

## Suitability Analysis of a Potential Future CBD Area of a Secondary Town Using AHP Model and Geographical Information

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### ABSTRACT

For a long earlier time, arranging is being denied from spontaneous metropolitan development that happens outcomes the metropolitan issues. A GIS-based site appropriateness investigation utilizing the AHP model is performed with standard: land use, populace dissemination, water organization, waste organization, and street organization. The reasonable development locales are decided through master feeling, pair-wise examination lattice lastly deciding the weighted worth. This paper discovered the expected urban development for the most part in ward no. 2, 7, and 6. Ideally, the right spots are those destinations where future metropolitan improvement can undoubtedly happen and have all the necessary offices with accessible business, mechanical. Official land use, moderate and exceptionally reasonable spots need a few offices, e.g., water gracefully, waste administration, street organization, and land use improvement. Not many and halfway reasonable destinations need significant inclusion of offices and updates of current land use for likely metropolitan events. This data can be valuable for strategy creators for arranging measures as a satisfactory logical cycle for site reasonableness examination in the region to keep away from the metropolitan issues and guarantee the practical turn of events.

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### 1. Introduction

Fast urbanization and ensuing heedless development of urban communities bring about decay of infra-structure offices, loss of rural land, water bodies, open spaces, and numerous miniature climatic changes (Parry, Ganaie, & Sultan Bhat, 2018). Choice of reasonable regions for metropolitan advancement is a perplexing cycle and needs numerous different signs based on which choice might be expected (Siqing, 2016). The populace increment is chiefly brought about by provincial to metropolitan relocation causing gridlock, joblessness, arising of spontaneous settlements, lacking foundation, and social and lodging administrations (Chandio et al., 2011). To conquer these difficulties there is a dire need to set up and decide appropriate areas of satellite towns to the edges of the central business district (CBD) to reinforce financial and social exercises utilizing solid methods (Mayunga2018). Bangladesh is one of the quickest developing nations with a high pace of metropolitan development. As of now, commonly created and non-industrial nations have encountered a remarkable extension of urbanization because of monetary turn of events, industrialization, monstrous relocations just as regular populace development (Sabbar *et al.*, 2015). Pabna is an optional town with tremendous potential. The pace of Urbanization and populace is expanding step by step. For a productive arrangement and an economical improvement of auxiliary municipality the same Pabna, it is imperative to get to the adequacy of CBD Planning. Pabna is an optional town with tremendous potential. The pace of Urbanization and populace is expanding step by step. For a productive arrangement and an economical improvement of auxiliary municipality the same Pabna, it is imperative to get to the adequacy of CBD Planning (Parvez, 2020a). AHP model assists with discovering arrangement on complex issues that best suit the normal objectives and difficulties. Additionally, it accommodates an exhaustive and reasonable structure by relating the chose components to the general objectives and for assessing options (Theobald, 2007). Pabna Paurashava is the largest Paurashava in Pabna District.

There are 15 wards consist in the Pabna Paurashava. The existing population of Pabna Paurashava is about 153245 (MIDP, Pabna). CBD is an important part of the development. Pabna has already a CBD which is more than hazardous. Now days it is high time to improve a new CBD area. This study might help the future development to identify newest area of CBD. This study will assess the existing CBD of the municipality and determine the criteria and will find out suitable location for establishing a CBD at municipality area. This will help to avoid making haphazard for the future phase of planning. Five standards (land use, population dispersion, water-, street and waste networks) were chosen for appropriateness investigation. Land utilize was ordered into business, industry and authority zone dependent on information from MIDP, Pabna. The second standard was populace. The word-wise extended populace information gave by BBS of the Pabna region was utilized. The third standard was water organization and the information of the water network was gathered structure land overview information of MIDP. The information on seepage and street network was likewise gathered from MIDP Pabna and utilized as a model for appropriateness examination.

