



Spatial Inequality in Socio-economic Development in Bangladesh: An Analysis

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Accepted: 21 December 2023 / Published online: 22 January 2024
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Abstract

This study aims to analyze the disparities in socio-economic development in the North-Western region of Bangladesh from a micro-spatial perspective, as well as to uncover the underlying factors that generate disparities. Both quantitative and qualitative methodologies were used in this study. Secondary data from Government organizations was compiled for 67 spatial units (upazila) to regionalize the study area based on 22 indicators from seven socio-economic sectors, and to identify the underlying factors, a structured questionnaire survey was conducted, followed by a literature review, group discussion, interviews, and field observation methods. According to the results, severe disparity in socio-economic development in the study area has been identified. Almost half of the study area, 46 percent (27 upazilas), has been classified as a very low-developed region, while the remaining 29 percent (19 upazilas), 22 percent (18 upazilas), 2 percent (2 upazilas), and 0.6 percent (1 upazilas) have been classified as low, moderate, high, and very high developed regions, respectively. Service and business-oriented professions, high income, easy accessibility to resources, developed transportation system, and technological advancement functions as factors of development, contrariwise, agro-based professions, low income, lack of accessibility to resources, a technological lag, transport system, and low-quality human resources are functioning as constraints of development. Few recommendations to reduce the disparity have been made based on the severity of disparity and underlying factors of different sectors.

Keywords Socio-economic development · Spatial disparity · North-Western Bangladesh

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1 Introduction

In recent years of sustainable development goals, spatial disparity in development, which emerged as a major problem decades ago (Minguela et al., 2017; Williamson, 1965), has been a widely debated topic around the world (Achten & Lessmann, 2020; Banerjee & Kuri, 2015; Gyuris, 2018; Niekerk, 2020; UN, 2020). The concept of equal opportunity for all and its implementation has been restricted from a local to a global scale by spatial inequality in development (Checchi & Peragine, 2005). Significant evidence has been provided on the extensive spatial disparity in many countries in the world (McKay, 2009). The severity of spatial inequality in development was even experienced by highly developed countries like the USA, the UK, and Canada at a considerable level during the first quarter of the 19th century (Chowdhury, 1990). Correspondingly, enclave-type development was experienced by developing countries (Sdasuk, 1976; Wang, 2015). Since spatial inequality grows until a specific level of development (Williamson, 1965), it still persists in several developed (Tafinay & Pass, 2011; Minguela et al., 2017; Iammarino et al., 2019) and is very widespread in most of the developing countries (Kanbur & Venebles, 2005; Kim, 2008). This problem is experienced by most of the developing countries due to the high concentration of modern facilities or agglomeration forces in urban areas (Venebles, 2005).

Bangladesh, one of the most densely populated (Farid et al., 2011) and developing countries of South Asia (Mohajan, 2013), has also been encountering the problem of spatial inequality in socio-economic development for a long time (Jobaid & Khan, 2018; Mithun, 2021; Sen & Ali, 2009; Zaman & Akita, 2012). Although Bangladesh exhibits homogeneous characteristics from historical and cultural perspectives (Rahman, 2014), the disparity in social and economic progress between the eastern and western divisions of the country has been evidently pointed out (WB, 2008; Khondker & Mahzab, 2015) since the term “East–West Divide” was coined earlier of this century (Sen et al., 2014). The western part of the country, comprising Rangpur, Rajshahi, Khulna, and Barisal divisions, geographically separated by the course of mighty Jamuna from the eastern part, comprising Dhaka, Chittagong, Sylhet, and Mymensingh, is less progressive (Khondker & Mahzab, 2015). The Household Income and Expenditure Survey of the Bangladesh Bureau of Statistics (BBS, 2010) also exhibits an identical picture. According to the report, in 2010 average poverty headcount rate of the east divisions was 28.26%, whereas the rate was 36.87% in the west divisions. Similarly, the average monthly household income in the east divisions was 12,182 BDT (111 USD) which was reduced to 9107 BDT (83 USD) in the west divisions. Rajshahi division, laying in the north-western part of the country, is the fourth largest division by area and third by population (BBS, 2015a). Though it is the residence of 12.8% of the country’s total population, the progress of development in the division is not promising compared to the Dhaka, Khulna, and Chittagong divisions (Rukunujjaman, 2016). Inter- and intra-district disparity in development also exists in the division (Rahman, 2004; Zaman & Akita, 2012). Within the periphery of the division, a few urban centers act as hubs of economic activities and attract factors of production, which stimulates income and employment opportunities in the surrounding local economy. These settings increase inequality in development since its impact on the peripheral rural areas is limited.

To understand and conceptualize the nature and principles of regional disparity several theories and empirical analyses have been provided (Lukovics, 2009). A widely acknowledged scientific explanation has been conveyed through Myrdal’s theory of cumulative causation, which argues that an underdeveloped region becomes less progressive since it supplies the required raw materials, capital, and labor to trigger development in developed

regions (Myrdal, 1957). Kuznets (1955) and Williamson (1965) put forth similar views about the nature of regional disparity. They claim that the growth of the economy or development of a region up to a certain stage increases the level of disparity among the regions, which tends to decrease with every advanced phase of growth and development. Dholaikia (2003) mentioned that regional disparity in income, human capital, and other aspects related to economic and social conditions is a source of political tensions and dissatisfaction in a federal system. Gajdova and Tuleja (2015) pointed out that, regional disparity occurs in three different spheres, i.e., social, economic, and territorial spheres. Various factors from these spheres, i.e., geographical location (Gallup et., al. 1999; Putri et., al. 2018), compatibility of natural resources (Venebles, 2005), accessibility (Hu, 2002), urbanization (UN, 2020), skilled labor force (Filippetti et. al., 2018), infrastructure (Paley, 2015; Rohima et. al., 2017), monetary resource allocation (Siburian, 2019; Anwar et. al., 2020), political situation (Lessman, 2012), migration (Amara & Jemmali, 2018; UN, 2020), concentration of political institutions (Henderson & Wang, 2007), assists a region to develop more rapidly than other.

One of the major challenges of development in developing countries is to reduce existing regional inequality (Baransano et. al., 2016). To formulate effective measures and adapt suitable policies to reduce regional inequality in development, data, information, and a clear understanding concerning the micro-level socio-economic development patterns and accountable factors of a region are essential resources. Although a number of researches to identify the spatial pattern and inequality in development based on a single indicator or multiple indicators from a single socio-economic sector have been conducted in the context of Bangladesh, a unified approach to address the problem considering multiple indicators from multiple sectors is still missing. Policymaking based on the findings of the analysis of one single indicator or multiple indicators from a single sector may not be the most effective one since most of the indicators of development are connected to each other. Actions taken to change the status of one indicator in a region would affect another in either a positive or negative way. Therefore, during policymaking, to make it the most effective one, information regarding as many indicators as possible from multiple socio-economic development sectors has to be considered. The number of research that provides this type of information is very scarce in the context of Bangladesh. To fill that existing gap, an attempt has been made in this research to identify the disparity in socio-economic development in the North-Western part of Bangladesh from a micro-spatial perspective by considering multiple indicators from multiple sectors. This research provides the collective information required to assist policymakers in formulating effective measures and policies to reduce inequality in socio-economic development in the region.

