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SMART CITY:

DEFINITIONS, APPROACHES, AND APPLICATIONS

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INTRODUCTION

Human history is largely a manifestation of the intertwined evolution of cities and technology, of humanity's struggle to transform its environment and survive. From the Stone Age to the Industrial Revolution and today's information age, cities have always been the testing ground for the most advanced technologies of their time. Every innovation, from aqueducts to sewage systems, railways to fiber optic networks, has changed the structure of cities. Today, with most of the world's population concentrated in urban areas, cities have become not only centers of economic production but also hubs of complex problems. In this context, the concept of the 'Smart City' is one of the current and comprehensive paradigms in which technology is presented as a solution to urban problems. However, this concept is a multi-layered structure that must be understood in its economic, social, and environmental dimensions, beyond being merely a pile of technological equipment.

The rethinking of cities through technology is based not only on the increasing number of smart city initiatives in recent years but also on the problems faced by city management. Population growth, the fragility of infrastructure networks, climate and disaster risks, mobility pressures, and increasing inequality in access to services require local governments to make faster and more accurate decisions. At this point, digital systems come to the fore in terms of increasing measurement, monitoring, coordination, and resource allocation capacities. However, the relationship between technology and the city cannot be explained by a simple equation such as "more devices equals a better city." This is because technology is not only a tool but also provides a framework that determines what data will be produced, what problems will be considered visible, and what performance indicators will be interpreted as success. Therefore, the smart city debate is an area of transformation that must be addressed in conjunction with the social fabric and institutional order of the city.

The aim of this study is to strengthen the reader's ability to distinguish between conceptual and practical levels rather than providing a single definition of a smart city. The target audience is considered to be researchers working in urban planning, public administration, local government units, relevant engineering fields, and social sciences, as well as practitioners evaluating smart city projects. Therefore, the study simplifies concepts while focusing on the values and dynamics behind them.

To understand the smart city correctly, it must be read not as a paradigm invented overnight, but within the framework of the city-technology relationship, as a current phase of technology-infrastructure transformations. The modern city is shaped not only by the accumulation of buildings and population but also by the establishment, expansion, and management of networks such as water, energy, transportation, and communication. How these networks are organized, which regions and groups they prioritize, and how they relate to inequalities in the city are important considerations. Establishing such a historical framework will also enable us to see the positive and negative aspects of smart city approaches more clearly. Therefore, proceeding through the city-technology relationship will make it possible to understand not only the technical components of the smart city but also its consequences in terms of city management and the right to the city.

The fundamental approach adopted in this study treats the smart city as a socio-technical phenomenon. The socio-technical tradition emphasizes that the success of a system is determined not only by technical efficiency but also by ways of working, inter-institutional coordination, user acceptance, competencies, and value conflicts. In the urban context, this shows that the assumption that 'technology solves problems' is limited; the impact of technology emerges in conjunction with the organizational style of local government and public policy preferences (Chourabi et al., 2012; Nam & Pardo, 2011). The socio-technical perspective requires smart city applications to be read in three parts. These are the technical infrastructure, the social dimension, and the governance dimension. If one of these layers is missing, issues of sustainability and legitimacy may arise. The literature particularly emphasizes that the factors affecting the success of smart city initiatives are related to the management-organization and policy context as much as they are to technology (Chourabi et al., 2012; Kitchin, 2015). Another consequence of this approach is that it does not confine the smart city debate solely to the question of 'which technology should be chosen?'. The key point here is to clearly define which public values will be enhanced through technology. Therefore, with a socio-technical perspective, it will be possible to create a conceptual framework on the one hand and a roadmap on how to interpret the concept in practice on the other.

[1]The most distinctive feature of smart city literature is the existence of many different definitions due to the concept being used in different disciplines and for different purposes. This plurality can lead to ambiguity in the objectives in practice and to the 'smart' label becoming an umbrella concept that sometimes carries technical capacity, sometimes sustainability, and sometimes competitiveness claims at the same time. This situation can also cause uncertainty about how to translate the smart city into concrete policy priorities, even though it is easily included as a vision statement in municipal strategy documents. Another consequence

[1] *definitional plurality*

of this plurality of definitions is that market actors and corporate campaigns increase their power to produce their own discourse. Critical literature explicitly discusses how the 'smart city' narrative can sometimes be constructed by companies as a story and marketing language, even creating "mandatory transition points" that make city administrations dependent on certain technologies (Söderström et al., 2014; Kitchin, 2015). Within this framework, the study treats the multiplicity of definitions not as an "error" but as a reality that must be managed.

