iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** VIII **Month of publication:** August 2024

DOI: https://doi.org/10.22214/ijraset.2024.63908

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VIII Aug 2024- Available at www.ijraset.com

Reviewing the City Concepts: Towards Smart, Sustainable, and Healthy City

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Abstract: ***The complex challenges of urbanization demand innovative strategies from both public and private sectors worldwide. Despite numerous planning initiatives branded with distinct city labels, the health of citizens remains an underemphasized concern. This qualitative study seeks to address the intricacies of urbanization and its negative health effects by advocating for an integrated framework that combines technology, sustainability, and health to create "smart, sustainable, and healthy" cities. The study aims to understand city concepts, their emergence, application, and evolution. It conducts a comparative analysis of achievements and challenges in implementing these concepts, identifying the need for progression. The study categorizes the city concepts under technology, sustainability, and wellbeing to highlight the need for a hybrid city concept, focusing on the need for a more integrated approach to urban planning. The findings reveal a dynamic and complex interplay among these domains, highlighting the need for collaborative efforts to prioritize health within the broader scope of smart and sustainable urban development. This approach ensures that urban health receives the attention it deserves in modern urban planning.***
Keywords: Healthy city, Smart city, Sustainability, Urban health, Urbanization.

I. INTRODUCTION

Urbanization is a defining phenomenon of the 21st century, presenting a myriad of challenges that require innovative and adaptive solutions. With over half of the world's population now residing in urban areas, cities have become epicenters of economic activity, cultural exchange, and technological innovation. However, this rapid urban growth has also led to significant challenges, including environmental degradation, resource scarcity, and socio-economic disparities. These issues necessitate a multifaceted approach to urban planning and development, integrating various dimensions such as technology, sustainability, and health to create livable urban environments.

Over the past few decades, numerous city planning initiatives have emerged, each characterized by distinct labels such as, participative cities, walkable cities, integrated cities, inclusive cities, just cities, open cities (focusing on social facet); entrepreneurial cities, competitive cities, productive cities, innovative cities, business-friendly cities, global cities (focusing on economic facet); efficient cities, managed cities, well-run- well-led cities (focusing on governance facet) etc. [1]. Subsequent paragraphs, however, are indented.

Smart City is a global initiative that uses technology to enhance urban quality of life and wellbeing [2]. Successful examples include Dubai's Smart Dubai Plan [3] and Singapore's Smart Nation Plan [4]. India's Smart City Mission, launched in 2015, aims to provide liveable, inclusive, and sustainable solutions to urban challenges [5].

Despite the proliferation of smart city initiatives, there is a noticeable gap in addressing the health of citizens comprehensively. The concept has evolved to cover sustainable development taking into account environmental, social, and economic factors [6] but health issues remain inadequately addressed, particularly in developing countries like India [7]. The COVID-19 pandemic has exposed the limitations of self-proclaimed smart cities in dealing with urban health challenges. Sassen & Kourtit (2021) cite examples from cities like Chicago, Beijing, and Athens to illustrate that being labelled as a smart city does not necessarily equate to effectively addressing urban challenges, including safety, income inequality, smog, congestion, and air pollution [8]. To address these issues, researchers suggest adopting more qualitative and equity-informed urban health frameworks that consider factors such as sanitation, water, housing, and socioeconomic inequalities [7]. Additionally, leveraging big data analytics and IoT technologies can help identify and resolve health-related challenges in smart cities [9], [10]. Integrating the 'healthy cities' concept with smart city initiatives and reconceptualizing digital divides in terms of socioeconomic gradients could promote better health outcomes and reduce inequities in urban environments [11].

Literature suggests that health often remains a secondary consideration, overshadowed by technological and environmental priorities in bringing about reforms in city planning. This oversight can lead to urban environments that, while technologically advanced and environmentally sustainable, may not fully support the physical, mental, and social well-being of their inhabitants.

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The Healthy City Programme (HCP) recommended by NITI Aayog in India in 2021 [12] is in response to the growing health and environmental concerns and aligns with the WHO HCP that was conceived in 1984. It prioritizes a holistic approach to health, focusing on physical, mental, social, and environmental well-being [13].

