

SDI and Open Source Geospatial Data Potential for Development: A case study on Dhaka City, Bangladesh.

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Abstract

A city's development not only depends on the planning and execution but also relies on accurate, accessible and up-to-date information, with better coordination among the sectorial government and non-government agencies; especially if the city has more than 15 million population and having the highest rate of urbanization in the world. Dhaka is the fastest growing megacities in the world and according to UN's estimation. Each year around 0.3-0.4 million people migrate to Dhaka city which has a significant impact on the urban environment and infrastructure. Such dynamics in population result into a surge of development projects by both government and private sectors that focus on different urban issues and requires collecting spatial data. Massive time, effort, and financial support are invested in these projects while often the products and methods overlap. In this paper, an attempt was made to explain the gaps and overlaps of current planning projects in Dhaka city and the potentials of an SDI in mending these gaps. We further argued that data collected through open mapping platform can complement authoritative data and reduce the repetition of work and effort. Finally, an overall discussion was made to understand the value of an open and accessible Spatial Data Infrastructure (SDI), with a focus on integrating open source geospatial data into the system.

Keywords: *Open Data, SDI, VGI, Geospatial, Government*

1. Introduction

Dhaka is the capital city of Bangladesh, located at the center of the country. While the country is listed as one of the world's top ten for its population density, the city has been ranked as the densest city in the world (Murphey, 2017). Dhaka is surrounded by rivers and has a road network system that connects it with rest of the country. The transportation system of both water and roadways are remarkably developed as this place has a long historical evidence to be a capital in different reigns. Being at the center of the country with feasible modes of transportation it has always been a major concentration of economic, industrial, educational, and political hub. Naturally this attracts people from all corners of the country with better facilities and opportunities of livelihood (Hossain, 2008). A study by Bangladesh Bureau of Statistics (BBS) showed that in the year 2014, on an average 1412 people came to Dhaka each day increasing the population by more than 517,500 by the end of the year. The city is continuously changing itself to make place for this increasing number of people, as well as serve them with proper services and facilities. As a result, construction of buildings, roads, and other infrastructure is increasing with time. In addition,

considering the city dynamics, numerous NGOs and international organizations also work on the urban development here including majorly on urban resilience, sustainability, economic development and such others important issues. However, these continuous efforts on city planning and management, often face the challenge of keeping pace with the changes in the city.

The organizations have their own particular objectives and goals for the projects which may differ from one another, but most of the planning projects involve methodologies that include survey and mapping. This not only results in repetition but also loss of time, money, and labor. The end products are also often incomparable due to different level of errors, concepts, and definitions. For example, both Survey of Bangladesh and Bangladesh Forest Department prepare land use/ land cover map for the country, but does not use the same map from other organization as a complementary source or base which has been prepared more recently (BFD, 2017). In addition, while all these organizations collect, analyze and visualize data for their decision making, these data are hardly made freely available in a usable format for others. Like many other countries,

it is not only a difficult to access these data in a readable and usable format, but also a gap of communication among the data stakeholders which results in data redundancy, misuse of financial and human resources (Hu & Li, 2017). To avoid such redundancy and ensure proper use of resources, it is essential to develop a Spatial Database Infrastructure (SDI)¹ by bringing these organizations under same umbrella and encouraging them to share the data they obtain following a more comprehensive methodology.

On the other hand, a recent trend in open data and open source software has opened doors for massive opportunities of development. Using the open platforms and data collection tools both expert and non-expert community members are collecting spatial data and contributing in different government and non-government projects. The local knowledge of community and vast distribution make them a good source of collecting more up-to-date and real information. While this approach requires adopting new modes of data collection and evaluation methods, the benefits of this volunteered geographic information (VGI) has proven to be manifold. The objective of this research was to take a closer look at the potential of SDI and scope of VGI to be integrated in this archive focusing on the context of Dhaka city.

