land

MDPI

Article

The Conceptual Framework of Smart TOD: An Integration of Smart City and TOD

Liwei Bai [1], Lelong Xie [2], Chaoyang Li [1], Shengqiang Yuan [3], Dening Niu [3], Tao Wang [1], Zheng Yang [1] and Yi Zhang [1,*]

[1] State Key Laboratory of Ocean Engineering, China Institute for Urban Governance, Shanghai Jiao Tong University, Shanghai 200240, China
[2] China Shanghai Architectural Design & Research Institute Co., Ltd., Shanghai 200063, China
[3] Shanghai Municipal Engineering Design Institute (Group) Co., Ltd., Shanghai 200092, China
* Correspondence: darrenzhy@sjtu.edu.cn

Abstract: Smart City (SC) is a booming model of urban development with great potential, armed to be one of the urban development's most powerful developing weapons. However, the development of SC is far from satisfactory. Therefore, finding new paths for SC becomes imperative. Transit Oriented Development (TOD), which often focuses on the core areas of SC, is believed to be a substantial contributor to the development of SC. Nonetheless, the relationship between SC and TOD and the effects of TOD in promoting SC are rarely studied. In this study, we proposed a conceptual framework of Smart TOD (S-TOD), which could highlight TOD 5.0 but more than that. S-TOD is an integration of SC and TOD, utilizing the deconstructive method and the abductive method. We first defined S-TOD, which integrates SC and TOD as the twin sources. Then, we employed the concept of Deoxyribonucleic Acid (DNA) to construct S-TOD in a cross-boundary path as the connection between DNA and its twin subchains can perfectly reflect the inner relationship between S-TOD and its twin sources, SC and TOD. Finally, we built up the structure of S-TOD with three layers, i.e., the cloud layer, the tactile layer, and the land zones layer. The purpose of this paper is to enhance the practical value of SC, from a perspective that has been neglected, that is, the combination with TOD, provide a new perspective for the research and practice of the integration of SC and TOD, and effectively facilitate the advantages of SC and global sustainable development.

Keywords: smart TOD; smart city; transit-oriented development; conceptual framework; Deoxyribonucleic Acid map; smart planning; urban planning

Citation: Bai, L.; Xie, L.; Li, C.; Yuan, S.; Niu, D.; Wang, T.; Yang, Z.; Zhang, Y. The Conceptual Framework of Smart TOD: An Integration of Smart City and TOD. *Land* **2023**, *12*, 664. https://doi.org/10.3390/land12030664

Academic Editor: Nicos Komninos

Received: 2 February 2023
Revised: 28 February 2023
Accepted: 2 March 2023
Published: 11 March 2023

1. Introduction

Smart City (SC) is a booming model of urban development with great potential, armed to be urban development's most powerful developing weapon. The first appearance of the term 'smart city' is in the book *The Technopolis Phenomenon-Smart Cities, Fast Systems and Global Networks* [1]. However, it didn't work very well at the time. However, since its second appearance by IBM in 2010, a wide range of academic research on SC has been conducted [2–4]. The main features of SC are presented in a framework fueled by recent technological advancement, particular city requirements and dynamics [5]. According to IDC (International Data Corporation), technology-related investment in the SC market worldwide will reach USD 189.46 billion, among which USD 38.92 billion is in China by 2023 [6]. According to Research and Markets, the scale of the SC market worldwide is valued at USD 62.09 billion in 2020, and it is estimated to reach USD 248.63 billion by 2030 [7].

Cities are facing a growing need to provide enhanced public services that have an impact on people's daily lives [8]. Although cities make up only 3% of Earth's surface, they drive our economy, consuming 75% of the world's energy, which produces 80% of

greenhouse gas additives. More specifically, cities are placing an increasing burden on energy, water, buildings, environment, transportation, climate, and so on [9]. SC are emerging in this context, which has become a global phenomenon and movement to enable us to use urban resources in a more efficient way, make public transport more attractive, and provide planners and decision-makers with data to allocate resources more accurately [10]. The shift in SC discourse is evident both at the national level (e.g., South Korea, Australia, United States) and in city-level policies and initiatives (e.g., Amsterdam, San Francisco, Vienna, Seoul) [11,12]. Currently, hundreds of SC initiatives are underway around the world, affecting large numbers of people and devoting significant resources to these projects [13,14]. While some of these projects incorporate dimensions beyond technology, in practice, there is little evidence that the key workings were fully being achieved in cities that call themselves SCs, bringing the concept of SC closer to the goal of sustainable cities [15].

Many cities around the world are so enthusiastic to be smart and jumped on the bandwagon to adopt the concept of SC. Although different institutions have researched the standards of SC in the past three decades, the authoritative standards of SC are still lacking. In addition, although SC had been packed to be one of the most advanced tools for urban development in the era, much of the current publicity around SC is seemingly superficial and boastful, except for the practical cities such as Glasgow, Hamburg [5], Antwerp, Helsinki [16], and so on. Some scholars were skeptical because they think there is weak evidence beyond speculation that SC can provide real answers to the complex challenges that cities are facing today [15]. However, things change when the development of SC continues with rich fruits, along with the Internet of Things (IoT), Cloud Computing and Blockchain [17], the Machine Learning [18], the 5G [19], the Digital Twins [20], and so on. We can see that SC is all-encompassing, but it misses an important tool called Transit Oriented Development (TOD). SC is involved in the current popular theoretical system in the field of urban planning, but for such a powerful theory as TOD that has existed and been popular for decades, it rarely involves. As some scholars have stated, the spatial areas of TOD would also form a new version along with the development of SC, so that the future TOD areas will have a new form and connotation, giving birth to a new intelligent TOD pattern [21]. According to that, this paper will further expand the feasibility based on limited literature reference to develop SC. The concept and practice of TOD can function as an important starting point of SC practice. The purpose of this paper is to enhance the practical value of SC, from a perspective that has been neglected, that is, the combination with TOD, provide a new perspective for the research and practice of the integration of SC and TOD, and effectively facilitate the advantages of SC and global sustainable development.

From our research, we can see that SC contains many subsystems such as transportation and so on. TOD is a mode developed under but went beyond the guidance of transportation, so the boundaries of SC and TOD are wrapped around each other. Nonetheless, the relationship between SC and TOD and the effects of TOD in promoting SC are rarely studied. To fill in the research gap, we propose a conceptual framework of Smart TOD (S-TOD) as an integration of SC and TOD, which could be more than TOD 5.0, aiming at strengthening the connection between them. The paper mainly employs two research methods, the deconstructive method and the abductive method. The deconstructive method deconstructs SC and TOD separately to find out their inner connections, aiming at the construction of S-TOD. The use of the abductive method is to disentangle the relationship between SC and TOD, to analyze the DNA map of S-TOD, and to form the structure of S-TOD. Deoxyribonucleic Acid (DNA), which is an important part of chromosomes, is the genetic material of living things, containing all their genetic characteristics [22]. In this paper, DNA has been likened to the core features of S-TOD, and the two subchains of DNA have been likened to the two sources of S-TOD, which are SC and TOD, so as to better deduce the whole system of S-TOD.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature on the development of SC and TOD. This is followed by Section 3, which provides an overview of the research design. Section 4 introduces the definition of S-TOD. Section 5 presents the mapping of the DNA of S-TOD. Section 6 builds up the structure of S-TOD. Section 7 discusses the findings of the research and Section 8 recapitulates the major findings, contributions, and recommendations for future research work.

2. Theoretical Backgrounds: A Literature Review

In the past several decades, governments and research institutions have been eagerly engaged in the theoretical research and planning practice of SC [14,23–25]. Many cities are called SCs, or at least they claim themselves to be SCs. Even though SC has been proposed for decades, there have been few authoritative definitions—even now. The first appearance of the term 'SC' is in the book *The Technopolis Phenomenon-Smart Cities, Fast Systems and Global Networks* [1]. Back then, the concept of SC was not adequately influential, making it lose its shine to the more acknowledged concept of 'global cities'. Twenty years later, however, IBM (International Business Machine) has redefined and promoted SC as its corporate strategy, which has taken the world by storm at that time, though not authoritative [26]. Likewise, there is still no authoritative standard for SC, although many institutions have researched SC standards, including ISO (International Standards Organization), ITU (International Telecommunications Union), IEC (International Electrotechnical Commission), BSI (British Standards Institute), ANSI (American National Standards Institute) and CEN/CELENEC/ETSI (European Standards Organizations), etc. [27]. For the group of critics, the very idea of SC needs to be suspected [28,29], although some of them have achieved some success [30]. On the contrary, many cities that are doing well neither advertise themselves to be SCs nor have a corporate strategy to back up the claim. This, in turn, led to the situation that SC is somehow incomprehensible, a state of being beyond reason [31]. It is urgent and necessary to build new theories for the research of SC [32]. The situation has changed when an increasing number of scholars and practitioners participate in the research and practice of SC. SC is the integration and upgrading of all urban development tools, transforming cities into SCs [5]. SC can improve practical results through smart urban planning and increase the resilience and sustainability of the whole system. SC is developed along with the integration of information and communication technology (ICT) with urban physical systems. The industry is gradually making use of advanced computing technologies such as the IoT, Artificial Intelligence (AI), Blockchain, Big Data (BD), Cloud Computing, and 5G to support urban development [33]. On this basis, some scholars put forward the development vision of society 5.0 [17].

While a variety of theoretical tools have been included in SC, we find that TOD, such a weighty theoretical tool for urban development, has not been thoroughly studied. SC includes subsystems such as transportation and so on, where the boundaries of SC and TOD are wrapped around each other. TOD is believed to be a substantial contributor to SC, and the areas of TOD are more suitable to take the lead in the practice of SC. In Peter Calthorpe's book, *The Future of American Cities: Ecology, Community and the American Dream*, he first proposes the development model of TOD by identifying efficient and mixed land use with public transportation hubs and stations as the core and by emphasizing its pedestrian-friendly environmental design [34] (Figure 1).

Until now, the concept of TOD has been widely implemented in urban planning practice, but different interpretations have emerged around the world due to the diversity of urban development. TOD has formed the basis of new urbanism to achieve smart growth [35]. Just as Goetz said, TOD is likely now an important part of a much more sustainable and smart approach to urban development [36,37]. In the context of SC, future urban TOD areas will form a new intelligent TOD pattern [21]. We have also been inspired by other scholars' work on international case studies, which can provide lessons for new researchers to maximize the application of TOD [35].

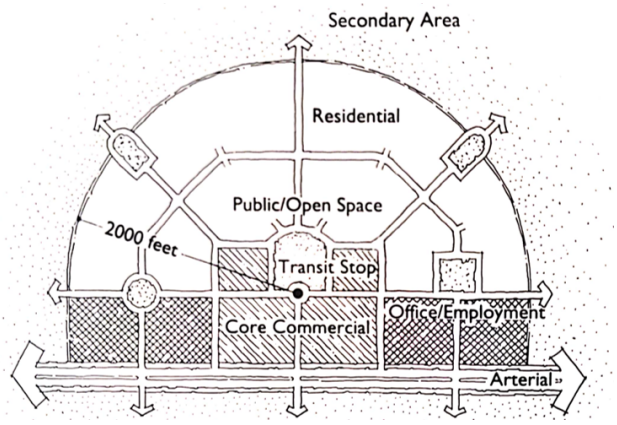

Figure 1. The concept map of TOD (Peter Calthorpe, 1993).