2 Methodology

This research is designed to conduct indicator-based socio-economic condition analysis to illustrate disparities among the spatial units of the study area by adapting a mixed-method research method. Upazila-level (4th-level administrative unit) spatial units have been selected in this research for scale suitability, range of accessible data, and requisite fulfillment likelihood in the context of the research. The course of the research comprises two distinct phases; (i) regionalization of socio-economic development based on certain indicators, and (ii) identification of factors causing unequal development among the regions. A

quantitative approach has been used to regionalize. Besides, qualitative analysis has been performed to visualize peoples' perceptions and researchers' insights.

2.1 Selection of Socio-economic Development Indicators

To gather relevant and appropriate data needed to analyze spatial inequality with the least degree of error, indicators exhibiting a strong relationship to socio-economic development were selected. A number of literature were reviewed thoroughly to select indicators from several sub-sectors of socio-economic development. These indicators include literacy rate, teacher-student ratio, and higher education attained population from the education sector; medical bed-people ratio, and doctor-people ratio from the health sector; working-age population, employed population, and labor force in tertiary sector from the employment sector; growth center, urban population, road network, and railway network from the urbanization sector; electricity connection, safe drinking water, sanitary toilet facility, and household structure from the household amenity sector; per capita arable land, cropping intensity, and irrigated land from agriculture sector; monthly average per capita income, monthly average per capita expenditure, and poverty rate from the economy sector. The validity, reliability, and bias factors of these indicators were evaluated to ensure the usefulness of data, and in case of incompatibility, an alternative source of data or alternative indicator was selected.

2.2 Sources of Data

In this research, both primary and secondary data were used. To regionalize the division based on socio-economic development, secondary data was collected from published and unpublished materials including books, journal articles, reports, thesis dissertations, etc. Various reports from the Bangladesh Bureau of Statistics (BBS) were key sources of secondary data in this research. In addition, to identify the major factors triggering disparity, primary data was collected through the processes of a questionnaire survey, focus group discussion, checklist, observation, and key resource interview. A questionnaire survey was conducted on the household level in one upazila of the very high developed region, one upazila of the high developed region, and two upazilas of the very low developed region, besides, the sample size was distributed proportionally according to the population of the upazila.

2.3 Data Analysis and Regionalization

As the indicators were from different sectors of socio-economic development, values were recorded in different scales accordingly. To standardize the datasets and convert them to the same scale individual weight or Transformed Value (TV) was calculated. This rescaling places values into a range of 0–1, where 0 and 1 represent the lowest and highest value respectively for an indicator. For example, the spatial unit with the highest income receives a TV of 1 and the lowest income receives a TV of 0. But in the case of the indicator where a higher value represents lower development, a reverse calculation was used so that 0 and 1 represent the highest and lowest values respectively. For example, the spatial unit with the highest poverty rate receives a TV of 0 and the lowest

poverty rate receives 1. To execute the process, a widely used Al-Maruf (2017), Mahmud and Rahman, (2017), Molnar (2007), Rahman (2016) following statistical formula was used.

Transform Value of 'i' indicator for 'j' spatial unit,

$$TV_{ij} = \frac{X_{ij} - X_{i(\min)}}{R}$$

where, TV_{ij} = Transform Value of Indicator 'i' for 'j' Spatial Unit, X_{ij} = X_i Value 'j' Spatial Unit, $R = X_{i(\max)} - X_{i(\min)}$ and $X_{i(\min)}$ & $X_{i(\max)}$ = Minimum and Maximum Value of 'i' Indicator among all spatial units.

After the scale transformation, the Total Transform Value (TTV) was calculated for all the spatial units by using the following equation (Mahmud & Rahman, 2017; Molnar, 2007; Rahman, 2016).

$$TTV_j = \sum_{i=1}^N TV_{ij}$$

where, TTV_j = Total Transform Value 'j' Spatial Unit, TV_{ij} = Transform Value of Indicator 'i' for 'j' Spatial Unit and N = Number of Indicators.

After calculating TV and TTV, all the spatial units were categorized into 5 classes by using the Equal Class Interval grouping technique. The grouping technique was applied firstly, to categorize all spatial units based on the values of a single indicator to show the spatial pattern of that indicator, and secondly, to the TTVs to categorize the spatial units based on the values of all indicators to show the overall spatial pattern.

$$CI = \frac{P}{H}$$

where, CI = Class Interval, $P = TTV_{(\text{High})} - TTV_{(\text{Low})}$, $TTV_{(\text{High})}$ = Highest TTV, $TTV_{(\text{Low})}$ = Lowest TTV, and H = Number of classes.

Grouping and regrouping were performed to generalize the classes to make the region continuous and of identical status by including scattered spatial units with the adjacent immediate upper or lower-class spatial units. Five development regions delineated in the study are as follows.

- Region 1: Very low developed region
- Region 2: Low developed region
- Region 3: Moderately developed region
- Region 4: High developed region
- Region 5: Very high developed region

SPSS, MS Excel, and ArcGIS10.3.1 were used to execute the statistics, prepare tables, and extract maps. Moreover, descriptive statistics (max, min, and mean) were used to describe the scenario of every indicator of socio-economic development in the study area. Moreover, to identify the contribution of each indicator in the formation of the development region or variation in the TTV, the standard deviation of the TV of the respective indicator was calculated as a measure of variability. Where the highest and lowest standard deviation represents the maximum and minimum influence or contribution of an indicator respectively in the observed variation.

2.4 Study Area

In this research, the Rajshahi division has been selected as the study area by considering its socio-economic development status and using the purposive sampling method. The division's 67 upazila have been used as spatial units. The geographical extent of the division lies between $23^{\circ} 48'$ and $25^{\circ} 16'$ north latitude and $88^{\circ} 01'$ and $89^{\circ} 48'$.

East longitude (Banglapedia, 2015). The division consists of 8 districts, covering an area of 18,153.08 km² (12.3% of the country area) inhabited by 18.48 million people, with a literacy rate of 48.05% (BBS, 2015a). The urbanization rate in the division is 17.95%, and the dominant economic sector is agriculture (62.15%), followed by service (27.37%) and industry (10.48%) (BBS, 2015b) (Fig. 1).

