Revisiting the Layout Plan as the Basic Unit for Citizen Engagement for Urban Resilience in Zimbabwe: Remodelling the Script Under the Impact of Big Data

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Abstract

'Big Data' is the shape of things to come and as we approach the 'Technological Singularity'.It is influencing contemporary urban experiences through advanced data analytics that interface with personal digital devices. This article explores how Big Data and the concept of digital User Experience (UX) can be utilised to improve urban resilience through innovative citizen engagement. From a desktop review of existing literature, there emerge interesting possibilities of how the concepts of Blockchain, Big Data and UX can be utilised to enhance resilience from the layout (neighbourhood) to city-wide level. The emphasis of this enquiry is based on an alternative view of the layout plan as a product or service utilised by consumers to derive a living experience. The extraction and analysis of data sets from the individual layout have the potential to be used to enhance the living experience, thereby mitigating the impact of shocks through innovative technology-based citizen engagement techniques. Reference is also given to global attempts in developing facets of the urban information system. To demonstrate the potential of Big Data, Blockchain and UX in urban resilience a community resilience, information system model is proposed.

Keywords:*technological singularity, data, blockchain, user experience*

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INTRODUCTION

With the inception of the fourth industrial revolution, the world is poised for tremendous shifts as it moves towards the middle of the 21st Century. The United Nations predicts that by the year 2035, 62.5% of the global population will be living in urban areas (UN-HABITAT, 2020). Blazing toe to toe with this century's rapid urbanisation is Technological Singularity. Technological Singularity, predicted to occur around the year 2050, is described as a confluence of two scenarios. First, it is the emergence of autonomous super artificial intelligence as the composite outcome of accelerated computer technology development. Secondly, it is the use of technology to enhance or amplify human capabilities, giving rise to the post-human race that will be capable of overcoming physical and mental limitations (Eden *et al.,* 2015).

In this era of disruption and as we approach the middle of the 21st Century, the convergence of rapid urbanisation and technology will bring about changes to humanity on an unprecedented scale. Therefore, new approaches to how global communities strategise around resilience are required (Figure 1).

Background: The Shock Scenario in Zimbabwe

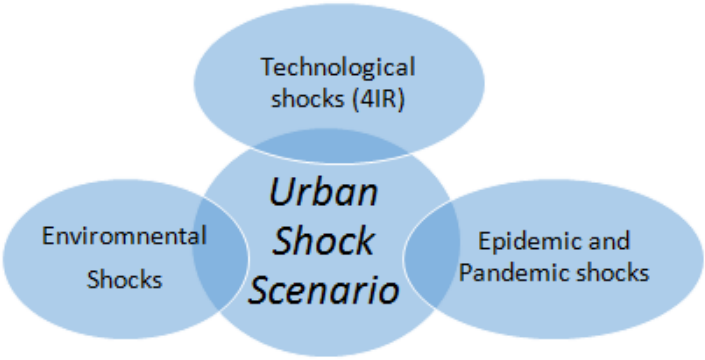

Figure 1: Existing Urban Shock Scenario (Author 2021).

Resilience is the ability to anticipate, absorb, accommodate or recover in a timely and efficient manner from the effects of a hazardous event. This includes the preservation, restoration and improvement of essential basic structures and functions (IPCC, 2012). The concept of resilience is based on strategies to mitigate natural and man-made shocks. It is critical within the context of this exploration to frame the existing shock scenario that exists in urban areas of Zimbabwe. First, there is the impact of climate shift. This global phenomenon is affecting existing urban infrastructure and its functionality through extreme weather events (excessive rainfall or droughts). In the case of Zimbabwe, cyclones Charlane, Eloise and Faraji that hit the country in the first quarter of 2021 are typical cases of extreme rainfall events (Moyo, 2021). The inverse of this phenomenon, extended dry spells, have also affected the country with negative impacts on traditional energy generation and supply.

The second shock set affecting the country are the impacts of the fourth industrial revolution. This technological revolution has remodelled traditional commercial and industrial urban functions (WEF, 2018), transmuting the majority of processes to digital platforms and consequently creating redundancies in conventional commercial and industrial processes. This has led to the extinction of traditional labour-based jobs in favour of more efficient automated systems. Thirdly, there is the impact of epidemics, such as cholera and pandemics, such as COVID-19. In the case of pandemics, such as COVID-19, with stringent lock-down measures being imposed throughout the world, there has been a shift from physical commercial interaction to online transactions as people across the world adapt to the global pandemic (Meyer, 2020). This rise in e-commerce will impact the structure, function and utility of urban space as we go into the future.