Through the literature review, we have presented existing research and practical cases on SC and TOD and demonstrated the inner connections, as well as the diversity and complexity of their features. In this study, we will start with the conceptual source of both SC and TOD to facilitate comparison and fusion between the two. Therefore, for SC, we choose the definition and system based on the one announced by IBM. For TOD, we choose the definition raised by Peter Calthorpe and use the theoretical systems of TOD 1.0 to 4.0 as its combined system. TOD 1.0 is the ancestor of the system, the first stage of TOD practice, which improves the accessibility and land use efficiency between cities, reduces environmental pollution, and optimizes urban structure and resource allocation [34]. TOD 2.0 is innovated and upgraded based on TOD 1.0, which is a new vertical and three-dimensional development mode from the urban surface to underground space. This brings people sustainable living, where Vertical City is regarded as the next generation of cities, and it is a beautiful imagination for the sustainable development of future cities [38]. TOD 3.0 is announced by ITDP (Institute for Transportation and Development Policy) through its Version 3.0 of TOD Standard, marking the path from complete streets to communities [39]. Through the integration of the most efficient and healthy modes of transportation, the lowest economic and environmental costs, and the highest resilience to ecological damage, all people within the region can enjoy inclusive opportunities and resources. TOD 4.0 is claimed by Nissin company, who sets a higher goal for the spatial design of TOD, which is to integrate the daily care of crowd behavior by meeting the needs of transportation, services, and consumption. It will be a charming place to showcase local culture or natural landscape and expand the urban personality and creativity by integrating station, city, and people [40]. In this way, we establish the basis for the research on SC and TOD, which will be described in detail in the following parts of the paper for the forming of S-TOD.

3. Research Design

To propose a conceptual framework for S-TOD, this paper employs the deconstructive method and the abductive methods, together with inductive and deductive reasoning. First, we use the deconstructive method to extract the key system elements of SC and TOD and explore their internal relationship. Then, we use the abductive method to integrate the elements and form the S-TOD conceptual structure. The deconstructive method, rooted in western traditional philosophy as a theoretical school, is formed under the influence of Derrida. Derrida's deconstruction theory is so complicated and contradictory that it is difficult to have a clear and recognized unified explanation. Even so, the method has been widely used in many fields, including medicine, information technology, clothing design, interior design, space design, etc. [41,42]. In this paper, we use the deconstructive method to deconstruct SC and TOD separately and to find their inner connections, aiming for the construction of S-TOD.

The abductive method is used to trace the cause of a causal connection and the logical nature of a sufficient conditional hypothetical proposition from the result. It not only incorporates different ways of knowing but also enhances the promising problem-based learning. However, literature on the abductive method is predominantly philosophical, so its practical consequences are worthy of further research [43]. The inductive reasoning is a kind of reasoning from individual to general. From a certain degree of an individual point of view to a wider range of points of view, deducing general principles and principles from specific cases. The deductive reasoning is the process of deriving a specific statement or individual conclusion from a general premise. In some sense, inductive reasoning and deductive reasoning are interrelated, complementary, and inseparable [44]. They are not only fuzzy reasoning methods but also can be accurately applied to quantitative research, which is of great practical value [45]. In this paper, we will research the relationship between SC and TOD by the abductive method, along with inductive and deductive reasoning, making an analogy similar to DNA and digging deep into their essential relevance, pointing to the certainty of S-TOD.

The conceptual framework consists of three major parts, i.e., defining S-TOD, mapping the DNA of S-TOD, and building up the structure of S-TOD (Figure 2). The use of the deconstructive method is to deconstruct SC and TOD separately and to find out their inner connections, aiming to the construction of S-TOD. The use of the abductive method is to disentangle the relationship between SC and TOD, to analyze the DNA of S-TOD, and to form the structure of S-TOD.

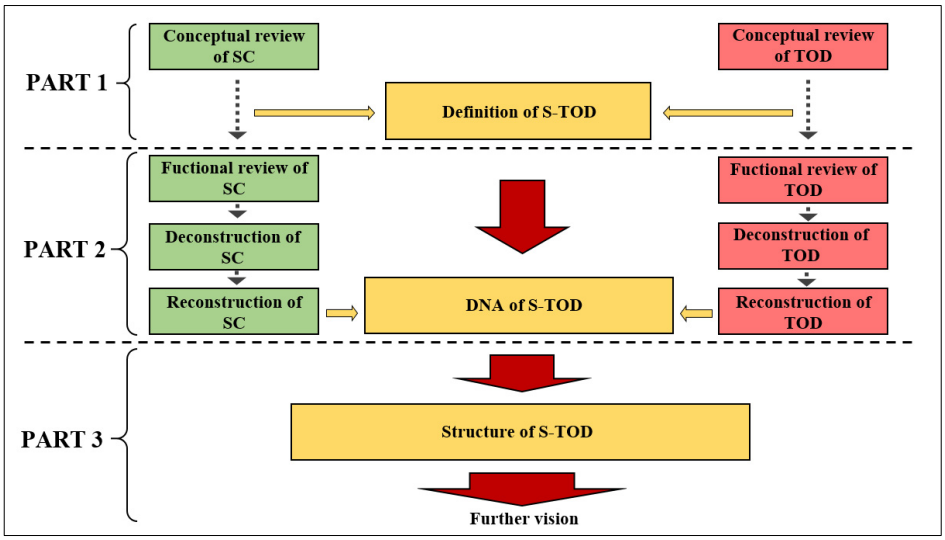

Figure 2. The three main parts of the research.

4. The Definition of Smart TOD

4.1. The Conceptual Review of the Definition of 'Smart City'

The ancestor version of SC announced by Tatsuno has been deviated to Global City since 1992 [1], which didn't get much buzz and lost its shine to 'global cities'. Therefore, we will pay more attention to its later version which was launched by IBM in *A Smarter Planet: The Next Leadership Agenda* in New York, 2008. It defines the Smart Planet as a new era when next-generation information technology applies to all industries [46]. Since IBM formally puts forward the concept of SC, it quickly spreads all over the world in 2010 [47] (IBM defines SC as 'making full use of information and communication technologies to detect, analyze and integrate key information of the core system of city operation, to respond intelligently to various needs including livelihood, environmental protection, public safety, city services, and business activities, with an ultimate goal of creating a better urban life for human'. According to IBM, SC is based on six core systems, namely people, business, transport, communication, water, and energy [3]. However, until now, there have been few

authoritative conclusions about SC. As some scholars have argued, there is no common definition of SC, and there is no "optimal formula" to follow in transforming each city into an SC. In a broader version, it can be seen as an opportunistic concept that paves the way towards smarter countries and a smarter planet, by enhancing harmony between the lives and the environment [5]. Furthermore, SC is a vague concept with rich meaning, and close to many relevant urban planning theories, including Digital City, Intelligent City, Knowledge City, Innovative City, Creative City, Compact City, Ecological City, Low-carbon City, Habitable City, and so on.

4.2. The Definition of Smart TOD

Although the connection between SC and TOD is close, the position of TOD in the theoretical system of SC remains vague. In SC, transportation becomes just one of the subsystems, which is often called smart transportation, and vice versa, where 'smart' is also understated in the theoretical system of TOD. Therefore, we put forward the concept of S-TOD, which is the joint form of SC and TOD (Figure 3), a comprehensive concept combining their cutting-edge research findings. In a word, S-TOD aims to focus on the core urban areas led by TOD and facilitate the application of the technology of SC. In this study, we define S-TOD as the combination of SC and TOD, cored with the public transport hubs proposed in TOD and armed with the information and communication technology proposed in SC, where the critical features of urban are fully mixed, such as land use, architectural functions, and activity functions, etc.

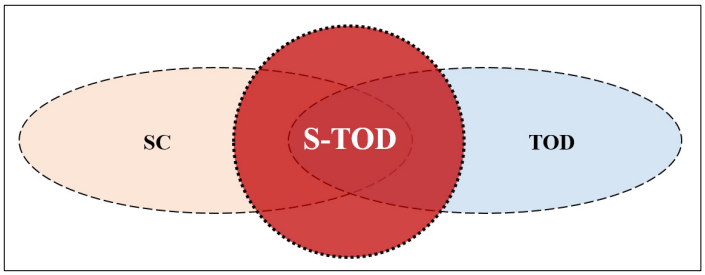

Figure 3. The logical relationship between SC, TOD, and S-TOD.

5. The DNA of Smart TOD

5.1. The DNA Sources of Smart TOD

It can be claimed that SC and TOD are the twin theoretical sources of S-TOD. Now we are going to get a better understanding that they can be compared and connected. According to Figure 4, the coverage of SC adds up to the whole urban area, and so does the coverage of TOD. Therefore, from a dialectical perspective, SC and TOD can be considered theories of equal magnitude that work on the same object, which is the whole urban area. Thus, we do believe that SC and TOD can be compared and connected in some way.

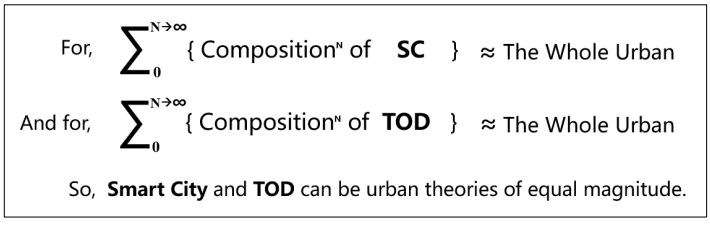

Figure 4. The dialectical relationship between SC and TOD.

Furthermore, the inner relationship between S-TOD and its twin sources is just like the relationship between DNA and its twin subchains. Using the abductive method, we can use the concept of DNA to construct S-TOD in a cross-boundary path. For S-TOD, the

DNA is a double helix, having twin subchains, one of which is named Subchain α sourced from SC, and the other is named Subchain β sourced from TOD (Figure 5).

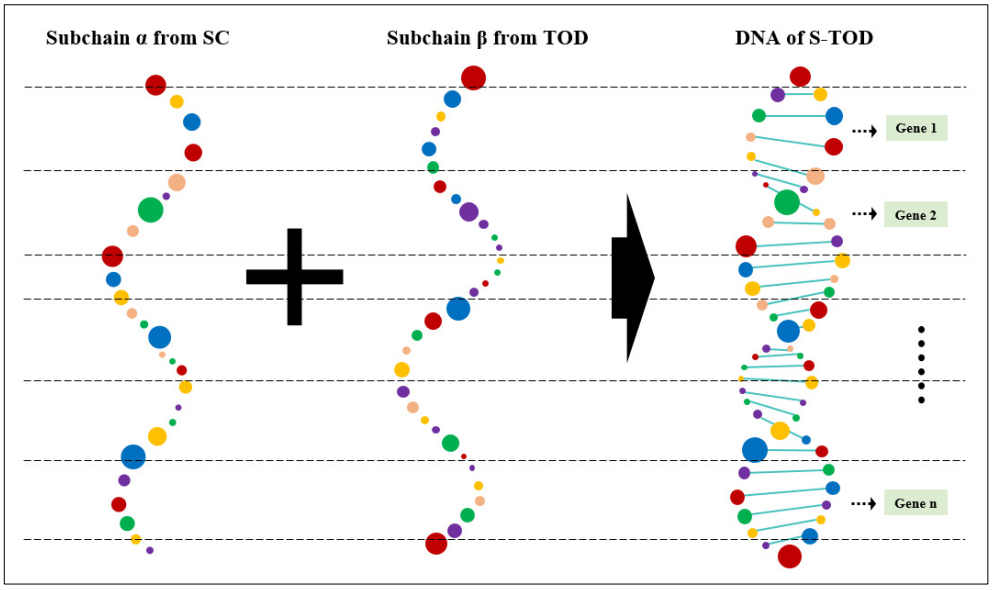

Figure 5. The DNA of S-TOD and its subchains.

