if the values were higher than or equal to 4, as in the 7-point Likert scale 4 was the mid values, which stands for “Neither Disagree nor Agree”.

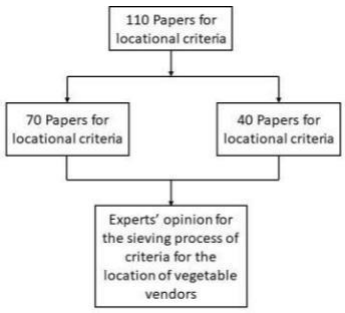

Fig. 1 Criteria selection process (Developed by authors)

2.2. Development of the AHP Structure

AHP is one of the most frequently used multi-criterion decision-making (MCDM) techniques [14]. It handles several criteria relatively easily; specifically, it involves pairwise comparison, priority vector, and ranking principles [15-19]. AHP was developed by Saaty in the 1970s [15].

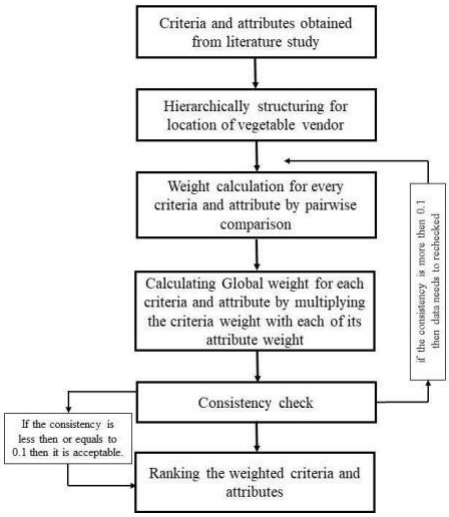

Fig. 2 AHP application procedure (Developed by authors)

Here, the objective of using the AHP was to obtain the experts‟ opinions and calculate the weights of the criteria and attributes. The application process is explained in Fig. 2. After gathering the required information from the literature review, the AHP structure is followed for the vegetable vendor's location criteria. The AHP method follows a general procedure that is:

1. Problem statement and derivation of goal.
2. Identification and selection of criteria and attributes to achieve these objectives.
3. A matrix is created between the sets of criteria and attributes. The comparisons are made between these sets. Furthermore, weights are obtained by comparisons between attributes for each criterion.
4. The consistency of responses is confirmed by calculating the consistency ration (CR).
5. By analysing the calculated weight ranking is determined [19-21].

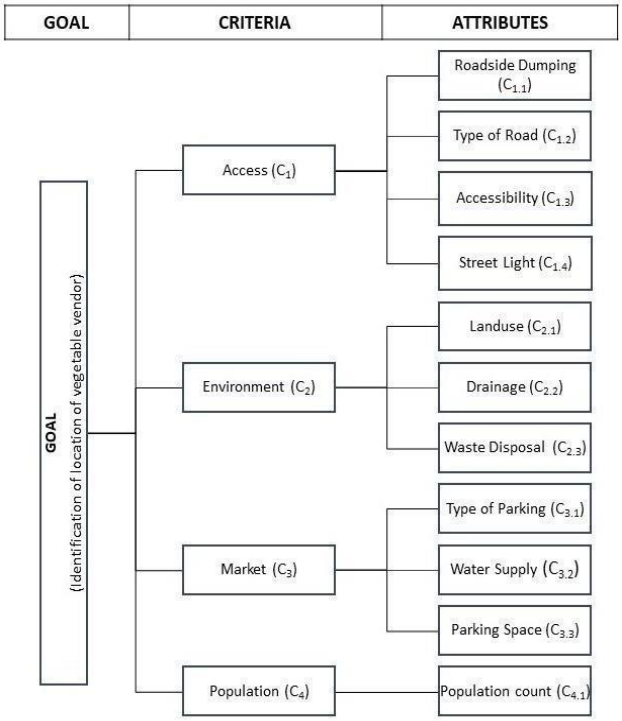

Fig. 3 The hierarchical structure of vegetable vendor location selection (Developed by authors)

2.3. Identification of Criteria and Attributes

The criteria for location were established using relevant literature and the experience of domain experts [22]. The study's goal, criteria, and attributes were further split down into the study's hierarchical structure (Fig. 3).