This paper proposes a holistic approach to urban development that integrates technology, sustainability, and health, advocating for the creation of "smart, sustainable, and healthy" cities.

II. METHODOLOGY

The study employs a systematic literature review with the following objectives:

1) To study the definitions of city concepts (what) in order to comprehend their respective focus areas, investigate the reasons behind their emergence (why), identify examples to illustrate their application (where), and determine the chronological development of these concepts (when) to discern patterns of evolution.

2) To conduct comparative analysis outlining the achievements and challenges in the implementation of city concepts to understand the need for progression from one city concept to another.

3) To categorize the city concepts under the major domains of technology (smart), sustainability (sustainable) and wellbeing (health) to highlight the need for a hybrid city concept.

A. City Concepts

TABLE I
DEFINITIONS OF DIFFERENT CITY CONCEPTS.

City Concept	**Definition (What)**	**Focus Areas**
Web/ Virtual Cities	Digital representations (2d or 3d) of urban areas for dissemination of wide range of services, functions and information to act as new 'electronic' public spaces [14].	Access to services and information through local ICT network initiatives.
Knowledge Cities	“A knowledge city is a city that aims at a knowledge-based development, by encouraging the continuous creation, sharing, evaluation, renewal and update of knowledge. This can be achieved through the continuous interaction between its citizens themselves and at the same time between them and other cities’ citizens. The citizens’ knowledge-sharing culture as well as the city’s appropriate design, IT networks and infrastructures support these interactions” [15].	Development and advancement of technologies and socio-economic activities.
Digital city/ information city	Large infrastructure for virtual communities [16].	Social inclusion
Ubiquitous City	The aim of U-city is to create a built environment where any citizen can get any services anywhere and anytime through any ICT devices [16].	Provision of services and data flow from anywhere to everyone.
Broadband/ wired City	A city which interconnects the households and local enterprises with the use of ultra-high-speed networks which is enabled by installation of fiber optic network [16].	Provision of education, and services like shopping, working, television from home, etc.
Mobile/Wireless/Ambient Cities	“A city in which the wireless infrastructure is based on transmission and reception of radio wave signals” [17].	Access to wireless broadband networks across the city or in some districts.
Eco City	“An urban environmental system in which input (of resources) and output (of waste) are minimized.” [18].	Shaping cities upon ecological principles using compatibly designed technology, Environmental sustainability
Sustainable city	“Development of a city that meets the needs [and aspirations] of the present without compromising the ability of future generations to meet their own needs” [19].	UN Sustainable Development Goals -17
Smart City	“A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens” [20]	Provision of Smart Economy, Smart Environment, Smart Mobility, Smart Government, Smart Living, Smart People using ICT.

Intelligent cities	"City which effectively utilises the vast knowledge which comprises all the city's components through the application of engineering and information technology to produce a networked, safe, compact, sustainable and beautiful city" [21].	Efficient management of resources and energy, Employing new sources of energy, Adopting renewable sources of energy.
Healthy cities	"A healthy city is one that continually creates and improves its physical and social environments and expands the community resources that enable people to mutually support each other in performing all the functions of life and developing to their maximum potential" [22].	Disease prevention and health promotion, Improvement of social and physical conditions to support the quality of life of residents
Liveable Cities	Liveable city or community is recognized as a place with qualities that are suitable or good for human life [23].	Basic goods and services and experiences essential for human life.

Table 1 provides an overview of different city concepts and their respective definitions (what) along with their focus areas. Table 2 presents an overview of year of emergence (when), reasons of emergence (why), examples (where) and of the city concepts.

These city concepts encompass diverse urban development approaches, ranging from digital and knowledge-based cities to sustainable and healthy cities highlighting the evolving nature of cities in response to urbanization challenges and evolving societal needs. The challenges faced by a city due to urbanization are overcrowding, lack of public spaces, congestion, sanitation, solid waste management, quality of housing, safe and adequate water supply, public health, poor air quality, climate change and environmental degradation, etc. [18], [23], [24]. The study of the city concepts highlights the imperative role of technology, need for sustainable environment and promotion of residents' well-being in shaping modern urban landscapes.