Then, we will build a 3-step work to fulfill the deconstruction and reconstruction, forming new subchains for S-TOD. S-TOD consists of two blocks, one of which is metaphysical, defined to be Conceptual Block, and the other is physical, defined to be Structural Block. In the following, the two blocks are further decomposed into five critical fragments, that are, Fragment 1, Fragment 2, Fragment 3, Fragment 4 and Fragment 5. The five sections stand for the inner law, the response points, the response ways, the spatial senses, and the spatial zones, respectively (Table 1).

Table 1. The instructions of the blocks and sections for the DNA subchains.

Blocks	Fragments		
	Serial	Names	Meanings
Conceptual Block	Fragment 1	Inner law	The reasons it is coming for.
	Fragment 2	Response points	The points it is aiming at.
Structural Block	Fragment 3	Response ways	The ways it is acting through.
	Fragment 4	Spatial senses	The senses it is relying on.
	Fragment 5	Spatial zones	The objectives it is working on.

5.2. The 3-Step Work for Getting the DNA Subchain α

We obtained the DNA Subchain α through three steps: (1) reviewing the functions of SC as clearly as we could; (2) deconstructing the functions of SC into element chains, looking for their inner regulations and choosing the chain that is most suitable for our research; and (3) reconstructing a new chain to form the DNA Subchain α. The following is the detailed process of obtaining the DNA Subchain α.

5.2.1. Step 1: The Functional Review of Smart City

In Step 1, we reviewed the functions of SC as clearly as we could. Since the second appearance of SC by IBM between 2008 and 2010, a wide range of academic research on SC has been conducted [2–4]. SC is an open elastic theoretical framework that integrates the most important factors of urban planning theories, forming a multi-level theoretical carrier and reflecting the diversification of urban development. Although there are many ways to

classify SC, it can be generally divided into two stages, 'SC 1.0' and 'SC 2.0'. 'SC 1.0' mainly focused on the utilization of intelligent technology for corporate interests, while 'SC 2.0' is a people-centered approach using intelligent technology to solve social problems [48]. SC 1.0 to 2.0 is a clear theoretical route, but it cannot change the fact that there are so many different opinions about SC but few authoritative ones. What it has done is changed the target of SC from the enterprise to society. We can see that there is still a long way to go for SC.

5.2.2. Step 2: The Deconstruction of the Functions of Smart City

In Step 2, we summarized some representative theoretical frameworks of SC and deconstructed them into element chains (Table 2). Since SC is an elastic and open theoretical framework, there are significant differences between the frameworks. We need to find the very one that is much more suitable for S-TOD. As seen in Table 1, different research on SC has different descriptions and classifications due to different purposes, making their element chains seemingly not comprehensive enough. From the perspective of the new relationship between humans and space, we can see that all the chains are describing something bigger, namely, human beings, human activities, urban space, and so on. Thus, they were all-encompassing. There is no absolute authoritative framework of SC by far, and we cannot argue that some chains are superior to others. Hence, we will take the origin definition by IBM as the chosen chain for the research. The framework consists of six elements (Figure 6), namely, 'People', 'Business', 'Transport', 'Communication', 'Water', and 'Energy' [3].

Table 2. The representative element chains of SC are based on the review.

Serial	The Representative Element Chains of SC
1	People, Business, Transport, Communication, Water, Energy, etc. [3]
2	Economy, Management, Mobile, Environment, Life, etc. [47]
3	Smart Economy, Smart environment, Smart life, Smart Travel, Smart safety, Smart education, etc. [4]
4	Technology, System, People, etc. [2]
5	Technology, Organization, Policy, etc. [2]
6	Smart Economy, Smart People, Smart management, Smart mobility, Smart environment, Smart life, etc. [49]
7	Management, Technology, Governance, Policies, People, Economy, ICT (Information and Communications Technology) infrastructure, Natural environment, etc. [50]
8	Urban system planning, SC layout, Smart urban infrastructure planning, Intelligent layout of public service facilities, The wisdom of urban living environment planning, etc. [51]
9	Smart governance, Smart community and social network, Smart safety and security, Smart mobility and traffic, Smart energy, Smart health and welfare, Smart environmental monitoring and control, etc. [5]

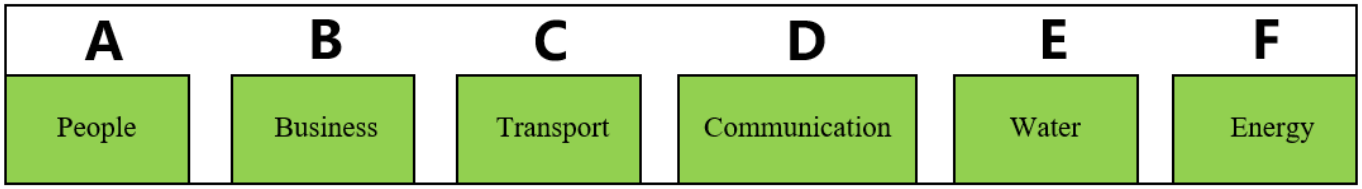

Figure 6. The selected chain from IBM.

5.2.3. Step 3: The Reconstruction for Subchain

In Step 3, we reconstructed a new chain, inspired by the deconstructed chains above, especially the one of IBM. Our new chain is human needs-oriented, where the relationship between humans and space is fully considered; the DNA Subchain α is accomplished (Figure 7).

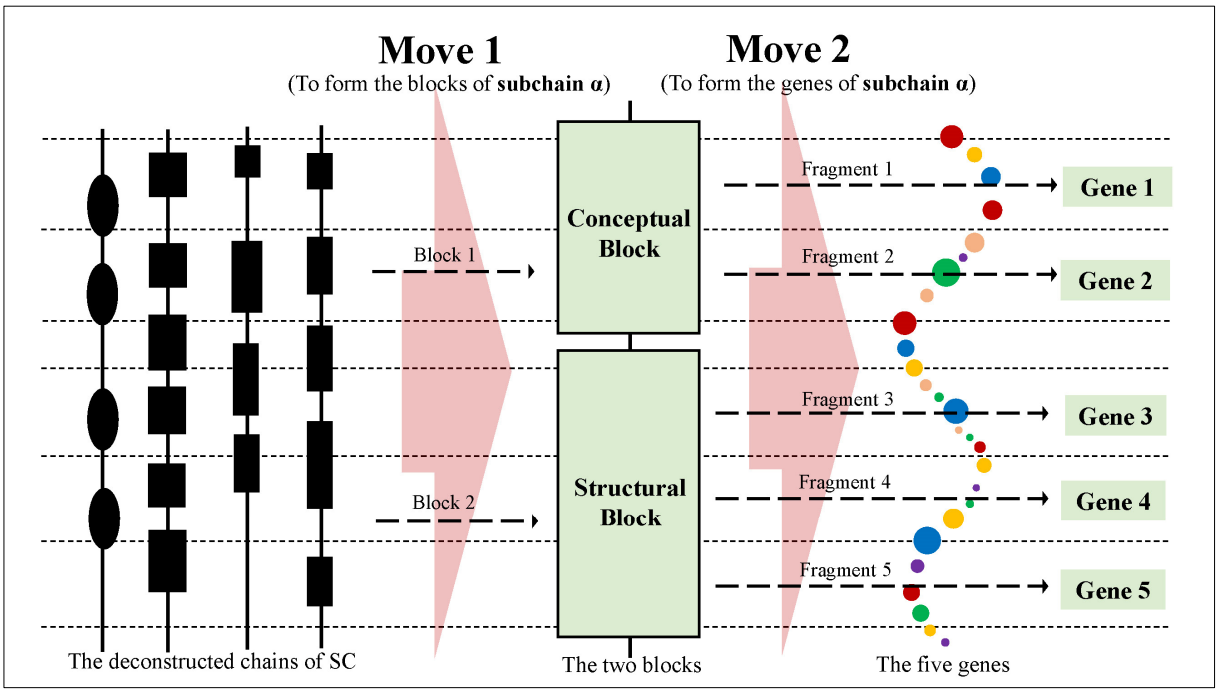

Figure 7. The logic expression from the reconstructed chains to the DNA Subchain α.

Table 3 shows more details about the DNA Subchain α and its five critical fragments. We can see that Fragment 1 and Fragment 2 are formed by Conceptual Block, while Fragment 3, Fragment 4, and Fragment 5 are formed by Structural Block. Fragment 1 stands for the inner law, Fragment 2 stands for the response points, Fragment 3 stands for the response ways, Fragment 4 stands for the spatial senses, and Fragment 5 stands for the spatial zones.

Table 3. The instructions of the blocks and fragments for the DNA Subchain α.

Blocks	Fragments		
	Serial	Names	Meanings
Conceptual Block	Fragment 1	Inner law	To develop urban utilizing technology, etc. (The reasons it is coming for.)
	Fragment 2	Response points	To respond to human needs in urban activities, etc. (The points it is aiming at.)
Structural Block	Fragment 3	Response ways	To capture and analyze signals of human needs by BD, Cloud Computing, and so on, and respond through IoT, etc. (The ways it is acting through.)
	Fragment 4	Spatial senses	To track human activities through mobile phones, cameras, etc. (The senses it is relying on.)
	Fragment 5	Spatial zones	The targeted urban areas, etc. (The objectives it is working on.)

5.3. The 3-Step Work for Getting the DNA Subchain β

We obtained the DNA Subchain β through three steps: (1) to review the functions of TOD as clearly as we could, and to choose TOD 1.0 to 4.0 for our research; (2) to deconstruct the functions of TOD 1.0 to 4.0 into element chains and look for their inner regulations, (3) to reconstruct a new chain to form the DNA Subchain β.

5.3.1. Step 1: The Functional Review of TOD

In Step 1, we reviewed the functions of TOD as clearly as we could. TOD is popular but can be a little bit tricky by turning common phrases into proper nouns by Peter Calthorpe. There have been many studies on the different dimensions of TOD [52–56] and the case comparisons of TOD [57–61]. Since the birth of TOD, relevant research has focused on several core issues including (1) the definition of TOD; (2) the key connotation of TOD, and (3) the building of the core link between TOD and urbanism. We can better integrate TOD with urban development if we address the above issues. Based on relevant studies, we choose the representative theoretical system of TOD, named TOD 1.0 to 4.0, which is relatively more comprehensive by far.

TOD 1.0 is the ancestor of the system, which is as the first stage of TOD practice, it significantly improves the accessibility and land use efficiency between cities, reduces environmental pollution, and optimizes urban structure and resource allocation (Peter Calthorpe, 1993). TOD 2.0 is innovated and upgraded based on TOD 1.0, being a new vertical and three-dimensional development mode from the urban surface to underground space. This brings people sustainable living, where Vertical City is regarded as the next generation of cities, and it is a beautiful imagination for the sustainable development of future cities (Gloria Serra-Coch, Charlotte Chastel, Sergio Campos, Helena Coch, 2017). TOD 3.0 is announced by ITDP (Institute for Transportation and Development Policy) through its Version 3.0 of TOD Standard, marking the path from complete streets to communities (ITDP, 2017). TOD 4.0 is claimed by the Nissin company, who sets a higher goal for the spatial design of TOD, which is to integrate the daily care of crowd behavior by meeting the needs of transportation, services, and consumption. It will be a charming place to showcase local culture or natural landscape and expand the urban personality and creativity by integrating the station, city, and people (Ying Lu, 2020).

5.3.2. Step 2: The Deconstruction of the Functions of TOD

In Step 2, we deconstructed the function of TOD into chains, looking for their inner regulations, which is administered upon TOD 1.0 to 4.0. According to TOD 1.0, the critical elements of the chain include center, walking, compaction, utility, street, diversification, public transport, guided by bus corridors, etc. According to TOD 2.0, the chain adds Vertical City and so on, along with the elements in the previous version. According to TOD 3.0, it further adds cycling, mixture, connection, density, shift, and so on, besides those in the previous version. According to TOD 4.0, the integration of 'Station, City and People' is highlighted, based on the previous version (Table 4). The evolution TOD 1.0 to 4.0 indicated that TOD 1.0 arranges and extends the spatial function around its core area, the transportation hub center; TOD 2.0 extends to the vertical space; TOD 3.0 generates a further functional mix with urban, and TOD 4.0 comprehensively considers the relationship between physical space and human beings (Table 4). It is a process of continuous upgrading and integration from TOD 1.0 to 4.0. Since the system is an ever-growing process, we can deconstruct it into four parts with the upgraded content (Figure 8).