One of the main reasons why discussions in the field of smart cities sometimes appear contextually disconnected is that the same words are used with different meanings in different texts. "Intelligence" can sometimes refer to automation and optimization, sometimes to learning and adaptation, and sometimes to participation and governance capacity (Nam & Pardo, 2011; Albino et al., 2015). Similarly, the word "data" is not just a technical raw material but also refers to a social relationship that determines which events are recorded, which groups are visible, and which decisions are legitimized (Kitchin, 2014; Couldry & Mejias, 2019). Therefore, the definitions of the concepts used in the study will also be provided.

The book is structured around two main sections. The first section, The Relationship Between Cities and Technology, will focus on the fundamental assumption that the smart city is not a "suddenly invented paradigm." The smart city will be approached as a current phase in the long-term relationship between cities and technology in urbanization. Therefore, the socio-technical character of the city and the logic of infrastructure networks will be addressed first. It will examine how networks such as water, energy, transportation, and communication shape and transform urban life. Subsequently, the history of urbanization will be discussed through waves of technology to place the smart city in its historical context. In literature, technology waves are generally addressed as pre-industrial, industrial, and post-industrial periods. However, when examining the development process of the fundamental dynamics of the smart city over time, it becomes clear that this classification is insufficient. It is evident that most fundamental concepts such as network society, electrification, data, and measurability gained meaning in the 20th century. Nevertheless, in order not to stray from the historical context in the literature, the pre-industrial and industrial revolution periods will also be examined. Subsequently, disruptions such as electrification, the automobile city, the network society, and today's platformization will be addressed. The distinction between digitization and digitalization, datafication, platformization, and algorithmic decision support will also be examined in this section. Thus, readers of will have the opportunity to examine both the historical accumulation and conceptual transformation of the smart city concept.

The second section, Smart City, will establish the theoretical framework of the concept. First, the concept of "intelligence" will be addressed, discussing how intelligence does not merely mean technology intensity or automation; it must be evaluated in conjunction with the dimensions of learning, adaptation, coordination, and institutional capacity. Then, smart city approaches will be examined from different perspectives, such as "technology-centered," "human-centered," "governance-centered," and "critical/political-economic," without being reduced to a single line. The backbone of the section will be the discussion of smart city definitions.

1. THE RELATIONSHIP BETWEEN CITIES AND TECHNOLOGY

In urban history literature, approaches that consider "smart city" as a concept born in the 1990s are frequently encountered (Lin et al., 2019; Shayan et al., 2020; Örselli, Binici, 2024; Kaya, Gökgür, 2019; Anthopoulos, 2017; Wu, 2025). However, the smart city was not invented overnight; it matured within the socio-technical nature of the city, with the intensification of infrastructure networks and the transformation of measurement/standardization techniques and management approaches. While the 'smart' label became prominent in the 1990s, the concept began to be redefined in the 2010s with data extraction and platformization. The fundamental aim here should not be to understand the history of the smart city as a label, but to historically comprehend how the city functions and is managed with technology. Therefore, adopting a process-oriented approach would be more appropriate, both when defining and when establishing a historical framework. In other words, the fundamental urban elements that enable the existence of the smart city today must also be considered from a historical perspective. At this point, it is important not to overlook developments such as population censuses, which are the first examples of urban data, the development of network infrastructures, the emergence of the digital city, sensorization, mobility, platforms, and the use of artificial intelligence in the transformation of urban space. However, to avoid anachronism, it is also necessary to correctly establish the relationship between these developments and the smart city. Otherwise, the claim will arise that every technical development concerning the city is directly linked to the smart city; that it is a result or a condition of the smart city.[2] One way to avoid this confusion is to consider the context of the

[2] For example, it is possible to approach population censuses from a "measure-classify-manage" perspective. And with this logic, it is actually possible to talk about

relationship between the city and technology. Indeed, establishing the historical framework within this context will both prevent the "history of conditions" from being overlooked and prevent anachronism.

1.1. The Socio-Technical Nature of the City

When the city is considered solely as a physical space or merely as a stage for social relations, it is impossible to understand urban functioning. The socio-technical[3] perspective addresses this very deficiency by considering the city as a system produced jointly by technical components and social-organizational components (institutions, roles, competencies, user practices). This approach argues that technology is not a "neutral tool." According to this view, technical choices also influence organizational choices, and organizational-social choices influence technical design. The first step here is to clarify how the city is built on the logic of "infrastructure-network" and why it operates through networks. Then comes the question of whether we should view "technology" merely as a tool or as a mechanism that constructs and governs the city.

The city's "infrastructure–network" logic

The socio-technical nature of the city is particularly evident in its infrastructure networks. Infrastructure such as transportation, energy, water, waste, and communications are not merely physical lines that carry services; they are fundamental systems that enable the daily functioning of urban life and allow people and economic activities to move regularly within the city. In other words, the uninterrupted operation of these networks enables modern institutions to function, ensures the continuity of services, and makes the "normal flow" of social life possible (Şenyel Kürkçüoğlu, 2021; Graham & Marvin, 2001). Questions such as which neighborhood in the city is growing, which area is attracting investment, and in which area life is "easy" or "difficult" are largely related to the capacity and connectivity of these networks. This is why smart city applications generally focus on these networks. Digitalization often aims to make these networks more visible, better monitored, and better managed (Kitchin, 2014; Bulut & Aslan, 2023).