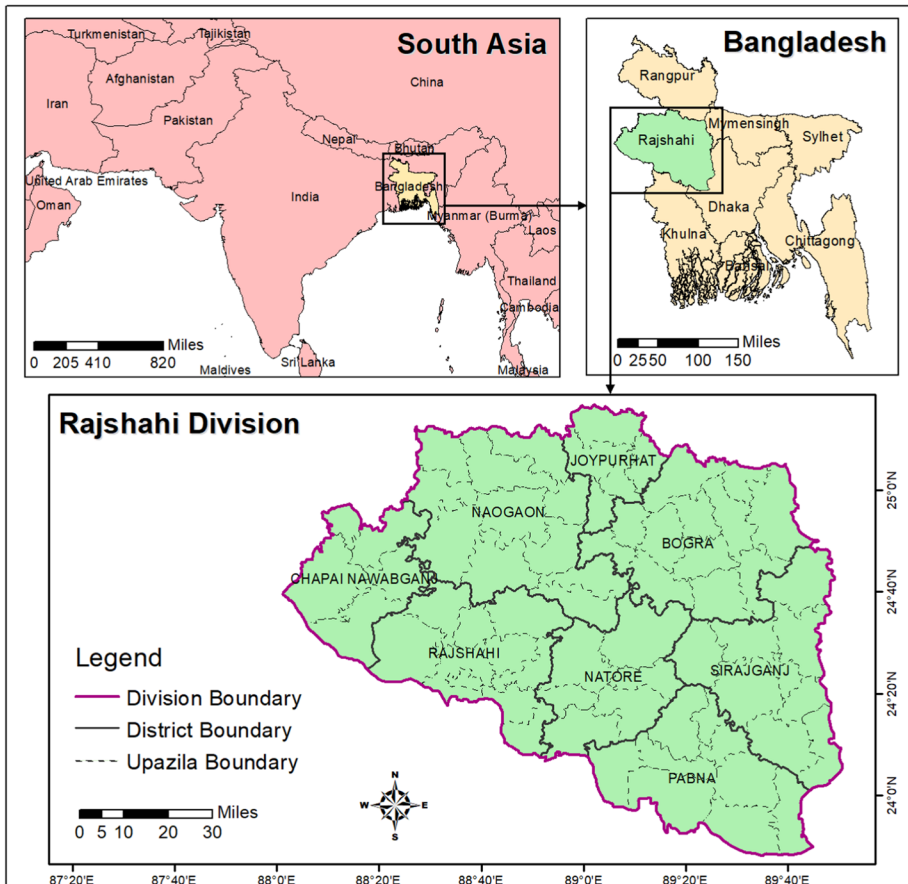


Fig. 1 Location of the study area

3 Result

3.1 Spatial Disparity in Socio-economic Development

3.1.1 Disparity in the Education Sector

Literacy Rate (LR): Fig. 2 depicts upazila-based spatial variation in literacy rate in the study area. In the central-north part of the division, the literacy rate is fairly high relative to other parts of the division excluding only a few upazilas in Natore, Pabna, and Rajshahi districts. The literacy rate is the highest in RCC with 74.10% of the total population aged 7 years and above. Contrariwise, the literacy rate is the lowest in Dhunat Upazila with only 35.60% of the population. The top five upazilas with the highest literacy rate are Rajshahi City Corporation, Bogra Sadar Joypurhat Sadar, Shajahanpur, and Akkelpur, and the top five upazilas with the lowest literacy rate are Dhunat, Chauhali, Sariakandi, Kazipur, and Royganj.

Teacher-Student Ratio (TSR): From Fig. 2, it can be seen that in the central part of the division teacher-student ratio (teacher/1000 students) is fairly low as compared to the southeast, southwest, and northeast parts of the division. TSR is the highest in Dhamoirhat Upazila, with 47 teachers per 1000 students, while in Belkuchi Upazila the ratio is the lowest with only 20 teachers per 1000 students. The top five upazilas with the highest teacher-student ratio are Dhamoirhat, Lalpur, Porsha, Bagatipara, and Bagmara, whereas the top five upazilas with the lowest teacher-student ratio are Belkuchi, Shahjadpur, Chauhali, Sujaganar, and Sirajganj Sadar.

Higher Education Attainment (HEA): The proportion of the HEA population is near expected in only a few upazilas whereas the rate is very low throughout the division (Fig. 2). In Rajshahi City Corporation, 8.34% of the population has a higher educational qualification, which is the highest among all the upazilas of the division, whereas the rate is the lowest in Sariakandi Upazila with only 0.67% of the population with higher level education. The top five upazilas with HEA population are Rajshahi City Corporation, Akkelpur, Bogra Sadar, Joypurhat Sadar, and Pabna Sadar as opposed to Sariakandi, Belkuchi, Gabtali, Porsha, and Bera upazila.

3.1.2 Disparity in the Health Sector

Medical Bed-Population Ratio (MBPR): MBPR analysis indicates that the medical bed-population ratio (bed/5000 people) is very low throughout the region except for the city corporation (Fig. 2). Among all the spatial units, MBPR is the highest in RCC as there are 31.35 beds per 5000 people, and in Royganj Upazila the ratio is the lowest as there are only 0.49 beds per 5000 people. The five upazilas with the highest MBPR are RCC, Bogra Sadar, Chauhali, Joypurhat Sadar, and Pabna Sadar, and the five upazilas with the lowest medical bed-people ratio are Royganj, Kazipur, Atrai, Santhia, and Shahjadpur.

Doctor-People Ratio (DPR): The distribution of DPR (single doctor per 5000 people), as shown in Fig. 2, was found highly variable throughout the study area. The map shows that in the entire division, DPR is very low as compared to Rajshahi City Corporation, where the DPR is 12.18, while in Mahadebpur Upazila the ratio is 0.09 which is the lowest among all the upazila units. Rajshahi City Corporation, Bogra Sadar, Joypurhat Sadar, Chauhali, and Baraigram are the top five spatial units with the highest

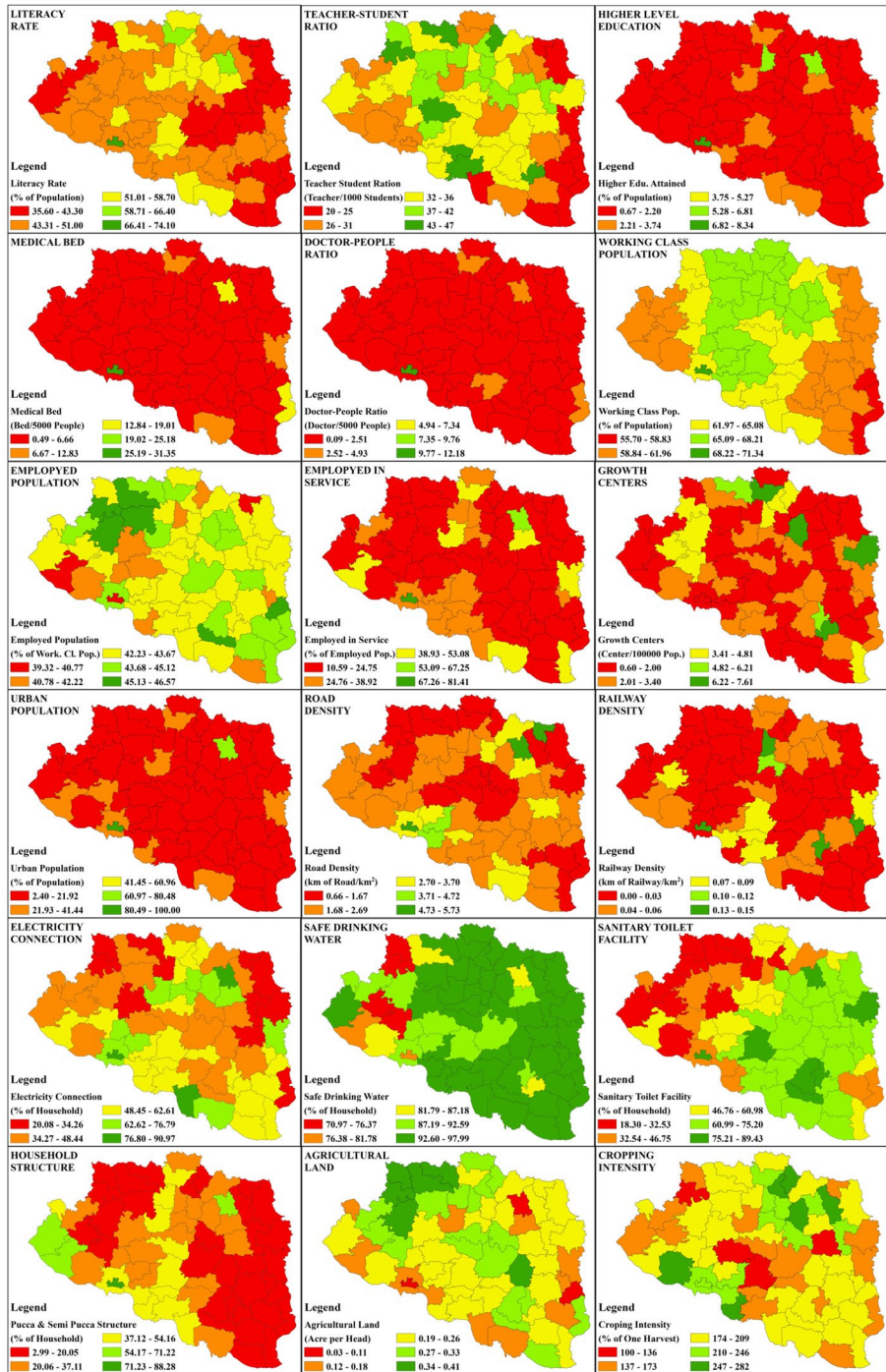


Fig. 2 Spatial pattern of socio-economic development indicators in the study area. Data source: BBS (2015b)