## **2. Literature Review**

GIS doesn't have skills to incorporate all determination factors identified with land reasonableness valuation all alone, despite the fact that it has expert in spatial examination. Or maybe, it should be joined with valuable appraisal and assessment apparatuses, e. g., AHP Multi-Criteria Decision Analysis techniques. AHP Multi-Criteria Decision Investigation has actual appearance (Triantaphyllou, 2000). A GIS-based site appropriateness investigation utilizing the AHP model is performed with rule: land use, populace dispersion, water organization, waste organization and street organization. The appropriate development locales are resolved through master sentiment, pair-wise correlation framework lastly deciding the weighted worth (Parvez & Islam, 2020). Significant contemplation mind boggling GIS capacities to get, stock, spare, work, and examine information while AHP based Multi-Criteria Decision Analysis abilities with the geographic data through the leader's inclinations into substitute choices (Munyao, 2010). Since site choice and appropriateness measure are identified with Geo-spatial issues, geological data framework (GIS) permits utilizing information related boundaries for reasonableness displaying. One of the benefits of utilizing GIS in site reasonableness examination is the capacity of GIS in improvement of elective situations for metropolitan turn of events (Aburas et al., 2017). Land use arranging assumes a significant function in site advancement, metropolitan recharging and accomplishment of reasonable metropolitan turn of events. The Analytic Hierarchy Process (AHP) is a hypothesis of estimation through pair savvy examination. The examinations are made utilizing a size of outright decisions that speaks to the amount more; one component overwhelms another as for a given quality. The determined need scales are blended by increasing them by the need of their parent hubs and adding for every single such hub (Saaty, 2007). One of the more extensive frameworks of the multi-measures investigation is Ordered Weighted Averaging (OWA). Land appropriateness is generally examined by Multi-Criteria Evaluation (MCE) methods, for example, OWA (Mokarram & Hojati, 2017). (Mohit & Ali 2006) integrated a diagnostic chain of command measure with GIS. GIS assumes an indispensable part in making arrangements for some times of land-use suitability mapping and demonstrating. (Mayunga, 2018) helps to identify the nature of a town and how multiple decision-making criteria helps to select a suitable site for a township development. (Deswal, & Laura, 2018) helps to understand the AHP model and helps to provide a total overview for suitability analysis

## **3. Materials and Method**

### **3.1 Study area profile**

Pabna municipality is one of the main conceived regions in Bangladesh and it transformed into set up in 1876. It is situated at 161 km north-west of Dhaka city and 100 ten km east of Rajshahi town. The district of the Municipality is prepared 16sq km and its general population is 1,33, 403. The Pabna Municipality is between 53" n and 05" n range and 09" e and 25" e longitudes. General area about 16 sq. Km is comprehensive of 15 wards and the quantity of 23 mouza (Parvez & Islam, 2020). The number of inhabitants in the Paurashava is 1, 17,633, including 61,377 (52.18%) male and 56,256 (47.82%) female populace. The absolute no. of family units is 23840. The normal proficiency rate in the Paurashava zone is 72.93% (MIDP, 2008). The complete land reserved for business use remains at 2.51% of the all-out metropolitan territory alongside modern land covered as it were 4.44%, complete land reserved for instructive classification remains at 4.45%, the all-out land under transportation use has been discovered 6.85% and office utilize 2.11% (Parvez, 2020b).



Figure-1: Location Map of the Study Area

**3.2 Research Method**

Land appropriateness is generally examined by Multi-Criteria Evaluation (MCE) techniques, for example, OWA. It includes homogenizing and designating the similar position of loads the guides of appropriateness. Next, the loads and weighted reasonableness maps are joined to deduct the exhaustive appropriateness cut. Every appropriateness investigation standard was renamed built on its reasonableness for suitable map creation, after unindustrialized the choice pecking order (Parvez & Islam, 2020). Numerous studies have been conducted in the literature to detect the suitable sites (Njiru and Siriba, 2018; Parry et. al., 2018; Zabihi et al., 2019). Most of these studies use different criteria for suitability analysis but some of them have used the expert opinion for the criteria and weighting. For example, seven criteria were used with the opinion of experts for dam site selection suitability (Njiru and Siriba, 2018). Therefore, five criterion and their ranking were determined based on the analysis of the previous studies and consulting with the experts.

