

Spatial Analysis of Fish Drying Cottage Industry Using GIS and R Programming; Case Study in Kudawella, Tangalle Pradehsiya Sabha

G. O Abeysooriya^a, K.G.P.K. Weerakoon^{b*}

^{a b}University of Sri Jayewardenepura, Sri Lanka

Abstract

Fish drying cottage industry of Kudawella is expanding fast in the village and to the nearby villages. This sudden expansion is backed by factors such as psychological factors of manufacturers, social, financial, institutional, cultural, market, occupational, environment, infrastructure and other factors. Most of these drives have spatial components in them. As a result, spatial analysis can be carried out by authoritative bodies to make plans and decisions to make the industry and its growth sustainable. For the study, the dependent variable is identified as the manufacturer's decision in entering the industry and it is spatially identified as locations with manufacturing sites and without manufacturing sites. Proximity to raw material market (Kudawella Harbour), accessible roads, environmentally sensitive areas, coastal belt, social institutions and population density are the independent variables. The binary results of the dependent variable led to a binary logistic regression analysis and the multi values were extracted from ArcMap 10.8. R Studio was used to perform the regression analysis on extracted values. The results revealed that only environmentally sensitive areas and population density significantly affect the variations in the dependent variable. So, it is recommended to focus more on socio-economic and other factors while not neglecting spatial factors, when predicting and making decisions related to the growth of the industry.

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Keywords: Spatial Analysis; Cottage Industry; Binary Logistic Regression; R

Introduction

Large and formal business entities are not enough for the survival of an economy. Specially, informal industries and cottage-based entities are vital for developing countries. Cottage industries have been able to maintain the popularity in such countries since the known history, due to factors such as less resource requirements, and knowledge requirements (Mochache, 1985). Technically, cottage industries are home-based entities which facilitate to get the support of family members and to use artisanal methods for manufacturing. So, most of these industries are practiced informally, at small scale, most of the times in rural areas. So, cottage industries reflect the cultural values, resource availability and overall significance of a certain location. Cotton weaving in Gujarat, Karnataka and Tamil Nadu of India (Business Maps of India, 2022), pottery and textile weaving of Bangladesh, Shea butter manufacturing in African region, cane and brass work of Pilimathalawa, Sri Lanka are some examples for popular cottage industries in developing countries.

Cottage industries had been much prominent in rural areas than in urban areas. But cottage industries are expanded to urban areas at present (Tasneem & Biswas, 2014). Textile

*Corresponding author: kgpk@sjp.ac.lk

manufacturing, processed food manufacturing, ornament manufacturing are some urban cottage industries practiced in Sri Lanka. Although these industries do not support the economy of the manufacturers at large, they promote substantiality and increase the standard of living. In Sri Lanka, most of the coastal areas are urban and the cottage industries in these coastal urban areas depend on the sea. Inevitably, growth and expansion of cottage industries accelerate around fisheries harbours due to high population commutation. Fish net manufacturing and repairing, boat repairing, provision of food, textile sewing and repairing, dried and Maldives fish manufacturing, farm food manufacturing are the major cottage industries practiced in such areas.

North-western Coast and Southern Coast of Sri Lanka are famous for fish preserving cottage industries such as dried and Maldives fish manufacturing. In the Southern region, dried fish manufacturing is majorly done offshore in multiday crafts. Day to day manufacturing of Maldives fish for family consumption was prominently seen in these areas since the past. However currently, the commercial motive of Maldives fish manufacturing is visible. More and more cottages are entering the industry due to unrestricted access. Tangalle fisheries district, which is the largest marine fish producer of Sri Lanka (National Aquatic Resources Research and Development Agency, 2018) has also shown a rapid development in the industry in the past decade. Kudawella, which is one of the major fisheries communities in the Tangalle fisheries district, shows a significantly higher number of entrants to the industry.

Introduction of commercial purpose of the industry to Kudawella was occurred in about 2015. With the stormy weather conditions prevailed, the yield of multiday crafts which board onshore after months, remained unsold. As a result, fisherman bought their own yield and smoked. This marked the very reason for the commercial Maldives fish industry in the village. In 2018, government support was received by means of financial aid, technical knowledge and supplementary materials such as smoking stalls and pots provision. However, it is observed that the sudden growth and expansion has affected the balance of sustainability. Many more social and environmental issues have been generated although the industry affects the growth of economy directly and indirectly.