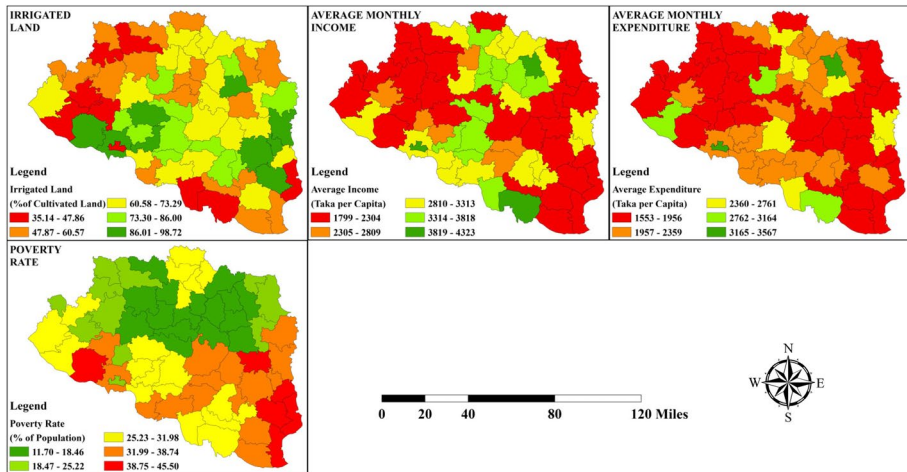


Fig. 2 (continued)

DPR, and Mahadebpur, Sonatola, Dhunat, Ullahpara, and Gabtali are the five spatial units with the lowest DPR.

3.1.3 Disparity in the Employment Sector

Working Age population (WAP): A relatively well-defined clustering of the spatial variation of the working-age population (aged 15–64) can be identified from Fig. 2. The highest proportion of WAP, among all upazila units, is observed in RCC (71.34%), contrariwise in Chauhali Upazila only 55.70% of the population is identified as WAP. Five upazilas with the proportion of WAP in descending order (highest to lowest) are RCC, Kalai, Bogra Sadar, Khetlal, and Patnitala, while in ascending (lowest to highest) order the least five upazilas are Chauhali, Bera, Belkuchi, Kamarkhanda, and Sujanagar.

Employed Population (EP): Fig. 2 indicates that the employment rate (employed population as % of the working-age population) varies over the study area. In the northwest and southeast and in some scattered upazilas in the central part of the division employment rate is fairly high as compared to other parts of the division. In Belkuchi Upazila, 46.57% population is employed, which is the highest among all the upazilas, inversely employment rate is the lowest in RCC with only 39.32% of the working-age population. The top five upazilas with the highest rate of employment are Belkuchi, Atgharia, Patnitala, Niamatpur, and Mahadebpur, and the top five upazilas with the lowest employment rate are RCC, Sonatola, Nawabganj Sadar, Bagha and Bagmara.

Labor Force in Tertiary Sector (LFTS): Participation of LFTS (% of the total employed population), as illustrated in Fig. 2, throughout the division is very low except for only a few scattered and Sadar upazilas. In RCC, 81.41% employed population is engaged in tertiary economic activity, which is the highest among all the upazila units, whereas the rate is the lowest in Tanore Upazila with only 10.59% of the employed population contributing to the service sector. The top five upazila with LFTC in descending order are RCC, Bogra Sadar, Naogaon Sadar, Shajanpur, and Nawabganj Sadar, as opposed to Tanore, Nandigram, Nachole, Sapahar, and Dhamoirhat upazila units in ascending order.

3.1.4 Disparity in the Urbanization Sector

Growth Centre (GC): As shown in Fig. 2, in only a few upazilas the number of growth centers (per 100,000 people) is slightly higher as compared to other areas of the division. Among the upazilas, the number of growth centers is the highest in Joypurhat Sadar with 7.31 centers per 100,000 people, while in Sherpur Upazila the number is the lowest with only 0.60 growth centers per 100,000 people. The top five upazilas with the highest number of growth centers are Joypurhat Sadar, Kazipur, Faridpur, Kahaloo, and Dharmoirhat, and the top five upazilas with the lowest number of growth centers are Sherpur, Gomastapur, Belkuchi, Shahjampur, and Natore Sadar.

Urban Population (UP): Spatial variation in the level of urbanization in the study area is remarkably high. Figure 2 illustrates the spatial distribution of the urban population (% of the total population) in the study area which shows that in only a few spatial units share of the urban population is relatively higher than in others. In RCC, 100% of the population lives in the urban area, which is the highest among all the spatial units. On the contrary, in Niamatpur Upazila only 2.40% of its total population lives in the urban area. The top five spatial units with the highest urban population are RCC, Bogra Sadar, Naogaon Sadar, Nawabganj Sadar, and Sirajganj Sadar, while the top five upazilas with the lowest urban population are Niamatpur, Badalgachhi, Manda, Raninagar, and Tarash.

Road Network (RN): In the study area, only a few upazilas of the northeast and southwest parts have a well-developed RN system. It is also observed that the density of road (km of Road/km²) is the lowest in the northwest, southeast, and central parts. Figure 2 indicates that, in Sonatola Upazila, the density of road is 5.73 km/km², which is the highest in the division, whereas the density is the lowest in Chauhali Upazila with only 0.66 km of road per square kilometer area. Five upazilas with the highest road density in descending order are Sonatola, RCC, Bogra Sadar, Charghat, and Puthia as opposed to Chauhali, Atrai, Shahjampur, Kazipur, and Sariakandi in ascending order.

Railway Network (RN): The density of RN (km of railway/km²) throughout the division is highly varied. Moreover, there are a number of spatial units with no railway connection. Figure 2 depicts that, in only a few upazilas of the central-south and central-north part, and in some dispersed upazila units of the division density of the railway is fairly high as compared to all other parts. It is also observed that the density is the lowest in the north-west, north-east, and south-east parts. In Kmarkhanda Upazila density of the railway is 0.15 km/km², which is the highest in the division, on the contrary, 35 upazilas have no railway connection. The five upazilas with the highest railway density are Kamarkhanda, Bhangra, Akkelpur, RCC, and Adamdighi, and the five upazilas with the lowest density are Chauhali, Shahjampur, Kazipur, Sariakandi, and Bera.

3.1.5 Disparity in the Household Amenity Sector

Electricity Connection (EC): The distribution of household having access to EC spatially vary throughout the study area. Figure 2 shows that upazilas of the northeast and north-western parts of the division have low access to EC, which rises to the southern direction and in some upazilas of the central-north part. Among the spatial units, the rate is the highest in RCC with 90.97% of households having EC, while the rate is the lowest in Chauhali Upazila with only 20.08% of households having EC. The top

five upazilas with EC are RCC, Bogra Sadar, Ishwardi, Pabna Sadar, and Adamdighi, as opposed to Chauhali, Sapahar, Dhunat, Porsha, and Dhamoirhat.