The nomenclature of the criteria and attributes are related to each other. In this case there are 4 criteria (C_1, C_2, C_3, C_4) and attributes are named on the basis of criteria in the form of sub numbering ($C_{1.1}$, ….$C_{1.4}$). Also, it shall be mentioned that when deciding where to put the vegetable vendors, planners must take into account four crucial criteria in level 2, which are access (C_1), environment (C_2), market (C_3), and population (C_4). In the next level 3, Fig. 3 shows 11 attributes are assigned for the location identification, which are accessibility ($C_{1.1}$), street light ($C_{1.2}$), road side dumping ($C_{1.3}$), water supply ($C_{1.4}$), a type of road ($C_{1.5}$), waste disposal ($C_{2.1}$), land use ($C_{2.2}$), drainage ($C_{2.3}$), parking space ($C_{3.1}$), a type of parking ($C_{3.2}$), and population count ($C_{4.1}$).

2.4. Data Collection

The expert‟s opinion was circulated through a questionnaire by email to sixty decision-makers. They were chosen from a cross-section of the society comparison of the vegetable vendors, architects, urban designers, town planners, business analysts, management analysts, and users.

In the paper of Chen [23], the 70 percent response rate was considered for the expert‟s opinion survey. The response rate of this study was 75 percent of the total survey, which was taken into consideration. The respondents were asked to assess the relative importance of the criteria and attributes in relation to the overall objective of identifying the location of vegetable vendors.

A pairwise comparison is the process of comparing criteria and attributes in pairs to determine which of each criterion and attribute is preferred, has a greater amount of a certain weight, or if the two entities are identical [24, 25]. Each criterion with the criteria and attributes with the attributes were compared pairwise to determine their relative importance, and then the weights were calculated using the nine-point scale developed by Saaty [15]. This 9-point scale measures the intensity of relative weight (importance or well-being).

When the intensity of relative importance is „1‟ it means that both the activities are of equal importance and both have equal contribution in achieving objective „1‟. When the importance value measures „3‟ it indicates that one of the activities has moderately high importance over another. The importance value „5‟ indicates that one of the activities has much stronger importance than the other. The intensity value measuring „7‟ indicates that one activity is strongly flavored and it demonstrates dominance over the other activity. The scale value „9‟‟‟ indicates that one of the activities is of the highest possible order of affirmation and it is an extremely importance activity than the other one. The intermitted values 2, 4, 6, and 8 indicate the middle judgment values.

2.5. Final Ranking

Table 1 highlights the weights for the criteria and attributes used to identify the location of vegetable vendors and their ranking. The attributes were ranked using global weights, which were derived by multiplying the relative weights of each attribute by the

relative weights of the criteria. Based on the global weights obtained, the attribute with the highest score is the priority.

2.6. Selection of the Sample Size

According to the Municipal Corporation of Raipur, there are 7336 street vendors, of which 1700 are in the category of vegetable vendors [26]. The sample size taken for the city of Raipur was 300 on an arbitrary basis, and the survey was conducted using GPS essentials for the geotagging of the location of vegetable vendors in Raipur.

2.7. Logistic Regression

It is possible to obtain the prediction, using machine learning algorithms because of their explainability and transparency. To the prediction, there are some supervised machine learning algorithms; some of which include Random Forest, ANN, Naïve Bayes, and Logistic Regression [27, 28]. Logistic regression is specifically used as a quantitative statistical method for prediction [29]. Logistic regression studies the relationship between a categorical dependent variable, and a set of independent (explanatory) variables [30].