LITERATURE REVIEW

The layout plan is a product of the urban design process. Urban design is the process of designing and shaping the physical features of cities, towns and villages. It also involves planning for municipal services that support the functioning of the city (Massip-Bosch, 2020). The layout plan comprises road networks, residential, commercial, industrial, institutional, infrastructure networks and recreational land uses. These components of

the layout are what define neighbourhoods through design and, consequently, the physical parameters of local communities. In Zimbabwe, the *Layout Design Manual*, (1999) guides the layout design process. However, the layout design as a product is the subservient and most locally operational tool within the broader package of four national planning apparatus. These planning tools are governed by the Regional Town and Country Planning Act (Chapter 29:12, 1996).

The plans are distinguished by their spatial coverage, planning authority responsible and local community influence. At the top of this hierarchy is the Regional Plan. This plan is managed by a presidentially appointed regional council and its spatial extent combines two or more areas administered by separate local planning authorities (e.g. Town Councils or Rural District Councils). Secondly, there is the Master Plan which is developed to determine the probable future urban planning direction of a whole city or town. Its extent covers only the jurisdiction of a single local planning authority. Thirdly, there is the Local Plan. This plan covers a specific portion of a city or town and may have a specific urban planning objective within the context of the whole city. Finally, there is the layout plan. This is the most operational and locally impactful plan of the four national planning tools. This plan is guided by the Regional Plan (if in existence), the Master Plan and the Local Plan.

The volume of data that clinically defines the layout plan is immense. This data is both quantitative and qualitative in nature. To clearly understand the dynamics of a typical layout, data on land use, socio-economic activity and urban layout interdependency are required. Therefore, in attempting to develop a degree of control over urban shocks and stresses and thus enhance resilience within local urban communities and consequently the entire urban system, a large volume of data and its analysis is pivotal. This data has to be stored, analysed and translated into information that can advise future urban resilience frameworks and strategies (Floridi, 2010).

Ordinarily, the term 'Big Data' is a general description attributed to large sets of complex structured or unstructured data that traditional data processing application software is unable to process and analyse. Naturally, Big Data is characterised by its volume, variety and velocity.

The Big Data concept has led to an evolution from a model-driven science into a data-driven science paradigm (Boyd and Crawford, 2012; Soomro *et al.,* 2017; Breur, 2016). Today the term 'Big Data' is synonymous with predictive and behaviour analytics that extract value from Big Data. This is now the most valuable and relevant characteristic of the new data ecosystem (Boyd and Crawford, 2011).

The urban resilience agenda is still driven by models, such as Sustainable Development Goals (United Nations, 2015) and the City Resilience Profiling Tool (UN-HABITAT, 2020). However, the volume of data that is used to create and manage urban settlements is immense, varied and extremely fluid in terms of time-space variations. To achieve enhanced resilience in our urban settlements, there is now need for urban settlement design and management to shift from a model-driven approach to a data science paradigm.

Citizen participation or civic engagement is a collective effort of people with a common interest attempting to develop solutions to a common cause and is a key pillar in the operation of democracy (Checkoway and Aldana, 2012). Civic engagement can be in the form of volunteerism, community engagement and organisational participation (Ekman and Amna, 2012). Technology can be a critical aid in enhancing civic engagement. The concept of civic technology can be helpful in this regard. It is described as technologies that enhance the relationship between people and governments through the use of software applications for purposes of communication, decision-making, service delivery and political processes (Mandarano, 2011).

The description of community is characterised by two key facets that aim at improving the quality of life. The community as a place and also the community as relationships. The concept of community is further operationalised by residents having a strong perception of their environment, a degree of control as regards collective action and participation in local social relationships (Charin and Wandersman, 1990). Furthermore, it has geographic boundaries and a common fate. It is comprisebuilt, natural, social and economic environments that influence one another in complex ways (Pfefferbaum and Wyche, 2008). These

definitions fit perfectly with the design standards of a layout plan (*Layout Design Manual,* 1999, Department of Physical Planning, Government of Zimbabwe).