Safe Drinking Water (SDW): Fig. 2 illustrates the distribution of households that have the facility of drinking water from safe sources, i.e., tube-well. It also demonstrates that only a few upazilas in the western part of the division have low access to the facility. In Gabtali Upazila, the highest portion of the households (97.99%), and in Porsha Upazila, the lowest portion (70.97%) have access to safe drinking water. The top five upazilas with access to safe drinking water sources in descending order are Gabtali, Kahaloo, Kamarkhanda, Bagha, and Nandigram, as opposed to Porsha, Sapahar, Tanore, Nachole, and RCC in ascending order.

Sanitary Toilet Facility (STF): As represented in Fig. 2, the lowest fraction of the households of the upazilas in the entire west and north-west parts of the division use sanitary toilet facilities, and the highest portion of the households in the whole east and south-east part, excluding few upazilas of Pabna and Sirajganj, have access to a sanitary toilet facility. Among all the spatial units the rate is the highest in RCC (89.43%), and the lowest in Sapahar Upazila (18.30%). Five upazilas with the highest rate are RCC, Bhangura, Chatmohar, Atgharia, and Kazipur, and five upazilas with the lowest rate are Sapahar, Gomastapur, Porsha, Godagari, and Patnitala.

Household Structure (HS): The number of households living in *pucca* (fully made of bricks and cement) and *semi-pucca* (*pucca* buildings with roofs made of materials other than bricks and cement) structures are found highly variable in the study area. In most of the upazilas, the dominant structure is *kutchha* (made with mud), except few upazilas in the Rajshahi, Natore, and Chapainwabganj districts. Figure 2 provides a clear image of the spatial variation of the household structure in the division. In RCC, 88.28% of the households have *pucca* and *semi-pucca* structures, whereas, in Chauhali Upazila, the rate is only 2.99%. Five upazilas with the highest proportion are RCC, Nawabganj Sadar, Bogra Sadar, Shibganj, and Naogaon Sadar, whereas with the lowest proportion are Chauhali, Kazipur, Niamatpur, Tanore, and Sariakandi.

3.1.6 Disparity in the Agriculture Sector

Per Capita Arable Land (PCAL): Fig. 2 indicates that the areal variation in PCAL is significantly high in the study area. Values are relatively high in the northwest and central parts as compared to other areas of the division. Among all the upazilas PCAL is the highest, 0.41 acres, in Porsha Upazila, and the lowest, 0.03 acres per capita, in RCC. Five upazilas with the highest value are Porsha, Dhamoirhat, Niamatpur, Sapahar, and Patnitala and five upazilas with the lowest value are RCC, Bogra Sadar, Belkuchi, Sirajganj Sadar, and Shahjadpur.

Cropping Intensity (CI): Distribution of CI (% of harvesting frequency/unit/ agricultural year) illustrates that in some upazilas of the northeast and southwest parts of the division, CI is high relative to other parts. In Godagari Upazila, CI is 282%, which is the highest among all the upazilas, whereas the lowest value is 100% in Sherpur Upazila. Five upazilas with the highest CI are Godagari, Kalai, Bagha, Kahaloo, and Khetlal, as opposed to Sherpur, Baghmaara, Porsha, Natore, and Gomastapur.

Irrigated Land (IL): In the central, central-east, and southwest parts of the study area most of the agricultural land is under irrigation coverage, whereas, the opposite scenario can be found in the west, southeast, and northwest parts. Figure 2 shows that, in Shahjahanpur Upazila, the highest portion of agricultural land, 98.72%, is under irrigation coverage,

whereas the rate is the lowest, 35.14%, in RCC. Five upazilas with agricultural land under irrigation system in descending order are Shahjahanpur, Puthia, Bagmara, Ullapara, and Paba, as opposed to RCC, Chauhali, Nachole, Porsha, and Tanore in ascending order.

3.1.7 Disparity in the Economy Sector

Monthly Average Per Capita Income (MAPCI): Spatial disparity in MAPCI (BDT/person) can be detected throughout the division. Figure 2 shows that in the central-south and central-north parts of the division, MAPCI is very high as compared to other parts of the division. In RCC, MAPCI is 4323 BDT (39.40 USD), which is the highest among all the spatial units, on the contrary, the lowest MAPCI is 1799 BDT (16.39 USD) in Sapahar Upazila. Five upazilas with the highest MAPCI are RCC, Pabna Sadar, Bogra Sadar, Shajahanpur, and Akkelpur, and with the lowest MACI are Sapahar, Gomastapur, Chauhali, Belkuchi, and Sujanagar.

Monthly Average Per Capita Expenditure (MAPCE): As shown in Fig. 2, the disparity in MAPCE (BDT/person) can be identified from a spatial perspective in the study area. The map shows that in the south and north parts of the division, MAPCE is very low, and in urban areas coupled with some scattered upazilas in the central part MAPCE is relatively high. The highest MAPCE is 3567 BDT (32.51 USD) in RCC, whereas, in Badalgachi MAPCE is only 1553 BDT (14.15 USD) which is the lowest in the division. Five upazilas with the lowest MAPCE are Badalgachhi, Panchbibi, Bagmara, Mahadebpur, and Patnitala, and with the highest MAPCE are RCC, Bogra Sadar, Pabna Sadar, Nawabganj Sadar, and Shahjahanpur.

Poverty Rate (PR): In the northeast and northwest parts of the division PR (% of people living below the upper poverty line) is very low, and the rate is the highest in the southeast, central and southwest parts. Figure 2 depicts that PR spatially varies in the study area. In Chauhali Upazila, 45.50% of the total population lives below the upper poverty line, which is the highest among all the upazila units, contrariwise PR is the lowest in Kahaloo Upazila with only 11.70% of its total population living below the upper poverty line. Five upazilas with the highest PR are Chauhali, Godagari, Belkuchi, Shahjadpur, and Royganj, and with the lowest PR are Kahaloo, Shahjanpur, Adamdighi, Dhupchanchia, and Gandhinagar.

3.2 Socio-economic Development Regions

A very well-defined clustering of socio-economic development in the study area, as depicted in Fig. 3a, has been identified. The study area is characterized with extreme disparity in all the considered sectors of socio-economic development, as the highest TTV found in the study area is 15.14, scored by RCC, which is fairly higher than the lowest TTV, 5.32, scored by Chauhali Upazila. TTV is very low all over the study area except only a few spatial areas. TTV is lower than 11 (50% of the highest achievable TTV) in more than 95% of the spatial units and ranges between 11 and 15.14 in the remaining units. Five spatial units with the highest TTV are RCC (15.14), Bogra Sadar (12.78), Joypurhat Sadar (11.23) Shajahanpur (10.88), and Kahaloo (10.80), and five spatial units with the lowest TTV are Chauhali (5.32), Sapahar (5.66), Shahjadpur (5.97), Sariaakandi (6.16) and Sujanagar (6.23).