The logic of infrastructure networks also raises the issue of "interoperability." Networks such as water, sewage, electricity, natural gas, telecommunications, and transportation often intersect beneath the same urban surface. An intervention in one can directly affect another. Therefore, mapping and digitizing infrastructure and coordinating

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urban data production. However, characterizing population censuses as a smart city application would be an anachronism.

between units has become critical not only for technical efficiency but also for the sustainability of urban order. Indeed, failure to keep infrastructure lines up to date in local administrations, weakening of institutional memory due to personnel changes, and lack of coordination between different units result in repeated excavations, cost increases, and problems with service continuity (Alıcı & Özaslan, 2018; Kılınç, 2021). At this point, viewing infrastructure as a "network" allows us to see the city not as a collection of disconnected sectors, but as a system with interdependent relationships. Therefore, the next step is to ask whether we should view "technology" merely as a neutral tool that operates these networks, or whether we should consider it as a mechanism that determines how the city is built and managed.

Tool or mechanism that shapes the city?

Positioning technology solely as "tools that facilitate service production" will render the political and social consequences of technical transformations in the city invisible. The fundamental claim of the socio-technical perspective is that technical systems are not independent of social organization. On the contrary, they are shaped together with institutions, norms, interests, and everyday practices. When considered in the urban context, this implies more than simply stating that "technology exists within the city." The networks, institutions, and decision-making mechanisms that hold the city together and the technical mechanisms produce each other reciprocally (Graham & Marvin, 2001). Therefore, the question "Is the city adapting to technology, or is technology reconstructing the city?" has become one of the starting questions in the smart city debate. The dimension of technology as a "city-building mechanism" becomes particularly visible through standards, classifications, registration systems, and measurement practices. This is because a significant part of city management relies on classifying and managing urban data in a measurable way. This process also often operates through information infrastructures. Here, technology is not merely an infrastructure investment but also produces a framework that determines the questions of "what is important and what is measured?" in relation to the city. Therefore, when discussing sensors, databases, indicator sets, and platforms in the context of smart cities, questions arise about the purposes for which they are established and the actors they serve (Kitchin, 2014).

In smart city literature, the distinction between "tool" and "foundational mechanism" is particularly evident in the areas of data-driven management and real-time analysis. Equipping cities with digital devices not only promises faster services but also brings technocratic tendencies, institutional lock-ins, and new dependency relationships in decision-making processes to the fore (Kitchin, 2014; Nochta et al., 2021). Turkish literature also emphasizes that the smart city debate should be addressed not only in terms of producing technical solutions to urban problems but also in terms of governance, coordination, and social impacts (Örselli & Bilici 2024). Therefore, if technology is not merely a tool in the city, the question of who has access to infrastructure networks, where they become fragile, and in what ways they fragment has become one of the fundamental mechanisms of urban inequality.

Infrastructure Networks and Inequality

Infrastructure networks are often thought of as "public services provided equally to everyone"; however, in practice, the level of access, quality of service, and continuity of service can vary depending on location and social groups. This variation demonstrates that inequality can be produced not only through income or the housing market but also through the material order of infrastructure (Şenyel Kürkçüoğlu, 2021). Even debates about accessibility in urban transportation alone show that infrastructure projects can systematically exclude certain groups. In this case, it is possible to say that "technical" decisions produce direct social consequences (Uslu & Güneş, 2017; Kayakök et al., 2025). Therefore, infrastructure policies should be addressed not only as a matter of investment and maintenance but also as an issue of justice and inclusivity that touches on the "right to the city."

In conclusion, the socio-technical nature of the city shows that urban life operates not only through physical space and social relations, but also through a system produced by infrastructure networks, institutional arrangements, and everyday practices. This framework necessitates thinking of technology not as a neutral tool added to the city from outside, but as a constitutive mechanism that affects service continuity, decision-making forms, and access justice. Therefore, to establish a healthy smart city discussion, it is first necessary to trace the historical development of these networks and how they have been reorganized through digital transformation.

