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Assessment of School Infrastructure at Primary and Upper Primary Level: A Geospatial Analysis

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ABSTRACT

With the introduction of powerful and high-speed personal computers, proficient techniques for infrastructure development and management have advanced, of which Geoinformatics technology is of great significance. An attempt has been made for broad mapping and analysis of existing infrastructures in the context of planning scheme in Paschim Medinipur district, and to delineate the development zones of educational infrastructure facilities. The thematic layers considered in this study are infrastructure accessibility, type and condition of classroom and number of classroom allocated for the educational system at primary and upper primary level. *Moran's I* statistics was used to estimate the spatial distribution of elementary infrastructure across the district. All these themes and their individual features were then assigned weights according to their relative importance in educational development and corresponding normalized weights were obtained based on the Saaty's analytical hierarchy process. The thematic layers were finally integrated in GIS software based on multi-criteria approach to yield educational development infrastructure index. *Moran's I* statistics shows girl's toilet, electric and boundary wall facility within the district are clustered in pattern at primary level. At the upper primary level, only electric and computer facilities shows the clustered distribution across the district. However, four different zones have been delineated, namely "very good", "good", "moderate" and "poor". The block covered by very good elementary educational infrastructure facility is Daspur-I and Dantan-II at primary level and Keshiary block at upper primary level in Paschim Medinipur district. Finally, it is concluded that the Geoinformatics technology is very efficient and useful for the identification of infrastructure development.

Keywords: Educational Infrastructure; Spatial Auto-Correlation; Saaty's Analytical Hierarchy Process; Multi-Criteria Approach

1. Introduction

Education is a decisive determinant of economic and social expansion, and also household livelihoods and food security status. Empirical studies also demonstrated that investment in elementary education amplifies the productivity in all the sectors of the economy much more than other levels of education, and that economic returns to investment in primary education are greater than those arising from other levels of schooling [1]. The development of education depends on large number of factors including the infrastructure resources available to a school. School infrastructure, such as the site, buildings, furniture and equipments contribute to a learning environment [2]. Study conducted by Ayeni and Adelabu [2], mentioned that the classrooms in most of the schools were inadequate in terms of decency, space, ventilation and insulation from heat; the incinerators and urinal were not conveniently placed, and the school plant was poorly maintained; these combined deficiencies constituted a major gap in the quality of learning environment. Hence, the school infrastructure management and planning is signifying the regional planning agencies to improve the educational facility in a particular area.

After nineties, secondary and higher education in India is experiencing structural changes due to the process of globalization [3]. The post nineties period witnessed a considerable increase in the infrastructure at tertiary level [4,5]. Nevertheless, any fundamental change has not been found in the structure and organisation of elementary education system which lags in the quality also. In India nearly 90 percent of schools at elementary level are run by government [6]. Most of the schools are situated in rural areas, and not have average criteria for quality education. It may be due to poor infrastructure such as

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shelter-less school building, insufficient building, and high ratio of pupil-teacher, traditional methods of teaching and high absentee rate. Ever since its commencement by the Government of India and State Government, the Sarva Shiksha Abhiyan (SSA) has accentuated decentralized planning of education with a focus on district planning. It envisages achieving goal of universal elementary education by 2010. A phenomenal growth in the education system has made in India at elementary level under SSA, in spite of paucity of resources. The number of primary schools (Government) is highest in Paschim Medinipur (4672). In general, existing condition of educational services in Paschim Medinipur show that in some parts of the region is suffering in educational infrastructure provision. The spatial distribution of those facilities is also not equitable across the district, and mostly located away from the urban centers. Consequently, there is a need to plan the distribution of educational infrastructure in Paschim Medinipur to assign great importance for planning and appraisal activities. So that information derived from the study may be helpful for quality implementation of the programme in Paschim Medinipur "Optimally", not fragmented as it is now.

There is actually a general belief that the condition of school's learning environment has an important impact on elementary infrastructure effectiveness and students' academic concert and or enrollment ratio. The facilities that are needed to facilitate effective education development and learning in an educational institution includes the girl's toilet, library, boundary wall, computer, play ground, classrooms, offices and other buildings structure. This required a comprehensive mapping of the obtainable infrastructure to scrutiny the gap in educational infrastructure. On the basis of that, the objective of the present study is to provide a broad mapping and analysis of existing infrastructures in the context of planning scheme in Paschim Medinipur district, West Bengal (India).

2. Materials and Methods

2.1. Study Area

The entire district of Paschim Medinipur in the state of West Bengal, India is considered to conduct the present study, extended between 21˚46′N and 22˚57′N between 86˚33′E and 87˚44′E (**Figure 1**). The district has 4

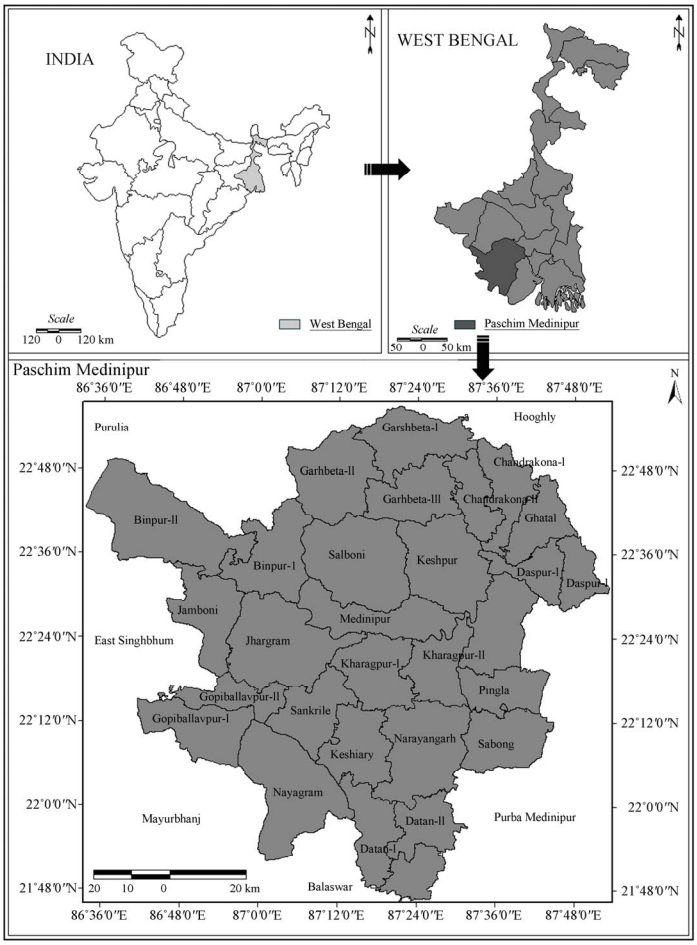

Figure 1. Location map of the study area.