The Logistic Regression technique produces a continuous spatial s-curve model for predicting the location of vegetable vendors with values ranging from 0 to 1. Values close to 1 indicate a high probability of presence, whereas values close to 0 indicate a high probability of absence [30, 31]. Here, binary logistic regression is used as a prediction for good or bad locations for vegetable vendors is predicted. Binary logistic regression (LR) is a regression model in which the target variable has only two possible values, 0 or 1 [32].

3. Results and Analysis

The evaluation criteria for location decisions were established using relevant literature and the experience of domain experts [22]. In Table 1, the relative and global weights for the location selection of vegetable vendors are shown:

3.1. Data Incorporation in the Prediction Model

Attributes in Table 1 are taken forward for the logistic regression model for the location prediction of the vegetable vendor.

The attributes in the Table are accessibility, street light roadside dumping, water supply, a type of road, waste disposal, land use, drainage, parking space, a type of parking, and population count. Then, the weights of the attributes and alternatives are incorporated in the logit function to predict the location of the vegetable vendor. The approach of training and testing data demonstrate under fitting and over fitting of the data with varying scores.

Table 1 Relative and global weights for each criterion and attribute in vegetable vendors' location selection (Developed by authors)

Criteria	Local Score (W_1)	Attributes	Local Score ($W_{1.2}$)	Global Weights (W_1 X $W_{1.2}$)	Ranking
Access (C_1)	0.265	Roadside Dumping ($C_{1.1}$)	0.053	0.011	10
		The Type of Road ($C_{1.2}$)	0.331	0.071	5
		Accessibility ($C_{1.3}$)	0.384	0.083	3
		Street Light ($C_{1.4}$)	0.232	0.050	8
Environment (C_2)	0.258	Landuse ($C_{2.1}$)	0.559	0.163	2
		Drainage ($C_{2.2}$)	0.184	0.054	7
		Waste Disposal ($C_{2.3}$)	0.257	0.075	4
Market (C_3)	0.118	The Type of Parking ($C_{3.1}$)	0.268	0.029	9
		Water Supply ($C_{3.2}$)	0.084	0.009	11
		Parking Space ($C_{3.3}$)	0.648	0.070	6
Population (C_4)	0.359	Population Count ($C_{4.1}$)	1	0.384	1
	1			1.000	

3.2. The Process for the Logistic Regression Implementation

The Machine learning-free software Kaggle Notebook containing the prediction model, which was developed using Python programming code. For the implementation of the proposed system, the following Kaggle Notebook procedures are carried out:

1) Adding data to a Pandas Data frame library using the Load Data method.

2) Then, confirming the data frame for null/missing/NaN (Not a Number) values.

3) To evaluate or interpret the data, EDA (Exploratory Data Analysis [34]) was performed.

4) Feature Engineering (FE) is selected when encoding data and assigning weights based on scale input data [34]. In which it refers to the manipulation, addition, deletion, combination, mutation of data set for better training of the model, and greater accuracy.

5) The data is then separated into two parts testing data (20%) and training data (80%).

6) A logistic regression model was built using training data, and it was then verified using the final 20% of testing data.

7) After finishing these steps, a mock evaluation was conducted for the city Raipur and inspected for over and under-fitting data frame.

8) The data is optimized for the removal of over-or-under fitting with hyper-parameter as a controller.

9) The remaining 20 per cent of unlabeled data was then predicted based on the preceding processes.

In Fig. 4, there are two scores: the Train Score and the Test Score. The prediction model is tested using the many points that fall between these scores. Hyper-parameters are the parameters that are explicitly defined to control the learning process. Based on this, the model had three regularization parameters (C) that fall into this category and have values of 10^{-4}, 10^{-5}, and 10^{-6}. The best score model is accepted with a difference of 5%–10% between the train score and test score. The model scores 99.16% train score and 90.00% test score in 10^{-4}. Whereas, 98.33% train score and 90.00% test score were found for 10^{-5}. Then, for 10^{-6}, 96.66% was the train score and 88.33% test score.