The selected chain can be summarized into four kinds of critical features: (1) the TOD up-to-date feature, pointing to the integration of 'Station, City and People'; (2) the traffic feature, including bus priority, pedestrian priority, and so on; (3) the spatial feature, containing vertical development and public transport corridor development and so on; and (4) the exploit feature, consisting of the mixture, intensity, compaction, conversion and so on.

Table 4. The representative element chains of TOD 1.0 to 4.0 are based on the review.

Serial	The Element Chains
TOD 1.0	Center, Walking, Compaction, Utility, Street, Diversification, Public Transport, Guided by Bus Corridors, etc. [34]
TOD 2.0	TOD 1.0 + 'Vertical City', etc. [38]
TOD 3.0	TOD 2.0 + 'Cycling, Mixture, Connection, Density, Shift', etc. [39]
TOD 4.0	TOD 3.0 + 'Integration of Station, City and People', etc. [40]

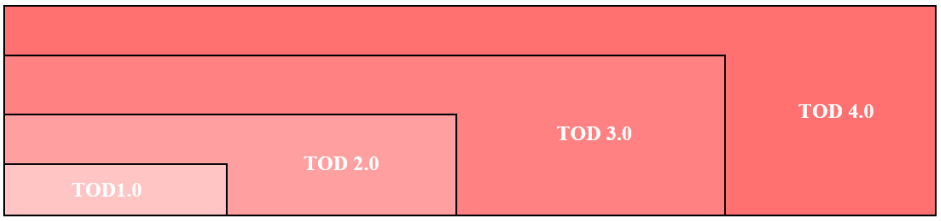

Figure 8. The selected chain from TOD 1.0 to 4.0.

5.3.3. Step 3: The Reconstruction for DNA Subchain β

In Step 3, we reconstructed a new chain for TOD. Inspired by the deconstructed chains of TOD 1.0 to 4.0, our new chain is human needs-oriented, where the relationship between humans and space is fully considered, named to be the DNA Subchain β (Figure 9). Table 5 shows the details of the DNA Subchain β and its five critical fragments. Fragment 1 and Fragment 2 are formed by Conceptual Block, while Fragment 3, Fragment 4, and Fragment 5 are formed by Structural Block. The five fragment respectively stand for the inner law, the response points, the response ways, the spatial senses, and the spatial zones. Although the names of the blocks and fragments for Subchain α and Subchain β are the same, their meanings are quite different, which contain their own attributes (Table 5).

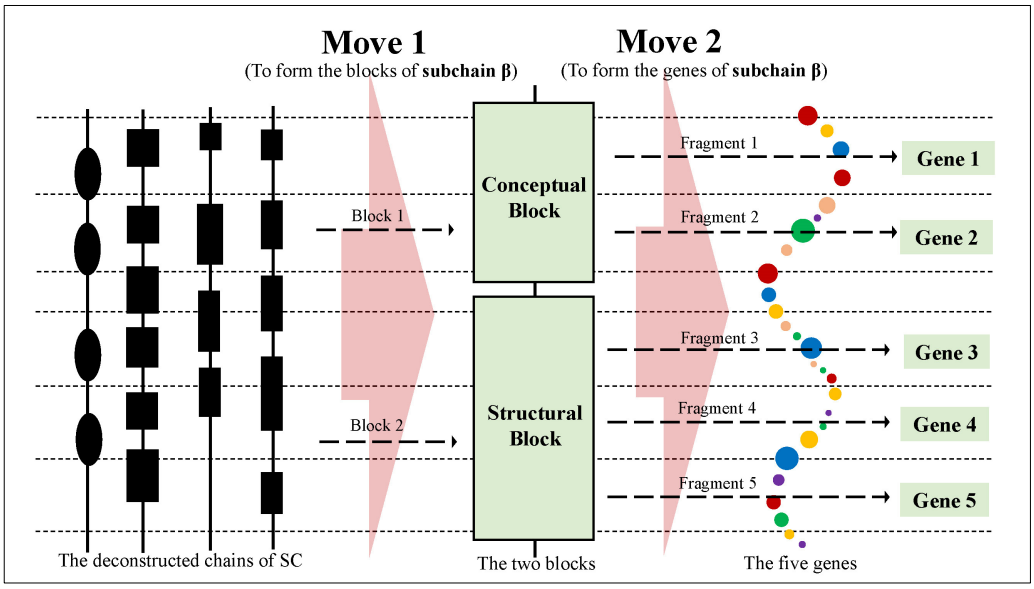

Figure 9. The logic expression from the reconstructed chains to the DNA Subchain β.

Table 5. The instructions for the blocks and fragments for the DNA Subchain β.

Blocks	Fragments		
	Serial	Names	Meanings
Conceptual Block	Fragment 1	Inner law	To develop urban utilizing TOD, etc. (The reasons it is coming for.)
	Fragment 2	Response points	To respond to human needs in urban activities, etc. (The points it is aiming at.)
Structural Block	Fragment 3	Response ways	TOD-related urban planning, traffic prediction-based research, etc. (The ways it is acting.)
	Fragment 4	Spatial senses	There are no special senses that are out of the ordinary, if any, they are regular planning data, traffic survey data, etc. (The senses it is relying on.)
	Fragment 5	Spatial zones	The targeted urban areas, etc. (The objectives it's working on.)

5.4. The DNA Map of S-TOD

Based on the above-mentioned findings, we looked deeply into Subchain α and Subchain β from a philosophical perspective. We considered them to be five critical genes of S-TOD and weaved them together (Figure 10). Since genes are the core of DNA, we can further map the DNA of S-TOD based on these critical genes.

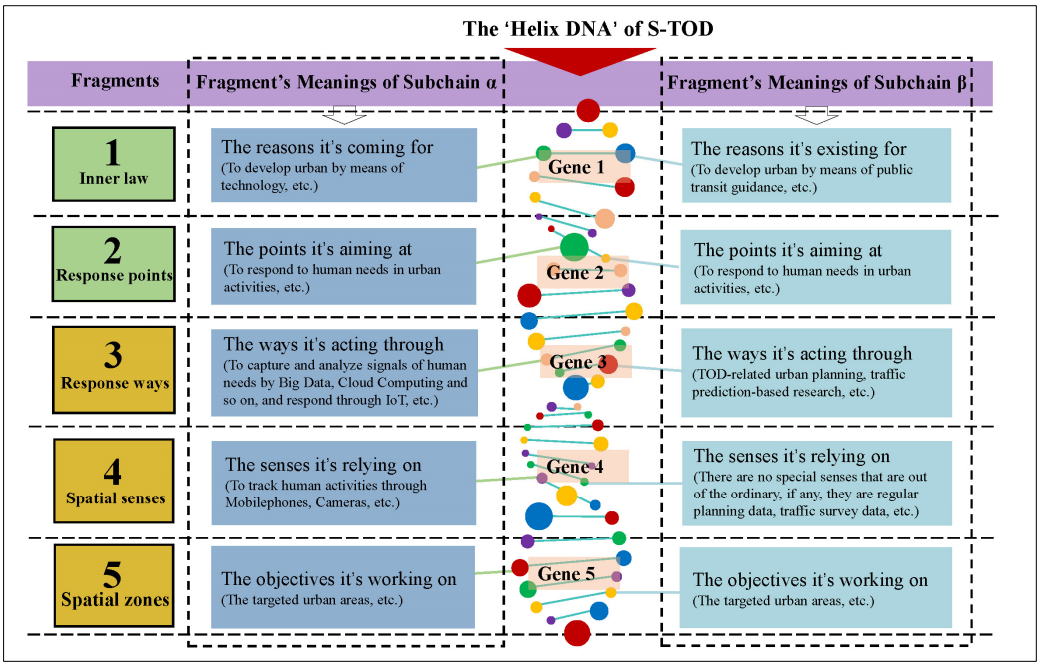

Figure 10. The construction logic of the DNA of S-TOD.

We formed a helix DNA for S-TOD, through the integration of Subchain α and Subchain β and the combination of their characteristics. The five fragments of the subchains are transformed to be five critical genes of the DNA of S-TOD. Figure 11 illustrates the DNA map of S-TOD including Gene 1 (the inner law), Gene 2 (the response points), Gene 3 (the response ways), Gene 4 (the spatial senses), and Gene 5 (the spatial zones). The meanings of the five genes are as below:

1. Gene 1 stands for the inner law of S-TOD, which is to develop urban utilizing technology and public transit guidance, etc. It is the reason why S-TOD is coming.
2. Gene 2 stands for the response points, which is to respond to human needs in urban activities, etc. It contains the points at which S-TOD is aiming.

3. Gene 3 stands for the response ways, which is to rely on TOD-related urban planning, traffic prediction-based research, BD, Cloud Computing, IoT, etc. It is the ways through which S-TOD is acting.
4. Gene 4 stands for the spatial senses, which is to track human activities through mobile phones, cameras, etc. It is the senses on which S-TOD is relying.
5. Gene 5 stands for the spatial zones, which is referring to the targeted urban areas, etc. It is the objectives on which S-TOD is working.

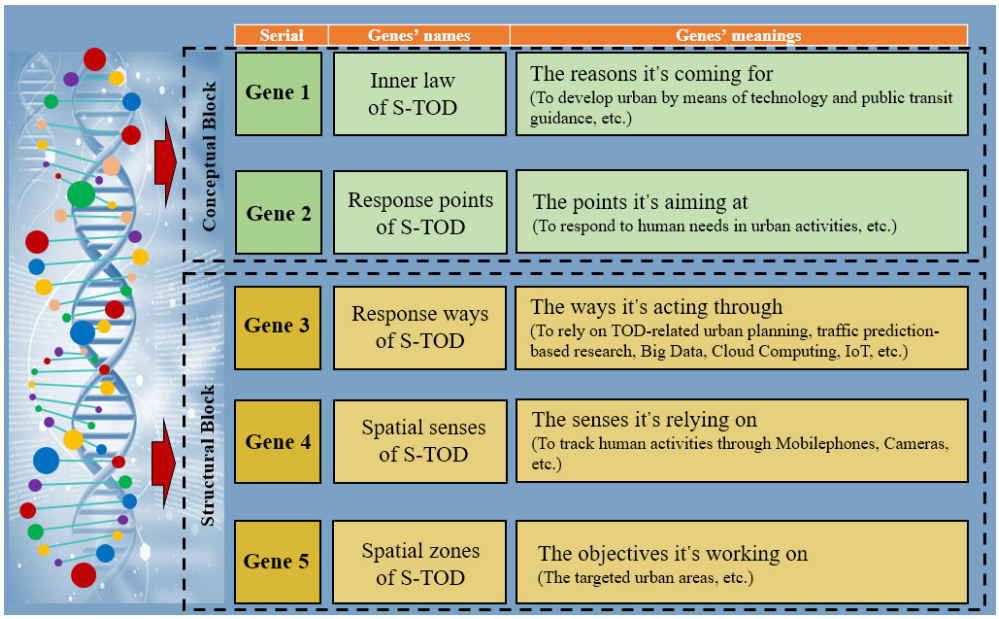

Figure 11. The DNA map of S-TOD.