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sub-divisions: Kharagpur, Medinipur Sadar, Ghatal and Jhargram. The district is bounded on the north by Bankura and Purulia districts, on east by Purba Medinipur district, on the south by Purba Medinipur district and Balasore district of Orissa and on the west by Mayurbhanj district of Orissa and Singbhum districts of Jharkhand. The total geographical area of Paschim Medinipur district is 9345 sq km. According to the 2011 census, Paschim Medinipur district has a population of 5,943,300. The district has a population density of 636 inhabitants per square kilometre (1650/sq mi). Its population growth rate over the decade 2001-2011 was 14.44%. The district has a sex ratio of 960 females for every 1000 males, and a literacy rate of 79.04%; where, the literacy rate of male and females are 81.13% and 56.90% respectively.

Individually the overall literacy rate is found maximum at Daspur II block (81.7%), where the male and female literacy rate is maximum at Sabang (89.3%) and Daspur-I (70.7%) block respectively. On the other hand individually the overall literacy rate is found minimum at Binpur II, (55.7%), Gopiballavpur I (56.5%) and Nayagram (40.6%) block respectively. The Sabang block is comparatively developed in respect to the other blocks. This may be due to the availability of the education facility but the stunning feature is present at Daspur-II, where educational facility is inadequate but the consciousness of people of these blocks has lead to reach at such a high level of literacy. In Binpur II, Nayagram and Gopiballavpur I the literacy figure is very poor for the dominance of the poor tribal population (e.g., Sabar, Santal, Gond etc.) marked by a fragile financial base, lack of banking facility, predominance of low yielding agriculture and forest resource collection. The block, Keshpur enjoys the most intensive educational facility but could not come at the top according to the literacy rate 67% respectively.

2.2. Methodology

The analysis is made on the basis on District Information System for Education (DISE) report on schools at primary and upper primary level of academic year 2009-2010.

2.2.1. Base layer Creation and Database Generation

The district and block maps of Paschim Medinipur were collected from the Office of the District Land and Land Reforms (DL & LRO Office), Medinipur and were geo-reference with the survey of India Topographical (SOI) sheet (scale 1:50,000). The process of geo-coding was done by the ground control points which were collected uniformly over the whole block and then mathematically warped to fit into the real world co-ordinates using Universal Transverse Mercator (UTM) co-ordinate system and the World Geodetic System (WGS) 84 datum by ERDAS Imagine Software (Version 9.2). Block and district boundary layers were digitized and the vector layers were generated from the rectified base map. A database were generated on the excel sheet considering the infrastructure facility of the school, such as, girls toilet, play ground, library, electric, kitchen shed, computer, ramp, drinking water, boundary wall available for each school per block and their percentage have been calculated. The excel files were merged together and exported to geodatabase.

2.2.2. Geographic Visualization and Data Exploration

For processing visual information, and for formulating research questions of infrastructure facility available at primary and upper primary level, geographic visualization procedure was adopted. Geographic visualization emphasizes map-based manipulations as data visualization process [7,8]. The day-metric maps were derived to delineate areas of homogeneous values, rather than follows administrative boundaries [8]. The derived data for each theme at primary and upper primary level was classified separately prior to mapping based on geometric interval in ArcGIS v9.3 software, and were symbolized using colour scheme for quantitative data.

2.2.3. Generation of Thematic Layers

In order to differentiate infrastructure facility block in the study area, a multiparametric data were used. The thematic layers of type of classroom (e.g., good condition, need of minor repair, need of major repair, pucca house, partially pucca house, kuncha house), condition of classroom (e.g., number of classroom) and school infrastructure availability (e.g. girls toilet, drinking water, library, electric, ramp, boundary wall, play ground, kitchen shed, computer facility) were prepared at primary and upper primary level separately. All the digitized coverages were spatially organized in the GIS environment with the same resolution and coordinate system. The checking of these spatial maps was done with respect to other database layers by the overlaying technique, and refined mutually as part of standardization of the database. The errors due to digitization and mismapping were removed in this process.

2.2.4. Spatial Autocorrelation Analysis

Spatial autocorrelation was measured based on the Moran's Index (*Moran's I*) spatial statistics to evaluate whether the pattern expressed is clustered, dispersed, or random [9]. Using the spatial statistical tool of ArcGIS software the *Moran's I* value and *Z score* were calculated to assess the significance of that index. In general, a *Moran's I* value near +1.0 indicates clustering while an in-

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dex value near –1.0 indicates dispersion.

2.2.5. Integration of Thematic Layers

The thematic layers of type of classroom, condition of classroom and school infrastructure availability were used for the delineation of suitable school infrastructure management system block at primary and upper primary level in the Paschim Medinipur district. To differentiate development block, all these thematic layers were integrated using ArcGIS software. The weights of the different themes were allocated on a scale of 1 to 5 based on their influence on the educational development. Different features of each theme were assigned weights on a scale of 1 to 9 according to their relative influence on educational development. Based on this scale, a qualitative assessment of different features of a given theme was performed, with: poor (weight = 1 - 1.5); moderate (weight = 2 - 3.5); good (weight = 4 - 5.5); very good (weight = 6 - 7.5); and excellent (weight = 8 - 9). Thereafter, a pairwise comparison matrix was constructed using the Saaty's analytical hierarchy process Saaty [10], to compute normalized weights for individual themes and their features. To differentiate better infrastructure facility available block, all the nineteen thematic layers after assigning weights were integrated step by step using multi-criteria approach in ArcGIS software. **Figure 2** shows the methodological flow chart for Education Development Infrastructure Index (EDII).

Educational development infrastructure index (EDII) is a dimensionless quantity that helps in indexing universal accessibility of school infrastructure development across the district. The range of EDII values were divided into four equal classes (called zones) based on geometric interval, and the EDII of different blocks falling under different range were grouped into one class. Thus, the entire study area was qualitatively divided into four zones based on the universal accessibility of school infrastructure. The final output showing these blocks which were performed very well to success the SSA mission for achieving goals of universalization of elementary education at grass root level using ArcGIS software.