In terms of community participation, current research asserts that traditional approaches relating to community engagement need to be shifted to achieve success in local reform programmes (Jones *et al.,* 2007; O'Flynn, 2007; Grindle, 2004). It requires city managers and local representatives to develop a customer-oriented approach as regards service delivery (Navarra *et al.,* 2005). There is now need for clarity in the conceptualisation surrounding the outcome of local governance (Kanat and Ozkan, 2009) and what is being done to achieve results. To solidify the applicability of community participation, communities need instrumentation to share their knowledge with city managers and local representatives (Bozeman, 2002; Geddes, 2005). This shift in approach to contemporary resilience programmes and community participation, can critically benefit from the understanding of community structure through the physical community layout design. This understanding of community structure can then be further augmented through the use of Big Data applications.

Blockchain may be described as a database storage system that is decentralised and utilises the distributed ledger technology. This database is continually updated as new transactions are entered into the system. The list of records in the system is decentralised and thus not controlled at one single location. Each entry (new record) into the Blockchain cannot be done in isolation but has to be recognised and approved by all parties in the system. This concept of distributed equal control makes the system tamper-proof and un-hackable (Zile and Renate, 2018; Gomber *et al.,* 2018). The main application of Blockchain has been in the financial sector with the inception of crypto currencies but its concepts of distributed ledger and communal verification can be applied to any sector that utilises database structures including urban planning and management systems.

To clearly understand User Experience (UX), it is first important to define a product. A product is any good, service or idea that is offered on the market in an attempt to satisfy a need or want. It is physically or

intellectually consumable (Kotler *et al.,* 2006). The common link between the consumer and product is the UX. User Experience is described as all aspects that a user has with a product, essentially how it is perceived. Seven factors describe UX. In terms of the product, the critical seven factors are, is the product useful, usable, findable, credible, desirable, accessible and valuable (Morville, 1998). The layout plan and, consequently, the urban settlement according to the above definitions, can be described as products of planning. Through the application of the concept of UX, a new perspective may be gained that can elicit new dimensions on how to engage citizen participation in enhancing resilience through UX based layout design.

The City Resilience Profiling Tool was developed as the flagship initiative of the City Resilience Profiling Programme (CRPP) under UN-HABITAT. This tool is designed to support local governments in improving resilience. It is designed to output more comprehensive and integrated urban planning and management strategies that measure and profile resilience at a city-wide level (UN-HABITAT, 2020). It considers five critical and inter-dependent aspects common to human settlements. These are spatial attributes, organisational attributes, physical attributes, functional attributes and time. Within the context of resilience, citizen engagement and Big Data, this tool is highly useful in developing urban database systems and models that can enhance resilience at local and city levels.

Simulation may be described as the mimicking of real-world events through the use of modelling aided by advanced super computer applications. These models are based on key behaviours or characteristics of the system and how it would react if system variables were altered (Banks*et al.,* 2001; Srinivasan *et al.,* 2020). The nature of Big Data is that as a stand-alone entity, it is difficult to make sense of, however, with the use of advanced computing algorithms, patterns and trends can be computed for analysis. The value of simulation in urban planning is futuristic in that it is used to anticipate and enhance preparedness for future shock events that might impact urban settlements, whether they are environmental, economic, social or political.

Social media has created many new mechanisms for data creation. Moreover, it democratises data creation. The simple answer is that data helps us make better decisions. Data is simply a record of events that took place. The first step in making Big Data useful is to identify the relevant data (Duvvuri and Umar, 2015). The explosion of social media platforms may be viewed as an opportunity that can allow urban planning and management to positively interact with citizens at the community level. These platforms essential thrive on the distributed ledger concept as information is only accepted within the social network if it is verified by the majority of users. The integration of such platforms into community management information systems will not only improve the character profile of city management, but also positively engage citizens in the affairs of their city.

RESEARCH METHODOLOGY

The research framework was posed about the concept of how Big Data and its application has the potential to enhance resilience within Zimbabwe's urban settlements. It focused on how the single residential layout can be the basic unit for city wide information systems that enhance resilience with citizen engagement as a major component. The main focus of the study was how citizen engagement can be effected at the community layout level, thus making the urban layout pivotal as it defines the physical territorial boundary of a community. Therefore, Big Data concepts that could be utilised on the individual layout were taken into consideration. The key parameter of the study was how concepts of data, data processing and analysis can be augmented into urban resilience. This approach was advantageous as it isolated only the key concepts of Big Data that are appropriate at a local level.