Regional development pattern, Fig. 3b, of the study area generates few vertical development blocks depicting that a very low developed region lies across the entire east and west part of the division. Moreover, the central part is occupied by moderately developed

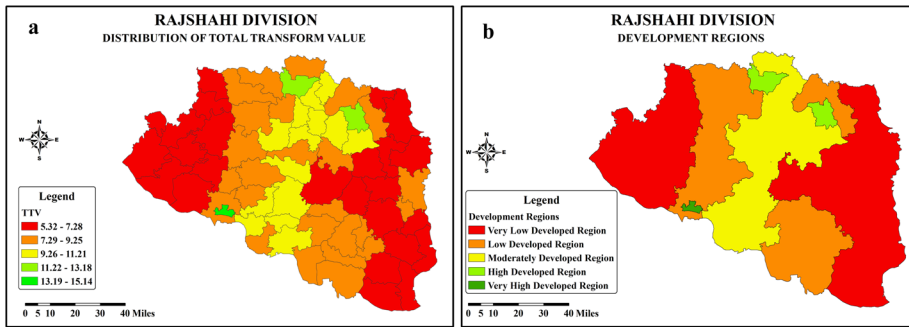


Fig. 3 Distribution of TTV and socio-economic development regions in the study area

region, and the area between very low and moderately developed region is occupied by low developed region, whereas high and very high developed region comprises two and one spatial units respectively.

As shown in Table 1, very low developed region comprises 27 spatial units occupying an area of 8352.44 km² which accounts for 46.01% of the total area and 44.21% of the total population of the study area. This region includes all the upazila units of Chapai Nawabganj and Sirajganj districts, and 3, 2, 3, 1, and 4 upazila units of Naogaon, Rajshahi, Pabna, Natore, and Bogura districts respectively. Two blocks of the very low developed region have been identified in the study area. The west block covers the entire west part including Chapai Nawabganj, Rajshahi, and Naogaon districts, while the east block, comprising Sirajganj, Pabna, Bogura, and Natore districts, covers the entire west part and a small portion of the central part of the division.

The low developed region includes 19 spatial units, inhabited by 27.59% of the total population, covering an area of 537.31 km², 28.85% of the total divisional area. This region includes 6 upazila units of Pabna, 5 upazila units of Naogaon, 4 upazila units of Rajshahi, and 2 upazila units of both Natore and Bogura districts. The low developed region is comprised of three development blocks, each located between moderately and very low developed regions. The largest of these three blocks covers the entire area between the moderately developed region and the west block of the very low developed region, comprising most of the upazilas of the Rajshahi and Naogaon districts. The west part of Pabna and the southeast part of Natore district form another block, and the smallest block occupies the north part of the Bogura district.

The central part of the study area comprising 18 upazila units of 5 districts forms a moderately developed region in a linear shape, extending north to south and occupying 405.82 km², 22.29%, of the area of the division which is home to 21.20% of the division's total population. This region includes 5 upazila units of Bogura, 4 upazila units of Joypurhat, and 3 upazila units of Rajshahi, Natore, and Naogaon districts. The northwest part of Natore and the southeast and east part of Rajshahi district forms the southern part of this region, while the north part is formed by the entire Joypurhat and the northwest portion of Naogaon district. The southeast part of Naogaon and the western part of Bogura form the central part of the region.

The high developed region comprises only two upazila units, Bogura Sadar and Joypurhat Sadar, occupying an area of 413.36 km² which is only 2.28% of the total area of the study area. Two separate parcels of this region lie on the northern part of the study area and

Table 1 Distribution of TTV and socio-economic development regions in the study area

TTV and regions	Occupied upazila units	No. of upazila	Covered area (%)	Share of population (%)
5.32–7.28; Very low developed region	Chauhali, Sapahar, Shahjadpur, Sariakandi, Sujanagar, Porsha, Nachole, Gomastapur, Belkuchi, Royganj, Bera, Singra, Tanore, Sonatola, Shibganj, Tarash, Bholahat, Nawabganj Sadar, Godagari, Shergpur, Dhunat, Niamatpur, Ullahpara, Kazipur, Santhia, Kamarkhanda*, Sirajganj Sadar*	27	46.01 (8352.44 km ²)	44.21
7.29–9.24; Low developed region	Manda, Patmitala, Bagmara, Mahadebpur, Aigharia, Baraigram, Gabtali, Gurudaspur, Chatmohar, Badalgachhi, Shibganj, Faridpur, Mohanpur, Pabna Sadar, Paba, Durgapur, Ishwardi, Dhamoirhat, Bhangura	19	28.85 (5237.31 km ²)	27.59
9.25–11.21; Moderately developed region	Raminagar**, Panchbibi**, Bagha**, Nandigram**, Kalai, Atrai, Lalpur, Naogaon Sadar, Khelal, Natore, Chorghat, Puthia, Dhupchanchia, Akkelpur, Bagatipara, Adamdighi, Kahaloo, Shajahanpur	18	22.29 (4045.82 km ²)	21.20
11.22–13.17; High developed region	Joypurhat Sadar, Bogra Sadar	2	2.28 (413.36 km ²)	4.57
13.18–15.14; Very high developed region	RCC	1	0.57 (104.15 km ²)	2.43

*Demoted from the immediate upper class, ** promoted from the immediate lower class

in the center of both Bogura and Joypurhat districts bounded by moderately and low developed regions. Only 4.57% of the division's total population lives in this region.

The very high developed region comprises only one spatial unit, RCC, occupying an area of 104.15 km² which is only 0.57% of the total area of the study area that has the lowest share of the population, 2.43%, among all the development regions. This region lies on the southeast part of the study area and the south of the Rajshahi district bounded by a low developed region.

3.3 Contribution of Indicators in the Observed Variation

Since this research uses a scale harmonizing method to standardize the dataset, most of the indicators have almost the same level of contribution to the observed variation or in formulating development regions. To identify the impact of each indicator on overall regional disparity, the standard deviation of the standardized value of the indicators has been calculated and compared. Table 2 demonstrates the standard deviation value which indicates that all the indicators have almost the same level of influence on the observed variation in the TTV or overall disparity in the region. Out of the total 22 indicators, the standard deviation value of 18 indicators ranges between 0.15 and 0.25. Among all the indicators, *Monthly average per capita income* has the highest contribution to the observed disparity in the study area with a standard deviation value of 0.27, and *Doctor-people*

Table 2 Standard deviation of the indicators

Sl. No	Sector	Indicator	Standard deviation
1	Household amenity sector	Literary rate	0.18
2		Teacher-student ratio	0.22
3		Higher education attained	0.16
4		Medical bed-population ratio	0.15
5	Education sector	Doctor-people ratio	0.13
6		Working age population	0.19
7		Employed population	0.18
8	Health sector	Labor force in tertiary sector	0.17
9		Growth center	0.22
10	Employment sector	Urban population	0.15
11		Road network	0.19
12		Railway network	0.26
13	Urbanization sector	Electricity connection	0.21
14		Safe drinking water	0.22
15		Sanitary toilet facility	0.24
16		Household structure	0.19
17	Agriculture sector	Per capita arable land	0.18
18		Cropping intensity	0.19
19		Irrigated land	0.25
20	Economic sector	Monthly average per capita income	0.27
21		Monthly average per capita expenditure	0.21
22		Poverty rate	0.26

ratio has the lowest influence with a standard deviation value of 0.13. Based on the influence, the indicators have been ranked in descending order as *Monthly average per capita income* > *Poverty rate* > *Railway network* > *Irrigated land* > *Sanitary toilet facility* > *Growth center* > *Safe drinking water* > *Teacher-student Ratio* > *Monthly average per capita expenditure* > *Electricity connection* > *Working age population* > *Road network* > *Cropping intensity* > *Household structure* > *Per capita arable land* > *Literary rate* > *Employed population* > *Labor force in tertiary sector* > *Higher education attained* > *Medical bed-population ratio* > *Urban population* > *Doctor-people ratio*. Among all the sectors, the economy sector has the highest and the health sector has the lowest contribution to the overall socio-economic disparity in the study area. Based on the contribution, the sectors have been ranked in descending order as Economy sector > Household amenity sector > Urbanization sector ≥ Agriculture sector > Education sector > Employment sector > Health sector.