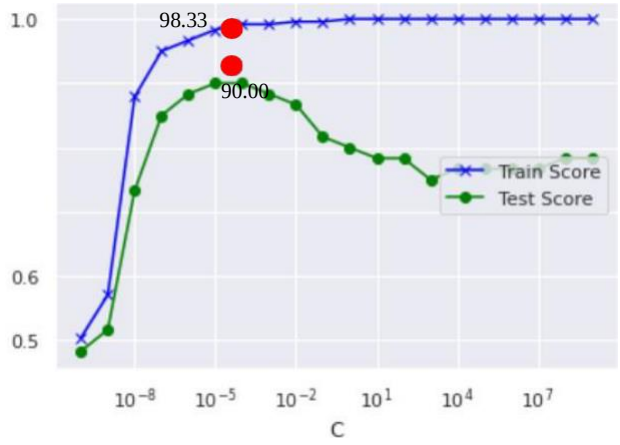

Fig. 4 Graph representing the train and test results of the model (Developed by authors)
Note: C - hyper parameter

The model 10^{-6} was rejected because the prediction score was found to be 78%. In the cases of 10^{-4} and 10^{-5}, both models were eligible because the model difference was less than 10% and their respective prediction scores were 86% and 88%. Since the 10^{-4} model was less precise than the 10^{-5} model, therefore the model 10^{-5} is adopted.

The 10^{-5} value model was found appropriate, with a difference of 8.33% between its train and test scores of 98.33 and 90.00 respectively. To validate the model, 50 new locations of vegetable vendors across Raipur City were studied. The model was found to be successful in 44 of 50 locations for Raipur city, achieving a prediction accuracy rate of 88%.

4. Conclusion

This paper suggests that vegetable vendors locate themselves in space based on waste disposal, land use zones, drainage, parking space, population, accessibility, distance from facility, availability of conveniences, and all-weather roads are attributes. The model works with 88% prediction accuracy in the study area. This model can be used in similar types of cities for the generalization; further more testing in similar cities is suggested.

The model can help design more effective planning proposals for the location of vegetable vendors. This would help the planners and developers to identify and earmark the probable location of vegetable vendors in cities such as Raipur.

Based on the findings of the study, all individuals involved in urban planning, development, and decision-making may benefit from this research.

The paper is novel because it incorporates a major service provider i.e., vegetable vendor who is a source of one of the basic requirements of human being that is vegetables and finding a location for vegetable vendor, which is an unignorable element in the planning of a city, which will be a helpful futuristic approach. This research‟s implication is in the similar Indian cities, i.e., tier II cities. This research will help in future planning of the similar Indian cities to locate the vegetable vendors.

The tool has further scope to incorporate other types of cities or other types of informal sectors for better utilization. Research in these areas may help in the development of tools like these in the future. Future development of similar tools may be facilitated by research in these fields.

References

[1] FEARON D. Alfred Weber, Theory of the location of industries. *CSISS Classics*, 2002. https://escholarship.org/uc/item/1k3927t6

[2] WORKING H., & HOTELLING H. Applications of the Theory of Error to the Interpretation of Trends. *Journal of the American Statistical Association*, 1929, 24(165): 73–85. https://doi.org/10.2307/2277011

[3] ISARD W. The general theory of location and space-economy. *Quarterly Journal of Economics*, 1949, 63(4): 476–506. https://doi.org/10.2307/1882135

[4] BRANDEAU M.L., & CHIU S.S. An Overview of Representative Problems in Location Research. *Management Science*, 1989, 35(6): 645-674. https://doi.org/10.1287/mnsc.35.6.645

[6] FUSKOVÁ M., HANÁČKOVÁ D., and GUBÁŇOVÁ M. Location factors and their importance in location (in conditions of Slovak Republic), case study. *Economics Management Innovation*, 2018, 10(1): 5–18. https://emijournal.cz/wp-content/uploads/2015/08/01_Localisation_factor_opraveny_03_2018-Vysledny.pdf