Table: 1 Numerical expression and comparative importance scales for suitability rating

Comparative Importance	Suitability rating	Numerical expression
Equal importance	Not suitable	1
Moderate importance of one over another	Marginally suitable	3
Essential or strong importance	Moderately suitable	5
Very strong importance	Highly suitable	7
Extreme importance	Optimally suitable	9
	Intermediate values	2,4,6,8

Source: Zabihi et al. (2019)

To assess the consistency of the pair-wise examination lattice, a mathematical file called Consistent Ratio (CR) is utilized (Njiru and Siriba, 2018) as shown in Equation 1.

$$CR = \frac{CI}{RI} \tag{equation 1}$$

The calculation of CI is given as:

$$CI = \frac{(\lambda_{max} - n) / (n - 1)}{RI} \tag{equation 2}$$

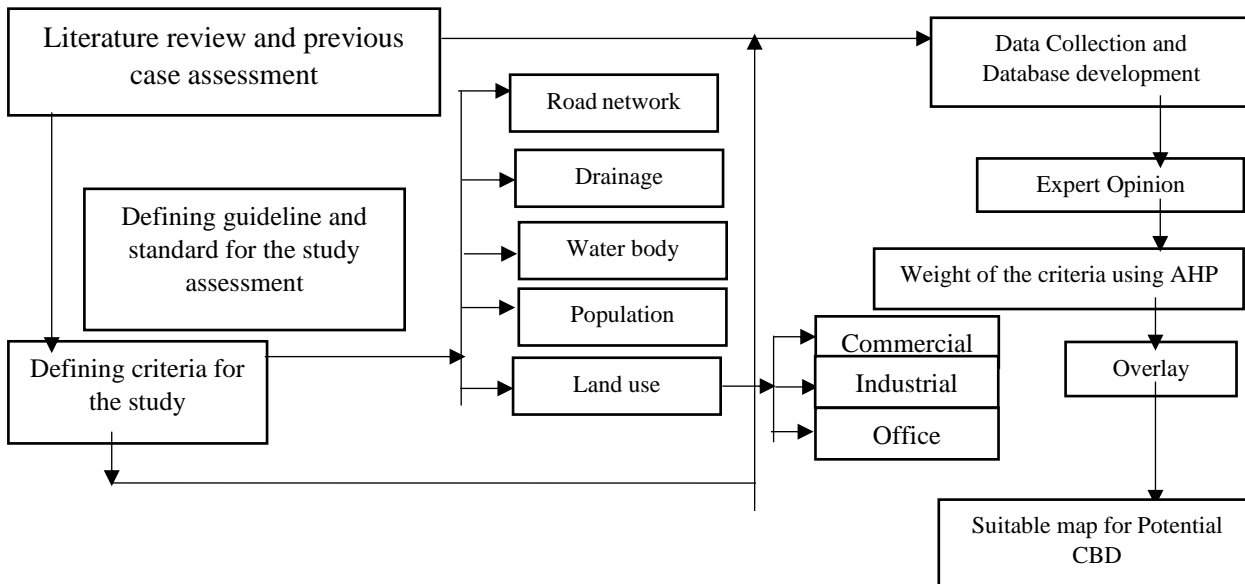
Where the term  $\lambda$  max speaks to the most noteworthy worth and n is the quantity of components, while the mean normal consistency list is signified by RI. Higher consistency and the adequacy of the AHP results as indicated by the important file ought to be beneath 0.10. The RI relies upon a variety of criteria (Saaty, 1990).

Where a determined CR esteem underneath 0.1 demonstrates a proportion that assigns a normal degree of routines in the pair-wise evaluation by a specialist judgment in AHP. The arbitrary record is signified by RI, which is the consistency file of a haphazardly created pair-wise correlation network (Hasan et al., 2019).