The data utilised included a desktop review of key Big Data application concepts, published journals and existing local urban development and management frameworks. Case studies from around the globe were also utilised to demonstrate the scope and potential of Big Data applications and citizen involvement in developing facets of physical, social and economic urban information systems. The data obtained are presented as key concepts in the literature review and was used to develop the three components of a probable city-wide resilience information system that can

be utilised for urban management and planning. This model was developed using the layout as a basis and, consequently, superimposing local and city data sets using concepts of Blockchain, UX and event simulation.

RESULTS

The implementation of resilience programmes has shifted from the national level to the grassroots and affected communities must rely on local assets, such as social networks, local infrastructure, social capital and manpower. In terms of community resilience, the utility of three basic elements, that are people network, common interests and shared identity must be capitalised on (Rapaporta *et al.,* 2018).

CASE STUDIES

The need to collect and analyse urban data has given rise to Urban Informatics. This is a trans-disciplinary practice that focuses on the three dimensions of people, place and technology. It refers to the study of how urban communities create, apply and use information, technology and data in cities and urban environments (Foth *et al.,* 2011). Within the context of data, urban resilience is, therefore, the applied amalgamation of urban information in the development of resilience strategies. Four casestudies are explored and cover how Big Data is being utilised to enhance resilience through urban infrastructure management systems, citizen participation, community health information systems and hotspot mapping.

CASE STUDY 1: CITY MANAGEMENT: DEVELOPMENT AND DESIGN OF AN URBAN INFORMATION SYSTEM (UIS), ZONGULDAK TURKEY

The city of Zonguldak initiated the development of an Urban Information System (UIS) in an attempt to understand spatial dynamics taking place in the city. This was driven by the awareness that rapid urban growth will continue to occur globally and will be most intense in lesser developed countries. This growth, from their perspective, would pose a significant challenge to urban planners and city managers. Thus, there was a need to capacitate urban planning management and develop a tool to assist them in tracking and analysing urban development movements over time. This database was developed using primarily Geographic Information Systems

and Remote Sensing technology. The outcome of this exercise was the UIS that urban planners would utilise to monitor developments and levels of service provision (Alkan and Gunnur, 2010).

Case Study 2: Citizen Participation: Resolution of City Public Complaints in Sri Lanka

Traditionally, city infrastructure complaint procedures are analogue in nature requiring complainants to make physical reports regarding the breakdown of city infrastructure. Complaint reports usually encompass requests to repair potholes, flooding, overdue garbage collection, burst water and sewer pipes. This reporting method is also uni-directional with typically no feedback for city authorities. In an attempt to implement the Open Government Initiative, cities in Sri Lanka developed a digital platform dubbed Spotlight® as a tool to solicit citizen participation in the complaints reporting process. This digital reporting system can upload video, images, GPS location, track complaint progress and receive updates and merge-common complaints. This innovative digital platform thus allows for continuous bi-directional communication between city management and citizens, thereby bolstering public participation in city operations. The main thrust in the development of Spotlight® was to bridge the gap between current and expected complaint report standards. Globally, Spotlight® is but one of many digital platforms available for city complaint reporting with other applications, such as SeeClickFix, BOS: 311 and FixMyStreet, being available on the market (Pathmanathan and Pouler, 2017).

Case Study 3: Design of Community-Based Health Information Systems: Mozambique

The World Relief Corporation (WRC), through the Child Survival Technical Support Project and in conjunction with the Ministry of Health (Mozambique), initiated the development of a community-based health information system. This was done in the district of Vurhonga that had an estimated population of 130 000. This project designed an elaborate health information system that was based on quarterly household surveys and monthly reports from field operators. It used the district physical maps as a base and on this base layer, mapped out all district health facilities and catalogued health cases that occurred. On completion of this

project, the community-based health information system was handed over to the Ministry of Health to be integrated into its mainstream management system (Child Survival Technical Support Project, 2003).

CASE STUDY 4: CITY OF HARARE HOTSPOT MAPPING

In 2020, a Rapid Hotspot Mapping exercise was conducted by the University of Zimbabwe, in collaboration with UNDP and the Ministry of Local Government. This exercise aimed at mapping areas within the City of Harare that were characterised by high socio-economic vulnerability, zones with a high intensity of informality, locations of disease outbreak and environmental vulnerabilities. This report is instrumental in providing local authorities, government departments and ministries with information about the spatial nature of vulnerability, thus allowing for more informed planning and decision-making. The hotspot data was developed using a GIS platform that allowed various data sets to be manipulated and analysed independently or in combination and thus reveal new insights into urban vulnerability (UNDP, 2020).

