Big Data for What? Deciphering Messages from Citizens towards Building Urban Resilience in Zimbabwe

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Abstract

The article examines the importance of citizens as a source of real-time data for urban resilience planning and building. One of the challenges that governments face in decision-making for urban resilience planning and building is the lack of real-time and high-quality data. This challenge is being encountered despite the existence of big data. However, other countries, such as the United States of America, Spain, China and Australia, are taking advantage of the rich and all-encompassing big data obtained from citizens to craft responsive urban resilience policies and plans. Using the qualitative research methodology, interviews were used to collect primary data, whilst document analysis and desktop review were used to gather secondary data. The study revealed that with proper data mining and analytics, governments can yield invaluable data from citizens for making good decisions that promote urban resilience. It concludes that currently, with good analytical approaches, there is an opportunity for governments to formulate sound and evidence-based policies for building urban resilience partly from the rich data that is generated by citizens.

Keywords:*data analytics, urban planning, data mining, big data for development, social media*

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INTRODUCTION

The advent of big data has transformed the world from an environment poor in data to a world of data abundance. With the world becoming more dynamic and challenges becoming more complex and heterogeneous, the importance of real-time and location-based data from the people for decision-making is also increasing. In cities, where the majority of the world's population is living (Thakuriah, Tilahun and Zellner, 2017) and expected to increase, challenges of infrastructure provision, water and sanitation, traffic management and disasters, among others, are threatening the resilience of urban dwellers and the capacity of city managers to handle the challenges (Ivanov and Gnevanov, 2018; Samarajiva *et al.,*). Big data is defined as large sets of complex data that is either structured or unstructured (Taylor-Sakyi, 2016), plays a critical role in revealing hidden patterns of the behaviour of urban dwellers, refining spatial, temporal and individual attribute data in real-time (Hao, Zhu and Zhong, 2015). This data is critical for resilience planning and for building resilience in cities.

Several types of research have been conducted on the importance of big data in urban planning in Europe, North America, Asia and Australia (Batty, 2013; Thakuriah, Tilahun and Zellner, 2017; Ivanov and Gnevanov, 2018). These studies skirt the role that big data can play in urban resilience planning and building. For example, Hao *et al. (*2015) focus research progress on big data and show that big data is consistent with people-centred urban planning. Another study by Ivanov and Gnevanov (2018) argues this can be improved by the introduction of big data, whilst French *et al. (*2015) discuss the challenges associated with the use of big data for long-term planning purposes. Whilst these studies are critical in shaping the understanding of the potential of big data in enriching planning practice, the studies leave a gap between big data and its potential in urban resilience-building and planning, yet urban resilience is a critical component of modern-day urbanites that should be at the fore of urban planning (Rathore *et al.*, 2016).

In Zimbabwe, a study by the United Nations Development Programme (UNDP) (2021) revealed that one of the challenges faced in planning for and building urban resilience is the lack of data characteristics and patterns

of vulnerabilities in cities. This is an indication of the missing link in Zimbabwe between big data and its potential in informing urban planning practice and in particular urban resilience. Against this background, the study informing this article examined the importance of real data extracted from citizens in informing decisions on urban resilience-building and planning. The study is important to policy-makers and practitioners as it presents better options for real time and location-based data that is important in shaping policy-making on urban resilience and planning in Zimbabwe.

CONCEPTUAL FRAMEWORK

Cities, as important centres for social and economic development, are exposed to man-made and natural disasters. These disasters, if not mitigated or tackled, will affect the continued existence and efficient functioning of cities with negative effects on the livelihoods and wellbeing of their residents (UNDP, 2020). Building urban resilience through the application of sound urban planning is one way of ensuring that cities remain more vibrant and more socially and environmentally liveable in the face of various shocks and stresses that are affronting them (Shen and Li, 2018). But the greatest challenge is that planning for urban resilience can be affected by the absence of adequate data (Spaliviero *et al.*, 2020; UNDP, 2021). The shortage of data compromises the design of effective planning solutions to address the vulnerabilities that affect cities and their residents. However, the challenge of inadequate data for decision-making on urban resilience, can be tackled through the use of a special type of big data, namely big data for development(United Nations Global Pulse, 2013).