Table: 2 Average random inconsistency indices (RI)

(n)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(RI)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

(Source: Saaty, 1980)



Source: Autor, 2020

Figure 1: Methodological flowchart

All rules the use of the essential scale is done with the pairwise assessment, which was proposed as a component of AHP. The profundity of noteworthiness is allocated to norms I while related with standards j and the joint expense is distributed to rules j as the request for rank. While contrast among all reasonable guideline’s sets are done, a heap of norms I, which is used in later investigation for reasonableness examination,

$$W_i = \sum_{i=1}^n P_{ij} / \sum_{i=1}^n \sum_{i=1}^n P_{ij} \quad \text{equation 3}$$

(Dai, 2016)

#### 4. Data Analysis and Findings

Each factor was appointed a weight which showed their importance. In this investigation AHP, a couple shrewd correlation technique was utilized. A few online projects are accessible for figuring AHP need loads which incorporate Microsoft Excel, BMSG AHP Online System. An assessment of the overall importance of every measure with each other inside a size of one to five transformed into utilized. This grants for the evenhanded evaluation of forces of reasonableness, with 1 being components of equivalent longing and 5 being the components with inordinate decision over the different as demonstrated in (table 1). From past chips away at CBD, related with the experts' sentiment on components influencing ability metropolitan development site, the request for centrality of every basis is as shown in (table 3)

Table 3: Order of importance.

Factor	Land Use	Transportation	Population	Drainage	Water
Order of Importance	1	5	3	7	5

Source: Expert opinion survey, 2019

To discover the Weight of each issue, pair-wise comparison changed into used as defined in Table- four. A matrix changed into given wherein associated with its significance, a criterion becomes in comparison with the other on a scale of 1 to 5.

Table 4: List of the dataset and computed weights of each factor

Suitability Area	Drainage	Population	Transportation	Land Use (Commercial, Industrial, and Office)	Water
Land use	1	5	3	7	5
Transportation	0.2	1	0.33	3	0.5
Population	0.3	3	1	7	3
Drainage	0.14	0.3	0.2	1	0.2
Water	0.2	2	0.33	5	1
Sum	1.87	11.3	4.87	21	9.7

Source: Author, 2020

Table: 5 The site goal Pair-wise assessment lattices for figuring principles loads

Criteria of Suitability	Land Use	Transportation	Population	Drainage	Water	Weight
Land use	0.53	0.44`	0.61	0.30	0.43	0.462
Transportation	0.10	0.08	0.06	0.14	0.15	0.106
Population	0.17	0.26	0.20	0.25	0.30	0.236
Drainage	0.07	0.02	0.04	0.05	0.02	0.042
Water	0.131	0.17	0.06	0.26	0.10	0.144
Sum	1	1	1	1	1	1

Source: Author, 2020

$$\lambda \max = (1.87 \times 0.462) + (11.3 \times 0.106) + (4.86 \times 0.236) + (21 \times 0.04) + (9.7 \times 0.144) = 5.22$$

$$CR = \frac{(\lambda \max - n)}{(n-1)} = \frac{5.22-5}{4} = 0.55$$

$$CI = \frac{CI}{RI} = \frac{0.005}{1.12} = 0.04 < 1 (\text{acceptable})$$

Table 6: Factors influencing the weighted value

Factor	AHP weighted influence (%)
Land use	47
Transportation	11
population	23
drainage	4
Water	15