6. The Structure of Smart TOD

6.1. The Overall Structure

SC is beyond tradition and there should be smart planning methods [62]. It is the same with TOD. From this point of view, S-TOD should be more than one of the cornerstones of smart planning. We will not elaborate too much on its Conceptual Block here. Instead, we will focus on its Structural Block, aiming to make the structure of S-TOD clear for implementation. The Structural Block of genes of S-TOD includes Gene 3, Gene 4, and Gene 5, responding to its structure (Figure 12). The function of Gene 3 is to form the response ways of S-TOD, that is, to rely on TOD-related urban planning, traffic prediction-based research, BD, Cloud Computing, IoT, etc. The function of Gene 4 is to track human activities through mobile phones, cameras, etc. The function of Gene 5 is to form the zones of S-TOD, that is, to shape and frame the targeted urban areas, etc., based on the new rules of S-TOD.

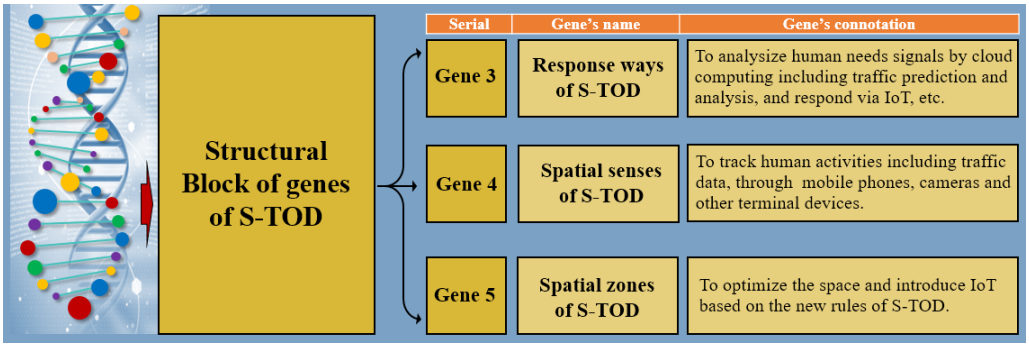

Figure 12. The structural genes of S-TOD.

As some scholars have suggested, what makes a city smart is not its complex architecture or masterplan in a complex technical environment, but the qualitative and quantitative collaboration established between its related subsystems [26]. Based on this idea, we propose the structure of S-TOD like a 'column', to detail its functions and make it more suitable for implementation. Figure 13 shows the whole picture of the columned structural system of S-TOD. It consists of three layers vertically and three zones horizontally, which is called 3 Layers and 3 Zones structure, shorted to be 3L3Z. On one hand, vertically, it consists of Layer A (the cloud layer), Layer B (the tactile layer), and Layer C (the foundational layer). Layer A is a smart layer and Layer B is an exchanging layer, which together emphasizes the support of SC. Layer C is a comprehensive layer, highlighting the combination of SC and TOD. On the other hand, horizontally, Layer C lies at the bottom and consists of Zone 1 (the traffic core zone), Zone 2 (the supporting zone), and Zone 3 (the covering zone), according to the different influence range.

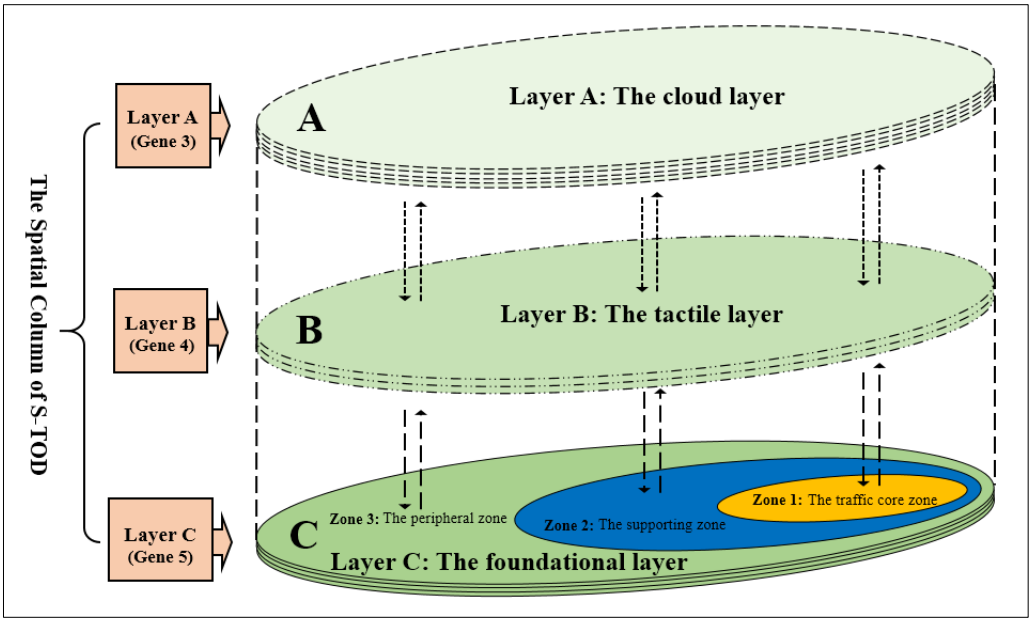

Figure 13. The columned structure of S-TOD.

To better understand the columned structure of S-TOD, we construct its matrix in Table 6. It indicates the vertical and horizontal associations between its three layers and three zones. Layer A is a smart layer, characterized by Flexible Planning, Cloud Computing, etc. Layer B is an exchanging layer, characterized by internet terminal equipment, etc. Layer C is a comprehensive layer and contains online and offline functions that are characterized differently according to the three zones.

Table 6. The detailed structure matrix of S-TOD.

Layers		Zones		
		Zone 1 (The Traffic Core Zone)	**Zone 2 (The Supporting Zone)**	**Zone 3 (The Covering Zone)**
Layer A	Key 1	Flexible Planning (Flexible urban planning and design means)		
	Key 2	Cloud Computing (Powerful processing abilities of Cloud Computing)		
	Key 3	Others (Other Internet development technologies)		
Layer B	Key 1	Internet Terminal Equipment (Internet terminals including computers, mobile phones, and other smart devices)		
	Key 2	Others (Other Internet terminals with similar functions)		

Table 6. *Cont.*

Layers		Zones		
		Zone 1 (The Traffic Core Zone)	**Zone 2 (The Supporting Zone)**	**Zone 3 (The Covering Zone)**
Layer C	Key 1	The Core Hub (The inner space of the TOD hub station)	The Direct Service Area (The parking support facilities and other direct facilities, etc.)	The Critical Area (The area with important urban functions)
	Key 2	The Evacuation Area (The evacuation space associated with the core hub and the outside space)	The Indirect Service Area (The commercial, office, and other facilities, etc.)	The Non-critical Area (The area that does not have significant urban functions)
	Key 3	The Traffic Area (The accepting traffic space outside the TOD hub)	The Traffic Area (The accepting traffic space)	The Traffic Area (The accepting traffic space)
	Key 4	The Online Area (Virtual space for online human activities relying on the Internet)	The Online Area (Virtual space for online human activities relying on the Internet)	The Online Area (Virtual space for online human activities relying on the Internet)
	Key 5	Others	Others	Others

6.2. The Characteristics of Layer A

Layer A, named the cloud layer, is the smart center of S-TOD. On one hand, it calls for flexible forward-looking planning. Flexible Planning is a more concentrated and distinct embodiment of human wisdom, based on the current traditional planning system, and injected full elastic planning elements. On the other hand, it calls for the processing ability of Cloud Computing. The captured signal and data will be induced to form a systematic feedback mode through complex computer algorithms and other means. This kind of feedback can be accurately connected to the physical space entity, but also can fully respond to human needs. Figure 14 explains the main characteristics of Layer A, including Flexible Planning, AI, Cloud Computing, conventional computing, BD, Blockchain, programming, and so on.

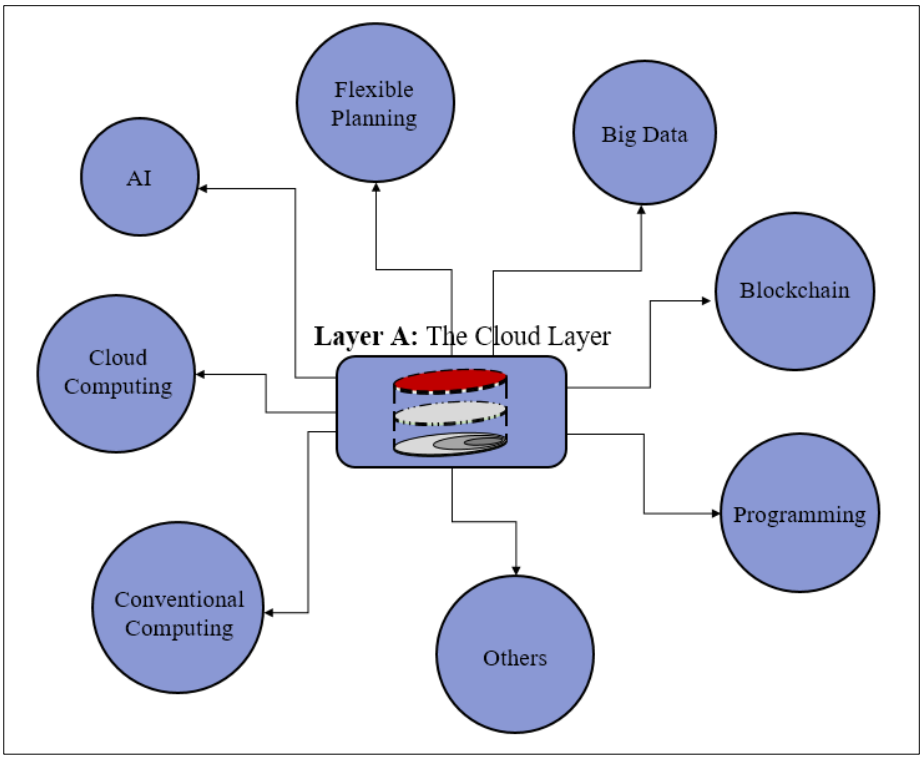

Figure 14. The main characters of Layer A.

6.3. The Characteristics of Layer B

Layer B, named the tactile layer, is the spatial sense of S-TOD which senses human needs. Layer B mainly includes intelligent terminal equipment such as the physical equipment of the Internet, IoT, urban security monitoring, and so on. Based on its characteristics, the system captures human needs within a safe and reasonable range and transmits them to cloud data processing. Then, the feedback of the cloud data forms the command signal, through which the spatial instruction is conveyed to achieve the spatial response. The main characteristics of Layer B include mobile phones, computers, pads, wireless local area network (WLAN), cameras, induction coils, IoT, monitors, etc. (Figure 15).