As cottage industries are usually practiced in the residence of the manufacturer and location cannot be shifted to somewhere else easily, it is needed to make decisions to sustain the industry within the premises. However, decision making and implementing such decisions are not easy for the authoritative bodies due to factors such as limitation of funds, delays in the decision-making hierarchy etc. So, these institutions must decide which geographical areas should be facilitated quickly and which areas are not in an urgent need of facilitating quickly. This can be done by studying the current manufacturers and the various factors which have influenced them to make the decision of engaging in the industry. A generalized decision can be made by identifying whether there is a significant relationship between such factors and the decision of engaging in the industry which is spatially identified as the locations in which the cottage industry is prevailing and the locations in which the cottage industries are not there. Locational drives or drives with spatial components usually affect this decision tremendously. So, it is expected to identify the causes of such establishment of cottage industry sites and their growth to assist the respective authoritative organizations to make necessary decisions on the location of the industries and other institutional decisions such as infrastructure provision.

Significance of the study

Undoubtedly, Maldives fish industry creates many economic advantages to the village and the country. Other than the emergence of direct employment opportunities, indirect employment opportunities such as transportation services, banking services, retail trade, reparation of instruments, provision of instruments have also emerged. Yet, the social and environmental issues generated by the industry should not be remained unmentioned. As this industry is cottage based, support of children is taken to engage in the industry. So, it is doubtful whether the children get

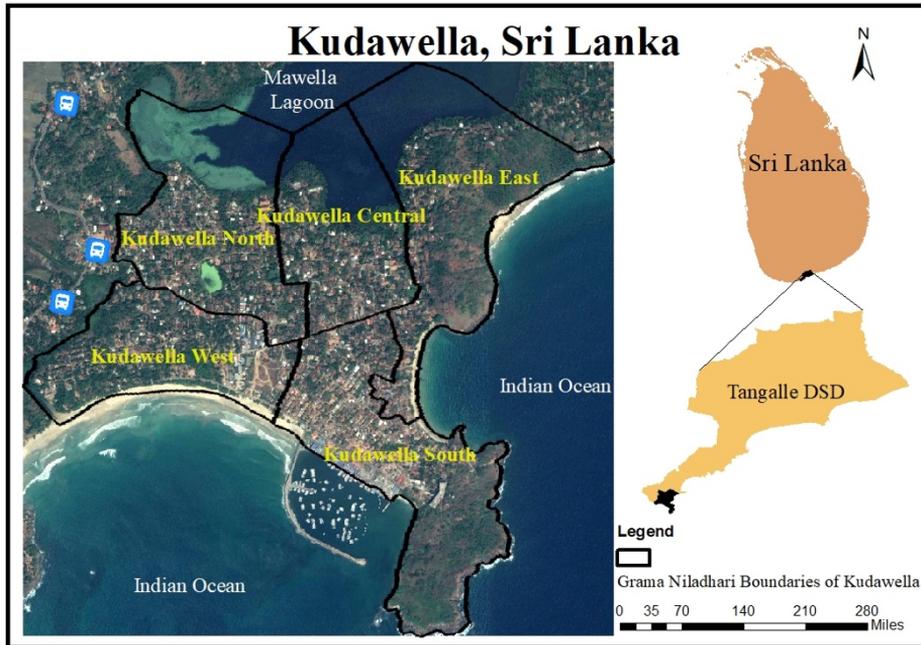
to pay enough attention to their studies. Generally, multiday craft owners get a chance to buy raw fish at lower prices at large scales. So, they generate a high produce of Maldives fish and as a result, finding a wholesale buyer is easy. This situation is vice versa to the others. This widens the economic disparity of people in the village. Road safety is also at risk as there is a heavy flow vehicle coming in and going out of the village. Disputes happen between and among neighbours due to various reasons such as odour, smoke and noise. In addition to such social aspects, environmental impacts can also be seen. Noise, air, soil and visual pollution, increase of flies, crows and cranes, disposal of waste to environmentally sensitive areas, clearing of tree cover get more sunlight, are some such impacts. The village has environmentally sensitive areas such as Mawella lagoon and swampy areas like Medamodara swamp and the Weheluvila swamp. Moreover, the tourist attraction, blowhole (“Hummanaya”) is in the Southern part of the village. So, the sustainable prevalence of the industry is vital to protect such environmentally sensitive areas and tourist attractions too. Most of these negative impacts are generated because of the challenges the manufacturers encounter when engaging in the industry. For an instance, according to the observations, disposal of residues generated in the industry are disposed at the environmentally sensitive areas as the manufacturers are not having proper awareness and resources for farm food manufacturing and liquid waste disposal through soakage pits.