The emergence of Web/Virtual Cities in 1997 was driven by the need for alternative public spaces amidst rapid urbanization and the widespread use of the internet. The inception of Knowledge Cities in 1998 was motivated by the imperative of effective knowledge management, leading to the development of knowledge-sharing communities like Barcelona's 22@bcn Plan and Singapore's One-North precinct.

Moreover, the rise of Ubiquitous Cities in 2004 stemmed from the aim of extending digital city services to local communities seamlessly, addressing the limitations posed by physical distance and time. This trend is exemplified by the implementation of innovative initiatives in South Korean cities like New Songdo and Busan.

Furthermore, the emergence of Sustainable Cities and Eco Cities in 1987 responded to the pressing need for environmental conservation and sustainable development, giving rise to eco-friendly urban areas such as Sweden's Hammarby Sjöstad and the Sino-Singaporean Tianjin Eco-city, as well as sustainable initiatives like Copenhagen's carbon-neutral plan and Vancouver's Greenest City Action Plan.

These city concepts do not follow a fixed pattern of the time of origin in different regions of the world. For example, the healthy city concept saw its inception in 1984 as a WHO initiative; gained momentum across Europe and eventually evolved in the other 6 regions of WHO and is still in a working phase. It is only in India, that this concept has been introduced in 2021[12]. Need-based evolution of these concepts is driven by social, political, economic, legal and technological factors.

It has been observed from the study of definition, objectives and reasons that there is an intricate interplay between the three domains of technology, sustainability and health; and policy formulation underscoring the importance of a holistic approach to city planning. Table 3 provides insights into the achievements and challenges of city concepts. Each concept has exhibited unique contributions and limitations in the implementation process. Web/virtual cities demonstrated advancements in information dissemination but encountered obstacles such as citizen engagement and digital divide issues. Knowledge cities attracted research interest and became hubs for innovation but faced challenges related to political will and financial support.

Similarly, digital cities facilitated cultural integration but were hampered by maintenance costs and technological dependencies. Ubiquitous cities enabled real-time data processing and automated decision-making but grappled with data privacy concerns and housing affordability. Broadband/wired cities fostered a networked society but overlooked social implications, reducing physical interactions. Mobile/wireless/ambient cities accelerated e-governance but brought forth issues of digital divide and technology addiction.

Eco cities emphasized sustainability but struggled with high implementation costs and diverse developmental priorities. Sustainable cities integrated multiple dimensions but encountered difficulties in managing existing urbanization and garnering public participation. Smart cities aimed for inclusivity but faced challenges with a top-down approach and health concerns. Healthy cities prioritized well-being but had limited reach, similar to the concept of liveable cities, which mostly remained a conceptual model.

TABLE 2
YEAR OF EMERGENCE (WHEN), REASONS OF THEIR EMERGENCE (WHY) AND EXAMPLES (WHERE) OF THE CITY CONCEPTS.