One of the most distinct advantages that Zimbabwe has is the existence of a robust urban planning framework. This framework includes the design process that produces the layout plan and it is this instrument that has the potential to be utilised as the basis of a new data-driven urban resilience strategy. That layout plan, by its nature, clearly defines urban community boundaries, thus make citizen engagement easier through the development of localised resilience information systems. The ground-breaking Hotspot Mapping exercise done in Harare demonstrates the potential applicability of Big Data in urban resilience planning and development. It also ushers in a new era of urban informatics which will potentially drive urban planning into the future. The availability of computing applications that directly interface communities with the planning process, coupled with information systems developed upon the concepts of Big Data, Blockchain and User Experience has the potential to transform the face of urban resilience strategies, thereby making local cities more adaptable to shocks and stresses.

CONCEPTUAL FRAMEWORK: BIG DATA, BLOCKCHAIN AND USER EXPERIENCE

Theoretically, the combination of the concepts of Big Data, Blockchain and User Experience, superimposed on a typical urban layout can begin to expose interesting data patterns that can be packaged into information sets to enhance resilience efforts in urban areas. This can be achieved by focusing primarily on the neighbourhood layout as the micro structure of the citywide urban ecosystem. The application of these technological concepts on urban development layouts can be foundationally based on active innovative community involvement through the use of digital applications available on personal digital devices (smart phones) that are widespread throughout communities.

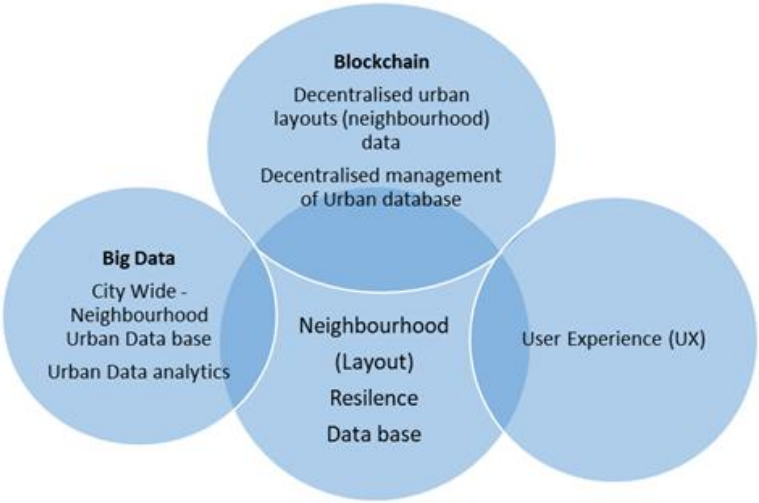

Figure 2: *Conceptual framework of the application of Big Data, Blockchain and User Experience for urban resilience (Author, 2021).*

THEORETICAL FRAMEWORK: THE NEIGHBOURHOOD RESILIENCE INFORMATION SYSTEM MODEL

The proposed Neighbourhood Resilience Information System will be predicated upon the single neighbourhood layout that defines a

community. Key in the design of this system will be the concepts of Big Data, Blockchain and User Experience (UX). This system will comprise three components, that are the neighbourhood information system, the city-wide information system and the neighbourhood user experience platform.

THE NEIGHBOURHOOD RESILIENCE INFORMATION SYSTEM

This system will comprise five key data sets, that are environmental, social, economic, built infrastructure and vulnerability hotspots. The environmental data will have subsets that catalogue topographical, ecological, hydrological and geological data. The social data set will have subsets that catalogue health, population, social behavioural trends and their locations. The economic data will have subsets that catalogue gross and net neighbourhood incomes, local expenditure patterns, economic goods and services generated in the neighbourhood. The built infrastructure data set will comprise subsets that catalogue roads (type and size), sewerage, electricity networks, storm water drainage networks, accommodation (types and size) and social infrastructure. The hotspot data category will catalogue zones of high socio-economic vulnerability, zones with a high intensity of informality, locations of disease outbreak and environmental vulnerabilities. To engage the community at the neighbourhood level (micro layout level), a queries and complaints platform with similar attributes as Spotlight® and other proprietary query software, will be integrated as a key component. The complaints-and-query platform will, as a standard, have the ability to upload video, images, GPS location, track complaint progress and receive updates and mergecommon complaints. Furthermore, the neighbourhood information system will also be a simulation capable to determine the impact of shocks by climate shift, technology advancements and disease outbreaks (epidemics and pandemics). Figure 3 illustrates the theoretical framework of the Neighbourhood Resilience Information System.