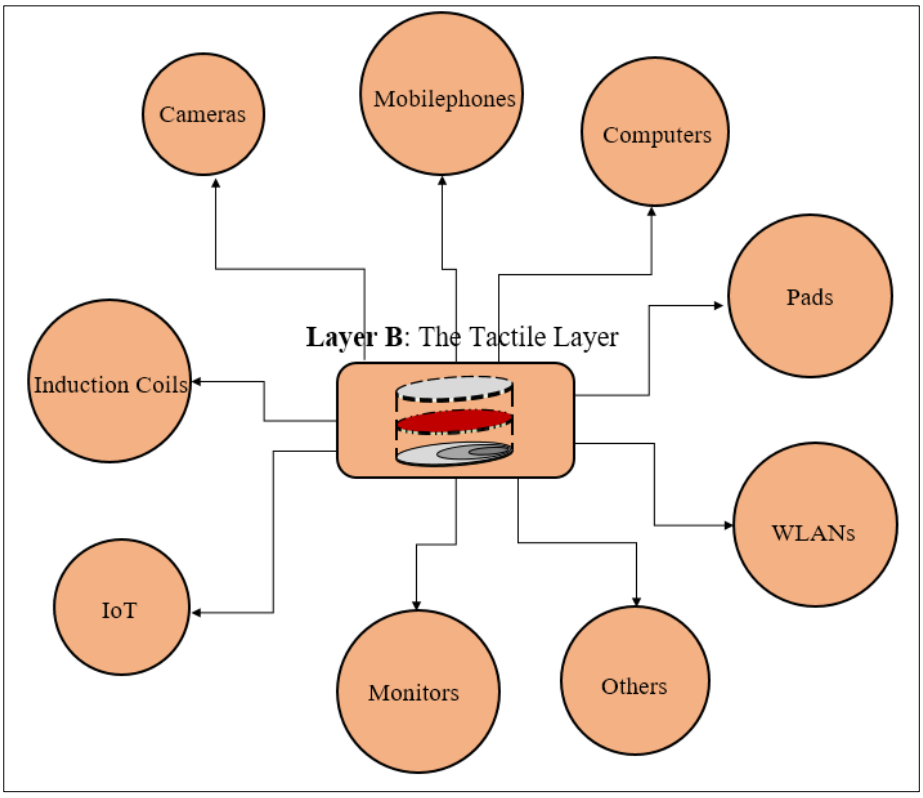

Figure 15. The main characters of Layer B.

6.4. The Characteristics of Layer C

Layer C, which is named as the land zones layer, is divided into three zones, including Zone 1 (The traffic core zone), Zone 2 (The supporting zone), and Zone 3 (The covering zone), just as seen in Figure 16. It is based on the original TOD characteristics and responding to the smart needs of S-TOD. Layer C is the comprehensive layer of S-TOD, highlighting the combination of SC and TOD, where four critical features stand for TOD and another critical feature stands for SC (Figure 17). On one hand, to inherit the power of TOD, Layer C emphasizes its critical four features: (1) the TOD up-to-date feature, pointing to the integration of 'Station, City and People'; (2) the traffic feature, including bus priority, pedestrian priority and so on; (3) the spatial feature, including vertical development and public transport corridor development and so on; and (4) the exploit feature, including mixture, intensity, compaction, conversion and so on (Figure 17). On the other hand, Layer C inherits the power of SC by taking in its critical feature of Six Elements, namely People, Business, Transport, Communication, Water, and Energy, which are combined with the four critical features of TOD above, especially with the integration of 'Station, City and People' (Figure 17).

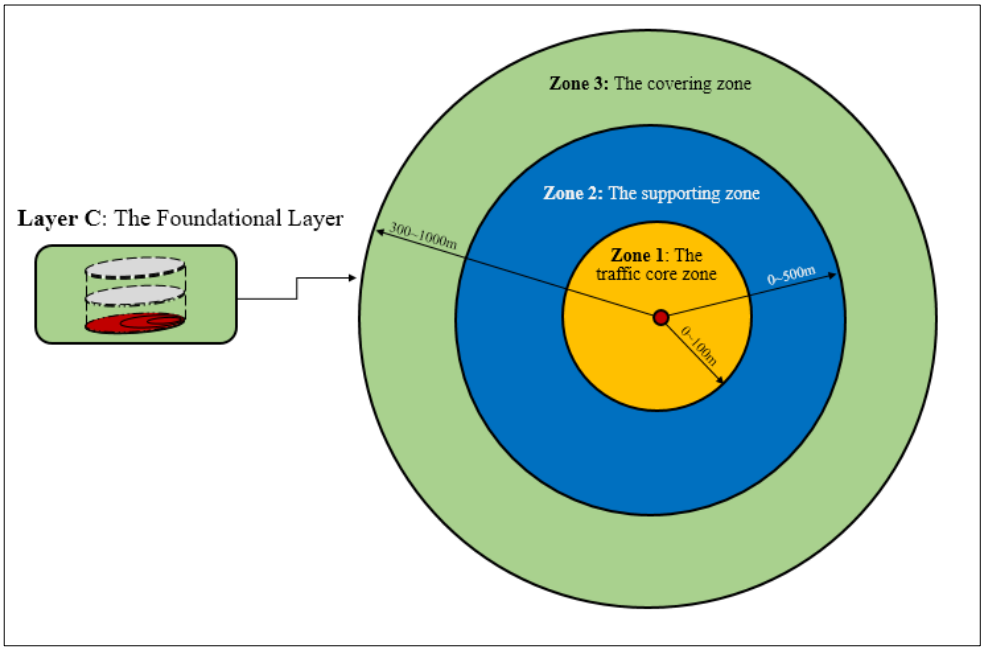

Figure 16. The three zones in Layer C.

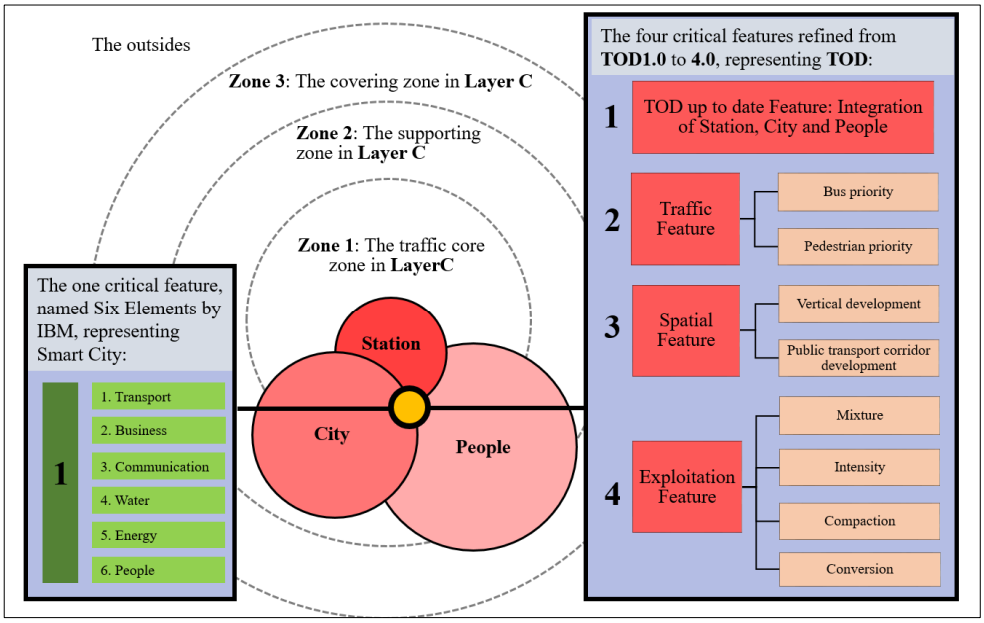

Figure 17. The features of the combination in Layer C.

The three zones of Layer C are so important that it is necessary to describe each of them in detail. From Zone 1 to 3, there are different characters according to their functions, which were illustrated from Figures 18–20. Zone 1 (the traffic core zone) mainly carries the functions of passenger flow introduction and service response for S-TOD. It often features a bus stop or subway station, around which comprehensive three-dimensional development will be constructed. Zone 1 forms a complex spatial structure according to the developing needs. Its main characteristics include traffic scheduling, traffic organization, safety protection, traffic management, brand building, ecological system, intelligent system, regional management, bus terminal, and so on (Figure 18). Zone 2 (the supporting zone) mainly carries the traffic service function, which has evolved from single transportation services to comprehensive urban services. Zone 2 often refers to the spatial areas and architectures integrated with Zone 1. Its main characteristics include traffic management, road system,

static traffic facilities, recreation, residence, office, commerce, support services, and so on (Figure 19). Zone 3 (the covering zone) undertakes more comprehensive urban functions abroad for S-TOD. Its main characteristics include the transport system, commerce, ecological system, culture, administration, office, residence, and so on (Figure 20).

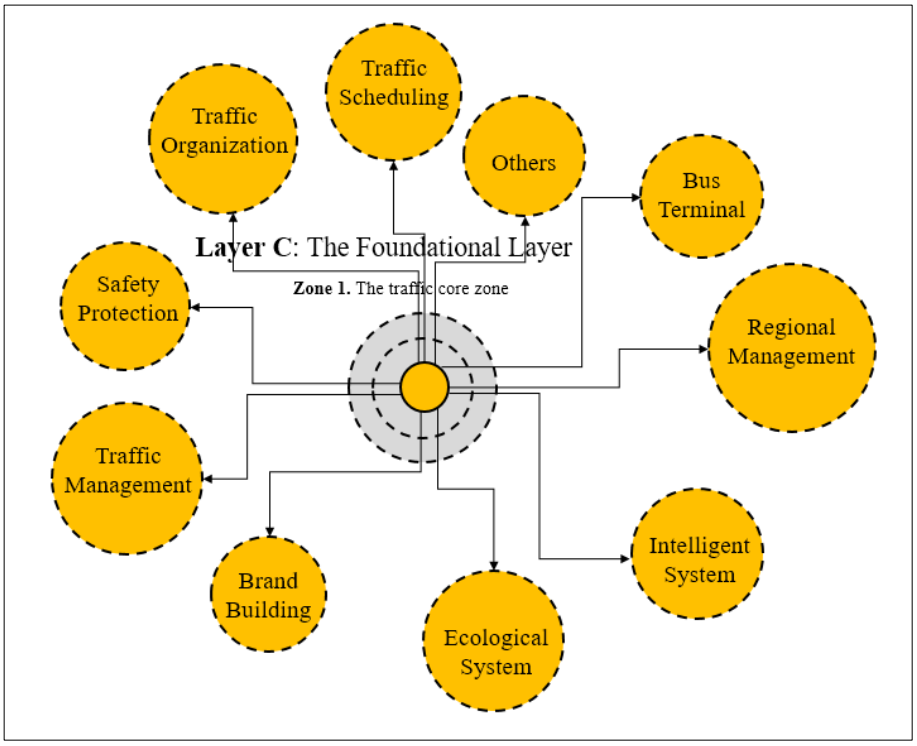

Figure 18. The main characters of Zone 1 in Layer C.

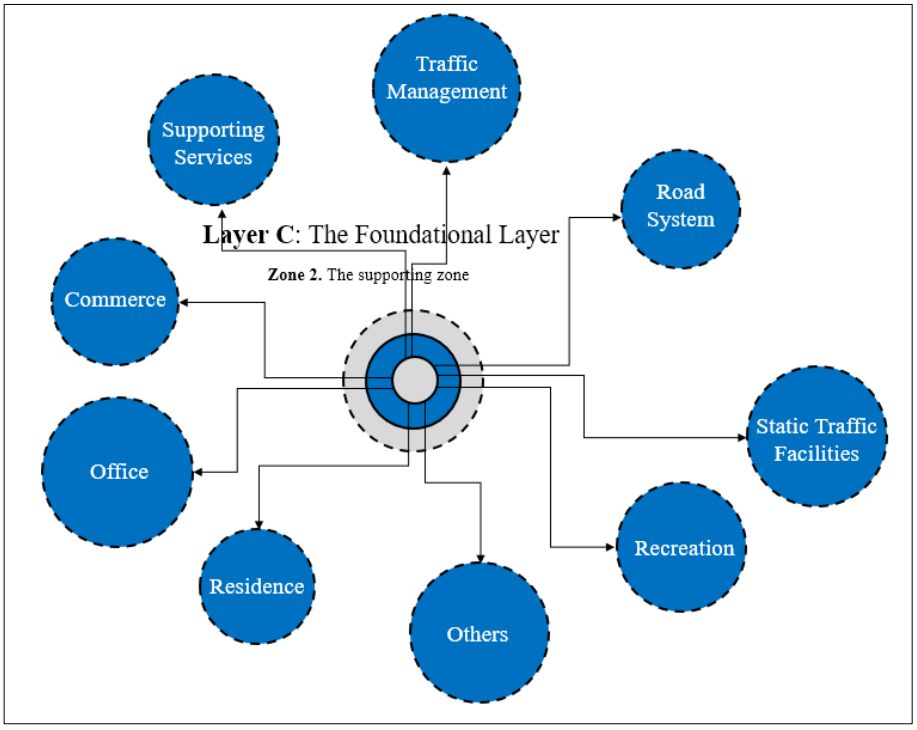

Figure 19. The main characters of Zone 2 in Layer C.