City Concept / Year of occurrence 'When'	Reason of evolution 'Why'	Examples 'Where'	Source
Web/ Virtual Cities/ 1997	Lack of public space due to urbanization, Haphazard widespread use of internet.	Tourism oriented: • Bristol OnLine, Bristol, USA (1997): (http://www.lembke.com/bristol.html)- obsolete link (http://www.digitalbristol.org/) History / archival data oriented • Rome Reborn (2007) (https://www.romereborn.org/) • Virtual Kyoto, Japan (2002) Government Initiated: • Virtual City Government of Lubbock, USA (1998) (https://ci.lubbock.tx.us/)	[14], [25], [26], [27]
Knowledge Cities/ 1998	Knowledge management.	• 22@bcn Plan, Barcelona (1999) • Austin 2010 Plan, Austin, Texas (2010) • Helsinki, Finland (early 1990's) • Connecting Victoria, Melbourne, Australia. (1999) • One-North knowledge community precinct, Singapore (2001) • Delft, The Knowledge City (1996)	[15], [16], [28], [29], [30]
Digital city/ information city/ 1994	Lack of association between people.	• De Digitale Stad (The Digital City) in Amsterdam (1994-2001) • Bologna Iperbole Initiative (1995) • Portuguese digital cities (1998)	[14], [16]
Ubiquitous City/ 2004	Digital city's limited spread to the local communities, To overcome the limitation on physical distance and time.	• Unjeong city, south Korea (2006) • New Songdo, South Korea, (2003-2020) • Busan, south Korea (2006 - 2012) • Mapo, South Korea (2009- ongoing)	[16], [31]
Broadband/ wired City/ 1970	To tackle urban problems through telecommunication. Lack of access of electronic communication services to households and businesses in local communities.	• Seoul, South Korea (1997) • Beijing, China (1999), • Helsinki (1995), • Geneva-MAN (1998), • Switzerland (1994), • (BEV) Blacksburg, USA (1990)	[32], [33]
Mobile/Wireless/Ambient Cities/ 1994	To promote social interactions and two-way communications.	• New York City (1994), • Kista Science City / Stockholm (2002) • Florence, Italy (2006)	[16], [17]
Eco City/ 1987	Environmental degradation	• Hammarby Sjöstad, Stockholm (1990) • Vauban and Rieselfeld, Freiburg, Germany • Bo01/Western Harbour, Malmö • Sweden • Dongtan Eco-City (2005) • Sino-Singaporean Tianjin Eco-city (2009) • Masdar City (2006) • Kunming (2010) •	[16], [18], [34], [35]
Sustainable city/ 1987	Degrading human & environmental health, cultural heritage, social equity, and social infrastructure etc.	• Carbon Neutral by 2025, Copenhagen, Denmark. (2012) • The Sustainability Plan, San Francisco, California (1997) • Greenest City Action Plan, Vancouver, Canada (2009) • The Singapore Green Plan, Singapore (1992) •	[36], [37], [38]
Smart City/ 2007	Challenges related to urbanization	• Smart Cities Marketplace, EU (2012) • Smart Cities Mission, India (2015) • Smart Dubai Plan, Dubai (2014) • The Smart Nation Plan, Singapore (2014) •	[20]
Intelligent cities/ 2001	Rapid population growth, declining resources, climatic/ ecological change, Global complexity	• New Taipei City, Taipei (nd)	[24], [39]
Healthy cities/ 1984	Impact on health due to urbanization	• Europe (1984-present)	[40], [41], [42]
Liveable Cities/ 1970	Urban liveability concerns such as overcrowding, housing quality, air and water quality, access to green spaces, sanitation, and public health.	• Europe and Canada, • Australia, • Brazil, • South Africa, • Japan (nd)	[23]

TABLE 3
ACHIEVEMENT AND CHALLENGES OF CITY CONCEPTS

Concept	Achievements	Challenges
Web/ Virtual Cities	• Led to improved Information dissipation • Laid the foundation for technological advancements future smart cities.	• Lack of citizen engagement. • Limited access due to IP restrictions. • Digital divide and social inequality. • Commercialization. • Lack of government initiatives. • Inconsistency due to replicated virtual models. • Obsoletion due to lack of skilled workers. • Decreased online presence due to outdated links [43].
Knowledge Cities (KC)	• Attracted research community interest. • Served as knowledge resource centres. • Bridged innovation-urban crisis gap. • Introduced start-ups for economic growth. • Majority of KC initiatives successful.	• Lack of political and societal will. • Absence of strategic plan. • Lack of financial support. • Inadequate multi-ethnic culture for diverse talent. • Visa requirements limiting international experiences. • Company relocation impacting KC development [15], [44].
Digital city/ information city	• Introduced free internet access. • Led to cultural and technological integration by attracting international interest. • Helped the establishment of a virtual community.	• Costly maintenance leading to privatization and commercialization. • Unresolved technical issues. • Decline in free maintenance services reduced the users. • People started getting addicted to technology.
Ubiquitous City	• Enabled real time processing of large volumes of data • Enabled remote access and easy monitoring of the city • Automated systems aided decision making, making way for e-governance. • Convergence of services: Education, health, transport, energy [45].	• High cost of maintenance gave rise to the concept of public-private partnership. • Cost of housing with ubiquitous technologies and infrastructure increased, making it unaffordable. • Data privacy, safety and security issues.
Broadband/ wired City	• Reinforced the vision of a networked society. • Reduced cost, increase convenience. • Renewed interest in the telecommunications and place-based communities. • Move towards research on big-data generated by the use of internet. • Enabled the development of other city labels such as wireless cities, smart cities, etc. [46].	• The concept of was only driven by technological advances, social, cultural, political and economic implications were not taken care of. • Physical interactions reduced. (People to people and people to built environment). [46].
Mobile/ Wireless/ Ambient Cities	• E-governance acceleration. • Reduced communication costs via stationed networks. • Facilitated interaction between public and private institutions. • Boosted businesses, created jobs, promoting economic development.	• Created digital divide and social polarization. • Data privacy, safety and security issues. • Addiction to technology
Eco City	• Emphasized ways of making the city more environment-friendly and sustainable.	• Costly regulation in existing urban built environment. • Lack of Global implementation and effectiveness. • Budget constraints, social concerns and developmental priorities specific to nations. • Based on innovation and experimentation (case of Masdar).
Sustainable city	• Integration of environmental, economic, social, and cultural dimensions. • Improvement of quality of life and well–being.	• Managing existing urbanisation is difficult • Lack of social acceptability of sustainable policies, public participation, emphasis on Long-term strategies, innovative solutions, coordination amongst different environment-related initiatives and regulations [37]
Smart City	• Provided liveable, inclusive, sustainable environment by harnessing technology	• Based on top-down approach • Health still a concern • Need of an integrated city plan
Healthy cities	• Prioritizes health and environment. • Acts as a support tool for local-level intersectoral collaboration	• Limited spread
Liveable Cities	• Emphasis on good living conditions.	• Limited spread • Mostly conceptual model