However, the unrestricted entry and exit allows more and more manufacturer entries to the industry while the challenges to the industry and bottlenecks of institutional decision making, and implementation remain unsolved. Hence, the unrestricted sudden expansion of the industry should be examined, and ways should be thought of to provide locational solutions. So, the study is conducted explaining and modelling the spatial factors affecting the location of sites. So, the relationship between the variations of the industry locations and spatial criteria of location decision such as accessibility is identified.

Study area

As mentioned earlier, Kudawella is one of the largest fisheries communities in the Tangalle fisheries district, which accounts for the highest marine fish production in the country. The village covers an area of 1.87km² and population density of the village is 2596 per km² (Tangalle Divisional Secretariat, 2021). Kudawella fisheries harbour is considered as the second largest fisheries harbour in the island. It provides livelihood for majority of villagers whose main mean of livelihood is fisheries. Other than the fisheries, the blowhole, “Hummanaya” generates a huge economic value to the village. When considering the infrastructure, village comprises two governmental banks, six private banks, three corporative shops, and forty-four retail shops. Other than that, three major ice manufacturing plants are currently operating inside the village. The village possess a network of asphalt, tar and chip and concrete laid roads. The area has a dry climate most of the time of the year because of its semi-arid climatic features. So, sunlight is abundant throughout the year. The village comprises of five Grama Niladhari Divisions, Kudawella South, Kudawella North, Kudawella West, Kudawella East and Kudawella Central. Figure 01 shows the location of Kudawella and its five Grama Niladhari Divisions.

Figure 01: Study area, Kudawella



Source: Generated by the author (2022); Google Earth Pro images (2022)

The objective of the study

The main objective of the research is to find the relationship between variations of fish drying cottage industry locations in Kudawella with spatial criteria which affect the locations of sites, or which reinforce the decision of engagement in the industry. The main objective is supported by specific objectives mentioned below.

- To identify the spatial factors affecting the decision of engaging in the of fish drying cottage industry in Kudawella
- To identify whether there is a significant relationship between fish drying cottage industry locations in Kudawella and spatial criteria

Literature Review

Cottage Industry

The major reason for employing at somewhere or engaging in a business is to secure living. People have to do such industry at household scale due to various psychological, social, economic limitations and commitments. Such cottage industries open paths to tackle increased living expenses and to earn daily expenses, fulfil educational needs of children, to utilize training received from various institutions (Rupasena, 2014), to preserve dignity (Sezhiyan & Gnanadeiveegam, 2020) etc. Cottage industries are simply the industries practiced at the house of the manufacturer. These industries are practiced at small scale (Kaara, et al., 2021) avoiding mass production (Balakrishnan & Arithar, 2018). Cottage industries use locally abundant raw materials, artisanal techniques passed down from generations (Tasneem & Biswas, 2014), less or no technology, small capital and use no or a small number of workers (Mexon, 2014). Cottage industries have characteristics of the informal economy and considered as a subset of it. So, most of the cottage industries do not have legal recognition.

Location of Cottage Industry

As the term itself suggests, cottage industries are home-based. So, the locations of industrial units are not deliberately chosen industry locations. Therefore, sometimes, the engagers have to change the nature of the home environment to suit the nature of the industry. Generally, psychological factors such as self-motivation and interest, social factors such as social support (Pathmanathan, et al., 2021) and communication, financial factors such as availability of capital, market factors, labour abundance and infrastructure availability (Naing, 2020) affects the decision of engaging in the industry. Mexon, (2014) states that low investment is needed for cottage industries. One of the major reasons for that is the ability to skip initial costs related with land. Most of the cottage industries are located closer to each other because of factors such as resource availability and market availability. These agglomerations impact the development of infrastructure, create market advantages, and generate benefits of resource sharing. Abundance of raw materials is one of the major factors affecting the affecting the introduction cottage industries to a village. Raw materials and artisanal knowhow drive people to engage in cottage industries (Muhammad & Ritter, 2011). According to Naing, (2020), transportation is also a crucial factor in cottage industries. Unavailability of connected network of transportation affect low growth of cottage industries.