[7] FAETANINI, M. *Urban Policies and the Right to the City in India Rights, Responsibilities and Citizenship*. United Nations Educational, Scientific and Cultural Organization, New Delhi, 2011: 102–106. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers20-12/010054550.pdf

[8] SHRESTHA G.A.K., DAHAL R., and SHRESTHA S. Street vendors in Kathmandu Durbar square: Use and management of space for informal activity. *Urban Informal Sector*, 2014, 2: 1–14. https://www.researchgate.net/publication/306112043_Street_Vendors_in_Kathmandu_Durbar_Square_Use_and_Management_of_space_for_Informal_Activity

[9] MINISTRY OF URBAN DEVELOPMENT (2014). Urban and Regional Development Plans Formulation & Implementation Guidelines. *Ministry of Housing and Urban Affairs*. https://mohua.gov.in/upload/uploadfiles/files/URDPFI%20Guidelines%20Vol%20I(2).pdf

[10] PŁAZIAK M., & SZYMAŃSK A.I. Importance of personal factor in decisions on locating enterprises. *Procedia - Social and Behavioral Sciences*, 2014, 110: 373–380. https://doi.org/10.1016/j.sbspro.2013.12.881

[11] HSIAO B. S., SIBEKO L., WICKS K., and TROY L. M. Mobile produce market influences access to fruits and vegetables in an urban environment. *Public Health Nutrition*, 2018, 21(7): 1332-1344. https://doi.org/10.1017/S1368980017003755

[12] RENNER G. T. Geography of industrial localization. *Economic Geography* 1947, 23(3): 167. https://doi.org/10.2307/141510

[13] RAWSTRON E. *Three principles of industrial location*. Nar Valley Books & Prints, King's Lynn, 1958. https://www.abebooks.com/Three-principles-industrial-location-Rawstron-Academic/863269612/bd

[14] EBRAHIMNEJAD S., GITINAVARD H., and SOHRABVANDI S. A New Extended Analytical Hierarchy Process Technique with Incomplete Intervalvalued Information for Risk Assessment in IT Outsourcing. *International Journal of Engineering*, 2017, 30(5): 739-748. http://dx.doi.org/10.5829/idosi.ije.2017.30.05b.14

[15] SAATY T. L. How to Make a Decision: The Analytic Hierarchy Process. *European Journal of Operational Research*, 1970, 48: 9-26. http://dx.doi.org/10.1016/0377-2217(90)90057-I

[16] WIND Y., & THOMAS, L. S. (1980). Marketing applications of the analytic hierarchy process. *Management Science*, 26(7): 641–658. http://dx.doi.org/10.1287/mnsc.26.7.641

[17] SIPAHI S., & TIMOR M. Fast-food restaurant site selection factor evaluation by the analytic hierarchy process. *International Refereed University Journal*, 2005, 4(1): 161-167. http://surl.li/cyojr

[18] GHAYOOMI M., EBRAHIMI A., VAHDATZAD M. A., and ABOOEI M. H. Designing a model for creation of Export Consortiain Business Cluster. *International Journal of Engineering*, 2020, 33(3): 459-467. https://doi.org/10.5829/ije.2020.33.03c.10

[19] GHASEMI R., AZIMI Y., and GHASEMI Z. Determining the optimal maintenance strategy for ammonium hydroxide production unit using risk -based inspection and analytic hierarchy process. *International Journal of Engineering*, 2021, 34(9): 2087-2096. https://doi.org/10.5829/ije.2021.34.09c.06

[20] JOHN A., ABRAHAM A. K. K., and KURIAN J. AHP Approach for Vendor Evaluation and Selection in a FMCG Company. *International Journal of Emerging Technology and Advanced Engineering*, 2014, 4(12): 408-415. https://www.researchgate.net/publication/273060528_AHP_Approach_for_Vendor_Evaluation_and_Selection_in_a_FMCG_Company

[21] HERNADEWITA H., & SALEH B. I. Identifying tools and methods for risk identification and assessment in Construction Supply Chain. *International Journal of Engineering*, 2020, 33(7): 1311-1320. https://doi.org/10.5829/ije.2020.33.07a.18