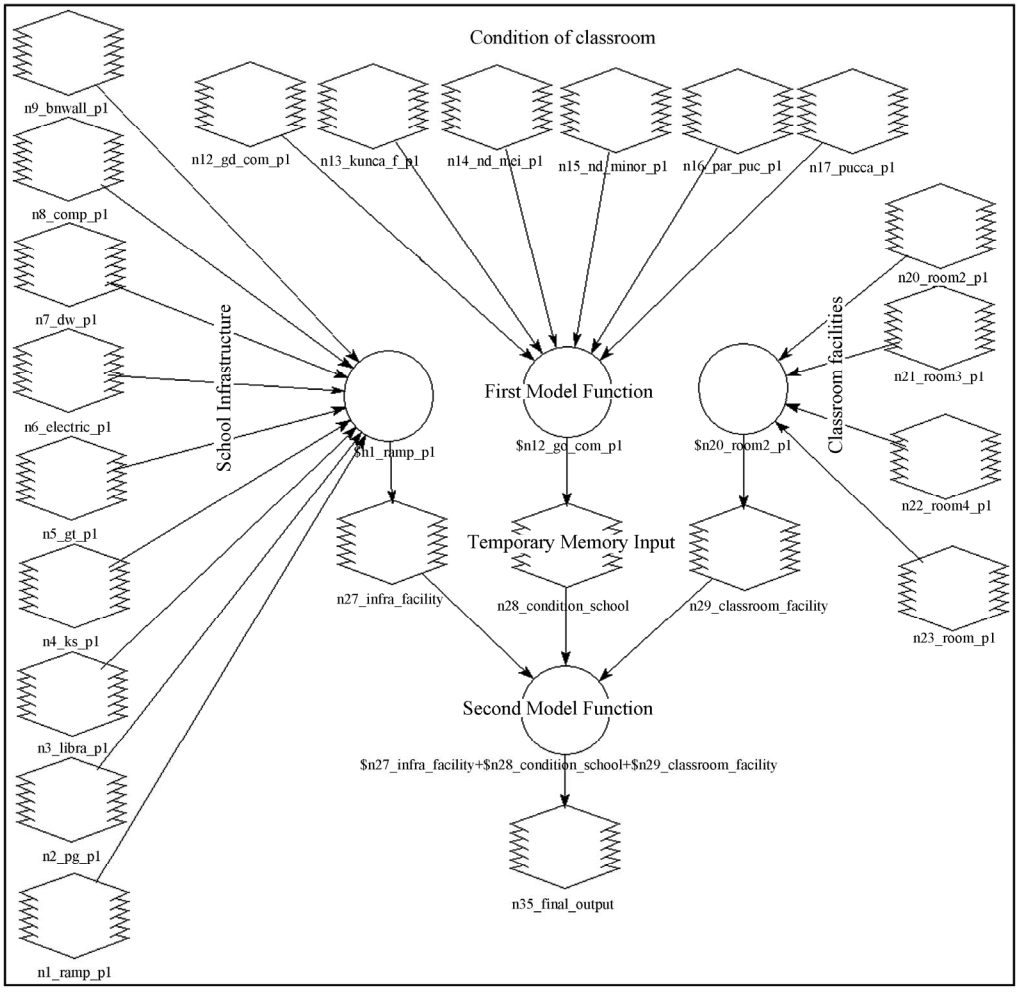

Figure 2. Methodological flow chart for Education Development Infrastructure Index (EDII).

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3. Results

The details of elementary infrastructure with their spatial distribution in the study area are presented below.

3.1. School Infrastructure

Educational infrastructure at grass root level is responsible for growth in secondary and tertiary education. A total of 4359 schools were surveyed at the primary level across the district. On the other hand, at the upper primary level, a total of 670 schools were surveyed. Thus, linking of infrastructure availability with the educational system provides a simple way to understand achievement of the SSA mission for the development process across the district. **Figure 3** shows the status of infrastructure facilities at block level in Paschim Medinipur district.

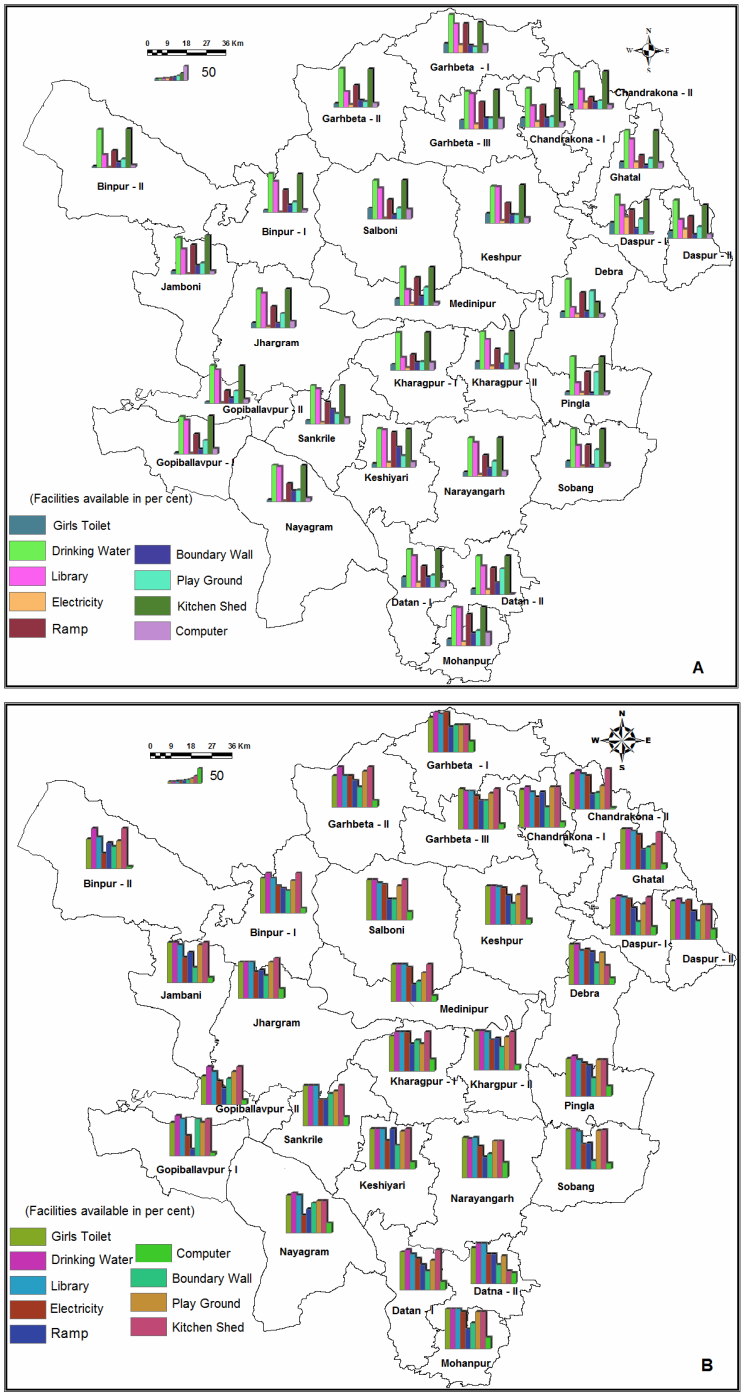

Figure 3. Infrastructure facility in Paschim Medinipur district (A) primary level; (B) Upper primary level.