Spatial Analysis of Cottage Industry

GIS is a tool used for much research when doing spatial analysis of cottage industry. Analysing the spatial changes or the spatial distribution within a certain time period has been a major interest in cottage industry related literature. Aung, (2020) has used spatial statistical tools to examine such industries and have used availability of raw materials, capital, labour, accessibility as factors affecting cottage industries are not yet examined by using spatial analyst tools such as GIS. However, spatial components affecting or reinforcing the establishment of cottage industries are not yet analysed in literature. As intergrating GIS with spatial statistics generate successful results to solve issues related with regional development (Hung & Yasuoka, n.d.), it is expected that GIS based spatial analysis will provide realistic results elivating uncertainties of pure statistical methods (Peggion, et al., 2008). However, universal criteria or models for spatial analyses is not suitable because of the heterogeinty of locations. So, micro details should be concerned and should be incident and location specific when determining criteria for spatial analysis (Peggion, et al., 2008).

Methods

Fish drying cottage industry in Sri Lanka is a less talked area in studies. Therefore, secondary data are limited, and primary data were the major data type used for the research. Open Street Map and Google Earth Pro facilities were used to identify 381 industry locations in Kudawella from August 2021 to November 2021. These relative locations were tested for accuracy using absolute locations of 21 cottages engaged in the industry, acquired via GPS. However, the sample is reduced to 150, to avoid spatial correlation or the dependency.

The decision of engaging in the industry generates two categories in space of the village. They are “industry locations” and “non- industry locations”. So, these binary results lead the study to binary logistic regression analysis. As mentioned in literature review, industry engagement (IE) decision is based on various factors. These factors are found in micro and macro environments and can be sub categorized as psychological factors (P), social factors(S), financial factors(F), institutional factors(I), cultural factors(C), market factors (M), occupational factors (O), environment (E), infrastructure (N) and others (T). The relationship between the dependent variable: engagement in the industry and the independent variables can be illustrated by using the equation mentioned below.

$$IE=X(P+S+F+I+C+M+O+E+N+T) \quad (1)$$

In other way, the relationship of the engagement of the industry with micro (Q) and macro (A) driving forces can be depicted as below.

$$IE=X(Q+A) \quad (2)$$

Micro factors are the driving forces within the manufacturer and his immediate environment. Psychological factors such as motivation and social factors such as support of the family can be considered as examples. Macro factors are driving forces which cannot be controlled by the person who is engaged in the cottage industry. Therefore, these drives are provided with the intervention of external parties. Government aid schemes, infrastructure provision are some examples. Psychological factors arise within the person himself whereas social factors are generated depending on the people around. Family and neighbour support is the best example. Financial factors include availability of fixed, working, and accelerated capital (Haider, et al., 2015) and possible means of finding capital etc. Availability of adequate and proper policy making institutions is another drive (Rahman & Kumar, 2018). Networking and coordinative decision making provide advantages to cottage industries. According to Lumna & Banu, (2019), cast system has laid foundation to cottage industry in Sri Lanka. It can be still seen that some cottages engage in the industry to promote their traditions. Stable prices, accessible markets, trade linkages (Rupasena, 2014) provide proper market facilities for cottage industries. There are other drives such as having adequate technical knowhow, adequate raw materials, and other resources such as labour which make the occupation in the industry easy. Availability of relevant infrastructure and their interconnectivities (Naing, 2020) motivate people to engage in businesses. Environmental factors like favourable climatic conditions also affect engagement. Moreover there are other factors which affect the decision of engaging in the industry, depending on the nature of the industry, personal preferences, country etc. However, it is clear that each category cannot be be universally defined as they change with the nature of industry and many other factors. Yet, an equation can be built as below by referring to equation 1 to show various components of each category.

$$IE=X_P\{a_1+a_2+a_3+\dots+a_n\}+X_S\{b_1+b_2+b_3+\dots+b_n\}+X_F\{c_1+c_2+c_3+\dots+c_n\}+X_I\{d_1+d_2+d_3+\dots+d_n\}+X_C\{e_1+e_2+e_3+\dots+e_n\}+X_M\{f_1+f_2+f_3+\dots+f_n\}+X_O\{g_1+g_2+g_3+\dots+g_n\}+X_E\{h_1+h_2+h_3+\dots+h_n\}+X_N\{i_1+i_2+i_3+\dots+i_n\}+X_T\{j_1+j_2+j_3+\dots+j_n\} \quad (3)$$

As mentioned by Rikalovic, et al., (2014), more than 80% of data used by decision makers have spatial components in them. However, for the study criteria with directly identifiable spatial criteria are chosen considering literature, observations and the personal knowledge of the researcher. Accordingly, raw material market (operational drive), accessible roads (infrastructure), environmentally sensitive areas (environmental and operational drive), coastal belt (operational drive), social institutions (social drive) and population density (Social drive) are considered for the study. It is assumed that all the other variables which affect the engagement in the industry are held constant within the concerned period of time. Therefore, the study will analyse whether there is a significant relationship between afore mentioned independent variables and the location of the industry.