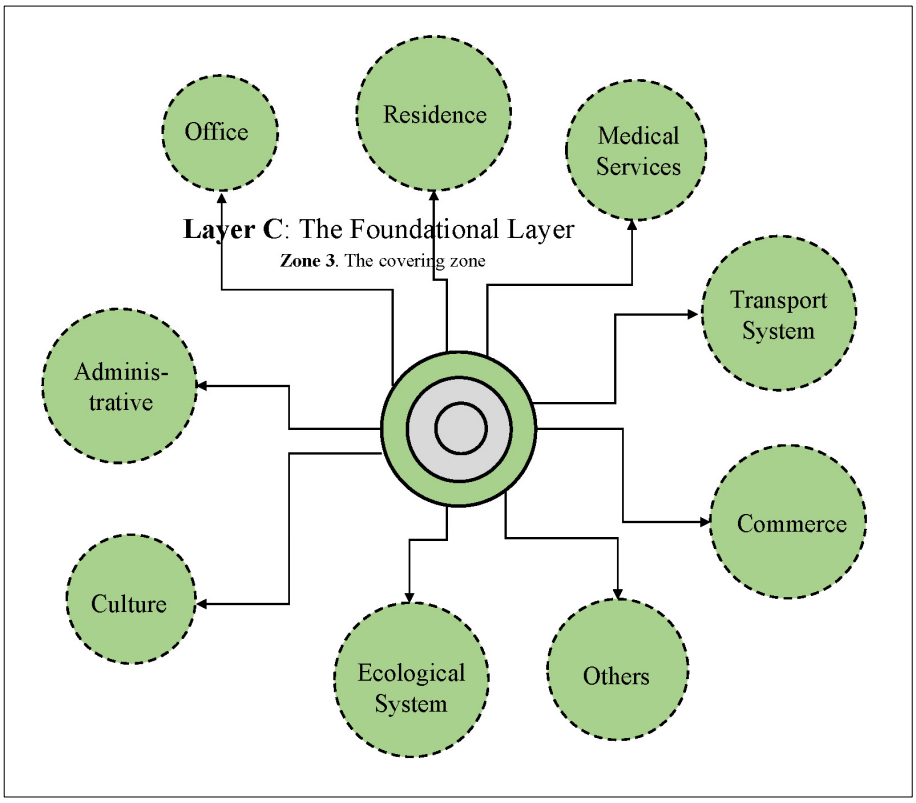

Figure 20. The main characters of Zone 3 in Layer C.

7. Discussion

What is S-TOD? Is it 'TOD in an SC' or 'TOD being smart in a common city'? It is worth asking. The answer would depend on the characteristics of the targeted city implementing S-TOD. If it has been sufficiently implemented with the technology of SC, then the showing up of S-TOD would be 'TOD in an SC'. Otherwise, it would be 'TOD being smart in a common city', where the implementation of smart technologies is not sufficient.

There are many well-established organizations (e.g., C40, Eurocities, ICLEI, UN-Habitat, SC World Expo, UK's Cities Standards Institute, The UK's Centre for Cities, Centre for Digital Built Britain, Future Cities Catapult, The Smart Cities APPGS, and Scottish Cities Alliance) to guide the moves of SC [63]. We can focus more on the cities concerned by these organizations because they are closer to the requirements of SC, although some controversies still exist. S-TOD in these cities can be called to be 'TOD in an SC'.

For cities that have not received sufficient attention from professional institutions or organizations, the development of SC is often stagnant, but it cannot be ruled out that TOD is already there. Therefore, S-TOD here is closer to 'TOD being smart in a common city'. In addition, we believe that TOD can help to better spatialize SC. Despite being all-encompassing in a considerable part of research consensus, SC is only a spatial plug-in of a city, rather than the city itself. The spatial boundaries of SC and the spatial differences of the subsystems of SC have not been discussed clearly, whereas TOD has done better in this respect. Therefore, we propose S-TOD to better promote the development of SC and to combine all available favorable resources as far as possible, especially TOD.

8. Conclusions and Further Research Agenda

The core characteristic of our paper is to put aside the kaleidoscopic integration which is popular in the current research on SC and TOD, and to gain an inside view into their underlying logic, to discover their essential nature and inner connections. In addition, through applying a kind of abstract analogy similar to DNA, SC and TOD are combined and transformed to be S-TOD, with a refined framework for further applications.

S-TOD has something much to do with TOD 5.0 but far more than that. It will provide a new perspective for the research and practice on SC and facilitate global sustainable urban development.

Through employing the deconstructive method and the abductive method, this paper proposes the conceptual framework of S-TOD, which integrates SC and TOD as its twin sources and could exceed any of them. The research findings contribute to the existing literature by (1) putting forward the definition of S-TOD, which integrates SC and TOD; (2) mapping the DNA of S-TOD in a cross-boundary path to perfectly reflect the inner relationship between S-TOD and its twin sources, and (3) building up the structure of S-TOD with three layers and three zones.

In this study, we define S-TOD as 'the combination of SC and TOD, cored with the public transport hubs proposed in TOD and armed with the information and communication technology proposed in SC, where the critical features of urban are fully mixed, such as land use, architectural functions, and activity functions, etc.' Based on the deconstruction of SC and TOD into functional element chains, we further integrate and reconstruct them to be new chains. The new chains form the twin subchains for the DNA of S-TOD, including five critical genes, namely, Gene 1 (the inner law), Gene 2 (the response points), Gene 3 (the response ways), Gene 4 (the spatial senses) and Gene 5 (the spatial zones). Finally, we take three functional genes from the DNA and build up a columned structure of S-TOD.

The structure of S-TOD constitutes three layers vertically and three zones horizontally, which we defined as the 3 Layers and 3 Zones (3L3Z) structure. Layer A is the cloud layer and includes main characteristics as Flexible Planning, AI, Cloud Computing, conventional computing, BD, Blockchain, programming, and so on. Layer B is the tactile layer with main characteristics such as mobile phones, computers, pads, WLAN, cameras, induction coils, IoT, monitors, etc. Layer C is the foundational layer, which is divided into three zones, Zone 1 (The traffic core zone), Zone 2 (The supporting zone), and Zone 3 (The covering zone). Layer C is the comprehensive layer of S-TOD. It highlights the combination of SC and TOD and include four critical features standing for TOD and another critical feature standing for SC. On one hand, to inherit the power of TOD, Layer C emphasizes its critical four features: (1) the TOD up-to-date feature, pointing to the integration of 'Station, City and People'; (2) the traffic feature, including bus priority, pedestrian priority and so on; (3) the spatial feature, including vertical development and public transport corridor development and so on, and (4) the exploit feature, including mixture, intensity, compaction, conversion and so on. On the other hand, Layer C inherits the power of SC by taking in its critical feature of Six Elements, namely People, Business, Transport, Communication, Water, and Energy, which are combined with the four critical features of TOD above, especially with the integration of 'Station, City and People'. As the research feature of this paper, the 3L3Z system facilities the materialization of SC in the space system and interprets the concept of TOD from the perspective of SC. This current study would provide a new perspective for similar research and practice.

The idea of S-TOD is presenting a stronger vitality due to the integration of SC and TOD. This paper is just the beginning of our research on S-TOD. In the future, we will extend our work from theoretical research to practical application, and we will apply our findings to help popularize S-TOD, even SC.

This study has obtained the S-TOD framework based on the preliminary research of SC and TOD. There are three limitations. First, this study is mainly qualitative and further quantitative analysis is needed for practice and policymaking. Second, an in-depth interpretation and expansion of current research and practice is needed. Finally, an exhaustive investigation is needed on the barriers and facilitators of the theoretical findings on practice. Future research will be conducted based on these limitations.

Author Contributions: Conceptualization, L.B., L.X. and C.L.; methodology, L.B.; validation, L.X., S.Y. and D.N.; resources, Y.Z.; data curation, L.B.; writing—original draft preparation, L.B.; writing—review and editing, L.B., T.W., Y.Z. and Z.Y.; visualization, L.B.; supervision, C.L.; funding acquisition, C.L. and Y.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Social Science Fund of Shanghai from Shanghai Planning Office of Philosophy and Social Science (grant number 2022BSH005), the Scientific Research Fund from the Science and Technology Commission of Shanghai Municipality (grant numbers 22DZ1203200, 21DZ1200800, 20DZ1202900, 21692106700), and the Scientific Research Fund from Shanghai Municipal Engineering Design Institute (Group) Co., Ltd. (grant number K2015K017).

Data Availability Statement: The data used to support the findings of this study have not been made available because they belong to on-going confidential research study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Gibson, D.V.; Kozmetsky, G.; Smilor, R.W. *Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks*; Rowman & Littlefield Publishers: Lanham, MD, USA, 1992.
2. Nam, T.; Pardo, T.A. Smart city as urban innovation: Focusing on management, policy, and context. In Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance (ICEGOV '11), Tallinn, Estonia, 26–29 September 2011; Association for Computing Machinery: New York, NY, USA, 2011; pp. 185–194. [CrossRef]
3. Scuotto, V.; Ferraris, A.; Bresciani, S. Internet of things applications and challenges in smart cities: A case study of Ibm smart city projects. *Bus. Process Manag. J.* **2016**, *22*, 357–367. [CrossRef]
4. Cohen, B. The Smart City Wheel [EB/OL]. 2020. Available online: https://www.smart-circle.org/smart-city/boyd-cohen-smart-city-wheel (accessed on 10 September 2021).
5. Kuru, K.; Ansell, D. TCitySmartF: A Comprehensive Systematic Framework for Transforming Cities into Smart Cities. *IEEE Access* **2020**, *8*, 18615–18644. [CrossRef]
6. IDC. Worldwide Smart Cities Spending Guide. 2020. V1. Available online: https://www.idc.com/cn (accessed on 5 September 2021).
7. Research and Markets. Smart Grid Market by Component, by Application, by End User—Global Opportunity Analysis and Industry Forecast, 2021–2030. 2020. Available online: https://www.researchandmarkets.com/ (accessed on 5 September 2021).
8. Puiu, D.; Barnaghi, P.; Tönjes, R.; Kümper, D.; Ali, M.I.; Mileo, A.; Parreira, J.X.; Fischer, M.; Kolozali, S.; Farajidavar, N.; et al. CityPulse: Large scale data analytics framework for smart cities. *IEEE Access* **2016**, *4*, 1086–1108. [CrossRef]
9. Kaur, M.J.; Maheshwari, P. Building smart cities applications using IoT and cloud-based architectures. In Proceedings of the 2016 International Conference on Industrial Informatics and Computer Systems (CIICS), Sharjah, United Arab Emirates, 13–15 March 2016; pp. 1–5.
10. Townsend, A.M. *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*; WW Norton & Company: New York, NY, USA, 2013.
11. Foth, M. The next urban paradigm: Cohabitation in the smart city. *IT Inf. Technol.* **2017**, *59*, 259–262. [CrossRef]
12. Cowley, R.; Joss, S.; Dayot, Y. The smart city and its publics: Insights from across six UK cities. *Urban Res. Pract.* **2018**, *11*, 53–77. [CrossRef]
13. Monfaredzadeh, T.; Berardi, U. Beneath the smart city: Dichotomy between sustainability and competitiveness. *Int. J. Sustain. Build. Technol. Urban Dev.* **2015**, *6*, 140–156. [CrossRef]
14. Praharaj, S.; Han, J.H.; Hawken, S. Urban innovation through policy integration: Critical perspectives from 100 smart cities mission in India. *City Cult. Soc.* **2018**, *12*, 35–43. [CrossRef]
15. Yigitcanlar, T.; Kamruzzaman, M.; Buys, L.; Ioppolo, G.; Sabatini-Marques, J.; da Costa, E.M.; Yun, J.J. Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework. *Cities* **2018**, *81*, 145–160. [CrossRef]
16. Badii, C.; Bellini, P.; Difino, A.; Nesi, P. Smart City IoT Platform Respecting GDPR Privacy and Security Aspects. *IEEE Access* **2020**, *8*, 23601–23623. [CrossRef]
17. Mishra, P.; Thakur, P.; Singh, G. Sustainable Smart City to Society 5.0: State-of-the-Art and Research Challenges. *SAIEE Afr. Res. J.* **2022**, *113*, 152–164. [CrossRef]
18. Band, S.S.; Ardabili, S.; Mosavi, A.; Jun, C.; Khoshkam, H.; Moslehpour, M. Feasibility of soft computing techniques for estimating the long-term mean monthly wind speed. *Energy Rep.* **2022**, *8*, 638–648. [CrossRef]
19. Shehab, M.J.; Kassem, I.; Kutty, A.A.; Kucukvar, M.; Onat, N.; Khattab, T. 5G networks towards smart and sustainable cities: A review of recent developments, applications and future perspectives. *IEEE Access* **2022**, *10*, 2987–3006. [CrossRef]
20. Raes, L.; Michiels, P.; Adolphi, P.; Tampere, C.; Dalianis, T.; Mcaleer, S.; Kogut, P. DUET: A Framework for Building Secure and Trusted Digital Twins of Smart Cities. *IEEE Internet Comput.* **2021**, *26*, 43–50. [CrossRef]
21. Liu, Q.; Qian, Z.; Huang, H.; Huang, D. A Reflection on Future Smart TOD Development: Discussion on the Pro-TOD and De-TOD. *Planners* **2020**, *36*, 5–11.
22. Graur, D.; Zheng, Y.; Azevedo, R.B.R. An Evolutionary Classification of Genomic Function. *Genome Biol. Evol.* **2015**, *7*, 642–645. [CrossRef] [PubMed]
23. Romão, J.; Kourtit, K.; Neuts, B.; Nijkamp, P. The smart city as a common place for tourists and residents: A structural analysis of the determinants of urban attractiveness. *Cities* **2018**, *78*, 65–75. [CrossRef]