2. Literature Review

Bangladesh has long been struggling with data accessibility challenges. Being a developing country, the government invests a significant share of its budget on data collection, and analysis of different ministries. However the researchers, students, or NGO workers often struggle to acquire these data for further research and planning. Although a data sharing act has been passed by the government in 2009 which dictates that the citizens have their right to access any information unless that poses harm or threat to others. Despite this act, the practice of sharing and accessibility of data are still a difficult process at the ministries as it requires a massive change in system, internal policies, and more importantly mindset. This not only hampers the research and development of the society but also reduces the transparency of government in many cases (Islam et. al. 2017). The government although had no structured SDI, gradually realized the value

of spatial data and importance of sharing them. In order to reduce the overlaps in data management tasks and ensure the optimum use of the data, the Prime Minister of Bangladesh has announced the development of National Spatial Data Infrastructure (NSDI) in 2016 with a collaboration between government and international organizations (The independent, 2016). The aim to establish the NSDI was to bring all kinds of organizations including government, non-government, and academia under the same umbrella through following the policy of data and information preservation to ensure sustainable development, reduce duplication and easing exchange of up-to-date data and information.

While the NSDI was being announced, another initiative, GeoDASH was undertaken by the World Bank Group and the Bangladesh Computer Council with somewhat similar urge. This initiative encouraged government, non-government, and academic institutions to display and share their geospatial data in a common platform. Each of the organizations can see the data displayed or made available by other organizations although making the data open is still a big challenge for these organizations. Nevertheless, the platform contains a concentrated portfolio of the organizations allowing them to connect with each other upon need. The platform, GeoDASH is a WMS based server which allows although not all but the basic characteristics of SDI including: interoperability, metadata, basic tools for analysis etc. (Hoque, 2016). Till date (September, 2018), 47 institutions and 362 layers have been shared on the platform, however, the establishment of open and free accessibility of information do not exist yet as the opening of data is a massive change both in the policy and in the organizational culture (Granickas, 2015). Thus opening data by the government is still a slow process as the cultural change cannot take place overnight and requires strong government motivations (Hu & Li, 2017).

The accessibility to authoritative database is a challenge observed worldwide. This is one of the main reasons behind the emergence of Volunteered Geographic Information (VGI) where citizens act as distributed sensors throughout the country and collect spatial information continuously (Goodchild, 2007). Different platforms of VGI like

¹ The SDI is a platform or digital archive of authoritative spatial data from different stakeholders which requires technological, strategic, and new policies of government (Dinebari et al. 2017).

OpenStreetMap (OSM), Ushahidi, Mapillary, or social media like twitter have gained much popularity because of the current and detailed data being collected in these platforms. Naturally, governments are also considering the incorporation of these modes of data collection in their system (Haklay et al. 2014). Different national mapping agencies are accessing the community through OpenStreetMap to update their authoritative databases for instance change in land use, number of floors in a buildings or even collecting data where there is no government data at the first place (Olteanu-Raimond et al. 2017). Studies have also proven that the VGI data is even more accurate and updated compared to many government datasets (Arsanjani et al. 2015, Haklay, 2010).

This powerful impact of VGI is encouraging governments all over the world to incorporate VGI into the SDI (Genovese & Roche 2010). The integration of VGI into decision making has already been adopted by some of the international organizations working in Dhaka city, Bangladesh. The Save the Children Bangladesh and Bangladesh Red Cross and Red Crescent Society are two good examples of this collaboration. Both of the organizations wanted updated and detailed data for the city for their projects. The existing authoritative data had different issues which challenged the usage by the projects which included the scale of details, currency, and in many cases accessibility. To create an updated database of their desired areas in the city these organizations trained volunteers on tools and applications of OSM, an open source mapping platform and used it to collected data with the help of the community. The data collection, analysis, and output of the projects encouraged the authorities to expand their projects and both of these projects are now continuing with larger area of interest in Dhaka city. In recent years, some government organizations are also showing interest in incorporating OSM for data collection or resource monitoring (FAO, 2018). Apart from the government and non-government organizations researchers are also finding open source geospatial information to be useful and accurate for research and planning purposes (Islam et al. 2017) as data coming from open source platform like OSM are open, updated, and often have some

additional details. There is no denying that being a new platform for data collection and involving the non-experts to collect data, a lot of challenges exist which makes the acceptance of VGI doubtful. However, studies have shown that the challenges of adopting such new data collection methods like VGI require better understating to compare with the potentials that they have (Coleman, 2013; Johnson & Sieber, 2013; Mooney et al, 2017)