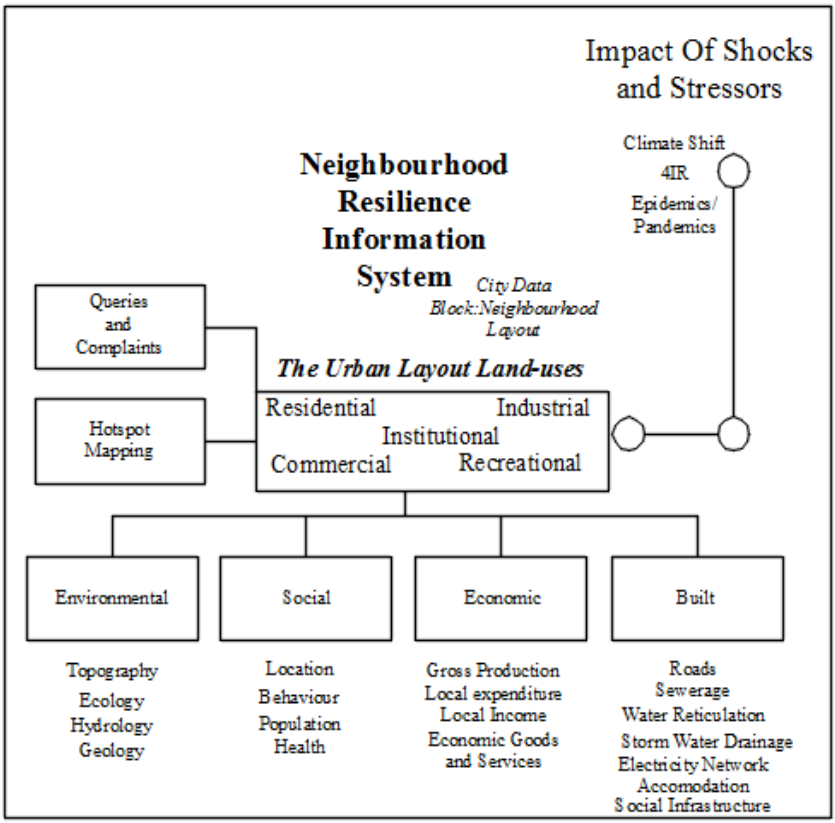

Figure 3: Theoretical framework for Neighbourhood Resilience Information System (Author, 2021).

THE CITY-WIDE RESILIENCE INFORMATION SYSTEM

The City-Wide Resilience Information System will be an aggregate of the neighbourhood information systems that are a part of the city. Apart from collecting, storing and analysing data from neighbourhood systems, the city-wide system will be able to execute simulations at a higher city-wide level and use this data to assess the response of the city system to shocks and stresses. Figure 4 illustrates the City-Wide Resilience Information System.

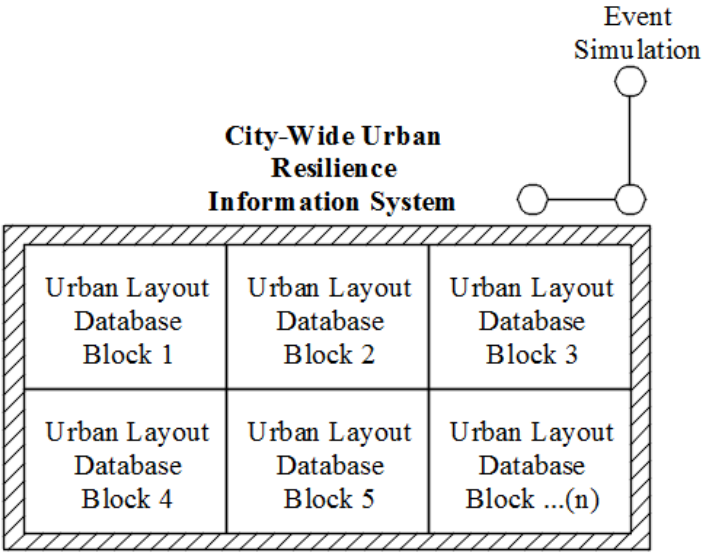

Figure 4: Theoretical framework for City-Wide Resilience Information System (Author, 2021)