24. Heaton, J.; Parlikad, A.K. A conceptual framework for the alignment of infrastructure assets to citizen requirements within a Smart Cities framework. *Cities* **2019**, *90*, 32–41. [CrossRef]
25. Yigitcanlar, T.; Kamruzzaman, M.; Foth, M.; Sabatini-Marques, J.; da Costa, E.; Ioppolo, G. Can cities become smart without being sustainable? A systematic review of the literature. *Sustain. Cities Soc.* **2019**, *45*, 348–365. [CrossRef]
26. Marsal-Llacuna, M.L.; Segal, M.E. The intelligenter method (I) for making "smarter" city projects and plans. *Cities* **2016**, *55*, 127–138. [CrossRef]
27. Anthopoulos, L. Smart utopia VS smart reality: Learning by experience from 10 smart city cases. *Cities* **2017**, *63*, 128–148. [CrossRef]
28. Fernandez-Anez, V.; Fernández-Güell, J.M.; Giffinger, R. Smart City implementation and discourses: An integrated conceptual model. The Case of Vienna. *Cities* **2018**, *78*, 4–16. [CrossRef]
29. Bunders, D.J.; Varró, K. Problematizing data-driven urban practices Insights from five Dutch 'smart cities'. *Cities* **2019**, *93*, 145–152. [CrossRef]
30. Huston, S.; Rahimzad, R.; Parsa, A. 'Smart' sustainable urban regeneration: Institutions, quality and financial innovation. *Cities* **2015**, *48*, 66–75. [CrossRef]
31. Deakin, M. Smart cities: The state-of-the-art and governance challenge. *Triple Helix* **2014**, *1*, 7. [CrossRef]
32. Zhao, F.; Fashola, O.I.; Olarewaju, T.I.; Onwumere, I. Smart city research: A holistic and state-of-the-art literature review. *Cities* **2021**, *119*, 103406. [CrossRef]
33. Rani, S.; Mishra, R.K.; Usman, M.; Kataria, A.; Kumar, P.; Bhambri, P.; Mishra, A.K. Amalgamation of Advanced Technologies for Sustainable Development of Smart City Environment: A Review. *IEEE Access* **2021**, *9*, 150060–150087. [CrossRef]
34. Calthorpe, P. *The New American Metropolis: Ecology, Community, and the American Dream*; Princeton Architectural Press: New York, NY, USA, 1993.
35. Knowles, R.D.; Ferbrache, F.; Nikitas, A. Transport's historical, contemporary and future role in shaping urban development: Re-evaluating transit oriented development. *Cities* **2020**, *99*, 102607. [CrossRef]
36. Goetz, A. Suburban Sprawl or Urban Centres: Tensions and Contradictions of Smart Growth Approaches in Denver, Colorado. *Urban Stud.* **2013**, *50*, 2178–2195. [CrossRef]
37. Knowles, R.D. *OURSUS: Transport Geographers: Ideas and Experiences about Aspects of Sustainable Cities*; International Geographical Congress: Beijing, China, 2016; Volume 22.
38. Serra-Coch, G.; Chastel, C.; Campos, S.; Coch, H. Graphical approach to assess urban quality: Mapping walkability based on the TOD-standard. *Cities* **2018**, *76*, 58–71. Available online: http://itdp-china.org/enpublication/?lang=0 (accessed on 10 September 2021). [CrossRef]
39. ITDP. *ITDP TOD Standard*, 3rd ed.; Institute for Transportation & Development Policy (IDTP): New York, NY, USA, 2017.
40. Lu, Y. The planning strategy integration of station, city and people of Shenzhen Rail Transit Line 4 under the guidance of TOD4.0. *Planners* **2020**, *36*, 84–91.
41. Bettencourt, A.; Sanches, M.J.; Alves, L.B.; Valcarce, R.F. *Conceptualizing Space and Place on the Role of Agency, Memory, and Identity in the Construction of Space from the Upper Palaeolithic to the Iron Age in Europe: An introduction*; Archaeopress: Oxford, UK, 2010.
42. Man, W.; Qun, Z. The Deconstruction and Reshaping of Space: The Application of Virtual Reality in Living Space. In Proceedings of the International Conference on Measuring Technology & Mechatronics Automation, Changsha, China, 14–15 January 2017; pp. 410–413.
43. Mirza, N.A.; Akhtar-Danesh, N.; Noesgaard, C.; Martin, L.; Staples, E. A concept analysis of abductive reasoning. *J. Adv. Nurs.* **2014**, *70*, 1980–1994. [CrossRef]
44. Soiferman, L.K. Compare and Contrast Inductive and Deductive Research Approaches. 2010. Available online: https://files.eric.ed.gov/fulltext/ED542066.pdf (accessed on 10 September 2020).
45. Mohamad, A.M.; Yan, F.Y.Y.; Aziz, N.A.; Norhisham, S. Inductive-Deductive Reasoning in Qualitative Analysis using ATLAS.ti: Trending Cybersecurity Twitter Data Analytics. In Proceedings of the 2022 3rd International Conference for Emerging Technology (INCET), Belgaum, India, 27–29 May 2022; pp. 1–5. [CrossRef]
46. Palmisano, S.J. A Smarter Planet: The Next Leadership Agenda. 2020. Available online: https://www.ibm.com/ibm/cioleadershipexchange/us/en/pdfs/SJP_Smarter_Planet.pdf (accessed on 10 September 2020).
47. Dirks, S.; Keeling, M. A vision of smarter cities: How cities can lead the way into a prosperous and sustainable future. *IBM Inst. Bus. Value* **2009**, *8*, 1–6.
48. Trencher, G. Towards the smart city 2.0: Empirical evidence of using smartness as a tool for tackling social challenges. *Technol. Forecast. Soc. Chang.* **2019**, *142*, 117–128. [CrossRef]
49. Rudolf, G.; Fertner, C.; Kramar, H.; Kalasek, R.; Pichler-Milanovic, N.; Meijers, E. *Smart Cities: Ranking of European Medium-Sized Cities*; Centre of Regional Science: Vienna, UT, USA, 2007; pp. 1–25.
50. Chourabi, H.; Nam, T.; Walker, S.; Gil-Garcia, J.R.; Scholl, H.J. Understanding smart cities: An integrative framework. In Proceedings of the 2012 45th Hawaii International Conference on System Sciences, Maui, HI, USA, 4–7 January 2012.
51. Wei, W.; Li, R.Q. A Primary Investigation into Revolution and Way to Reform under the Background of Smart City Construction. In *Advanced Materials Research*; Trans Tech Publications, Ltd.: Wollerau, Switzerland, 2011; Volume 368–373, pp. 3593–3597. Available online: https://doi.org/10.4028/www.scientific.net/amr.368-373.3593 (accessed on 10 September 2020).
52. Vessali, K.V. Land use impacts of rapid transit: A review of the empirical literature. *Berkeley Plan. J.* **1996**, *11*, 71–105. [CrossRef]

53. Cervero, R.; Day, J. Suburbanization and transit-oriented development in China. *Transp. Policy* **2008**, *15*, 315–323. [CrossRef]
54. Hess, D.B.; Lombardi, P.A. Policy support for and barriers to transit-oriented development in the inner city: Literature review. *Transp. Res. Rec.* **2004**, *1887*, 26–33. [CrossRef]
55. Dittmar, H.; Poticha, S. Defining transit-oriented development: The new regional building block. In *The New Transit Town: Best Practices in Transit-Oriented Development*; Island Press: Washington, DC, USA, 2004; pp. 19–40.
56. Xu, W.A.; Guthrie, A.; Fan, Y.; Li, Y. Transit-oriented development: Literature review and evaluation of TOD potential across 50 Chinese cities. *J. Transp. Land Use* **2017**, *10*, 743–762. [CrossRef]
57. Jacobson, J.; Forsyth, A. Seven American TODs: Good practices for urban design in transit-oriented development projects. *J. Transp. Land Use* **2008**, *1*, 51–88. [CrossRef]
58. Papa, E.; Bertolini, L. Accessibility and transit-oriented development in European metropolitan areas. *J. Transp. Geogr.* **2015**, *47*, 70–83. [CrossRef]
59. Millward, H. Urban containment strategies: A case-study appraisal of plans and policies in Japanese, British, and Canadian cities. *Land Use Policy* **2006**, *23*, 473–485. [CrossRef]
60. Thomas, R.; Bertolini, L. Beyond the case study dilemma in urban planning: Using a meta-matrix to distil critical success factors in transit-oriented development. *Urban Policy Res.* **2014**, *32*, 219–237. [CrossRef]
61. Searle, G.; Darchen, S.; Huston, S. Positive and negative factors for transit oriented development: Case studies from Brisbane, Melbourne and Sydney. *Urban Policy Res.* **2014**, *32*, 437–457. [CrossRef]
62. Balducci, A. Smart planning for smart cities. *DisP Plan. Rev.* **2012**, *48*, 4–5. Available online: https://www.tandfonline.com/doi/abs/10.1080/02513625.2012.702953 (accessed on 5 September 2021). [CrossRef]
63. Wilson, P. State of smart cities in UK and beyond. *IET Smart Cities* **2019**, *1*, 19–22. [CrossRef]