[22] DARKO A. P. C., CHAN E. E., AMEYAW E. K., OWUSU E. P., and EDWARDS, D. J. Review of application of analytic hierarchy process (AHP) in construction. *International Journal of Construction Management*, 2019, 19(5): 436–452. https://doi.org/10.1080/15623599.2018.1452098

[23] CHEN C. F. Applying the analytical hierarchy process (AHP) approach to convention site selection. *Journal of Travel Research*, 2006, 45(2): 167–174. https://doi.org/10.1177/0047287506291593

[24] AKALIN M., TURHAN G., and SAHIN A. The Application of AHP Approach for Evaluating Location Selection Elements for Retail Store: A Case of Clothing Store. *International Journal of Research in Business and Social Science*, 2013, 2: 1. https://doi.org/10.20525/ijrbs.v2i4.77

[25] VIGNESH S., & SHANMUGAPRIYA S. Improvement of Decision Making Process in Construction Supply Chain Management using Analytical Hierarchy Process. *International Journal of Emerging Technology and Advanced Engineering*, 2016, 6(4): 109-118. https://www.researchgate.net/publication/311843304_Improvement_of_Decision_Making_Process_in_Construction_Supply_Chain_Management_using_Analytical_Hierarchy_Proce ss

[26] MINISTRY OF HOUSING AND URBAN AFFAIRS *Support to urban street vendors*. National Urban Livelihoods Mission, 2022. https://nulm.gov.in/Default.aspx

[27] TRIPEPI G., JAGER K. J., DEKKER F. W., and ZOCCALI C. Linear and logistic regression analysis. *Kidney International*, 2008, 73(7): 806–810. https://doi.org/10.1038/sj.ki.5002787

[28] CHITRA K., & SUBASHINI B. Data Mining Techniques and its Applications in Banking Sector. *International Journal of Emerging Technology and Advanced Engineering*, 2013, 3(8).

[29] DO H. M., YIN K. L., and GUO Z. Z. A comparative study on the integrative ability of the analytical hierarchy process, weights of evidence and logistic regression methods with the flow-R model for landslide susceptibility assessment. *Geomatics, Natural Hazards and Risk*, 2020, 11(1): 2449–2485. https://doi.org/10.1080/19475705.2020.1846086

[30] HOSMER D.W., & LEMESHOW S. *Applied Logistic Regression*. John Wiley and Sons Inc, Hoboken, 2000. https://doi.org/10.1002/0471722146

[31] MENARD S. *Applied Logistic Regression analysis.* Sage Publications, Thousand Oaks, 2002. https://dx.doi.org/10.4135/9781412983433

[32] ARTETXE A., BERISTAIN A., and GRAÑA M. Predictive models for Hospital Readmission Risk: A systematic review of methods. *Computer Methods and Programs in Biomedicine*, 2018, 164: 49–64. https://doi.org/10.1016/j.cmpb.2018.06.006

[33] SAHOO K., SAMAL A. K., PRAMANIK J., and PANI S. K. P. K. Exploratory Data Analysis using Python. *International Journal of Innovative Technology and Exploring Engineering*, 2019, 8(12): 4727-4735. https://doi.org/10.35940/ijitee.L3591.1081219

[34] VERDONCK T., BAESENS B., ÓSKARSDÓTTIR M., and VAN DEN BROUCKE, S. Special issue on feature engineering editorial. *Machine Learning*, 2021. https://doi.org/10.1007/s10994-021-06042-2

http://dx.doi.org/10.5829/idosi.ije.2017.30.05b.14

参考文:

[1] FEARON D. 阿尔弗雷德·韦伯，产业区位理论。空间整合社会科学经典中心,2002. https://escholarship.org/uc/item/1k3927t6

[2] WORKING H., 和 HOTELLING H. 误差理论在趋势解释中的应用。美国统计协会杂志，1929年，24(165)：第73-85 页. https://doi.org/10.2307/2277011