The concept of big data commonly refers to the voluminous and complex amounts of data that are incessantly generated globally by people on many aspects, including urban issues structured or unstructured (United Nations Global Pulse, 2013; Taylor-Sakyi, 2016). However, big data for development is differentiated from the general big data in that it is applied in decision-making and planning of development programmes, including the management of urban issue (United Nations Global Pulse, 2013). This type of big data is useful in the sense that when analysed, it provides insights into the wellbeing of people and other development-related issues

in specific geographical and temporal contexts at given periods. In this case, this data assists in identifying spatial patterns and trends of urban problems, thereby indicating areas that require intervention(Wang and Moriarty, 2018). Besides that, this type of data is also automatically collected and is constantly updated.

There are various sources of big data for development, that is, sources that provide big data to support decision-making on urban issues, including tackling vulnerabilities (Shen and Li, 2018; Wang and Moriarty, 2018). These include sensors on smart infrastructure from that location-based data is passively collected *(ibid.)*. In addition, another source of big data are the points of interests where information is collected on citizens' activities at entry points or places of interaction *(ibid.)*. Then there are the social media comprising Facebook, WhatsApp, Twitter and many other related platforms.That is one of the invaluable sources of big data for development *(ibid.)*. Social media is a versatile source in that it is used in a manner that is two-way (Wang and Moriarty, 2018). Firstly, social media can be used to produce data through crowd sourcing of data, where citizens actively submit information to municipalities and other development agencies by using mobile phone-based surveys, hotlines and other means(Maaroof, nd). Secondly, municipalities and other development agencies can collect and filter data on urban issues from social networking sites through data mining and analytics *(ibid.)*.

It is noteworthy that if big social media data, that is, data generated by citizens and is stored in social network sites, if properly mined and analysed, it will be useful to municipalities and other development agencies in planning for and enhancing urban resilience. This data, at strategic levels, can be used to formulate evidence-based and responsive policies for urban resilience (*ibid.*). This is because big data provides real-time awareness of the prevailing situation in cities and, hence, can inform better design of policies and programmes for enhancing urban resilience (United Nations Global Pulse, 2013; Maaroof, nd). The same data can also be applied for monitoring purposes and provide early warning of impending dangers, thereby enabling quick responses to disasters(Bettencourt, 2014; Maaroof, nd). In addition, social medial data also provides real-time feedback on impacts of policies and programmes

that also enables prompt adjustment to action (Maaroof, n.d.; Wang and Moriarty, 2018).

It is important to note that while big data for development generated from citizens' invaluable potential for use in planning for and building urban resilience it has some challenges (United Nations Global Pulse, 2013 and Wang and Moriarty, 2018) One of the issues on big data relates to ethical issues of violating the privacy of individuals who have no control over the data collection processes, storage, retention and presentation. In this context, it is important to develop relevant legislative frameworks and ethical rules to protect the privacy of individuals when using big data for development (United Nations Global Pulse, 2013). For instance, ethical guidelines that emphasise the anonymisation of big data when it is being aggregated, analysed and used for development purposes can be developed.

The other issue on the utility of big data generated from citizens concerns the challenge of the digital divide, that is, the technological differences between countries and social groups in internet and cellular communication. For example, countries with low internet connectivity and cell phone use have fewer data generated by citizens, compared to countries with high internet connectivity and cell phone use which tend to have higher leverage on social media big data. Besides that, the generation of big data by citizens also varies with economic status and age groups. However, the limited use of big data in decision-making for urban resilience caused by technological differences can be resolved by increasing internet penetration rates and promoting the use of cell phones in countries and communities with less connectivity.

Further, the application of big data from citizens in planning for urban resilience is affected by the lack of capacity to analyse the data (United Nations Global Pulse, 2013; Fan, Han and Liu, 2014; Wang and Moriarty, 2018). This challenge is compounded by the complexity of big data and the lack of investment in the appropriate infrastructure and data storage and processing systems (Fan, Han and Liu, 2014; Taylor-Sakyi, 2016). However, this challenge can be addressed by continually and improving technologies and data mining analytical skills to making big

data generated from citizens useful in planning for urban resilience (United Nations Global Pulse, 2013).

The foregoing analysis shows that while cities are under threat of various shocks and stresses, these can be tackled through building urban resilience. The availability of large data sets from citizens through social media provides opportunities for improving planning decisions for urban resilience. To this end, formulation of right policies and design of better strategies to mitigate the impact of urban shocks and stresses can no longer be constrained by traditional ways of collecting data. The important issue is to tackle various challenges affecting the utility of big data generated from citizens to maximise its use for development purposes, including building urban resilience.