NEIGHBOURHOOD USER EXPERIENCE ASSESSMENT INFORMATION SYSTEM

The neighbourhood and city-wide databases essentially comprise objective data. If the resilience drive in Zimbabwe is to be multispectral, there is a need to develop information systems that catalogue and analyse subjective data. This is where the User Experience (UX) Assessment Information System plays a key role. The theoretical concept of this system is based on the assessment of experience that the community derives from living in a specific neighbourhood (layout). This system will be an integral component of the city-wide system and will provide city urban planning management with data on the perceptions of the community as regards how this urban product/service (layout) is meeting their needs and wants. This system will be based on a social platform that will allow residents to comment and suggest improvements. The community environment will be assessed based on the matrix of human needs (Max-Neef, 1991). Figure 5 illustrates the theoretical framework of the Neighbourhood User Experience Assessment Information System.

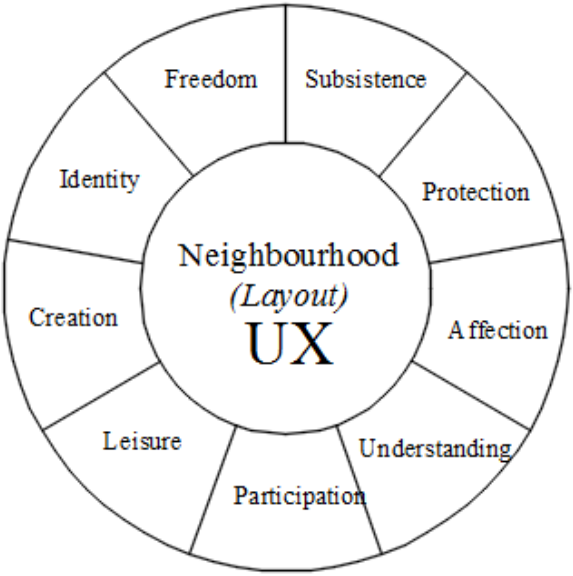

Figure 5: User Experience Design for Assessment of Neighbourhood Liveability (Author, 2021).

DISCUSSION

The results of the study demonstrate how the challenge of rapid urbanisation and associated urban shocks and stresses can be mitigated by tactfully integrating Big Data applications into urban management systems. The outcome of this study strongly points to the potential of using Big Data generated at the neighbourhood (layout) level to enhance resilience through innovative citizen engagement. The development of the proposed Neighbourhood Resilience Information System, the City-Wide Resilience Information System and the Neighbourhood User Experience Assessment Information System will benefit both communities and planning authorities by presenting a common and accessible platform upon which innovative city development and management solutions are formulated. The distinct advantage of the model proposed is that it is

intended for use at the urban micro level which is the neighbourhood, whether it is formal or informal. This will, therefore, ensure the equitable representation of minority, low income and youth groups that are generally overlooked in conventional local governance systems (Griffin and Newman, 2008). Citizen engagement at local urban levels through the use of digital platforms, will ensure greater buy-in of decisions, thus fostering trust between all urban actors. It will also lead to the successful realisation of resilience strategies through creative solutions developed by communities. Consequently, citizen engagement will lead to the faster implementation of urban resilience policies and programmes, thereby building sustainable communities and better service delivery (Moore *et al*., 2016)

Within the context of local resilience initiatives, this study contributes to the ground-breaking resilience Hotspot Mapping of Harare (UNDP, 2020) by proposing conceptual neighbourhood and city-wide resilience models. These models can be developed using the Hotspot Mapping exercise as a reference framework. This study also expands urban planning and management to encompass and derive benefit from the trans-disciplinary field of urban informatics, thereby empowering it with the concepts and tools of applying Big Data into urban planning and management.

CONCLUSION

The purpose of this study was to explore the potential contributions of the layout as the basic unit for citizen participation in the drive to enhance resilience in urban settlements. Through the exploration of Big Data concepts such as Blockchain, User Experience and Event Simulation, coupled with the corroboration of case studies, it has been demonstrated citizen engagement can be enhanced locally through the use of Big Data applications. Finally, the proposed Neighbourhood, City-wide and the Neighbourhood User Experience Assessment Information Systems have the potential to transform how the resilience drive is approached within the cities of Zimbabwe.

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