1.2. The Measured and Recorded City

One of the best ways to reduce the risk of limiting the historical process to the label of "smart city" is to set aside the debate of "was there a smart city or not?" and examine how the practices of measurement, recording, classification, and standardization that make the city governable have progressed (Scott, 1998). Historically, the city has been established not only as a place where population and structures are gathered, but also as an object of governance where administration, resource allocation, and security are carried out. In this process, measurement and recording have increased the state's and local government's capacity to "see" the city, making urban data manageable. Scott's (1998) discussion of "legibility" demonstrates how censuses, mapping, and standards form a fundamental framework for governance. At this point, censuses are important in terms of early forms of urban data. The purposes and forms of censuses in the Ottoman Empire varied over time; before statistical information production in the modern sense, administrative purposes such as taxation and military service were seen to be more decisive (Doğan, 2014; Güneş, 2014). Such censuses are not "smart city" applications in today's sense. However, making the city and its population administratively "countable and classifiable" is part of the management logic upon which digitization will be based in the future (Scott, 1998). Therefore, historical continuity should be sought not so much in the technology itself, but in the way measurement and recording practices relate to institutional decision-making.

As measurement and recording practices became more widespread, decisions regarding the city began to be increasingly formed and legitimized through "statistical reasoning." In his work, Desrosières (2002) concluded that statistics not only "count what is," but also establish which categories are considered real, which issues are seen as priorities, and how the state's criteria for success are defined. Therefore, when reading urban history through the lens of technological waves, it is necessary to pay attention not only to the transformation of devices and infrastructure, but also to the new reality of governance that emerges from the connection between measurement, standards, and classification (Scott, 1998; Desrosières, 2002).

Census and "making visible"

Census takings are seen as one of the earliest and most effective tools in the modern states, and indirectly the city administration's efforts to make society visible and manageable. In the Ottoman example, this logic began with records such as Tahrir and Avarız during the classical period. In the 19th century, it intensified with modern censuses that supported a more regular administrative rationality, primarily for military and tax purposes (Güneş, 2014; Başaran, 2017). The critical point here is that the census does not merely answer the question "how many people are there?" but also involves a concern for "making visible" who will be counted under which category, with which characteristics, and for which administrative purposes. In this context, "making visible" means more than just a technical recording activity; it means the administration simplifying the data and transforming it into readable schemas. Scott's discussion of "legibility" is particularly relevant here. The state's simplification of social reality through certain schemes for purposes such as taxation, military service, security, and order is likely to exclude local knowledge and everyday practices (Scott, 1998; Porter, 1995). The fact that the 1830–31 general census in the

Ottoman Empire proceeded on the basis of the male population provides a concrete example of how the categories of taxation/military service determined reality. The fact that census registers employed a classificatory language with administrative priorities such as "fitness for military service" is also noteworthy in this regard (Başaran, 2017; Güneş, 2014).

Thus, while censuses make certain aspects of the city and society "measurable," they simultaneously obscure areas that cannot be measured. The logic of classification and registration increases administrative capacity on the one hand, while revealing those outside the administration, those considered deficient, or those misclassified on the other. Bowker and Star's approach to classification systems conceptualizes precisely this tension. Categories do not merely represent the world; they can also shape social order by determining which differences are considered meaningful (Bowker & Star, 2000). Therefore, approaching censuses as a practice of "making visible" allows for a more careful reading of the historical roots of the data-driven governance claim currently being discussed in the context of smart cities. Making the population visible through statistics is a powerful starting point for governance. However, for population information to be operationalized, it often needs to be linked to space. Therefore, the second major step in making it visible is mapping and classification, which relates the number to "place."

Mapping and classification practices

Mapping translates administrative information into a spatial language, linking administrative decisions to place. The institutionalization of cartography and initiatives to train cartographers in the Ottoman Empire show that the modern state sought not only to count the population but also to bring land, settlement, and infrastructure into a measurable/mappable order (Geçili, 2020; Ebel, 2005). Here, the map is considered not just a simple drawing, but a representation technique that enables the administration to answer the question "where" by providing a standard. Thus, the city is redefined within both physical and administrative boundaries (Ebel, 2005). The link between mapping and classification is often overlooked. Producing a map inevitably requires deciding which elements to show, which scale to choose, and which sign system to use. Harley's approach, which reads maps within the context of power and representation relations, opens up the discussion that a map may not be a "neutral window" but rather a form of discourse and selectivity established for specific purposes (Harley, 1989). Similarly, cadastral surveys do not merely define space; they also expand the capacity for administrative intervention in areas such as property, public benefit, health, and social life. Therefore, the map/cadastral line increases the manageability of urban space while simultaneously establishing a powerful selection mechanism that determines what constitutes "legitimate information" (Harley, 1989).

Standardization, on the other hand, creates the conditions for this spatial information to be comparable across different places and times. The diversity of measurement units causes administrative difficulties in terms of trade, taxation, and public order. The adoption of common standards such as the metric system to reduce these difficulties has emerged as one of the fundamental moves of modern administration (Bacanlı, 2022; Porter, 1995). From a cartography perspective, the issue of scale, measurement, and technical education ensures that information can be produced and controlled institutionally (Geçili, 2020; Bacanlı, 2022). Thus, the "representation of space" (map), the "recording of space" (cadastre), and the "unity of measurement" (standard) come together to form the backbone of management information.