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Given that health issues are known to impact on school attendance and completion [11], establishing an impact of separate-sex toilets on girl's health could build indirect evidence of an impact of separate toilets on girl's educational outcomes. Going to a school lacking proper basic facilities, like toilets, could be one of the most frustrating situations for many children in the rural and urban schools. A school environment, often hostile or unappealing, with no special facilities for girls (toilets, a protective wall around the school, etc.) is conducive to the enrolment of girls. It is very common for boys not only to intimidate and make fun of girls, but also attack and beat them up. In our study area, with regard to the availability of girl's toilet, the numbers of schools were 15.84 percent at primary level, and 92.14 percent at upper primary level. The highest girl's toilet facility was found in the Daspur-I block (29.46 percent), while, lowest facility was available in Gopiballavpur-I (3.82 percent) at the primary level. Moreover, the average distribution of girl's toilet facility at primary level showed 14.67 percent (standard deviation ±7.48). In the upper primary level, the numbers of schools were 92.14 percent of separate girl's toilet facility. In Gopiballavpur-II block area, lowest numbers of girl's toilet facility were available (70.59 percent) at the upper primary level. However, in Pignla, Sabang, Salbani, Sankril, Narayangarh, Mohanpur, Kharagpur-II, Keshiary, Jambani, Ghatal, Garhbeta-III, and Debra all these school having girl's toilet facility.

The building of toilets in schools has not only brought about a change at the school compounds, but lack of girl's toilet facility may act as a deterrent to girls' attendance in schools or impact negatively on their learning [12]. The spatial distribution of the availability of girls toilet at the primary level shows clustered pattern (*Moran's I* 0.29, *Z score* 2.72), whereas, at the upper primary level random pattern has been found (*Moran's I* 0.01, *Z score* 0.35).

Drinking water (DW) is another important elementary aspect for the school infrastructure development. At the primary level and the upper primary level, percent of schools with drinkable water available is almost same across the district. The overall percentage of DW availability showed 98.24 percent (SD ±1.75) and 98.50 percent (SD ± 2.70) at primary and upper primary level respectively. However, the spatial distribution is somewhat random for the both the level. The Moran's I statistics of the spatial distribution of drinking water facility for the entire district showed 0.05, with *Z score* of 0.01 at the primary level. In the upper primary level, the *Moran's I* values showed 0.01, with a *Z score* of 0.34 that represent the blocks are randomly distributed based on their availability of DW facilities.

Library is a very important element in any education level as they serve as knowledge source for the students. The availability of library facility has been derived through the number of primary schools having library facility expressed as percentage of total number of schools. It was observed that facility of libraries at upper primary levels is comparatively good across the Paschim Medinipur district (68.34 percent), in respect to the upper primary level (91.34 percent). More than 95 percent school in Keshiary and Mohanpur blocks having the library facility at primary level. However, Debra (26.21 percent), Binpur-II (33.86 percent), Kharagpur-I (33.67 percent), and Pingla (31.03 percent) blocks have recorded the lowest percentage of library facility. Moreover, the spatial distribution of highest and lowest facilities of library is partially random (*Moran's I* 0.11, *Z score* 1.10). Alternatively, in Narayangarh, Mohanpur, Kharagpur-I, Datna-II and Keshiary block has the 100 percent availability of library. The lowest availability of library facility was recorded from the Binpur-II (77.27 percent) and Garhbeta-II (77.78 percent) blocks. The spatial auto correlation between highest and lowest library facilities at upper primary level also illustrated partially random pattern (*Moran's I* 0.11, *Z score* 1.18).

Percentage of schools having electricity may be considered an indicator of elementary infrastructure. At Primary level, majority of the school in Paschim Medinipur district, do not have electricity. The overall percentage of electricity availability across the district is 10.68 percent. Highest percent of electricity availability has been recorded from Daspur-I block (44.19 percent), while, lowest percent have been documented in the Binpur-I block (0.73 percent). The spatial distribution between highest and lowest percent of electricity availability across the district showed clustered pattern (*Moran's I* 0.49, *Z score* 4.71). The percentage of electricity availability at the upper primary level varied enormously in the district, ranging from a low 36.36% in Binpur-II to 100 % in Kharagpur-I. The overall availability of electricity in the district is 76.22% (Standard deviation ±15.88). The spatial distribution pattern of electricity at the upper primary level showed clustered pattern (*Moran's I* 0.40, *Z score* 3.42).

For the assessment and management of student's mental health in wellbeing in primary and secondary schools, it is necessary that every school should have ramp. In general, at the primary level, availability of ramp facility was 55.81% across the district. However, the highest facility of ramp was recorded from Keshiary block (90.16%), and the lowest ramp facility was recorded from Chandrakona-I (30.17%). The spatial autocorrelation of ramp facilities between the blocks showed random pattern (*Moran's I* 0.09, *Z score* 0.40). At the upper primary level, 63.78% schools across the district had provision of ramps. The availability of ramp per-

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centage school is ranging from a low 16.67% in Gopiballavpur-I to 100% in Keshiary block. However, these blocks were randomly distributed across the district (*Moran's I* 0.09, *Z score* 1.01).

Availability of boundary wall is also other very significant issues for cater education. The problem of schools building and boundary wall is not so good in several elementary schools in Paschim Medinipur district. The issue of boundary wall is very severe that most of the schools do not have boundary walls. The lowest percentage of boundary wall availability (6.09%) was recorded from the Sabong block, and the highest percentage was documented in Keshiary block (52.46%). The spatial distribution of boundary wall facilities between the blocks showed clustered pattern (*Moran's I* 0.40, *Z score* 3.55) at the primary level; whereas, at the upper primary level it showed somewhat clustered pattern (*Moran's I* 0.23, *Z score* 2.14). Additionally, the highest percentage of boundary wall facilities block has been documented as Gopiballavpur-I (91.67%), and the lowest percentage were recorded as Sabong block (20.83%) at the upper primary level. Moreover, at the primary level, the facilities of boundary wall availability in the school is found higher in southeast part of the district, while low facilities are presented in the western pockets.

Distribution of schools having play ground in primary level were 32.95 percent across the district; however, at the upper primary level had 79.49 percent schools had the play ground. While lowest percent of play ground (13.86 percent) had in Garhbeta-II block and the Debra had the highest percent (69.42 percent) of play ground in the school at the primary level. It is further observed that play ground facilities in highest and lowest percent schools were distributed in clustered pattern across the district (*Moran's I* 0.31, *Z score* 2.81). On the other hand, at the upper primary level, Chandrakona-II block had the highest percent (100 percent) of play ground facility, and the lowest percentage has been recorded from Ghatal (60.61 percent). The spatial autocorrelation of play ground facilities block at upper primary level showed random pattern (*Moran's I* 0.16, *Z score* 0.96).