Looking at these array of scopes of VGI in the present context, we argue in this paper that VGI as an open geospatial data source can have a positive impact in planning and decision making. Therefore, it is important to explore the benefits of incorporating VGI into SDI as these open source geospatial data fits with the SDI principles very well.

3. Methodology and Data Collection

The study was conducted using literature review, observation of availability and coverage of OSM and government database, and key informant interviews and review of some case studies. Visual items, including photographs and diagrams were used to support explanations. Both primary and secondary sources were used for the collection of required data. Primary data were collected through interviews with GO and NGOs. Use of secondary data involved observations from OSM, government data portal, literature including: articles, presentations, press release, report, newspaper documentation.

The literature was used for the background discussion of the study, designing of the report and discourse analysis. The main objective of the research places itself in a socio-political context which is why a critical discourse analysis was essential for understanding. The social cognition is what monitors the perception, experience, as well as the interaction between government and citizens in this process eventually developing different discourse (Van Dijk, 1993). The understanding of organizational behavior, practices, and perspective towards VGI in context of Dhaka city was essential to understand in order to identify the scope of the data.

For the interviews, people from both government and non-government organizations involved in mapping or planning tasks were interviewed. The key informants were thoughtfully selected from a wide range of people who have firsthand knowledge about the sector and specific components of open data and/or VGI. It was ensured that these experts, with their particular knowledge and understanding, can provide insight on the existing practices of mapping along with scopes and challenges of adopting VGI.

The KIIs were conducted at the city level stakeholders who are actively engaged with the open data and open geospatial movement and uses. KIIs were conducted with personnel from 8 government and non-government organizations as below:

1. Dhaka North City Corporation (DNCC)
2. Dhaka Water Supply & Sewerage Authority (DWASA)
3. Rajdhani Unnayan Kartipakkha (Capital development institution) (RAJUK)
4. Local Government Engineering Department (LGED)
5. Bangladesh Computer Council (BCC)
6. Save the Children International Bangladesh (SCIB)
7. Bangladesh Red Cross and Red Crescent Society (BDRCS)

The past and present experiences with government collaboration and projects involving OSM community helped the authors to observe and gather in-depth information to get a clearer concept of the context. As OSM is an open platform, it was convenient to look into the data collected for different parts of the city. At the same time, same areas were reviewed from the authoritative databases.

Data preparation (or processing) is "the least glamorous aspect of survey research" (Straits, 2005). The collected primary data were well collected by taking notes during the interviews. The data were carefully audited for errors and redundancies was avoided. The information was then compiled and organized according to the outline of this paper.

4. Result and Discussion

In order to explore the potentials of VGI two projects ('Data4Action' & 'Kolorob') in Dhaka city have been considered in this paper. Before going directly to these projects, it is important

to take an insight on the current status of parallel authoritative or government data.

4.1. Mapping in government planning projects

Starting with RAJUK, the Central Planning Authority of Dhaka city, it is one of the core government organizations which focuses on proper management and planning of Dhaka city. The organization has developed a hierarchical plan 'Dhaka Metropolitan Development Plan' (DMDP) which has three major tiers. At the lowest level tier, the field base implementation is known as the 'Detailed Area Plan' (DAP) of DMDP (DAP, 2005). The DAP consists of 5 Detailed Planning Zone or DPZ which covers the whole Dhaka city. The major objectives of this project includes providing basic information of the existing infrastructure and services of the city, analyze the suitable locations for different land use, form some regulatory rules for investors and constructors, and implementation of the planning strategies of DMDP. The first step of field based methodology was to map the whole city in detail to record the present land use and infrastructures like buildings and roads, along with their details like address, condition, structure etc. With time the map was expected to be updated which can provide the city planners a basis for understanding the land use change, areas with poor services, vulnerable to hazards etc.