LITERATURE REVIEW

Building and planning for urban resilience require real-time and location-based data to inform decision making (Klein, Koenig and Schmitt, 2017; Villegas, Martinez and Krause, 2018). The decisions to be made include addressing questions on what to expect and prepare for, how to prepare for the shocks and risks, who are affected and where and by what magnitude and, in some cases, how frequent and what the time scale of the shock is. As put forward by Yamagata and Maruyama (2016), urban resilience is an umbrella domain that subsumes a complex combination of natural environments with diverse biological systems, civil infrastructure that is made up of engineering systems, economic, political and organisational systems. This, by implication, entails that data requirements for planning and building urban resilience are big.

Although it is acknowledged that planning and building urban resilience requires large volumes of complex data (Klein, Koenig and Schmitt, 2017; Villegas, Martinez and Krause, 2018), decision-making in developing nations is still constrained by lack of data and incapacitated human resources (Spaliviero *et al,* 2020). Relevant data on the behaviour of citizens, level of service delivery, the spatial distribution of people and services and levels of poverty are all critical for urban resilience planning (Yamagata and Maruyama, 2016; Deal *et al.,* 2017).

Yamagata and Maruyama (2016) also argue that to formulate an effective urban resilience strategy, it is important to determine the frequency and magnitude of shocks, the level of anticipation and the time scale of the shocks and risks. To determine these elements of shocks, there is a need for data that enables forecasting, establishing trends on occurrences of risks and shocks. Another critical component that is highly dependent on data from citizens is the behaviour and attitudes of the citizens themselves(Batty, 2013). This data is useful in establishing the goals and objectives of stakeholders that are varied and yet important for urban resilience-building(Hao, Zhu and Zhong, 2015; Rathore *et al.,* 2016; Cheshmehzangi, 2020b). Other issues that are of critical consideration in building urban resilience are data on crime hot spots and criminal activities, waste management and flood-risk zones, among others (Ivanov and Gnevanov, 2018).

Recent studies indicate that big data has the potential to assist cities in their day-to-day management of operations despite its current limited use by public institutions as compared to its application in the private sector (Shen and Li, 2018; Ivanov and Gnevanov, 2018; Wang and Moriarty, 2018). Big data can be applied to enhance decision-making in resolving an array of urban issues that include natural disasters, waste management, health, crime and safety, transportation and urban governance among many others(Wang and Moriarty, 2018; Spaliviero *et al.*, 2020). Some of the most important big data for urban management is social media big data that is generated from citizens through social networks.

Social media big data in cities has the potential of aiding cities in addressing service delivery issues (United Nations Global Pulse, 2013, Bettencourt, 2014; Maaroof, nd). Poor provision of urban services, if not addressed, undermines the liveability, sustainability and resilience of cities. While cities depend on various services, solid waste management service is one critical area where social media big data plays a vital role (Wang and Moriarty, 2018). Waste management involves processes of collection, transportation, monitoring and disposal. While these processes are driven by municipalities, they also depend on information from citizens whose input contributes to better decision making by authorities in providing waste management services (United Nations Global Pulse, 2013; Wang

and Moriarty, 2018). For instance, residents provide information to municipalities on areas requiring waste collection through citizen reporting platforms, thereby averting an environmental crisis that may occur if the waste remains uncollected. The data from social networks also assists the authorities in maintaining good environmental and sanitary conditions in cities, thereby enabling them to control vermin and diseases that affect urban resilience.

In addition, social media big data can be used in assisting traffic management and sustainable mobility planning in cities. Sustainable transport planning depends on data from various sources, including location-based data from sensors. Recent studies also indicate that data from urban residents' social networks, if mined and analysed properly, is vital in sustainable transport planning (Wang and Moriarty, 2018). For instance, big data from residents can be used to analyse the effects of permanent or temporary changes to the transport network system. These changes can be in speed limits, road closures or the introduction of bus-only lanes along some roads, In this case, the social big data be used in crowd sourcing the views of the citizens, who are the users of the road network to analyse the effects of such changes to improving mobility (ibid.). Besides that, filtering of data from social networks can also be used to resolve other urban transport issues, like congestion and parking within the system (Maaroof, nd).