4 Discussion

4.1 Dynamic Factors Analysis of Spatial Disparity

A wide range of interconnected factors and constraints, which very effectively accelerate and decelerate the progress of development in the study area, have been identified. Causes of spatial disparity in the study area range from household-level action to national-level policy for development and includes factors from both the physical and socio-economic sphere. Each of the regions also demonstrates distinct characteristics of social, political, and economic interest. In high developed regions service and business-oriented professions, high income, easy accessibility to resources, developed transport systems, and technology functions contribute as factors of development, contrariwise, in low developed regions agriculture based professions, low income, lack of accessibility to resources, less improved technology and transport system, and low-quality human resources are functioning as constraints of development.

Variation in professional distribution is the most active factor of unequal development in the study area. Low developed regions are characterized with agriculture as the dominant employment sector engaging 49.72% of the total employed population, whereas only 8.57% and 10.47% of the population are engaged in service, and business and commerce respectively, which very effectively control poverty level in the region by limiting average income. Unlike that, service is the dominant sector of employment in high developed regions employing 41.4% of the total employed population followed by business and commerce, employing 31.24% of people, while only 5.45% of the population is employed in the agricultural sector, which leads the region to gain higher average household income and minimize the population living below the poverty line.

Poverty itself is also a factor with a versatile impact on development in the study area, as it is coupled with other factors, that limit people's ability to reach certain resources and services to develop human resources and enhance the quality of life. In low developed areas, the households that do not have access to electricity, safe drinking water, and sanitary toilet facilities, 28.23%, 10.1%, and 22.3% respectively are due to poverty or lack of capital, whereas, in the high developed area, the rates are only 6.33%, 2.67%, and 4.67% respectively. Out of 36.27% of the people in low developed areas, who do not take any effective health measures, 21.8% are the result of poverty, which is very high compared to 5.33% in the high developed areas.

The development of human resources and their equal distribution is extremely restrained by poverty in the study area. A considerable portion of students, 29.67%, do not attend or complete higher education due to a lack of credit and to support their families, which limits the development of human resources to a certain extent. In rural areas, low developed human resource is also an outcome of poorly trained faculty in educational institutions delivering poor and inadequate education, which also raises the rate of school dropout due to insecurity and lack of enthusiasm by holding back students from reaching their full potential. Besides low concentration of vocational training and higher educational institutions in rural areas is another constraint to the development of human resources. Contrariwise, in high developed areas only a tiny portion, 7.25%, of the students do not complete higher education due to poverty. Moreover, a high concentration of highly developed and higher educational institutions with skillful professionals efficiently contribute to developing human resources.

The uneven distribution of employment rate and growth of the local economy in the study area is largely generated by educational qualifications and the average age of joining the workforce. The average age of joining the workforce is higher among the graduates, 27 years, than those of school dropouts, 16 years. Dropout students usually engage in low-paid work, mostly vulnerable, and slightly contribute to the local economy in the earlier stage of their life as compared to the highly educated portion of the population, therefore there is an increase in the unemployment rate in high developed areas, i.e., the rate is the highest in RCC. Paradoxically, people with higher educational qualifications have mostly non-vulnerable professions with higher income and have money-saving tendencies, which contributes to the rapid growth of the local economy.

The transport system plays a vital role in shaping the development pattern in the study area. Access to various facilities, i.e., health care, education, market, and urban facilities, highly depends on the transport system of the region. Low-developed transport system disturbs the channeling of agricultural products, forcing farmers to trade their harvested products at low prices. Besides, new business establishments in rural low developed areas are often halted by unimproved transport networks. The highly developed transport system in developed areas is a notable contributing sector of employment with huge employment capacity. In high developed areas 9.47% of the employed population is engaged in transportation and related professions, while the rate is 6.19% in low-developed areas. The number of growth centers, rate of urbanization, development of settlements, access to modern technological resources, the utility of goods, etc. directly depend on the transport network. Figure 4 illustrates the linkage between the transport system and socio-economic development in the study area.

Lack of access to or coverage of certain resource and services in rural and remote areas create uneven distribution pattern of certain indicators in the region. The ratio of population to the doctor and medical bed is lower in rural low developed areas as a result of the lower number of medical centers in these areas, though the scenario is reversed in urban and high developed areas. Correspondingly, the teacher-student ratio is determined by the concentration of educational institutions. Spatial units with a higher number of educational institutions have a lower teacher-student ratio compared to the spatial unit with a lower number of educational institutions. The density of the population of these spatial units plays an important role to fluctuate these ratios as well. In low developed area lack of electricity coverage restrict a notable portion, 27.71% of the population to access electricity, whereas in high developed area hundred percent of the population are under electricity coverage. Installation of sanitary toilets, pucca or semi-pucca structures, and safe drinking water sources in 9.4%, 3.4%, and 10.2% of

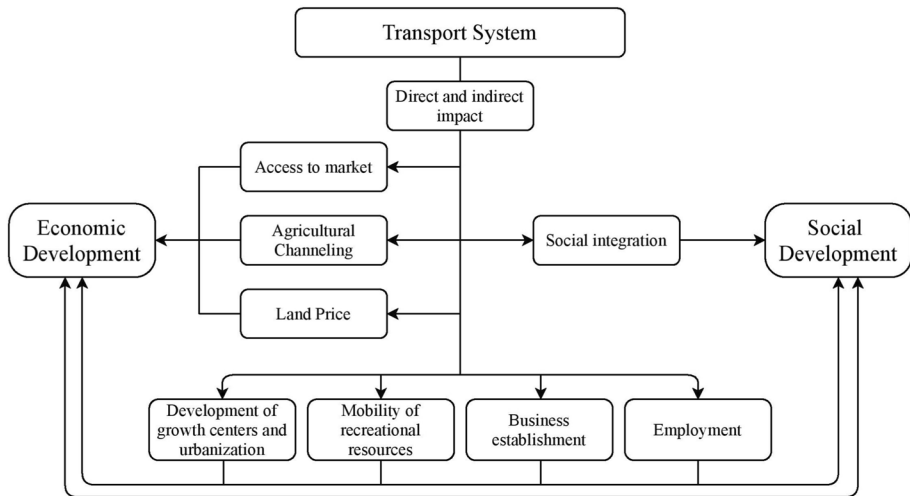


Fig. 4 Linkage of the transport system with socio-economic development

households respectively are resisted by land shortage under personal ownership in some highly dense rural settlements.

The level of technological advancement is one of the vibrant factors of development in the study area. In the high developed areas, 93.8% of mobile users use the internet, 61.9% of the population have computer literacy, 35.3% of farmers use mobile technology in agriculture and 81.8% of the student receive education in institutions with digital technology. Out of 31.27% of people engaged in business and commerce, 16.3% use technology for advertising their products, and 15.6% of households use mobile doctor service in case of emergency. Unlike that, in low developed areas only 33.8% of the mobile users use the internet, 21.9% of the population have computer literacy, 7.3% of farmer uses mobile technology in agriculture and 11.8% of the student receive education in institutions having technology. The use of technology highly depends on people's ability to buy technological devices, internet coverage, and technological knowledge which vary through the study area creating an uneven pattern.