The significantly high rate of change in population results into massive change in Dhaka city infrastructure, in terms of keeping pace with this change, the DAP plan struggled to meet the efficacy. It was mentioned that one of the major shortcomings of this project was lack of collaboration. Another reason was the limitation of resources to execute surveys in a faster and frequent manner. More than half of all the ministries are involved somehow with city planning and all the planning works involve the mapping of city (Islam, 2000). However, these projects or organizations working on the same city lack proper communication and liaison among them. Consequently, a major overlap of the methods is observed. For example, Dhaka City Corporation which covers the most concentrated part of the city and contains one of the largest DPZ zone of 108.97

sq. km (DAP, 2005) has its own planning program, 'Urban Master Plan' (UMP). Figure 1 shows the overlap of jurisdictional areas among three organizations Dhaka City Corporation, RAJUK, and Dhaka WASA and all three of them have projects which overlap among each other.

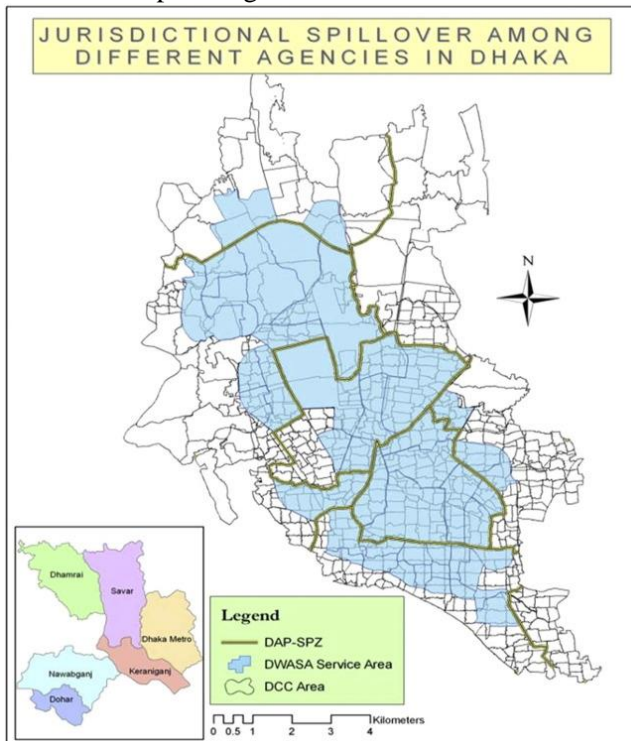


Figure 1: Overlapping administrative areas of different government organizations of Bangladesh, (Rahman 2015)

The UMP aims to: survey the city to prepare statistics of the infrastructure and services; conduct a thorough mapping of the city for development, expansion, and improvement of any area within the city; imposing restriction, rules, and construction strategies considering the present situation (DNCC, 2016). Comparing these objectives with those of DAP, some similarities can be found between these two projects. While the map of DAP was prepared in 2008, UMP map was developed in 2009. This map reserves proprietary right and requires purchasing from the DCC. In spite of having similar objectives, method, and timing both of the organizations prepared the maps separately which resulted in duplicity with a cost of resource including money, time, and labor.

Similarly, DCC has its own Geographic Information System (GIS) wing to map the urban slums. The

DCC area contains 4.2 million people living in 1925 slums in its administrative zone (Mahbub, 2017). Most of these people are involved in informal economic activities like transport driving, home assistance, or laborers at construction sites (Jinnah, 2007). These people earn very low generating a massive economic inequality in the city. At the same time, the standard of living in the slums is also very poor compared to the overall city with lesser exposure to services. DCC aims to map the slums to assess their standard of living with the available services around them.