As per the observations, raw material availability is the major consideration which has led the villagers to engage in the industry. Prevalence of Kudawella fisheries harbour ensures the continuous raw material supply to manufacturers. According to the observations, this has affected the manufacturers to engage in the industry. Prevalence of accessible roads also is a significant factor as the manufacturers must transport heavy weights from the harbour to the manufacturing

site. Paved and accessible roads are much preferred by drivers. According to the views of manufacturers, they have to use wheelbarrows to transport raw fish to sites which are located away from paved and accessible roads. So, villagers who are living far from paved and accessible roads prevent from manufacturing to avoid the exhaustive process of transportation. Specially, transportation becomes much difficult if there are only old people in the family. There are three major environmentally sensitive areas in the village: Medamodara Swamp, Weheluvila Swamp and Mawella lagoon. All these has become a residue dumping sites for manufacturers. So, it should be examined whether the environmental sensitivity has repelled the industry, or the attraction created by garbage dumping has attracted the industry. According to observations, a significant number of families living near these environmentally sensitive areas are engaging in the industry. As per the views of the villagers, these families get more space for garbage disposal, as they have an unbounded side in their lots which is opened to the environmentally sensitive areas. So, solid or liquid garbage disposal, which is a challenge to other manufacturers, is not a challenge to such manufacturers living near the environmentally sensitive areas. Coastal belt provides good opportunity for the manufacturers to access space and sunlight which is the major source of drying out fish. So, manufacturers consider proximity to the coast as a great free of charge opportunity. Establishing the industry in cottages near the social institutions always generate social unrest because of noise, odour and smoke created by the industry. Therefore, the industry locations and social institutions have a repellent relationship according to the views of manufacturers. Higher population density demotivates cottages to engage in the industry. Less population densities allow manufacturers to engage in the industry with less legal interferences. Manufacturer's views showed that they prefer to be in areas with less population densities to avoid turbulent circumstances.

Accordingly, literature review, observations, views of stakeholders of the industry and the views of the author identified the independent variables of the study. Figure 02 shows the conceptual model of the research which indicates the relationship between the dependent variable and the independent variable.

Figure 02: Conceptual model

Hypothesis built in relation to these variables are as shown in table 01.

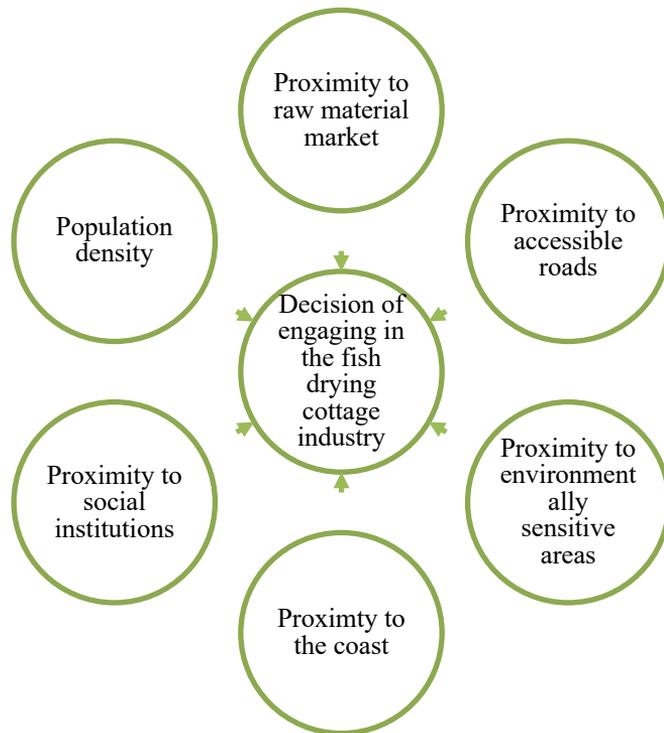


Table 01: Hypothesis of the study

Variable	Hypothesis
Proximity to raw material market	H ₀ : There is no significant relationship between distance to the raw material market and the fish drying cottage industry locations in Kudawella
	H ₁ : There is a significant relationship between distance to the raw material market and the fish drying cottage industry locations in Kudawella
Proximity to accessible roads	H ₀ : There is no significant relationship between distance to accessible roads and the fish drying cottage industry locations in Kudawella
	H ₂ : There is a significant relationship between distance to accessible roads and the fish drying cottage industry locations in Kudawella
Proximity to environmentally sensitive areas	H ₀ : There is no significant relationship between distance to environmentally sensitive areas and the fish drying cottage industry locations in Kudawella
	H ₃ : There is a significant relationship between distance to environmentally sensitive areas and the fish drying cottage industry locations in Kudawella
Proximity to the coast	H ₀ : There is no significant relationship between distance to coastal belt and the fish drying cottage industry locations in Kudawella