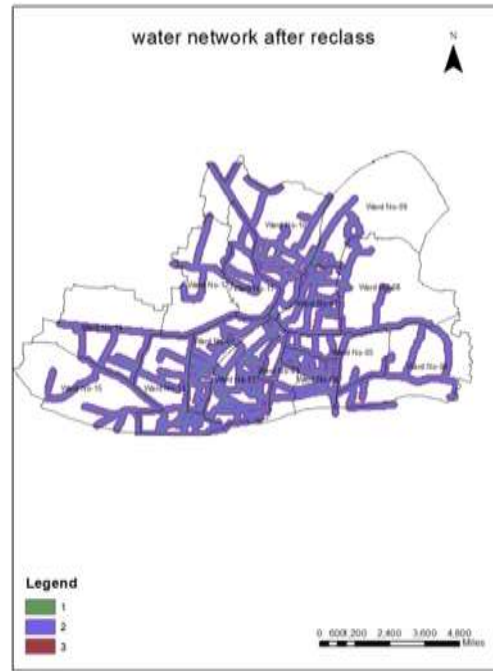
Source: Author, 2020

## 5. Results

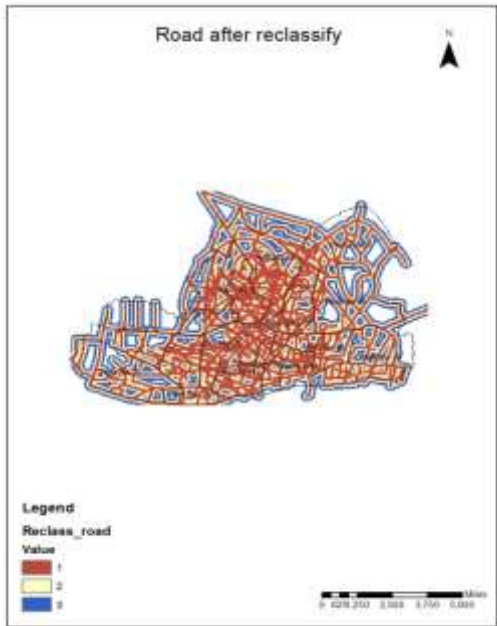
Contributions of overlay are altogether the layers normalized directly into a standard size of 1 to 5, with 5 being the most helpful as affirmed in parent 4. With the helpful asset of the utilization of the weighted entirety apparatus in bend GIS, each info raster is improved by means of the utilization of the extraordinary weight. It at that point overlays all enter raster layers together to pick up the leftover reasonableness map (figure five). The guide was when renamed into 5 reasonableness training. A bar cool enlivened film indicating a region in pixel and depend upon pretty a few reasonableness ranges transformed into once moreover delivered.