Dhaka Water Supply & Sewerage Authority (DWASA) is another government organization aiming to provide proper water and sewerage services to the city. It also has a project that assess the need and supply of these services to urban slums. Both DWASA and DCC working on urban slums require thorough mapping of the slums to assess and analyze (CBSG, 2010). Due to their differences in collection strategies and organizational policies, there is no liaison between these organizations to use each other's data.

It is evident that there are a number of government organizations who are trying to address the crucial issues of the city to ensure proper management and planning, and almost all the planning projects involve mapping. They all aim to provide a better urban environment with a healthy social and economic environment. However, often the effectiveness of these government projects fail to serve its best, majorly due to lack of collaboration and sharing approach among the organizations. In order to make the most use of the resources, and planning strategies, the government should push its ministries and eventually the organizations to open their data. This will lead to bringing all the organizations into one common platform and improve data sharing and acceptability policies. However, in addition to the massive effort and resources invested by the organizations there also remains the issue of losing track of changes due to limited number of city workers. This is where we find the prospects of VGI.

4.2. Projects Collecting VGI

Dhaka, being a dynamic city with tremendous opportunities and challenges, encourages different Non-government organizations (NGOs) both local and international to undertake development projects. Several NGOs are engaged in different development projects which involve objectives, methods, and even analysis those may support the government organizations in their own work.

The ‘Data4Action’ project conceived as a collaborative effort of International Federation of Red Cross and Red Crescent Society (IFRC), Médecins Sans Frontières (MSF) UK, and Humanitarian OpenStreetMap Team (HOT) to map vulnerable areas of Dhaka city involving the community and volunteers of both Bangladesh and UK (Hoque, 2017). A team of 32 volunteers mapped two extremely dense locality of the city which are assumed to be severely vulnerable due to earthquake and flood. The working process involved all open source tools and platform to create and generate the geospatial information of these two areas. The HOT volunteers first trained the MSF and IFRC volunteers on Mapping process in Open Street Map using both android application (OpenMaplKit) as well as desktop application (ID editor). The method involved remote mapping, ground validation, and adding detail information to their map including building and road structure, level, material, age, as well as use of the infrastructure (i.e. residential, commercial, educational etc.) with the help of local people. These detailed attributes were again incorporated into the OSM platform to make the map more informative and detailed.



Figure 2: 3D mapping of Gendaria, Dhaka using OSM data (Data4Action, 2016)

The map information was then assessed by the GIS expert of Red Cross and Red Crescent Society to check the quality and then analyzed to understand the vulnerability of the study areas. This

datasets is also preserved to help in crisis periods like earthquake or flood. This mapping process took place in 2015 and the information are still open and available at OSM platform although BDRCS has extracted the information in 2015 and saved it for their analysis.

At the end of 2015, another project, ‘Kolorob’ was initiated by Bangladesh and Australian Save the Children. Kolorob is a virtual knowledge bank set up for slum dwellers to help them navigate their city using web and mobile applications. Users can also locate services in slums via a digital map—which will boast a feedback component—through kiosks in user-friendly community centers. Equipped with computers, internet, and room for gatherings, these safe spaces for children, especially adolescent girls, will host local facilitators who will offer information to slum dwellers. Kolorob’s vision is to create an on-line platform to improve access to information on essential services aimed at reaching a large proportion of the estimated 2-3 million residents living below the poverty line in Dhaka (Hoque, 2015). As mentioned in earlier section, urban slums have a very poor quality of life with limited options of services though government organizations are continuously working on this issue. However, though there are services and opportunities that exist in the slum neighborhood, many of the dwellers lack proper knowledge about their existence and available services. To fill this gap, the ‘Kolorob’ project aimed to create an android app with detailed map of the slum and nearby service centers. In the pilot project, around 4500 service centers including infrastructures, educational, occupational, financial, medical, and even recreational services were mapped with all necessary details (SCIB, 2017). Similar to the ‘Data4Action’ project, the OSM volunteers remotely mapped the slums’ infrastructures at first. Then teaming up with the community volunteers they added the details of the infrastructures and their uses from field. This information were then added back to OSM and the information were analyzed and used for creating the ‘Kolorob’ application for android devices.