Apart from that, data from social networks has been found to have the potential in facilitating timely responses to health vulnerabilities like epidemics and pandemics to cities(United Nations Global Pulse, 2013; Wang and Moriarty, 2018). These problems require quick responses as any delays can cause a severe impact on cities. In case of any such heath disasters like disease outbreaks occurring, social big data is useful in various ways (Cheshmehzangi, 2020a). It assists in providing early warning and awareness of the diseases in cities so that proactive action is taken (United Nations Global Pulse, 2013 and Cheshmehzangi, 2020). Further, the social big data is also important in indicating affected areas within cities and, hence, assists in directing action to those areas. Therefore, proper filtering and analysis of the social big data are

important in the health management of cities and assist in enhancing resilience.

Social big data has important use in planning and designing crime prevention and reduction strategies in cities, thereby creating a safe built environment for business, living and recreation. Some of the socio-economic vulnerabilities affecting cities are crime and insecurity. These twin problems have several consequences if left unmanaged and one of their worst effects is reducing the competitiveness of cities. In this case, once cities experience disinvestments due to crime and insecurity,itleads to the impoverishment of residents, thereby impacting their wellbeing and coping strategies in face of shocks and stresses. However, there are several proactive and reactive approaches to the management of urban crimes and insecurity in cities(UN-Habitat, 2007; Crowe and Fennelly, 2013).But, their effectiveness depends on addressing input from residents are affected by these issues. Thus, data from social networks is important in the planning and designing of crime prevention and reduction strategies in cities. Among other issues, this data assists in identifying crime hotspots and the nature of crimes that, in turn, help to inform the design of the management strategies.

Data from social networks can be used to assess vulnerabilities of the environment and ecosystems in cities to build urban resilience. This is because the state of the environment and ecosystem is related to the level of wellbeing and resilience of cities (UNDP, 2021). Thus, the degradation of the elements of the environment and ecosystem exposes cities' assets and their residents to risks, thereby compromising urban resilience. While the environment and ecosystem play an important part in reducing risks on cities, they are also prone to degradation from various factors (*ibid*.). To this end, social big data can be used to assess some elements of the environment and ecosystem in cities to understand their vulnerability status concerning urban resilience. A recent study shows that social big data in the Netherlands is being mined and analysed to measure air and noise pollution on city-wide scales to protect the health of residents

because polluted air and excessive cause illnesses (Wang and Moriarty, 2018).

Harnessing the potential of big data for urban panning involves many challenges. These challenges range from the digital divide, the design of the processing systems to means of analysing the data ((United Nations Global Pulse, 2013; Fan, Han and Liu, 2014). Some of the challenges are caused by the characteristics of big data, while some of the challenges are linked to current models and methods of analysing data. Fan, Han and Liu*(*2014) identify three main challenges; data complexity, computational complexity and system complexity. The complexity of big data, including the complex type, structures and patterns, makes the perception, understanding, representation and computation more challenging. On the other hand some of the feaures of big data, such as multiple sources, large volume, veracity and velocity, make it difficult to process, analyse and compute(Fan, Han and Liu, 2014; Jin *et al.*, 2015; Taylor-Sakyi, 2016).

The other challenge faced with big data pertains to the availability of suitable systems to handle big data in its diversity of types and applications (United Nations Global Pulse, 2013). French *et al. (*2015) add that in the field of planning, big data is challenging to use for long-range planning that requires anticipating policy intervention effects that cannot be met by big data alone. In the Zimbabwe situation, urban resilience-building is still in its infancy partly because of the challenges of data availability (UNDP, 2021).

RESEARCH METHODOLOGY

The study was informed by the interpretive philosophical worldview using the qualitative research approach. The qualitative method can get in-depth information about the usefulness, nature and value of big data. The qualitative method was adopted also because of its flexibility and that it generates insights for an understudied phenomenon where there is little or prior knowledge (Gratton, Jones and Jones, 2014; McNabb, 2015).

The exploratory research design was adopted in the study. This form of qualitative method is flexible and seeks to generate insights for an

understudied phenomenon with little or prior knowledge Hence, this approach was appropriate for the study, since issues of big data for planning and building urban resilience in Zimbabwe are understudied and there is a dearth of existing knowledge. Fifteen interviews were conducted to collect primary data, whilst document analysis of relevant council minutes and desktop review were used to gather secondary data. The documents were selected because they had data that is relevant to this study. Interviews were conducted with purposefully selected key informants from the public and private sector and experts in data collection, storage and analysis. The data collected was analysed using thematic narrative methods in which data was presented along thematic lines.