(a) Suitability Map of Land use



(b) Suitability Map of Water network



(c) Suitability Map of road



(d) Suitability Map of population



(e) Suitability Map of Drain

Figure2: Suitability Criteria

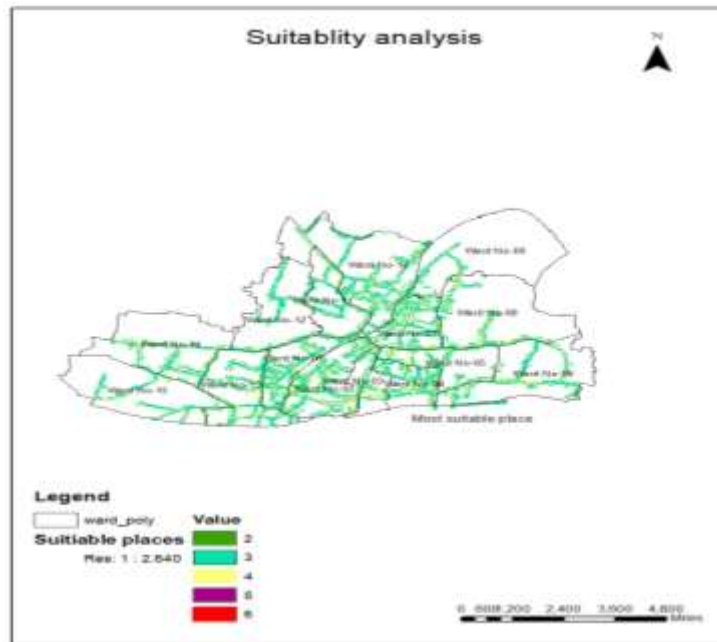


Figure 3: Suitability Map

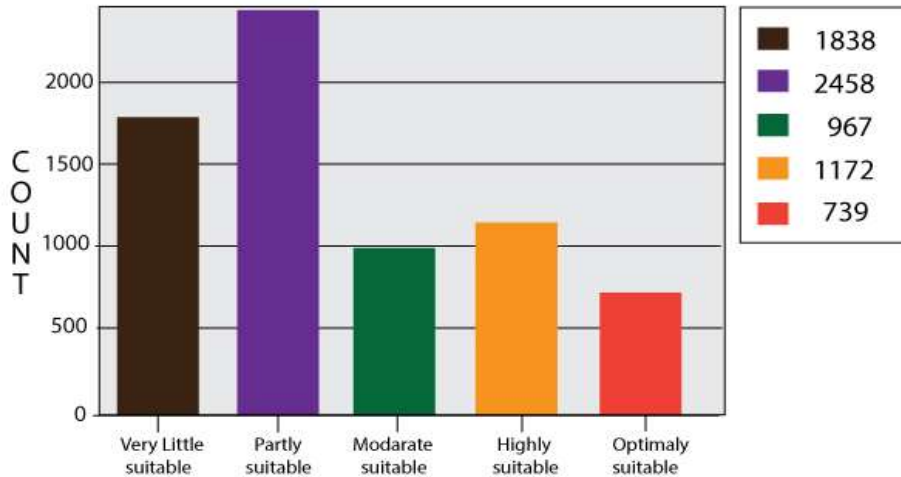


Figure 4: Summary of suitability

In the above figures, the individual appropriateness map for land-use, water organization, populace, seepage, and the street are being appeared. 200-meter cradle is taken for singular cases and afterward the Euclidean separation is concealed, at that point they are being renamed were the most appropriate spot and a less reasonable spot is being discovered. On the guide, the vast majority of the spots are discovering not reasonable, and not many spots are being discovered appropriate for CBD. At last, all the guides are being coordinated and a last inclusion has come out. Ideally fitting spots are the one's spots wherein future city advancement can without trouble emerge and highlight all the necessary places with accessible business, business, and true land use, slight and incredibly reasonable areas need a few communities e. g., water conveyance or waste or street organization and reworking of land use. A couple and incompletely fitting spots need basic contribution of offices and updates of current land use for transforming into capacity metropolitan advancement spots. From the outcome it is seen that the greater part of the reasonable spot for CBD is in Ward no-7 district has the most appropriate spot for metropolitan development at that point word no 2 and word no 6 has likewise had ideal expected CBD and another locale has less possible CBD. Also, from figure 6, it is seen that not many reasonable spots are check 1838 destinations and truly appropriate locales are tallied 739 spots. From the investigation generally, 7174 spots are perceived for the limit of a metropolitan blast. Among them 26. Five% is next to no appropriate, 34. 26% is incompletely appropriate, 13. 47% is sensibly proper, sixteen. 33% is pretty reasonable and 10. 30% is ideally reasonable. As an auxiliary municipality with an enormous measure of expanding populace, Pabna Municipality is having an extraordinary expected CBD. This decided spots can be helpful for the future CBD and the policymakers and Planners can utilize this appropriate spots for making a legitimate arrangement by which metropolitan issues (for example value climb of land, metropolitan aimless, contamination, strong waste issue, lace improvement, gridlock, water logging, etc.) can be killed and a legitimate city can be effortlessly worked with leads toward maintainable advancement of a city.

**5. Conclusion**

Pabna is a very expanding and important city. This study will help the future development of the Pabna municipality and also may control the development of the city. Five potential sites can be used for further development and will have a great impact on development and future sustainability. From the outcomes, it is seen that acclimatizing GIS with AHP multi-norms inclination assessment has been advantageous in distinguishing a fitting feasible town blast spot. Thusly, totally everybody is proficient and steady of the decision-making gadget. The outcome proposes that the joining of GIS with AHP Multi-Criteria Choice Assessment for fitting sensible city builds the potential metropolitan development site choice is achievable and ground-breaking. The investigation shows the possible metropolitan development territory mostly at a ward no. 2, 6, and 7. This assessment gives a reference for fate GIS fundamentally based city development choice explicitly with multi-standards decision-based assessment for a metropolitan development decision to be done and help the policymakers to fabricate an appropriate arranged optional municipality and stay away from the possible metropolitan issues.



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## Conflict of Interest

The authors confirm no conflict of interest.

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