Mapping and standardization produce powerful representation tools for management. In contrast, modern management does not settle for representation alone but increasingly translates decision-making processes into numerical language by linking performance, risk, success, and priorities to criteria. Therefore, the very act of measurement becoming a "management language" is a critical link in this historical chain.

Measurement as a management language

In modern management, measurement is positioned not only as an objective assessment of the situation but also as a powerful language used to justify administrative decisions. Porter's "trust in numbers" debate emphasizes that "*quantitative indicators* can become *a source of legitimacy that claims objectivity and impartiality in public life*" and thus measurement can reframe political and administrative debates (Porter, 1995). In this context, the question of "what is considered a problem" is established not only by the spontaneous emergence of social needs, but also by which indicators are selected, which thresholds are considered "failure," and which targets are deemed measurable (Scott, 1998). Discussions on performance measurement and performance management in public administration literature show that measurement has become an institutional reflex. Köseoğlu and Şen (2014) argue that performance management became widespread, particularly after the 1980s, with the new public management wave, and that the purposes and tools of measurement also transformed and expanded during this process. Similarly, criterion- and indicator-focused approaches are legitimized with the goal of basing decisions on clear and concrete data. However, this goal also carries the risk of drawing management's attention toward the measurable, thereby marginalizing unmeasurable values (Porter, 1995). Therefore, performance indicators not only measure results but also effectively define how the organization and service should be restructured according to specific objectives.

In the urban context, this dynamic produces a two-way effect. On the one hand, measurement can strengthen management accountability by increasing monitoring capacity in areas such as infrastructure, transportation, environment, and security. On the other hand, it makes the definition of "problems" dependent on indicators, thereby rendering the qualitative dimensions of urban life relatively invisible (Scott, 1998; Porter, 1995). Therefore, measurement must be approached not merely as a technical advancement but as a governance choice that determines urban priorities. The historical continuity here is clear. The concern for visibility, which began with censuses, is linked to space and measurement standards through mapping and standardization.

1.3. The Concentration of Network Infrastructure and Modern Urban Management

From the second half of the 19th century onwards, cities became increasingly dependent on a way of life organized through networks. As services such as water supply, sewage disposal, solid waste collection, energy supply, and urban transportation expanded, the primary goal of city management became not only to "build" but also to operate and maintain. This transformation also changed the "invisible" nature of infrastructure. As the network grew, infrastructure ceased to be a backdrop for urban health and economic order and became one of the areas where management capacity was most concretely tested (Melosi, 2000; Star, 1999). The first major concentration in this historical line is seen in the field of water/sewage and urban sanitation. When problems such as epidemics, odors, and environmental pollution were combined with discussions of "urban order," the source, distribution, and disposal of wastewater became central to municipal services. Melosi's study, which traces the history of infrastructure over the long term, shows that water and sewerage systems are not only technical innovations but also reconfigure city management through public health, financing, and administrative organization (Melosi, 2000). Specifically in Istanbul, Hayal's discussion of 19th-century public health and sanitary infrastructure also shows how infrastructure is intertwined with "regulating circulation in the city" and "expanding administrative capacity" (Hayal, 2023).

The second major threshold is the acceleration of the electrification process from the beginning of the 20th century. Electricity connects the city to a new energy regime through lighting and production. Hughes's classic study, which reads electrification in the context of "power grids," reveals that electricity should be understood not as a singular invention but as a system that grew alongside companies, municipalities, technical standards, and user practices (Hughes, 1983).

The third threshold was observed in transportation networks. Early urban transportation investments such as rail systems, trams, and tunnels reconfigured the city's center-periphery relationship. The struggle over street use at the dawn of the automobile age demonstrates that transportation technology did not merely generate movement in the city but also gave rise to new regulatory regimes and a new "traffic management" (Norton, 2008).

With the growth of network infrastructures, the city is increasingly tied to an operating logic defined by continuity and maintenance. At this point, what is critical is not so much the initial establishment of the network, but rather the resolution of faults, the replacement of parts, the reduction of leaks, the increase in capacity, and ensuring the simultaneous operation of different institutions. Graham and Thrift's work, which points to the central role of maintenance and repair in urban life, emphasizes that it is often maintenance regimes and the organizational capacity that carries these regimes, rather than plans, that keep cities "up and running" (Graham & Thrift, 2007). As this operating logic grows, coordination capacity becomes one of the defining issues of city management. Networks share the same spatial surface, and work on one can directly affect another. Therefore, fragmented execution of infrastructure services can result in repeated excavations, increased costs, and social hardship. In this context, the concentration of network infrastructure requires municipal services to strengthen not only their technical expertise but also areas such as tendering, pricing, maintenance planning, and institutional coordination.