RESULTS

The study revealed that data from citizens has been useful in raising awareness about health problems in Zimbabwe. Zimbabwe has been affected by cholera and typhoid epidemics in the past two decades with Harare City being the most affected. In the recent past, the COVID-19 pandemic has also emerged as another health threat to the country. In these threatening health situations, social media has assisted in raising awareness about these diseases by indicating their spatial patterns of occurrence. The awareness of the occurrence of diseases has, in turn, assisted in targeting interventions in the affected areas. For instance, the identification of cholera and typhoid epidemics hotspots led to the implementation of water and sanitation programmes and other projects to alleviate the health crisis in suburbs, like Budiriro and Glenview. In addition, social media also assisted in indicating the hotspots for the COVID-19 epidemic in the country that happened to be the major cities and this led to the institution of responses limiting the movement of people in the form of lockdowns to manage the disease.

Case Study 1: Potential Of Big Data Harnessing And Utilisation In Harare City

Harare City is experiencing a plethora of challenges associated with service delivery, such as waste management, which is negatively affecting the quality of life of citizens (Murimoga and Musingafi, 2014). Big data has the potential of addressing most of these challenges. Using Big data,

Harare City can focus on making data-driven decisions in various facets of its operation, improving the lives of Harare residents. For example, Big data can be used by municipalities to develop smart cities and to integrate investments in social and human capital with the expansion of modern ICT infrastructure and traditional infrastructures to fuel growth. They refer to cities that are innovative and use ICTs to improve the quality of life of citizens through innovative products and services provided (Tomar et al., 2016). Usually, smart cities are a combination of components such as:

i. Physical infrastructure: technological factors, virtual, smart and mobile technologies. *Technological factors:* virtual, smart, physical infrastructure, smart and digital networks.
ii. Human factors: skilled computer scientists and statisticians, engineers, specialised teams sensitive to regulations and data ethics.
iii. Data collection tools: automated tools (sensors, digital devices, transponders, financial transactions), human-directed (drones, surveillance through satellites, CCTV) and volunteered (crowdsourcing, social media)
iv. Institutional factors: policy, governance, directive oriented and regulations.

MANAGEMENT OF MUNICIPALITY VEHICLES AND MACHINERY IN SMART CITIES

Council can use sensors data from their vehicles, machinery and other operating equipment for predictive maintenance to prevent cost-intensive vehicle breakdowns and machine failures. These vehicle breakdowns and machine failures can lead to poor service delivery and deteriorationof the quality of life of citizens. The sensors will collect and produce data about the vehicle or machinery conditions, such as temperature, voltage and vibration. The continuous generation of this data will allow municipalities to identify low-quality components and to monitor the condition of the vehicles and machinery and wear and tear in real-time.

TRAFFIC MANAGEMENT IN SMART CITIES

The smartness of cities is achieved by sensors and devices that collect useful information to provide services. For example, Harare City can use

traffic cameras in traffic management through the collection of real-time information about traffic status in different areas in Harare. This information can even be broadcast to citizens through radio for example, to inform citizens of major vehicular congestion issues, such as accident or traffic lights not functioning. This improves the quality of life of citizens through a reduction in energy use as the citizens use the shortest/most convenient route. This also reduces pollution. Thus, traffic optimisation can be done through the utilisation of real-time traffic information. Various industries can also use huge amounts of collected data to make informed decisions and, ultimately, smart services.

CASE STUDY 2: POTENTIAL OF BIG DATA HARNESSING AND UTILISATION

The study also showed that social media big data is important in managing crimes and insecurity in Harare and Epworth. It was found that the twin problems of crime and insecurity constitute socio-economic vulnerabilities in Epworth Township and the suburbs of Hatcliffe and Mbare in Harare. Residents in the affected suburbs indicated that these problems were severely affecting their livelihoods and psychological wellbeing as they are living in perpetual fear of crime and violence. The residents indicated that the high incidences of crime and insecurity in these areas are overwhelming the policing agencies. However, citizens are complementing the authorities in enhancing policing activities in various ways. The use of social media is one of the useful means that is aiding policing. Social media is assisting policing by providing information to authorities on committed crimes through citizen reporting, identifying crime hotspots and the nature of the prevalent crimes in these hotspots. The residents confirmed that social media is contributing to crime prevention and reduction, and improvement of safety in these affected areas.