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VIII Aug 2024- Available at www.ijraset.com

III.RESULTS AND DISCUSSION

A. Categorization of City Concepts

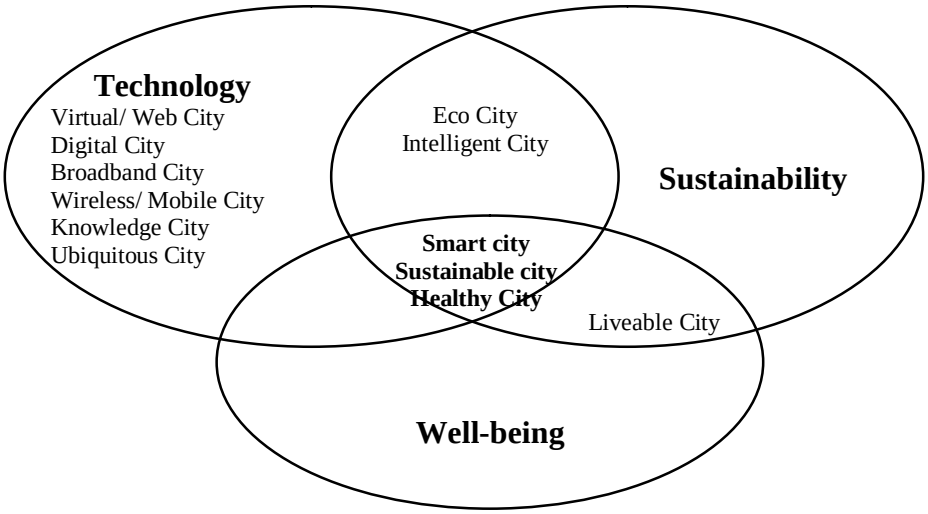


Fig. 1 Categorization of City Concepts
Source: Author

"Technology" here is defined as the use of digital technologies and the use of Information and digital technology.
"Sustainability" is defined as the wise use of resources in the present times for the sake of future generations. [19]
"Well-being/ good health" is the state of complete mental, physical and social well-being [47]

Based on the above studies, an attempt has been made to categorize the city concepts with similar attributes (Fig. 1). The city concepts that are evolved using technology are virtual/ web city, digital city, broadband city, wireless/ mobile City, knowledge city, ubiquitous city.
Eco-cities and intelligent cities are centered around sustainable development and technology. A liveable city emphasizes sustainability and uses technology for its development. Smart cities, healthy cities, and sustainable cities utilize technology to prioritize the health and well-being of their citizens, with a focus on sustainable development.
Smart city, with its focus on creating a technologically advanced environment, employs technology to ensure optimal environmental conditions for its inhabitants. This approach indirectly conserves resources and prioritizes the well-being of citizens. In today's context, technological advancements have eliminated the need for individuals to endure long queues for service tasks. With the shift towards "smartness," almost all services have become digitized, leading to smart service delivery [16]. This transition not only saves resources such as fuel and paper but also indirectly contributes to the physical well-being of individuals, particularly in harsh environmental conditions, and their mental well-being by reducing the frustration associated with traditional service processes. This observation highlights the strong interconnectedness between the three domains of technology, sustainability and health.