Finally, the fact that networks have become the backbone of urban life inevitably brings the issue of risk and resilience to the fore. In times of crisis, such as outages, breakdowns, disasters, and epidemics, infrastructure is put to the test of "operability." This is because a disruption in one network can often trigger others, producing chain reactions. Graham's compilation, *Disrupted Cities*, demonstrates through various crisis examples that infrastructure disruptions are not merely technical failures. According to him, these disruptions are intertwined with social vulnerabilities, political decisions, and emergency response capabilities. (Graham, 2010). Therefore, when establishing the historical framework of the city-technology relationship, it is necessary to read "infrastructure revolutions" not merely as a sequence of inventions. Instead, it would be more explanatory to read them in terms of the establishment, operation, maintenance, and resilience of networks in the face of crises.

1.4. The Emergence of the Digital City

The emergence of the digital city should be understood as a long institutional-technical accumulation aimed at making cities manageable, monitorable, and comparable, which reached a new threshold in the 1990s. Prior to 1990, information production in city management was mostly carried out through fragmented inventories, paper maps, reports, and internal records. However, with the increase in data processing capacity, this information began to be reorganized within the logic of digitization and databases. The critical aspect of this transformation is not only the faster processing of data but also the more systematic integration of spatial information into institutional decision-making processes. Indeed, discussions surrounding geographic information systems (GIS) emphasize that they create an information regime that enables the integration of "where-what" information (address, parcel, building, transportation, infrastructure, etc.) in the city into the daily operations of the administration (Goodchild, 1992; Çabuk, 2015). In this context, GIS/KBS (City Information System) is seen as the first solid foundation of the digital city. This is because the digital city begins with the digitization of the city's spatial memory. Without linking map layers, zoning-cadastral records, address components, infrastructure inventory, and inter-institutional data circulation to a specific standard, "digital" city management is not sustainable. In Turkish literature, it is particularly emphasized that GIS is a framework that enables municipalities to perform analyses such as planning, infrastructure maintenance and renewal, zoning and cadastral relations, transportation, and population in a more modern way (Çabuk, 2015). This line also explains why the threshold of the 1990s is important. The proliferation of personal computers and the software ecosystem, along with the falling costs of digital cartography and database solutions, accelerated the transformation of "institutional data" production into a routine activity for municipalities. Therefore, digitization is not a singular achievement but a reorganization of the municipality's inventory, coordination, and decision-making capacities.

By the 1990s, the second axis that defined the concept of the digital city was the "e-government/e-municipality" initiative, which emerged with the transfer of service processes to the electronic environment. The issue here is not only the municipality's internal organization of data, but also the redesign of processes that involve citizens, such as applications, payments, information requests, complaints, permits, and inquiries. In Turkey, e-municipality is considered the local counterpart of the e-government approach. The diversification of electronic service delivery by municipalities, particularly through their websites, is associated with the goals of reducing transaction costs and facilitating access to services

(Arıkboğa, 2017; Güven, 2022). This transformation also generates visible performance competition between municipalities. Criteria such as which municipality completes which process online, which municipality operates municipal interaction channels, and which municipality can establish feedback loops come to the fore (Güven, 2022).

These two axes (GIS and e-municipality) fed into a third ground in the 1990s. This is the concept of the "digital city" as a new urban experience in the context of public communication and network society. Online community networks designed through the urban metaphor of the 1990s in the digital city literature (such as De Digitale Stad/DDS in Amsterdam) are noteworthy in this regard. Here, the city is conceived not as a direct replica of physical space, but rather as an interface/space for accessing information and public communication (Ishida, 2000). Ishida's comparative study of digital cities also highlights that different digital city experiments in the 1990s had different objectives (such as public communication space, metropolitan network infrastructure, vertical market, and social information infrastructure) (Ishida, 2000). Thus, the "digital city" has acquired a broader context, encompassing both the management of institutional data and the digitization of processes, as well as the redefinition of the urban experience and the public communication sphere through networks.

This picture also explains why the "smart" label has been able to take hold more easily since the 1990s. The discourse of the smart city did not emerge suddenly; it gained meaningful ground only after the digital representations of the city (GIS/KBS), then service processes (e-municipality), and finally urban interaction in the context of network society (digital city) reached a certain level of maturity. Therefore, the 1990s should be seen not as the starting point where the "smart city" was directly invented, but rather as a transitional threshold where the representability of the city through data, the capacity for inter-institutional coordination, and digital interfaces for citizens became visible together. Reading the 1990s threshold in this way both limits anachronism and makes it possible to define the "smart" label specifically in terms of data, platform, and governance discussions.