Both these projects cover areas and objectives similar to those of the government projects mentioned in previous section. However, the most important element that creates the differences between the government and non-government projects here are openness, currency, and coverage. Both the projects ‘Data4Action’ and ‘Kolorob’ have used OSM platform to create and archive their data

enabling other users or stakeholders use this information as well. The analysis of the projects come from this map which also ensures the transparency of their work. Both of these projects were initiated in 2015; which are more current than the DAP and UMP and hence, has the potential to complement the later datasets.

4.3. Strength of Adopting Open Source Geospatial Data into SDI

Both government and non-government organizations are working on better management and planning for the city. A collaboration among these organizations will make the most of all the efforts given for mapping and producing the data. In addition, sharing the VGI datasets to a common platform may also prove to be a potential source of

updated, freely available data. Having an open platform to share these data will be helpful for all the stakeholders including government, non-government, and the community with the following prospects.

Accessibility is one of the major key points for open data. Sharing the producer generated geospatial data by the organizations in SDI is the evidence of a step taken towards open governance or data sharing initiative. VGI like OSM data have very flexible license and sharing policies making it easier to share and reuse of the information based on need will be easier (Panek, 2015). Also, when organizations are working with similar objectives but in different times these details datasets can be a baseline to understand the dynamism of the city through change analysis.