The percentage of school with kitchen shed facilities had shown a very interesting result. The majority of such schools, 94.65 percent, at primary level had kitchen shed facility. Though their distribution pattern across the district is slightly random (*Moran's I* 0.09, *Z score* 1.67), however, only Daspur-II block documented as lowest percent (39.81 percent) of schools having the kitchen shed facility. The majority of the school in Paschim Medinipur district had kitchen shed, more than 90 percent connection with the school at primary level. Alternatively, at the upper primary level, almost an equal percentage (90.41 percent) had the kitchen shed facility. In the study area, the percentage of such upper primary schools having kitchen shed facility varying from 31.58 percent in Datan-II block to 100 percent in Sankril, Kharagpur-I, Garhbeta-II, Garhbeta-III, Datan-I, Chandrakona, I, II and Binpur-II block. The spatial distribution pattern of kitchen shed facility in the study area is totally random (*Moran's I* 0.03, *Z score* 0.08).

The availability of computer facility in the schools of the study area showed much lower percentage of such school. The lowest percentage of schools with computer facility in case of the primary level is shown in Datan-II (2.17 percent). The percentage of such school is also high in the district of Mohanpur block (34.57 percent). However, blocks had computer facility, randomly distributed in the study area (*Moran's I* 0.01, *Z score* 0.54). Comparatively, the percentage of upper primary school with computer facility was found to be higher (19.57 percent) than the primary levels. In upper primary level, Narayangarh block had maximum percentage of school having computer facility (37.84 percent). The lowest percentage of block in upper primary school having computer facility is notified as Chandrakona-I (4.17 percent). Nevertheless, the clustered pattern has been observed among the blocks connection with computer facility in upper primary level of the study area (*Moran's I* 0.25, *Z score* 2.26).

3.2. Condition of Class Room

The condition of classrooms at primary and upper primary level also reveals that it is an important factor for elementary school development. The conditions of schools building is not so good in several elementary schools in Paschim Medinipur district (**Figure 4**). In our study we considered the pucca, partially pucca, kuncha, need minor repair and need major repair classrooms for EDII model development. It is observed that in the primary level 40.90 percent building had good condition, while in the upper primary level, the percentage was 54.72 percent. Further it is observed that Garhbeta-III block; more than 60 percent of all such schools have good condition buildings. On the other hand, in Sabong less than 30 percent schools have good condition. While at the upper primary level, Garhbeta-III, Gopiballavpur-I, Kharagpur-II, Mohanpur have more than 60 percent school in good condition. However, the percentage of minor repaired school at the primary level was 26.84 percent, and at the upper primary level, the percentage was 20.33. The provision of major repaired percentage of school building in primary level varies from 15.84 percent (Garhbeta-III) to 48.46 percent (Datan-I). Additionally, it was also observed that at the upper primary level, 13.22 percent of such school in Gopiballavpur-I block have need to be major repaired, whereas in Chandrakona-II, 42.75 percent schools have need for major re-

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pairing. However, the spatial relationship among the distribution of classroom condition of Paschim Medinipur district is shown in **Table 1**.

3.3. Type of Classroom

Brief looks at the block-specific percentages of schools having type of classroom were also examined at the primary and upper primary level of Paschim Medinipur district. The result of the study reveals that 85.24 percent at the primary and 97.37 percent at the upper primary level schools of the Paschim Medinipur district have provided pucca buildings. It varies from 41.25 percent in Narayangarh to 100.00 percent in Kharagpur-I of schools having pucca buildings at the primary level. More than 95.00 percent schools in each block of Paschim Medinipur district also have pucca school buildings.

The percentage of primary schools having partially pucca buildings were 11.69 percent in Paschim Medinipur district, whereas, at the upper primary level the percentage was 1.53 percent only. Narayangarh, and Garhbeta-III block have worst position in respect of % of pucca classroom *i.e.*, 41.25 and 59.74 respectively. The percentage of schools having kuncha buildings is somewhat high (e.g., 3.07 percent) at primary level, in respect to the upper primary level (e.g., 1.10 percent). The percentage is as high as 14.29 percent in Narayangarh and 9.69 percent in Dantan-I at the primary level. In the upper primary level, Chandrakona-I having the highest percent of kuncha building schools (e.g. 8.40 percent). The spatial autocorrelation of classroom type among the blocks of Paschim Medinipur district is shown in **Table 1**.

3.4. Number of Classroom Distribution

There are 13.10% of schools having one room, 33.10% of schools having two rooms, 24.94% of schools having three rooms and 28.84% of schools having above three rooms at primary level in the district. It is also observed that Binpur-II and Keshpur have the highest number of

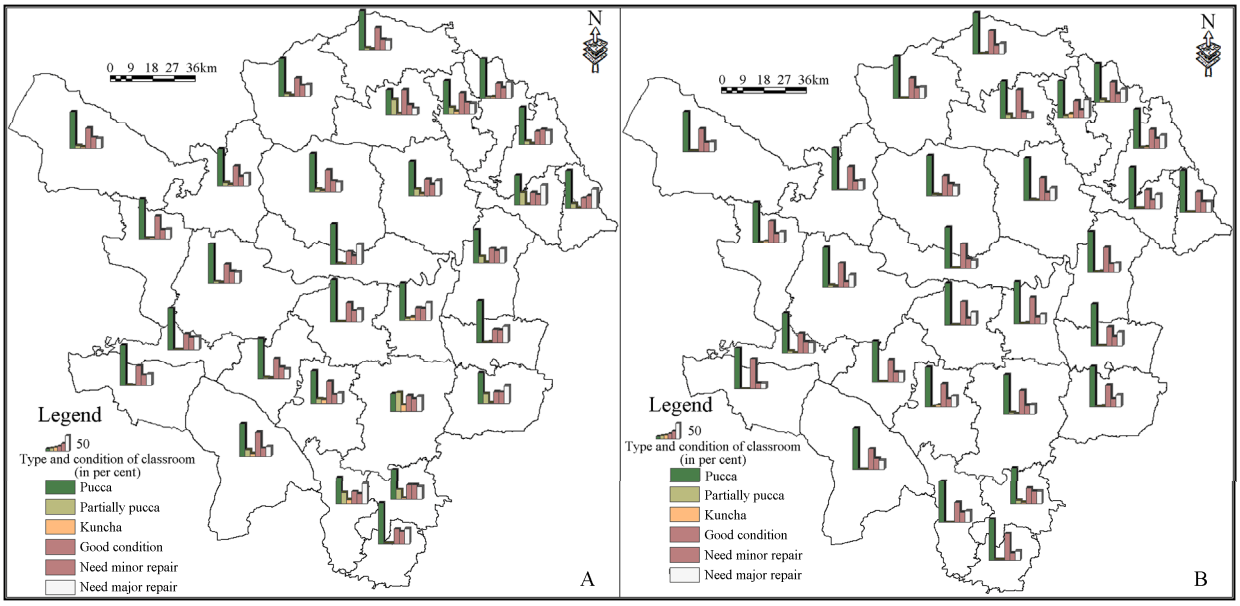

Figure 4. Type and condition of classroom availability in Paschim Medinipur district (A) Primary level; (B) Upper primary level.