1.5. Sensorization, Real-Time, and Monitoring[4]

With the 2000s, the city has become not only an administrative area where data is processed, but also a technical-organizational environment where data is continuously produced. The distinctive aspect of this transformation is the expansion of the source of data and the change

[4] This process, which can also be described as urban instrumentation, essentially refers to equipping the city with digital measurement infrastructure.

in the time regime. Through sensors, cameras, meters, mobile devices, and location-based systems, urban processes have become monitorable in real time. A significant part of the smart city claim is concentrated precisely at this point, namely the ability to recognize and manage the city with real-time data (Batty et al., 2012; Kitchin, 2014). Therefore, the "sensorization—real-time—monitoring" line represents an important historical phase.

Sensorization, in its simplest sense, is the collection of measurable quantities such as temperature, humidity, air quality, flow, occupancy, speed, and vibration through sensors placed at different points in the city. At this stage, the "internet of things" approach becomes decisive. Sensors producing data through machine-to-machine communication, the transmission of this data over networks, its storage, and its processing through analytical processes form the technical backbone of smart city projects (Gökrem & Bozuklu, 2016; Kitchin et al., 2015). In the Turkish literature, IoT architectures are also discussed in the context of raw data from sensors being transferred to cloud/data processing environments via communication layers and interpreted through big data analytics (Gökrem & Bozuklu, 2016). The important point here is that sensors should be viewed as a socio-technical whole that works together with infrastructure, software, data quality, and institutional capacity (Kitchin et al., 2015).

Real-time capability involves linking the data stream generated by sensorization to decision-making processes as "instant feedback." Those who advocate for the production and operation of big data generally point to two dynamics. These are the claims that big data enables real-time analysis and makes more effective and transparent management possible. However, this also brings about a new information regime and a new management style in city management (Kitchin, 2014). City indicators, benchmarking tools, and especially dashboard applications reduce the complex and large-scale data produced within the city to specific numerical forms, while also reconfiguring the ways in which managers and citizens see and know the city (Kitchin et al., 2015). This approach sometimes has the potential to improve service quality and strengthen accountability, but at the same time, due to the scope of measurement, blind spots in data production, methodological preferences, and measurement-based incentive mechanisms, it also carries the risk of "limiting the reality of the city to what is shown."

Monitoring refers to the concrete institutional framework linking these two strands. The data collection—data integration—visualization—intervention cycle is designed as an operational management capacity, particularly in areas such as transportation, environment, security, and disaster management. Studies addressing smart city governance in Turkey show that some municipalities are attempting to increase coordination capacity with digital systems in environmental monitoring, traffic management, and service processes, but this has created new needs in areas such as institutional maturity, task sharing, data governance, and human resources (Doruk, 2022). In other words, while monitoring systems aim to strengthen operational capacity through functions such as maintenance, resource allocation, and early warning in crisis management, the monitoring infrastructure itself can create new vulnerabilities and dependencies. Therefore, monitoring should be understood not merely as a technical tracking activity, but as a management domain complemented by administrative responsibilities, data sharing protocols, security architectures, and accountability mechanisms established alongside measurement infrastructures.

At this point, the fundamental criticism in the literature focuses on how data is collected, its purpose, and its accessibility. In other words, even if sensorization and real-time monitoring are presented with the assumption that they will produce more accurate information about the city, questions such as how the data is collected, for what purpose it is collected, who has access to it, how long it is stored, and what decisions it automates are important. Kitchin particularly emphasizes that in big data-based smart city applications, the strengthening of data politics, technocratic governance tendencies, institutional/technological lock-ins, fragile and vulnerable systems, and surveillance tendencies can grow together (Kitchin, 2014). In the Turkish literature, the personal data security and privacy dimension of smart city applications is also considered critical in terms of both the legal framework and citizen participation (Hayta, 2021; Düger, 2023). Therefore, cities equipped with sensors and monitored in real time, while producing a faster response capacity to urban problems on the one hand, also increase debates on inequality, privacy, and democratic control on the other hand due to the scope of measurement and the way it is used. Therefore, correctly interpreting this phase within its historical context will enable a clearer understanding of which technical transformation produced which governance outcome when discussing post-2010 disruptions such as platformization and the data economy in the next phase.

1.6. Data and Platform

With the 2010s, the discourse of smart cities has expanded beyond the framework of digitalized municipalities and cities monitored by sensors, increasingly moving towards a data-driven and platform-mediated urban logic. This expansion has been made possible, on the one hand, by the city becoming an environment that continuously produces data from multiple sources and, on the other hand, by the organization of the storage, processing, and conversion of this data into services increasingly through intermediate layers called platforms. Kitchin's discussion of the real-time city and data-driven smart city approach points to the restructuring of urban management routines around a cycle of data-based monitoring, analysis, and guidance (Kitchin, 2014; Kitchin, 2015). Similarly, the platform society approach emphasizes that digital platforms are not merely market actors but have become foundational structures that influence public values and governance practices (Plantin et al., 2018).