[3] ISARD W. 位置和空间经济的一般理论。经济学季刊，1949 年，63(4)：第 476 – 506 页. https://doi.org/10.2307/1882135

[4] BRANDEAU M.L., 和 CHIU S.S. 位置研究中代表性问题的概述。管理科学, 1989, 35(6): 第645-674页. https://doi.org/10.1287/mnsc.35.6.645

[6] FUSKOVÁ M., HANÁČKOVÁ D., 和 GUBÁŇOVÁ M. 位置因素及其在位置中的重要性（在斯洛伐克共和国的条件下），案例研究。经济管理创新, 2018, 10(1): 第5 – 18 页 . https://emijournal.cz/wp-content/uploads/2015/08/01_Localisation_factor_opraveny_03_2018-Vysledny.pdf

[7] FAETANINI, M. 城市政策和印度城市权利权利、责任和公民权。联合国教育、科学及文化组织，新德里，2011 年：第 102-106 页. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers20-12/010054550.pdf

[8] SHRESTHA G.A.K., DAHAL R., 和 SHRESTHA S. 加德满都杜巴广场的街头小贩：非正式活动空间的使用和管理。 城市非正规部门，2014 年，2 ：第 1-14 页. https://www.researchgate.net/publication/306112043_Street_Vendors_in_Kathmandu_Durbar_Square_Use_and_Management_of_space_for_Informal_Activity

[9] 城市发展部 (2014). 城市和区域发展计划制定和实施指南。住建部. https://mohua.gov.in/upload/uploadfiles/files/URDPFI%20Guidelines%20Vol%20I(2).pdf

[10] PŁAZIAK M., 和 SZYMAŃSK A.I. 个人因素在企业选址决策中的重要性。程序-社会和行为科学，2014 年，110：第373 – 380页. https://doi.org/10.1016/j.sbspro.2013.12.881

[11] HSIAO B. S., SIBEKO L., WICKS K., 和 TROY L. M. 移动农产品市场影响城市环境中水果和蔬菜的获取。公共卫生营养, 2018, 21(7): 第 1332-1344 页. https://doi.org/10.1017/S1368980017003755

[12] RENNER G. T. 产业定位地理。经济地理1947, 23(3): 第 167 条. https://doi.org/10.2307/141510

[13] RAWSTRON E. 产业区位三原则。纳尔谷图书与印刷品， 金斯林, 1958. https://www.abebooks.com/Three-principles-industrial-location-Rawstron-Academic/863269612/bd

[14] EBRAHIMNEJAD S., GITINAVARD H., 和 SOHRABVANDI S. 一种用于信息技术外包风险评估的具有不完整区间值信息的新扩展分析层次过程技术。国际工 程 杂 志, 2017, 30(5): 第 739-748 页 .