Issues and incidences of drug abuse by youths are also brought to light by social media. The details of the effects of such abuses is made public through social media platforms, such as Twitter, Facebook and WhatsApp, through videos, images and textual narrations. The places where such acts occur and, in some instances, the causes, are exposed and elaborated on social media. The use of such data to craft intervention

measures to address cases of drug abuse, or to further interrogate, cannot be underestimated and the contribution towards creating resilient urban communities is of great value. Social big data has been used by police agencies to control crimes related to drug abuse.

Managing the degradation of the elements of the environment and ecosystems is one area where data from social media networks has contributed immensely to planning urban resilience. The maintenance of ecological balance in cities enhances urban resilience and this is achieved by maintaining environmental elements and ecosystems in good condition. For instance, wetlands in Harare are one element of the environmental ecosystems that are under threat of degradation due to encroachment of human settlements and other activities. Over the years, citizen, through various social network platforms, have been providing data that has enabled the monitoring of the state and use of these wetlands in Harare by the authorities and other stakeholders in environmental protection. This social media big data has facilitated central government and environmental organisations to take action to protect the wetlands in the city from degradation, thereby ensuring that they continue playing their environmental functions that improve urban resilience.

Zimbabwe's major cities have been affected by floods in the recent past. The occurrence of floods in different areas and their severity have been posted on social media by citizens from various cities. For example, several videos and pictures were posted on social media platforms by citizens on floods in Bulawayo, Gweru, Chitungwiza, Mutare and Harare in the 2020-21 rain season. In some cases, audio files of affected people narrating their experiences with the floods, were also posted on social media platforms. Instances of information on the occurrences of such disasters being shared on social media platforms by citizens have become common over the years. This shows the ability of social media as a source of data provided by citizens. This data can be used to inform interventions to build urban resilience in response to disasters that affect cities.

Findings also reveal that citizens use social media to raise awareness or complaints about various infrastructural and service delivery issues in

cities. Cases of burs water and sewer pipes are posted on social media. In most cases, the posts will have details on the location, the period that the burst has gone unattended and the effects of the bursts. Citizens also use social media to warn other citizens and to inform authorities about dangerous potholes or broken-down vehicles on dangerous spots on the roads. Similarly, traffic congestion on some roads has been reported by citizens using social media to inform other road users and the authorities to act on the issues raised.

DISCUSSION

It is important to note that in the new millennium, social big data is playing an important role in planning for urban resilience. One area in which big data generated from residents is assisting in building urban resilience is the management of epidemics and pandemics. These health threats, once they occur, require quick responses to reduce their debilitating impacts, particularly in cities where the concentration of people is higher. Among other benefits of social big data in managing health vulnerabilities in cities, is its usefulness in quickly indicating the spatial patterns of occurrence of the health problems. The identification of the hotspots of health vulnerabilities is important in subsequently informing the designing and targeting of responses to health problems. However, the use of social media in tackling health vulnerabilities is limited by the lack of proper systems of data mining, storage and analytics (Fan, Han and Liu, 2014; Jin *et al.,* 2015; Taylor-Sakyi, 2016).

Social media big data is playing an important role in aiding the management of crime and insecurity in cities. The magnitude of these problems is increasing in cities in tandem with rapid urbanisation. As a result of increasing crime and insecurity challenges in cities, policing authorities are overwhelmed by work, thereby prompting the need to find new ways of managing these challenges. The involvement of citizens in policing operations is one way that has been adopted to improve management of urban crimes and insecurity. Citizens are contributing to crime prevention and reduction in cities through providing invaluable data directly and indirectly to the policing and security agents through social networks. It is noteworthy that without using this social big data, it

is difficult to combat crime and insecurity, challenges in today's rapidly urbanising world. This shows that social big data plays a significant part in managing crime and insecurity, thereby impacting positively on urban economies and the social being and safety of residents.

A Model for Big Data and Citizen Participation Enhancement in Urban Zimbabwe

Citizen participation is crucial in the process of governance in smart-city initiatives to enable policy-makers and urban planners to take account of the citizens' real needs (Zhao and Yang, 2011). To support decision-making based on real citizen needs, there is need to incorporate the comments and opinions of the citizens (Luo, 2012). In Zimbabwe, cities have an opportunity to come up with big data solutions to improve service delivery, performance, productivity and policy-making process. However, for these to effectively harness the power of big data, organisations must consider several elements to get the expected benefits. There is need to promote citizen participation and the adoption of bid data initiatives by the organisations. Big data has vast potential to transform Zimbabwean cities. This article proposes a model for the implementation of big data initiatives and the enhancement of citizen participation in urban Zimbabwe. The model covers the pillars necessary for successful big data adoption (Figure 1).