Table 1. Spatial autocorrelation of type and condition of classroom facilities distribution across the Paschim Medinipur district.

Variables	Primary			Upper primary		
	Moran's *I*	*Z score*	Distribution pattern	Moran's *I*	*Z score*	Distribution pattern
Pucca	0.13	1.45	Random	0.14	1.53	Slightly random
Partially pucca	0.08	1.00	Random	0.05	0.73	Random
Kuncha	0.22	2.27	Somewhat clustered	–0.14	1.00	Slightly random
Good condition	0.41	3.73	Clustered	–0.08	0.42	Random
Need minor repair	0.04	0.66	Random	–0.07	0.30	Random
Need major repair	0.26	2.52	Somewhat clustered	0.05	0.72	Random

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school with single room. Moreover, in Narayangarh, Jhargram and Binpur-II has been recorded maximum number of schools with two classrooms. The minimum number of schools with three classrooms has been recorded from Datan-I, Datan-II, and Mohanpur block. Furthermore, Daspur, Debra and Sabong have the maximum number of schools with four classrooms at the primary level. The spatial relation of the distribution of schools in each block having number of classroom at the primary and upper primary level was also examined by *Moran's I* statistics, and the result has been given in **Table 2**.

There are 0.40% of schools having less than four rooms, 4.93% of schools having four rooms, 4.39% of schools having five rooms and 90.15% of schools having above five rooms at upper primary level in the district. However, maximum number of schools of above five rooms was recorded from Sobang block, while lowest number was documented in Kharagpur-I block.

3.5. Weight Assignment for EDII and Geoinformatics Based Modeling

Suitable weights were consigned to the nineteen themes at primary and upper primary level and their individual features after understanding their infrastructural significance in causing educational development in the study area. The normalized weights of the individual themes and their different features were obtained through the Saaty's analytical hierarchy process (AHP). The weights assigned to different themes are presented in **Table 3**. The process of attaining the normalized weights of the themes is presented in **Table 4** for primary level and in **Table 5** for upper primary level. The normalized weights of different features of the nineteen themes were obtained in the similar approach.

After deriving the normal weights of all the thematic layers and each feature under indivial mes, all the thematic layers were incorporated with one another using ArcGIS software in order to segregate EDII zones in the study area. The final weights of each polygon in the final integrated layer were derived by summing up the weights of polygons from individual layers and the highest derived sum of the weights in the final integrated layer was divided into four equal classes, *i.e*. "very good", "good", "moderate" and "poor", in order to mark out educational infrastructure development zones as per SSA mission. The delineation of EDII zones was done by grouping the polygons in the final integrated layer having weights of any of the four classes.

Table 2. Spatial autocorrelation of classroom facilities distribution across the Paschim Medinipur district.

	Primary			Upper primary			
Variables	Moran's *I*	*Z score*	Distribution pattern	Variables	Moran's *I*	*Z score*	Distribution pattern
Single room	0.01	0.36	Random	Less than 4 room	0.23	2.93	Somewhat clustered
Double room	–0.08	0.36	Random	4 room	0.21	2.18	Somewhat clustered
Triple room	0.23	2.27	Somewhat clustered	5 room	0.04	0.64	Random
Above 3 room	0.41	3.80	Clustered	Above 5 room	0.36	3.41	Clustered

Table 3. Weights of the infrastructural facilities themes for educational development zoning in Paschim Medinipur district.

Primary		Upper Primary	
Variable	Weightage	Variable	Weightage
Girl's toilet	3	Girl's toilet	4
Drinking water	6	Drinking water	4.5
Library	5	Library	6
Electricity	2.5	Electricity	3.5
Ramp	2	Ramp	3
Boundary wall	3.5	Boundary wall	4
Play ground	4.5	Play ground	3.5
Kitchen shed	4	Kitchen shed	3
Computer	4.5	Computer	5
Single classroom	3	Less than 4 classroom	1
Double classroom	2	4 classroom	2.5
3 Classroom	1.5	Above 5 classroom	3
Above 3 Classroom	1	Pucca houses	2.5
Pucca houses	2	Partially pucca houses	1.5
Partially pucca houses	1.5	Kuncha	2.5
Kuncha	1	Good condition	5
Good condition	3	Need minor repair	2
Need minor repair	2	Need major repair	1.5
Need major repair	1.5		

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Table 4. Pair-wise comparison matrix of the thematic layers for EDII at primary level in Paschim Medinipur district.