[15] SAATY T. L. 如何做出决定：层次分析法。欧洲运筹学杂志，1970年，48：第9-26页.
http://dx.doi.org/10.1016/0377-2217(90)90057-I
[16] WIND Y.，和 THOMAS, L. S. (1980). 层次分析法的营销应用。 管理科学， 26(7)：第 641 – 658 页.
http://dx.doi.org/10.1287/mnsc.26.7.641
[17] SIPAHI S.，和 TIMOR M.
快餐店选址因素的层次分析法评价。国际评审大学学报，2005年，4(1)：第 161-
167 页. http://surl.li/cyojr
[18] GHAYOOMI M., EBRAHIMI A., VAHDATZAD M. A., 和 ABOOEI M. H. 设计用于创建出口联合企业集群的模型。 国际 工程杂 志 , 2020, 33(3): 第 459-467 页 .
https://doi.org/10.5829/ije.2020.33.03c.10
[19] GHASEMI R., AZIMI Y.，和 GHASEMI Z. 使用基于风险的检查和层次分析法确定氢氧化铵生产装置的最佳维护策略。国际工程杂志, 2021, 34(9): 第 2087-2096 页.
https://doi.org/10.5829/ije.2021.34.09c.06
[20] JOHN A., ABRAHAM A. K. K.，和 KURIAN J. AHP 快速消费品公司的供应商评估和选择方法。国际新兴技术与先进工程杂志 , 2014, 4(12): 第 408-415 页 .
https://www.researchgate.net/publication/273060528_AHP_Approach_for_Vendor_Evaluation_and_Selection_in_a_FMCG_Company
[21] HERNADEWITA H.，和 SALEH B. I. 确定建筑供应链中风险识别和评估的工具和方法。国际工程杂志, 2020, 33(7): 第 1311-1320 页 .
https://doi.org/10.5829/ije.2020.33.07a.18
[22] DARKO A. P. C., CHAN E. E., AMEYAW E. K., OWUSU E. P.，和 EDWARDS, D. J. 层次分析法在建筑中的应用综述。国际施工管理杂志, 2019, 19(5): 第436 – 452页.
https://doi.org/10.1080/15623599.2018.1452098
[23] CHEN C. F. 将分析层次过程方法应用于会议地点选择。 旅游研究杂志 , 2006, 45(2): 第 167 – 174 页 .
https://doi.org/10.1177/0047287506291593
[24] AKALIN M., TURHAN G.，和 SAHIN A. 层次分析法在零售店选址要素评价中的应用：以服装店为例。国际
商业与社会科学研究杂志，2013 年，第 2 期：第 1 篇.
https://doi.org/10.20525/ijrbs.v2i4.77
[25] VIGNESH S.，和 SHANMUGAPRIYA S. 使用层次分析法改进建筑供应链管理中的决策过程。国际新兴技术
与先进工程， 2016, 6(4)：第 109-118 页 .
https://www.researchgate.net/publication/311843304_Improvement_of_Decision_Making_Process_in_Construction_Supply_Chain_Management_using_Analytical_Hierarchy_Process
[26] MINISTRY OF HOUSING AND URBAN AFFAIRS 支持城市街头小贩。国家城市生计使命,2022.
https://nulm.gov.in/Default.aspx
[27] TRIPEPI G., JAGER K. J. , DEKKER F. W.， 和 ZOCCALI C. 线性和逻辑回归分析。肾脏国际, 2008,

73(7): 第 806–810 页. https://doi.org/10.1038/sj.ki.5002787

[28] CHITRA K., 和 SUBASHINI B. 数据挖掘技术及其在银行业的应用。国际新兴技术与先进工程杂志, 2013, 3(8).

[29] DO H. M., YIN K. L., 和 GUO Z. Z. 层次分析法、证据权重和逻辑回归方法与流-R 模型在滑坡敏感性评价中整合能力的比较研究。地理信息学、自然灾害和风险, 2020, 11(1): 第 2449–2485 页. https://doi.org/10.1080/19475705.2020.1846086

[30] HOSMER D.W., 和 LEMESHOW S. 应用逻辑回归。约翰·威利父子公司, 霍博肯, 2000. https://doi.org/10.1002/0471722146

[31]MENARD S. 应用逻辑回归分析。智者出版社，千橡市, 2002. https://dx.doi.org/10.4135/9781412983433

[32] ARTETXE A., BERISTAIN A., 和 GRAÑA M. 医院再入院风险的预测模型：方法的系统回顾。生物医学中

的计算机方法和程序,2018,164: 第 49–64 页. https://doi.org/10.1016/j.cmpb.2018.06.006

[33] SAHOO K., SAMAL A. K., PRAMANIK J., 和 PANI S. K. P. K. 使用 蟒蛇编程进行探索性数据分析。国际创新技术与探索工程杂志, 2019, 8(12): 第 4727-4735 页. https://doi.org/10.35940/ijitee.L3591.1081219

[34] VERDONCK T., BAESENS B., ÓSKARSDÓTTIR M., 和 VAN DEN BROUCKE, S. 特征工程编辑特刊。机器学习, 2021. https://doi.org/10.1007/s10994-021-06042-2