B. Timeline of City Concepts

The inception of the healthy city, sustainable city, and eco-city concepts can be traced back to as early as 1984 and 1987, indicating that the detrimental effects of urbanization on the health and well-being of citizens, resources, and the environment were already evident. Subsequently, advancements in technology led to the introduction of digital city, virtual city and smart city etc. As cities face an increasing array of challenges, it is expected that more conceptual frameworks will be introduced to address these complexities.
The preceding investigation results in the development of a city concepts timeline (Fig. 2), based on their first appearances in literature and practice.

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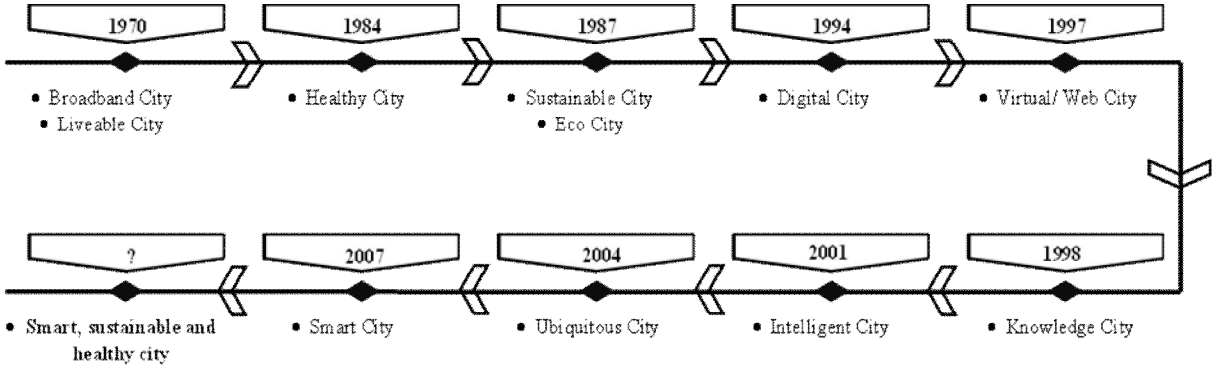


Fig. 2 Timeline of City Concepts
Source: Author

C. The Need for a Hybrid Approach.

The study findings suggest that various city concepts faced formidable challenges individually, compelling urban planners and authorities to devise hybrid models integrating elements from several of these concepts. As a result, the emergence of the Smart-Sustainable City and Ubiquitous-Eco City concepts came into existence. Analysis of these hybrid models reveals a clear association between 'smart' and 'technology' and between 'sustainable' and 'efficient resource utilization.' Likewise, 'ubiquitous' is correlated with 'technology,' while 'eco' pertains to the environment.

Cities, as dynamic entities, undergo constant evolution, necessitating continuous reform in urban planning strategies. Implementing hybrid concepts in city development facilitates a more adept approach to address the challenges arising from urbanization. Consequently, there is a compelling need for further reform in planning concepts, paving the way for the introduction of a novel hybrid concept that encompasses the facets of 'technology,' 'sustainability,' and 'health' simultaneously. This proposed integrated concept may be termed the Smart, Sustainable, and Healthy City.

Encouraging the development of cities that prioritize health, in collaboration with those that emphasize smart technology and sustainable practices, is imperative to effectively incorporate urban health considerations within the realm of urban planning. Such an approach could potentially foster a more holistic and comprehensive framework for managing the complexities of modern urban environments.

IV. CONCLUSION

Cities face the dual challenge of managing increasing population sizes and urban sprawl, prompting the need for the city concepts to provide a good quality of life to its citizens. Despite the progression from one concept to another, the persistent challenge of addressing health issues within the urban landscape remains largely unaddressed. It is imperative to recognize this gap, and move towards a city concept that is comprehensive and holistic.