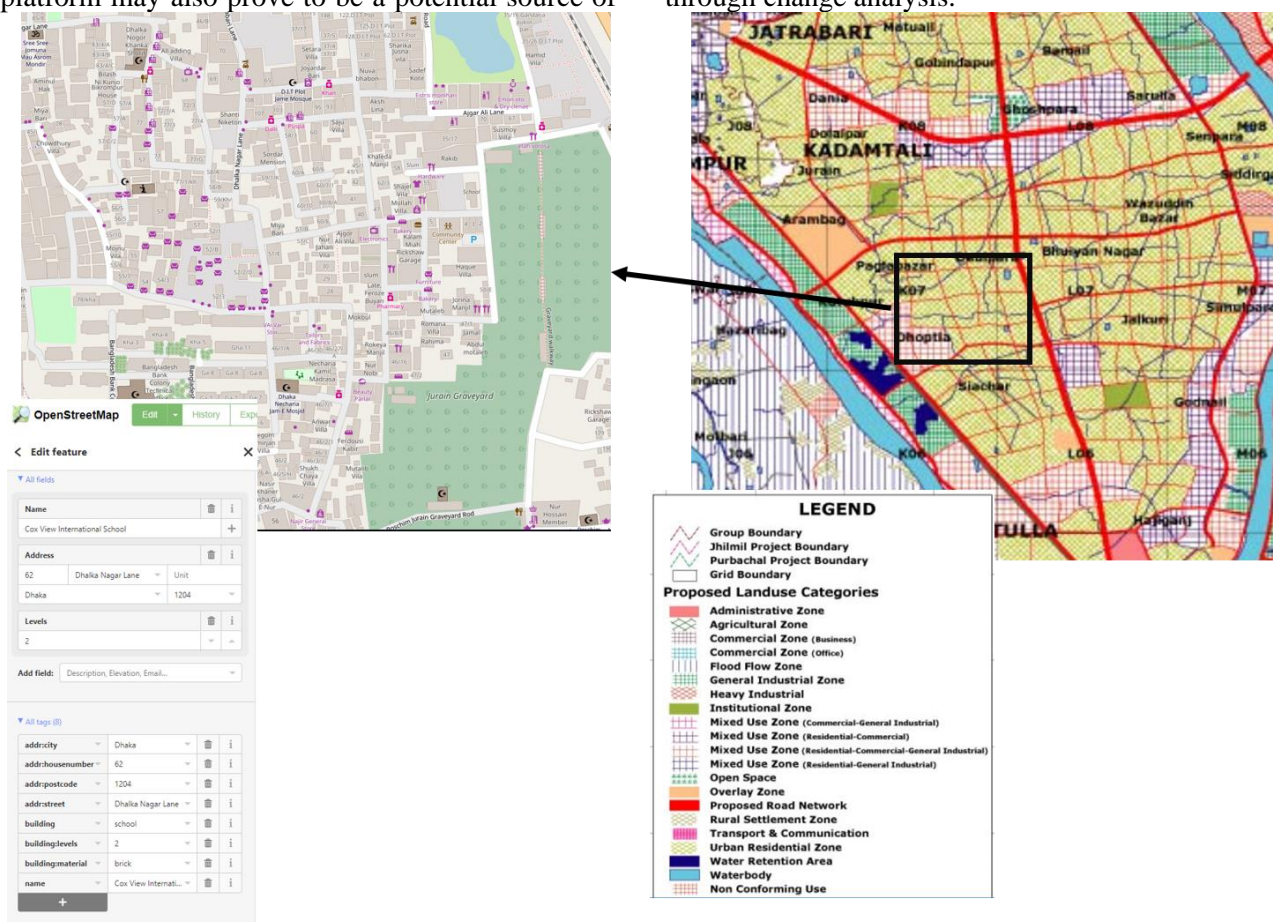


Figure 3: A part of Gendaria mapping in OSM by Data4Action project (on left) and the map of similar area prepared by DAP project (bounded by black border, on right)

4.3.1. Easier accessibility and comparability

Figure 3 represents a comparison between OSM (left) and available DAP (right) maps. The area confined by the black box in DAP map is the area

shown in left. Considering the DAP legends, it is apparent that both the maps represent same land cover however, the OSM map includes more details.

The details could also be arranged based on the need of the project and customization. While the DAP map was prepared in 2008, the OSM map was updated in 2015 which gives the basis for considering one data source with the potentials to complement the other, however, with some constraints of common basis and concept considered for classification.

In short, the SDI will play the role of a middleman by archiving the VGI and making it more visible and trustworthy to different stakeholders.

4.3.2. Enhanced collaboration and monitoring

The organizations often overlap each other in city development projects by either working for the same objectives of partially having similar methodology. Surveying Dhaka city is a complex and expensive task as the city is overburdened with people and resultant construction work. Making the VGI datasets available by the particular organizations (which collected them) can reduce the efforts being put for the survey and mapping. In addition, this can also help to update the database of an organization following the data shared by a more recent study by another entity.

Using open platform for mapping like OSM has already been proved to be a powerful tool to monitor, classify, and quantify different land use, and therefore, a geoportal with VGI can serve as an important source of information for researchers and policy-makers involved in city-planning and development monitoring (Yang et al., 2017).

4.3.3. Increased transparency

Involving citizens, government and NGOs with a common platform, the open government initiative can earn more meaning and sustainability

(IPCO, 2016). Sharing the geospatial information of planning and development organizations will not only enable them to have an idea of who are working in similar projects and focusing on which particular arena; but also will help other stakeholders or citizen to see how these data reflect policies and decision-making. Also, the limitations found in one organization can be focused by another to mend the gap in an easier and faster way.

4.3.4. Involve community to escalate sustainability

One of the major shortcomings of the DAP plan was that the authorities were mentioned to have overlooked planning guidelines and encroached on environmentally sensitive areas (Senes, 2007). However, involving community participation or enabling the citizens to explore the map in a platform could aware the people about such issues and that may have helped the government to be concerned about the sensitivity of data. Also in this project, RAJUK played a dual role as a promoter of development and as the principal agency for urban planning which gave no room for looking at the project policy from a different perspective or considering scoping with other projects (Senes, 2007).

Sharing the community generated data in a common platform will give the community a stronger position to share their context. In addition, the concerns, ideas, or issues of community could also be highlighted more effectively and in a timely manner with the help of such system.

Overall, assessing the current situation, a framework like the following, can be used for data sharing through collaboration which involves all possible stakeholders dealing with planning and management of Dhaka city.