	GT	DW	Lib	Elect	Ramp	BW	PG	KS	Comp	Sin. room	Dob. room	Trip. room	>3 room	Puccca house	Par_ pucca	Kuncha	Gd. cond	Need minor	Need major	Nth root of the product values	Eigenv-ector
GT	1.00	0.50	0.60	1.20	1.50	0.86	0.67	0.75	0.67	1.00	1.50	2.00	3.00	1.50	2.00	3.00	1.00	1.50	2.00	1.21	0.06
DW	2.00	1.00	1.20	2.40	3.00	1.71	1.33	1.50	1.33	2.00	3.00	4.00	6.00	3.00	4.00	6.00	2.00	3.00	4.00	2.42	0.11
Lib	1.67	0.83	1.00	2.00	2.50	1.43	1.11	1.25	1.11	1.67	2.50	3.33	5.00	2.50	3.33	5.00	1.67	2.50	3.33	2.02	0.09
Electric	0.83	0.42	0.50	1.00	1.25	0.71	0.56	0.63	0.56	0.83	1.25	1.67	2.50	1.25	1.67	2.50	0.83	1.25	1.67	1.01	0.05
Ramp	0.67	0.33	0.40	0.80	1.00	0.57	0.44	0.50	0.44	0.67	1.00	1.33	2.00	1.00	1.33	2.00	0.67	1.00	1.33	0.81	0.04
BW	1.17	0.58	0.70	1.40	1.75	1.00	0.78	0.88	0.78	1.17	1.75	2.33	3.50	1.75	2.33	3.50	1.17	1.75	2.33	1.41	0.07
PG	1.17	0.75	0.90	1.80	2.25	1.29	1.00	1.13	1.00	1.50	2.25	3.00	4.50	2.25	3.00	4.50	1.50	2.25	3.00	1.79	0.08
KS	1.33	0.67	0.80	1.60	2.00	1.14	0.89	1.00	0.89	1.33	2.00	2.67	4.00	2.00	2.67	4.00	1.33	2.00	2.67	1.61	0.07
Computer	1.50	0.75	0.90	1.80	2.25	1.29	1.00	1.13	1.00	1.50	2.25	3.00	4.50	2.25	3.00	4.50	1.50	2.25	3.00	1.82	0.08
Sin room	1.00	0.50	0.60	1.20	1.50	0.86	0.67	0.75	0.67	1.00	1.50	2.00	3.00	1.50	2.00	3.00	1.00	1.50	2.00	1.21	0.06
Doub room	0.67	0.33	0.40	0.80	1.00	0.57	0.44	0.50	0.44	0.67	1.00	1.33	2.00	1.00	1.33	2.00	0.67	1.00	1.33	0.81	0.04
trip room	0.50	0.25	0.30	0.60	0.75	0.43	0.33	0.38	0.33	0.50	0.75	1.00	1.50	0.75	1.00	1.50	0.50	0.75	1.00	0.61	0.03
Abv3 room	0.33	0.17	0.20	0.40	0.50	0.29	0.22	0.25	0.22	0.33	0.50	0.67	1.00	0.50	0.67	1.00	0.33	0.50	0.67	0.40	0.02
Pucca	0.67	0.33	0.40	0.80	1.00	0.57	0.44	0.50	0.44	0.67	1.00	1.33	2.00	1.00	1.33	2.00	0.67	1.00	1.33	0.81	0.04
Par_pucca	0.50	0.25	0.30	0.60	0.75	0.43	0.33	0.38	0.33	0.50	0.75	1.00	1.50	0.75	1.00	1.50	0.50	0.75	1.00	0.61	0.03
kuncha	0.33	0.17	0.20	1.25	0.50	0.29	0.22	0.25	0.22	0.33	0.50	0.67	1.00	0.50	0.67	1.00	0.33	0.50	0.67	0.43	0.02
gd_cond	1.00	0.50	0.60	1.20	1.50	0.86	0.67	0.75	0.67	1.00	1.50	2.00	3.00	1.50	2.00	3.00	1.00	1.50	2.00	1.21	0.06
need min	0.67	0.33	0.40	0.80	1.00	0.57	0.44	0.50	0.44	0.67	1.00	1.33	2.00	1.00	1.33	2.00	0.67	1.00	1.33	0.81	0.04
need maj	0.50	0.25	0.30	0.60	0.75	0.43	0.33	0.38	0.33	0.50	0.75	1.00	1.50	0.75	1.00	1.50	0.50	0.75	1.00	0.61	0.03

GT = Girl's toilet, DW = Drinking water, Lib = library, Elct = Electric, BW = Boundary wall, PG = Play ground, KS = Kitchen Shed, Comp = Computer, Sin. Room = Single room, Dob room = Double room, Trip room = Triple room, Par Pucca = Partially pucca houses, Gd. Cond = Good condition.

Table 5. Pair-wise comparison matrix of the thematic layers for EDII at upper primary level in Paschim Medinipur district.

	GT	DW	Lib	Elect	Ramp	BW	PG	KS	Computer	Less than 4	4 room	abv5 room	Pucca	Par_ pucca	Kuncha	Gd cond	Need minor	Need maj	Nth root of the product values	Eigenvec-tor
GT	1.00	0.89	0.67	1.14	1.33	1.00	1.14	1.33	0.80	4.00	1.60	1.33	1.60	2.67	1.60	0.80	2.00	2.67	1.37	0.07
DW	1.13	1.00	0.75	1.29	1.50	1.13	1.29	1.50	0.90	4.50	1.80	1.50	1.80	3.00	1.80	0.90	2.25	3.00	1.54	0.08
Library	1.50	1.33	1.00	1.71	2.00	1.50	1.71	2.00	1.20	6.00	2.40	2.00	2.40	4.00	2.40	1.20	3.00	4.00	2.05	0.10
Electric	0.88	0.78	0.58	1.00	1.17	0.88	1.00	1.17	0.70	3.50	1.40	1.17	1.40	2.33	1.40	0.70	1.75	2.33	1.20	0.06
Ramp	0.75	0.67	0.50	0.86	1.00	0.75	0.86	1.00	0.60	3.00	1.20	1.00	1.20	2.00	1.20	0.60	1.50	2.00	1.02	0.05
BW	1.00	0.89	0.67	1.14	1.33	1.00	1.14	1.33	0.80	4.00	1.60	1.33	1.60	2.67	1.60	0.80	2.00	2.67	1.37	0.07
PG	0.88	0.78	0.58	1.00	1.17	0.88	1.00	1.17	0.70	3.50	1.40	1.17	1.40	2.33	1.40	0.70	1.75	2.33	1.20	0.06
KS	0.75	0.67	0.50	0.86	1.00	0.75	0.86	1.00	0.60	3.00	1.20	1.00	1.20	2.00	1.20	0.60	1.50	2.00	1.02	0.05
Computer	1.25	1.11	0.83	1.43	1.67	1.25	1.43	1.67	1.00	5.00	2.00	1.67	2.00	3.33	2.00	1.00	2.50	3.33	1.71	0.09
Less than 4 room	0.25	0.22	0.17	0.29	0.33	0.25	0.29	0.33	0.20	1.00	0.40	0.33	0.40	0.67	0.40	0.20	0.50	0.67	0.34	0.02
4 room	0.63	0.56	0.42	0.42	0.83	0.63	0.71	0.83	0.50	2.50	1.00	0.83	1.00	1.67	1.00	0.50	1.25	1.67	0.83	0.04
Abv5 room	0.75	0.67	0.50	0.86	1.00	0.75	0.86	1.00	0.60	3.00	1.20	1.00	1.20	2.00	1.20	0.60	1.50	2.00	1.02	0.05
Pucca room	0.63	0.56	0.42	0.71	0.83	0.63	0.71	0.83	0.50	2.50	1.00	0.83	1.00	1.67	1.00	0.50	1.25	1.67	0.85	0.04
Partially_pucca	0.38	0.33	0.25	0.43	0.50	0.38	0.43	0.50	0.30	1.50	0.60	0.50	0.60	1.00	0.60	0.30	0.75	1.00	0.51	0.03
Kuncha	0.63	0.56	0.42	0.71	0.83	0.63	0.71	0.83	0.50	2.50	1.00	0.83	1.00	1.67	1.00	0.50	1.25	1.67	0.85	0.04
Good_cond	1.25	1.11	0.83	1.43	1.67	1.25	1.43	1.67	1.00	5.00	2.00	1.67	2.00	3.33	2.00	1.00	2.50	3.33	1.71	0.09
Need minor	0.50	0.44	0.33	0.57	0.67	0.50	0.57	0.67	0.40	2.00	0.80	0.67	0.80	1.33	0.80	0.40	1.00	1.33	0.68	0.03
Need major	0.38	0.33	0.25	0.43	0.50	0.38	0.43	0.50	0.30	1.50	0.60	0.50	0.60	1.00	0.60	0.30	0.75	1.00	0.51	0.03

GT = Girl's toilet, DW = Drinking water, Lib = library, Elct = Electric, BW = Boundary wall, PG = Play ground, KS = Kitchen Shed, Comp = Computer, Abv5 room = Above 5 room, houses, Good Cond = Good condition.