The proposition of a hybrid concept, the Smart, Sustainable, and Healthy City, is put forward as an integrated approach to tackle the multifaceted challenges of modern urban environments. It is imperative to emphasize that the successful conceptualization, promotion, and implementation of this hybrid model require collaborative efforts between private and governmental initiatives. This article opens a new opportunity for research by introducing a new concept for city development and improvement. Future researches may focus on deriving the detailed features and impacts of development based on such a model.

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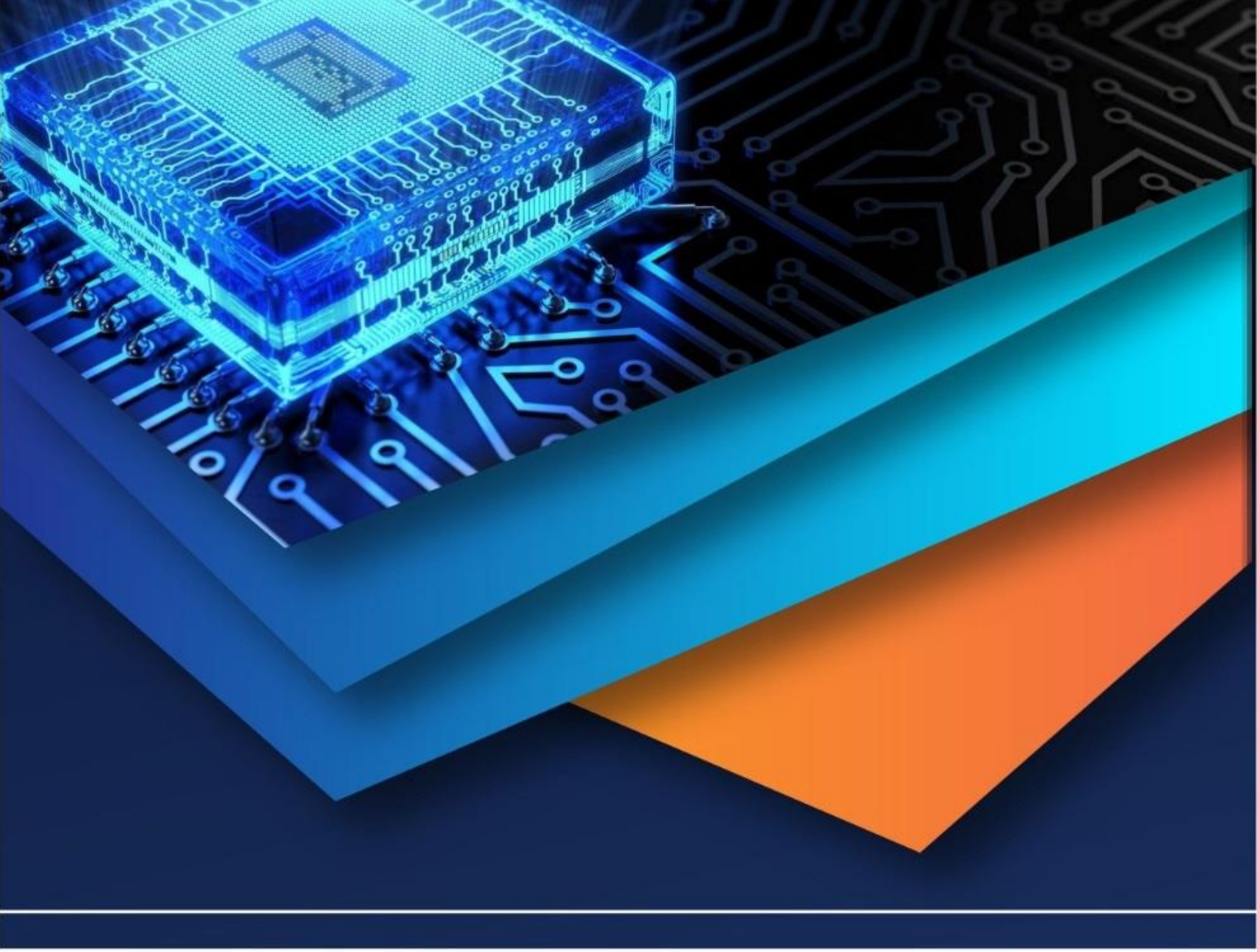
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