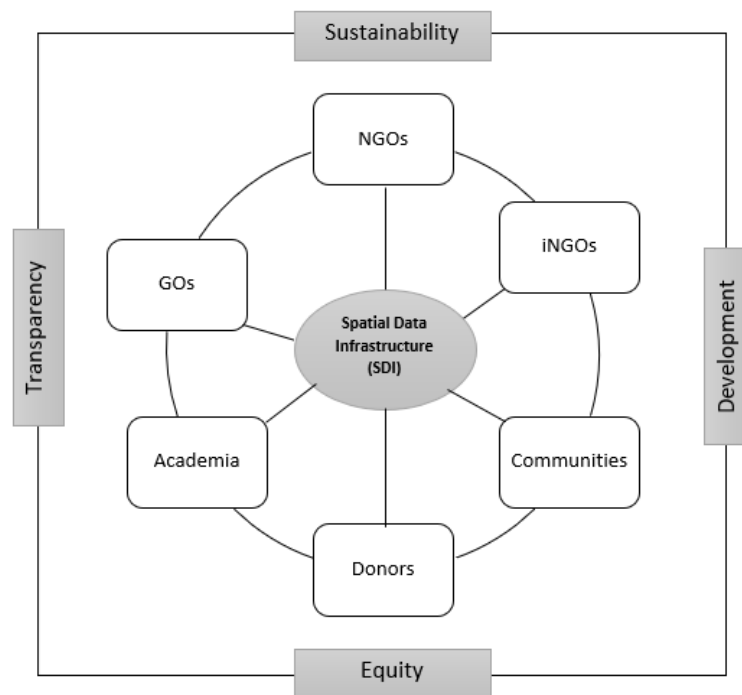


Figure 4: A conceptual framework for SDI incorporating the contribution of all stakeholders impacting the development, transparency, sustainability and ensuring equity.

Being a new mode of data collection, open source platforms have gained noteworthy acceptance and consideration worldwide. At the same time, being a new method, there are challenges which the traditional approaches have not likely experienced much. For instance, credibility and legal issues are major concerns and much debated when it comes to data quality. Acceptance of VGI by the government often requires validation of data and accuracy check. The process of validation, however, may involve different approaches as VGI is a different method than the traditional one and is impacted by varied set of factors like volunteer motivation, preferences, skills etc. (Begin, Devillers & Roche, 2013). License compatibility is another challenge that requires attention. The license of data products and sharing policy are different not only between government and non-government organizations but also within different departments of government. Although OSM has a flexible license (https://wiki.openstreetmap.org/wiki/Questions_to_LWG_on_ODbL) adopting into SDI also depends on the policies of government, and the organization that has collected the data.

It is important to understand that adopting VGI is a huge shift from authoritative to collaborative

approach this also raise some challenges which require a shift from traditional solutions.

5. Conclusion

Bangladesh has a vision to become an upper-middle income country by 2021 and by 2035 it is projected that more than half of the people will live in cities while 35% of them would be living in Dhaka city (Mahbub, 2017). In order to achieve the vision of 2021, it is essential to manage the current challenges in Dhaka, specially the planning and management issues. At present, the city is under numerous projects by different organizations to address the existing problems in planning and provide sustainable solution. All these projects involve mapping different infrastructures, services, and land use of the city. However, the processes of these projects are operating somewhat haphazardly. VGI like OSM data have proven to be a good source of updated data or to complement the existing database in many countries. Creating an SDI with open geoportal, and encouraging all stakeholders to share and use VGI can reduce the burden and hardship of the planning tasks. Developing an SDI and accepting VGI as a part of it hence is a

noteworthy solution to this problem. This is not only a solution for mending the existing gap but is also a step towards adopting the open government initiative by bringing all stakeholders including citizens under one umbrella. To achieve a comprehensive development of the city and increasing the efficacy of overall planning projects through community engagement collaboration among the stakeholders is crucial and to bring in such collaboration encouragement and instructions from higher authorities are essential. At the same time, motivations to bring a positive shift in organizational practices as well as mindset to explore new opportunities and increase efficiency is also needed

for all stakeholders to ensure proper planning and management support for the city.

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