Proximity to social institutions	H4	: There is a significant relationship between distance to coastal belt and the fish drying cottage industry locations in Kudawella
	H ₀	: There is no significant relationship between distance to social institutions and the fish drying cottage industry locations in Kudawella
Population density	H ₅	: There is a significant relationship between distance to social institutions and the fish drying cottage industry locations in Kudawella
	H ₀	: There is no significant relationship between population density of Kudawella and the fish drying cottage industry locations in Kudawella
	H ₆	: There is a significant relationship between population density of Kudawella and the fish drying cottage industry locations in Kudawella

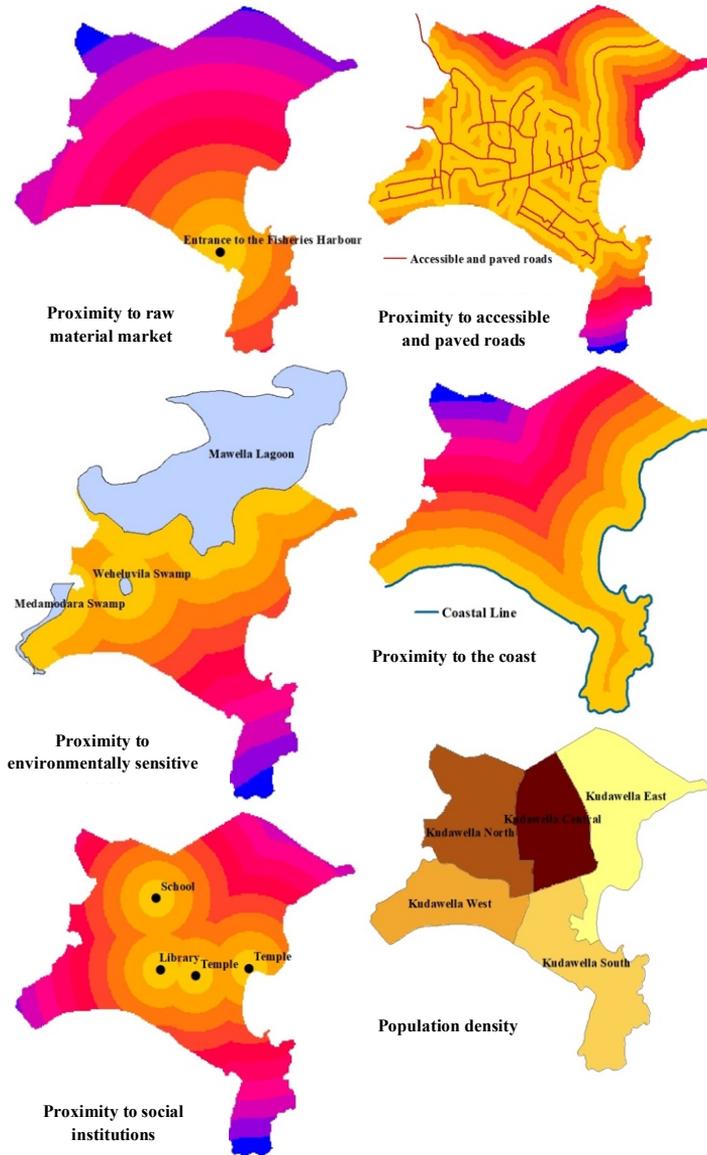
Base map used for the preparation of criteria maps is the GN Division map of Survey Department of Sri Lanka. Criteria maps were developed using data analysis tools of ArcGIS 10.8. For the regression analysis, the dependent variable was created as a vector file and the independent variables were created as raster files using Euclidean distances. Euclidean distances were estimated because of the continuous nature of the independent variables used. Variables and their data types are shown in the table 02.

Table 02: Variables of the study and the data types

Variable	Data type
Dependent Variable	
Decision of engaging in the fish drying cottage industry	Binary Cottage industry locations (1) Non-industry locations (0)
Independent variables	
Proximity to raw material market	Continuous
Proximity to accessible roads	Continuous
Proximity to environmentally sensitive areas	Continuous
Proximity to the coast	Continuous
Proximity to social institutions	Continuous
Population density	Continuous

Criteria maps created for the study are as shown in figure 03.