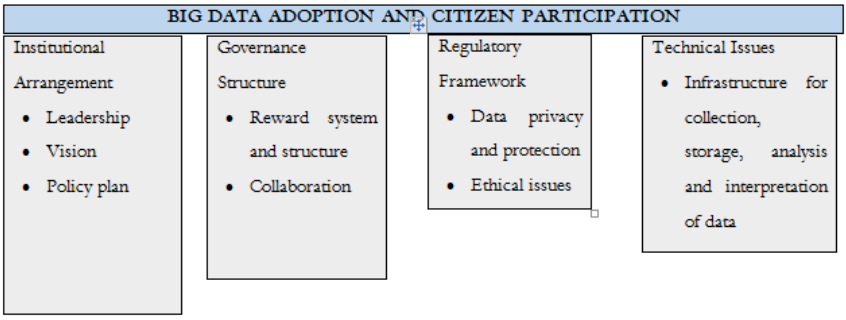

Figure 1: Pillars Necessary for Successful Big Data Adoption (Source: Authors' Creation, 2021)

Leadership: For big data initiatives to be successful, there is need for executive support and commitment. Leaders need to set clear vision and a policy plan forthe initiative.

Governance structure: There is need for governance structures that foster collaboration.For example, the private sector, universities and research organisations should work closely together to tackle complex public problems.

Regulatory Frameworks: There is need for regulation to ensure proper data usage and management. There is need to create rules in unfamiliar policy space that should cover appropriate sanctioning mechanisms for non-compliance and ethical usage.

*Technical issues:*For big data to be integrated, there is need for investment into the following infrastructure:

i. A platform for storing, organising and making data accessible.
ii. Computing power and technology that have the capacity of processing large scale data sets
iii. Data formats that are usable and structured (Bertot *et al*., 2014).

THE CONSCIOUSNESS OF CITIZEN PARTICIPATION IS NOT STRONG

This study showed that social big data can be useful in addressing vulnerabilities of elements of the environment and ecosystems to building urban resilience in cities. The use of data from social networks has been useful in protecting wetlands in Harare as residents assisted in alerting environmental agencies about the vulnerabilities of these ecologically sensitive areas. The data from citizens prompted action by relevant authorities to protect the wetlands from degradation. A recent study shows that the Netherlands has taken a more systematic approach to use social big data in environmental management to enhance urban resilience (Wang and Moriarty, 2018).

As cities grow and physical developments increase in concentration and spatially, disasters are also increasing. These disasters impact negatively on the lives of affected people who are, in most cases, the vulnerable and poor people. Their capacities and ability to bounce back to normal is often

difficult and, hence, the need for policy interventions to enable them to return to normal after disasters. Using social media platforms, it is possible to decipher data from citizens on disasters, that is, the nature of disasters, the magnitude of the disaster and the location. These are key attributes of data that is required to formulate interventions for resilience-building.

The challenges of infrastructure that is also key in resilience-building, can also be gathered from social big data. Citizens use various social platforms to raise infrastructural problems and traffic challenges. As such, the use of big data from citizens aids authorities in developing quick interventions, such as police control at road intersections. Thus, the findings from the study concur with those of the United Nations Global Pulse (2013) and Wang and Moriarty (2018), that big data plays a big role in ensuring timely responses to situations that require interventions.

CONCLUSION AND RECOMMENDATIONS

The study has shown that social big data is an important ingredient in the planning of support systems. More specifically, it has revealed that social big data, if properly mined and analysed, contributes immensely to planning for building urban resilience. Citizens are an invaluable source of rich data that can be used in urban resilience analysis and informing the designing of developmental interventions to tackle different vulnerabilities. The study also showed that big data comes in different formats, that is, videos, audio files, texts and pictures. This differentiation in the format and the heterogeneity of the data sources, makes it difficult to gather, store and analyse. Generalisations and, sometimes, the authenticity of the data provided by citizens using social media, pose challenges to the use of social big data.

Given the utility of big data generated from citizens in planning for urban resilience-building, it is recommended that governments and their agencies should recognise social big data as part of big data for development, that is, as a source of data for supporting policy-making and planning of development programmes, like building urban resilience, invest in the development of data mining and analytics of social media big

data. This entails the government building capacity in research that utilises big data generated from citizens to inform planning policy and action.

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