Governmental policy, monitoring gaps, and insufficient allocation of resources are major constraints to development in the study area. The government trend to build government offices, higher educational institutions, health care centers, road networks, bus terminals, train stations, bank branches, recreation centers, etc. in the urban densely populated region making rural areas more backward, moreover they allocate more money for development activity in these areas compared to rural low developed areas.

Monitoring gap and allocation insufficiency distress health sector in rural areas. Among the 41.45% of the patients who avoid treatments from government health care centers, 17.67% are due to the poor quality of services provided. The severity of the corruption of government officials highly affects vulnerable populations. In the study area, only 41.07% of disabled people receive a disability allowance, 15.38% of 65+ aged people receive an old-age allowance and 57.69% of widows receive a widow allowance. Moreover, due to poor audit frequency development activities are hardly supervised in rural areas conveying poorly or partially completed and unusable infrastructures. Figure 5 illustrates the linkage between governmental actions and increasing regional disparity.

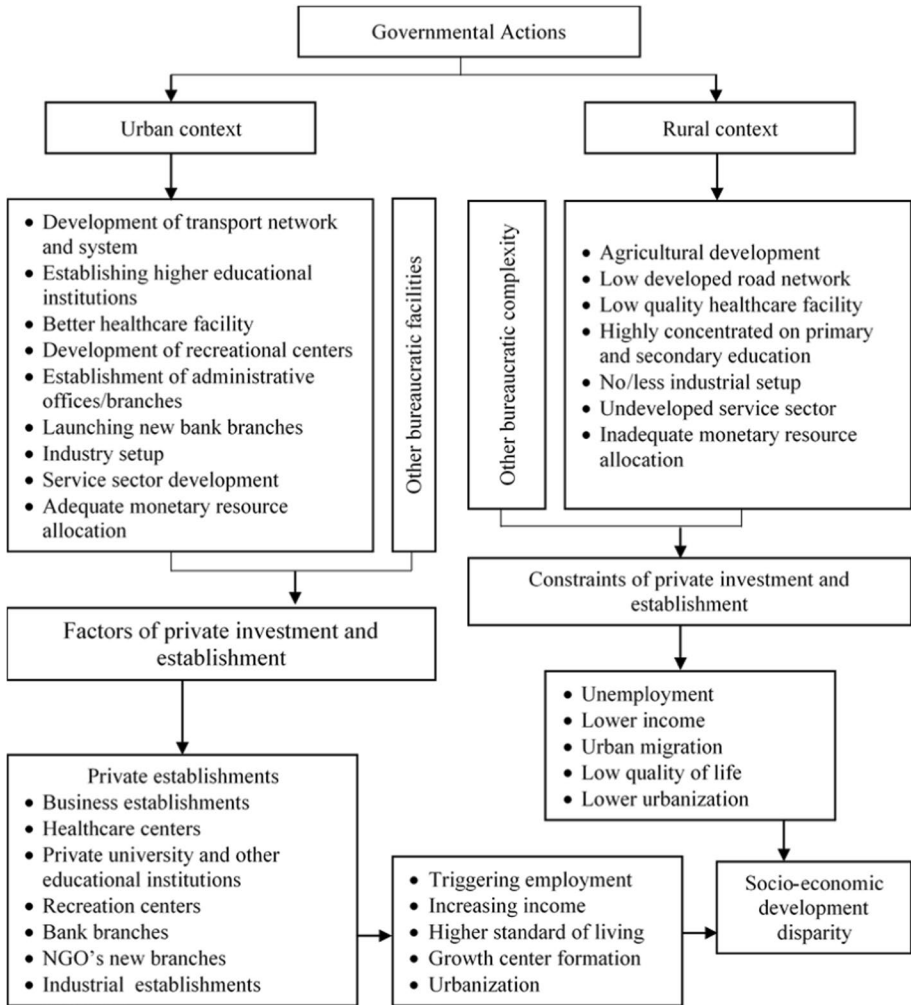


Fig. 5 Linkage between governmental actions and increasing regional disparity

Besides all social and economic factors, some physical factors as well as natural phenomenon also restrict the equal distribution of some resources. Allocation of arable land per capita is limited by several physical factors i.e., vegetation cover, barren land, wetland, etc. as well as by some social and economic factors, i.e., land transformation and urbanization. In the lower land *Chalan Beel* area, spreading over Pabna, Natore, and Sirajganj districts, cropping intensity is lower compared to other arable areas due to its marshy characteristics which allow farmers to harvest only once in an agricultural calendar. People living in disaster, mostly flood-prone areas are deprived of safe drinking water and sanitary toilet facility along with other requirements for a certain period of the year. Spatial units with tenants in river char land were found to be very low developed as many services are restricted by physical barriers. Wetland, relief, vegetation cover, river basin, etc. are major restrictions in the development of transport networks in some rural low-developed areas in the region.

5 Conclusion and Recommendations

Unequal development in social and economic spheres is one of the major constraints to ensuring equal and balanced development of the country. This type of disparity to a certain extent can affect all the spheres of human interaction. Both developed and developing nations have been experiencing its severity to a certain extent. The spatial pattern of development in the study area symbolizes typical development disparity between urban and rural areas of the country. Spatial units with higher urbanization rates and high concentrations of public infrastructure are more progressive than those with high concentrations of agricultural activity. Development in one socio-economic sector triggers development in other directly or indirectly connected sectors. Factors from both social and economic spheres as well as some natural phenomena are accountable for the spatial disparity in socio-economic development in the study area. These factors interact and influence each other in linear and non-linear methods. Consequently, the level of disparity is found to be very high in the region. Proper and effective measures should be taken to eliminate disparity from the root level. A new policy should be adapted to bring forth regional disparity issues and to build a separate fund for development in lagging areas. Decentralization of political power, various government offices, higher-level educational institutions, medical centers, and private organizations might be an effective measure to reduce inequalities among regions. The development of the communication system between regions would increase local employment opportunities and ensure easier access to market and input capital. Non-farm economic activities should be promoted in the lagging areas by providing training and financing facilities. Partnership building between the government and NGOs could be a fruitful initiative in this regard. Manufacturing opportunity should be created by establishing industrial zones in lagging areas to trigger economic growth, increase employment, and encourage small and medium enterprises. The initiative to create a suitable platform for and provide financial support to new entrepreneurs from rural areas would trigger economic growth on the local scale. By providing proper training, the skills of existing human resources in educational institutions should be developed. The establishment of cost-free night schools in rural areas would be an effective measure to attain satisfactory attendance and literacy rates among working young people. Strengthening the role of local government, such as Upazila and Union office, in development activity would trigger the development at the root level. Tracking temporal dynamics of the socio-economic development status of the delineated regions at a specific interval would help to identify the effectiveness of taken measures or formulated and implemented policies. That would also assist in identifying the dynamic factors of spatial inequality in the region more precisely. Therefore, further research to track the temporal dynamics of socio-economic development in the region is recommended by the authors.

Author contributions Conceptualization: HM, KS; Methodology: HM, MMR; Formal analysis and investigation: HM, KS; Writing—original draft preparation: HM, KS; Writing—review and editing: HM, KS, MMR; Supervision: MMR.

Declarations

Competing interests None of the authors have any financial or non-financial interests that are directly or indirectly related to this work that is being submitted for publication.

Ethical approval All authors contributed to the study conception and methodology design. Material preparation, data collection, and analysis were performed by Hasan Mahmud and Kanij Shobnom. The first draft of

the manuscript was written by Hasan Mahmud and Kanij Shobnom and Md. Mizanoor Rahman commented on and edited previous versions of the manuscript. The entire process of the research was supervised by Md. Mizanoor Rahman. All authors read and approved the final manuscript.

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