Figure 03: Criteria Maps



Results and Discussion

As mentioned earlier, the space of the village is of two categories as fish drying cottage industry locations (1) and non- fish drying cottage industry locations (0) in Kudawella. Cottage industry locations are given the value "1" as the probability of conversion of space to industry locations will be evaluated with relevance to the probability of not converting into an industry location. Therefore, binary logistic regression analysis is used for the analysis. Binary logistic regression analysis is considered to be advantageous than other types of regression analysis as there is no need to assess the normality. The general formulae for logistic regression can be presented as below.

$$y = a + b_1x_1 + b_2x_2 + b_3x_3 + \dots + b_nx_n + \varepsilon \quad (4)$$

Here, depicted in x are the explanatory variables and the linear relationship with the variable y is depicted. Shown in b are the coefficients. E, the random error term, depicts the dependent variable's unexplained portion. Usually, in such model, predicted values are different from the observed values. The difference between the predicted and observed y values are explained by using the random error term or residuals. Large residual values always shows that the model fitness is low.

If the binary values of the dependent variable are considered as 1 and 0, the value 1 means transition of a non- cottage industry location into a cottage industry location, while 0 means no transition. So, 0 will mean the existence of non- cottage industry locations as they are. The likelihood of a location being a cottage industry location can be estimated by getting the log of the odd ratio in relation to the y function. Here, P indicates the probability of occurrence of a new transition into a cottage industry location.

$$y = \log_e \left(\frac{P}{1-P} \right) = \text{logit}(P) \quad (5)$$

As per the equations, the probability necessarily increases when the value of y increases. Y value is affected by coefficients of regression and those coefficients indicates the amount of influence of the explanatory variables on the probability. So, a negative value of such coefficient indicates that the explanatory variable affects in decreasing the probability and a positive value indicates affecting to increase the probability.

According to Waldo R. Tobler, "Everything is related to everything else, but near things are more related than distant things." (Neto, 2017). In order to avoid the unreliable results occurring due to the dependency of spatial criteria, spatial autocorrelation was performed by using Moran's I Test. The original data set of 381 manufacturing locations took a z-score value of 13.726 stating that there is a significant clustering of locations and that there is a less than 1% likelihood that this clustered pattern could be the result of random chance. Therefore, random sampling, stratified sampling and systematic sampling were chosen to tackle the issue of dependency. Here random sampling reduces the chances of missing important data while the systematic sampling reduces the spatial dependency. Stratified sampling assisted to represent all Grama Niladhari Divisions in the sample chosen. Usually, in sampling, the ratio between the cases and the independent variables is considered as 20:1 (Weerakoon, 2017). As, the study is having 6 independent variables, a minimum number of 120 cases are preferred. Therefore, 150 cases were selected preserving a number of cases to independent variable ratio of 25:1. Moran's I Test was performed again on the selected sample. It was identified that, as he z-score is 1.21, the pattern does not appear to be significantly different than random.

The independent variables were used to create multivalued to the vector points of the dependent variable (sample cases). As mentioned under the equation 5, binary logistic regression requires logit transformation. Execution of regression was done by using R studio. The resulted model output of the logistic regression analysis of variables are mentioned in table 03.

Table 03: Logistic regression analysis of variables

	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	-6.5860317	0.8370558	-7.868	0.0000000000000036 ***
Raw material market	0.0008130	0.0008805	0.923	0.3558
Paved and accessible roads	-0.0021656	0.0012258	-1.767	0.0773
Environmentally sensitive areas	0.0016784	0.0008522	1.969	0.0489 *
Coast	-0.0006001	0.0006634	-0.905	0.3657
Social institutions	-0.0006874	0.0007585	-0.906	0.3648
Population density	0.0006383	0.0001388	4.599	0.0000042519610165 ***

In regression analysis, the rule of thumb is to reject the null hypothesis (H_0), if the p value is less than the significant value ($P \text{ value} < \alpha$) and to fail to reject the null hypothesis, if the p value is greater than the significant value ($P \text{ value} \geq \alpha$). So, in the study, the independent variable must have a probability value less than 0.05, to have a significant relationship with the dependent variable. According to the table 2, distance from environmentally sensitive areas and population density have a significant relationship with cottage industry sites. Distance from paved and accessible roads, distance from the coast, and distance from social institutions whose intercept of the alpha level (β) are -0.0021656, -0.0006001 and -0.0006874 respectively, are negatively contributing to the conversion from non-cottage industry sites to cottage industry sites and the variables: distance from paved and accessible roads, distance from raw material market, distance from the coast and distance from social institutions deem to have weak relationship with the dependent variable. Accordingly, the following hypothesis were accepted.