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The EDII zone map of the Paschim Medinipur district reveals four distinct classes (zones), representing very good', 'good', 'moderate' and 'poor' educational development infrastructure availability in the area (**Figure 5**). The very good EDII zone mainly encompasses maximum availability of type of classroom (e.g., pucca houses, kuncha houses, room facilities, etc.), condition of classroom (e.g., good condition, repair etc.) and school infrastructure (e.g., girl's toilet, computer, library, boundary wall, play ground ramp etc. availability) facilities. The block covered by very good educational infrastructure facility is Daspur-I and Dantan-II at primary level. In the upper primary level, only keshiary block showed highest facilities for educational development. However, western, central and central-north shown the good facilities of infrastructures are available at the primary level. Central-north and southwest part of Paschim Medinipur district showed good availability of educational infrastructure at upper primary level. Conversely, the poor EDII zone has been delineated where the availability of these above mentioned facilities is less in number and/or percent. Binpur-II, Jamboni, Nayagram, and Chadrakona-I showed the low availability of infrastructure at the primary level. The distribution of low availability of infrastructure at the upper primary level is much higher than the primary level in Paschim Medinipur district.

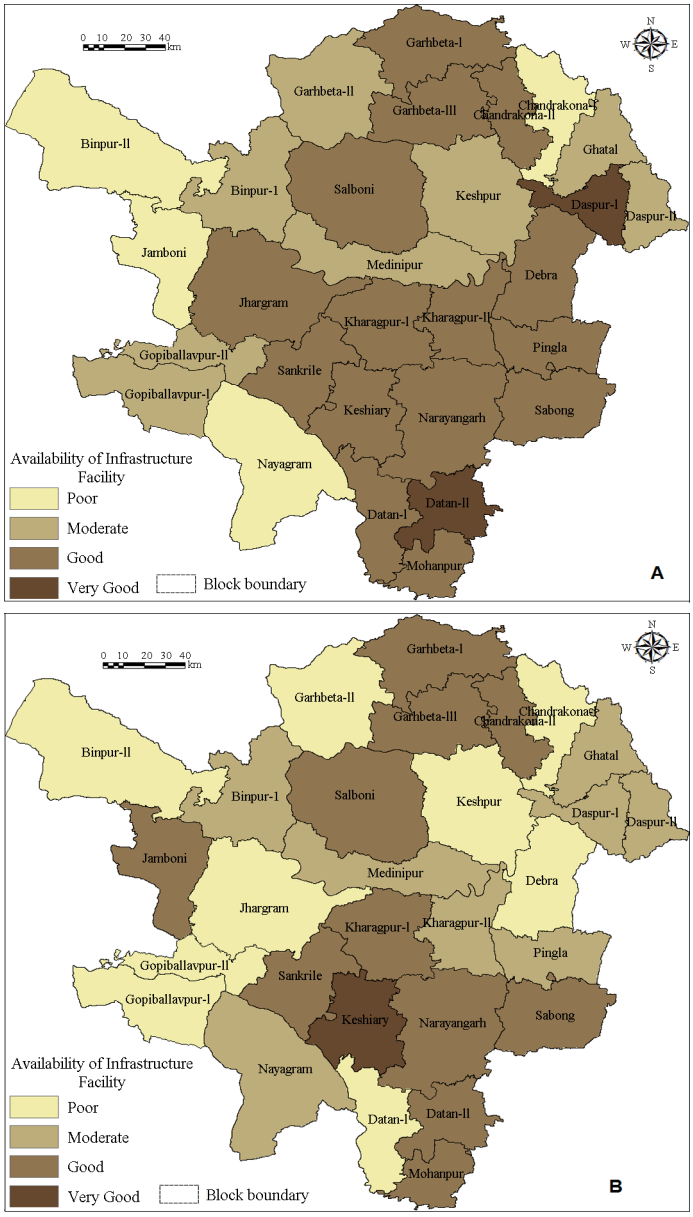

Figure 5. Educational development infrastructure index (EDII) map of Paschim Medinipur district (A) Primary level, (B) upper primary level.

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In Binpur-II, Jahrgram, Gopiballavpur-I, II, Datan-I, Keshpur, Debra, Garhbeta-II and Chandrakona-I blocks has the low facilities of infrastructure availability at the upper primary level.

4. Conclusion

The main concern in this study has been on infrastructure availability stratification at micro level in the education system, its impact on educational process and to a lesser extent outlining block to educational disparities. Government of India instigated a flagship system Sarva Shksha Abhiyan (SSA) particularly meant for increasing infrastructure up to elementary education for development and increasing literacy rate. However, our results recommend that the availability of infrastructure elements such as availability of toilets, electricity, library, computers, type and condition of classroom is very of great significance for improving the learning environment. As a process that produces specific functional products, EDII is fundamentally an educational micro-planning effort focused on increasing school resource efficiency and equity. An ample number of thematic layers and proper assignment of weights are the keys to the accomplishment of Geoinformatics techniques in identifying infrastructure development process. However, based on our analysis, we found that the availability of infrastructure is not well distributed everywhere across the district. Some of the blocks (e.g., north-central and southeastern part) are having the good facilities, while north western and south western does not. This demand has a particular importance when it is connected with the area of education which is sensitive and important for the future progress of societies. The relationship between student achievement and infrastructure condition has been perfectly expressed in the phrase of Prof. Berner "Good infrastructure is truly at the base of quality education". This may be due to the reason of socio-economic barrier, political problem and low accessibility of the area. The present approach may help facilitate more relevant and effective educational micro-planning based on logical conditions and reasoning, it can also be applied in other regions of India or abroad. Moreover, this study may also help the investors and funding bodies, as well as those who are responsible for planning, managing and designing educational facilities to take necessary action in those areas suffering from the deficiencies of elementary school infrastructure in the near future. Overall, the results of this study demonstrated that the Geoinformatics technology is a powerful tool for assessing the current status of infrastructure development zone, based on which concerned decision makers can formulate an efficient elementary infrastructure development plan for the study area to achieve the success of SSA mission.

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