- H_3 : There is a significant relationship between distance to environmentally sensitive areas and the fish drying cottage industry locations in Kudawella
- H_6 : There is a significant relationship between population density of Kudawella and the fish drying cottage industry locations in Kudawella

If the odds ratio which concerns the odds that a certain result will incur at the presence of a certain exposure compared to that of absence of the exposure, reveals the facts mentioned below.

- When the distance from the environmentally sensitive area increases by one unit, the probability of a location being a fish drying cottage industry, compared to a location being a non- fish drying cottage industry site is 0.17%. That means a unit change in distance from the environmentally sensitive area affects more than 0.04 times change in the conversion of non- cottage industry site to a cottage industry site.
- When the population density increases by a unit, the probability of a location being a fish drying cottage industry, compared to a location being a non- fish drying cottage industry site is 0.064%. That means a unit change in the population density affects more than 0.000004 times change in the conversion of non- cottage industry site to a cottage industry site.

R value is used to define the correlation between the observed and predicted values. So, it can be used to determine the fitness of model. So, a higher value means higher fitness to data. MCFadden R^2 was found by using “pscl” package of R Studio to find the fitness. R^2 of 0.0297 (3%) was received and this shows that the independent variables have explained only 3% of variations in the dependent variable. Therefore, the fitness of the model is low.

The probability of a site being a fish drying cottage industry location increases further from environmentally sensitive areas. So, this reveals that disposing residues does not attract cottages near the environmentally sensitive areas to engage in the industry. Transportation matters in this case. It was revealed that even the manufacturers who are distant from these locations dump waste in the three locations. It can be identified that neighbor unrest caused by environmental pollution,

recent actions taken by the Central Environmental Authority have affected to limit the industry engagement near the environmentally sensitive areas.

According to the model, probability of a location being a cottage industry is high when the population density increases. Agglomeration impacts and other personal ideologies usually affect this. However, neighbor unrest, environmental concerns increase when the population density increases.

However, relatively lower values in probabilities and the low value of the model fitness depicts that the model do not significantly represent the variations in the dependent variables. So, it can be understood that socio economic and other concerns must be affecting the decision of engaging in the industry rather than the spatial criteria concerned. So, a model should be built by considering both spatial and aspatial factors to predict the conversion of non-fish drying cottage industry sites to fish drying cottage industry sites.

Conclusion

The study was conducted with the intention of finding out whether there is a relationship between the spatial criteria concerned for establishing industries and the decision of engaging in cottage industries/ fish drying cottage industry locations in Kudawella of Tangalle Pradeshiya Sabha and modelling the location of such sites in relation to the spatial criteria concerned. The industry is highly dynamic and also there is free entry and exist. As a result, an expansion of number of cottages engaged in the industry has occurred unsustainably. So, in order to find land related solutions, the relationship between spatial criteria and the decision to engage in the industry should be evaluated. This is to have an idea about how significantly the locational factors have affected the manufacturer to make the decision of engaging in the cottage industry.

Accordingly, the criteria maps for the selected independent variables with spatial characteristics were prepared by using ArcGIS, extracted multi values to background and site points and were analysed by using binary logistic regression analysis using R Studio. The model fitness recorded a low R^2 value of 0.0297 and the variables, distance from environmentally sensitive areas and population density were proven to have a significance relationship with whether a certain location is a cottage industry site or not. According to the model, the other criteria concerned, distance from paved and accessible roads, distance from the coast, distance from social institutions and distance from the raw material market do not have significance relationship with the dependent variable.

The area concerned for the research is a relatively small geographic location and accessibility is not much difficult from point to point as a result. Even the accessibility to raw materials can be easily done with the help of proper distribution networks. So, spatial factors have not being a major consideration of manufacturers when making the decision of engaging or entering the industry. However, spatial criteria should not be less concerned when making decisions as they ultimate contribute to affect the expansion. However, it is recommended to focus much on socio-economic and other factors when modelling the location of cottage industries and formulating decisions about fish drying cottage industry in Kudawella, while considering the spatial components too.

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Centre for Real Estate Studies (CRES), Department of Estate Management and Valuation, University of Sri Jayewardenepura, Sri Lanka.

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