Datafication is the process of converting different dimensions of urban life into numerical data and using this data as evidence in decision-making processes. The critical point here is that data does not arise spontaneously; choices such as which behaviors to measure, which categories to classify them under, and which indicators to consider successful are directly related to urban policy. Therefore, datafication is not merely an increase in technical capacity. It also brings about a restructuring that amplifies debates on values, priorities, and control (Kitchin, 2014). Literature frequently criticizes that this process, along with the conversion of data into economic value, may give rise to a new form of accumulation and domination, and that the use of behavioral traces for prediction and guidance purposes carries serious risks in terms of privacy and autonomy.

Platformization, on the other hand, highlights the intermediary mechanisms that enable data to become "operational." In the 2010s, ecosystems began to function through smart cities, app stores, location services, payment infrastructures, mapping services, cloud computing, and APIs. These ecosystems do not merely provide services in the city. They also reshape urban interaction. The platform capitalism approach focuses on how platforms have become fundamental economic structures with the capacity to collect data and connect different markets (Srnicek, 2017). At the city level, this situation is manifested by the proliferation of Uber/Airbnb-type intermediary platforms in areas such as transportation and accommodation, and by municipalities being increasingly pushed into regulatory and service provider positions working alongside platforms. At this stage, it is possible to say that the smart city is being redefined. This is because, at this point, municipalities have taken on the role of data managers in addition to their role as infrastructure operators. City indicators, dashboards, performance comparisons, and control centers make the city readable through specific metrics, while also directing the administration's attention to specific problem definitions and specific forms of intervention (Kitchin et al., 2015; Kitchin, 2014). In recent years in Turkey, metropolitan municipalities publishing data sets through open data platforms has become one of the visible examples of this transformation at the local level. Here, criteria such as the data format, timeliness, accessibility, and reusability of the platforms directly affect whether smart city practices produce social benefits (Atçeken, 2025; Kitchin et al., 2015). At this point, it is insufficient to view platformization merely as "the municipality purchasing software." This is because platforms can evolve over time into structures that function like infrastructure and generate dependencies. While this transformation technically facilitates city management, it also generates new types of institutional risks in areas such as data ownership, access rights, standards, interoperability, and supplier dependency (Plantin et al., 2018; Kitchin, 2015). Therefore, since the 2010s, the concept of “smart city" has increasingly been discussed not in terms of sensor/data production, but rather in terms of who collects the data, how it is processed by which platform logic, and which decisions are guided by which processes.

This redefinition also shifts the focus of smart city approaches. 'Intelligence' must now be discussed more explicitly in terms of the governance of data flows, the alignment of platform-mediated services with public values, and democratic oversight capacity. Discussions on digital governance at the local level also emphasize that smart city applications must strengthen not only infrastructure efficiency but also participation and accountability (Bozkurt, 2023). Therefore, developments since the 2010s necessitate reinterpreting the smart city not as "*more technology*" but as "*an urban order reconfigured through datafication and platformization.*"

2. SMART CITY

The term smart city has rapidly become a widespread concept in both academia and politics over the last thirty years (Hollands, 2008; Albino et al., 2015). An important reason for this prevalence is the difficulty of managing the intertwined problems of contemporary cities. Areas such as transportation, energy, water, security, environment, social services, and disaster management are interconnected through digital infrastructure and data-based coordination capacity. Decision-making processes are also increasingly reorganized around software, platforms, sensors, and data flows (Kitchin, 2014). Therefore, a smart city means not only the use of technological tools in the city, but also the transformation of institutional arrangements, actor relationships, and forms of governance related to the production, delivery, and control of urban services (Nam & Pardo, 2011; Kaygısız & Aydın, 2017). However, a clear problem in the smart city literature is that the concept is defined by different disciplines based on different priorities. In one text, the smart city may be addressed as digital infrastructure and integration capacity, while in another text it may be framed as human capital and innovation, and in yet another text as governance quality and participation capacity. Similarly, in the Turkish literature, the concept is discussed in terms of governance and institutional readiness as much as its technological dimension. This plurality is not a flaw, but when the boundaries of the concept remain vague, it is inevitable that every digitalization initiative will be labeled as *smart*, which in turn will obscure the evaluation criteria. Therefore, it is necessary to first focus on what the concept of *smartness* means. Then, smart city definitions and approaches can be properly understood.

2.1. What is "smartness"?

In everyday language, "smartness" is mostly associated with individual mental capacity. However, when it comes to cities, the concept corresponds not to a single intelligence but to the capacity of a multi-actor system to work together. The point of agreement in the smart city literature regarding the definition of smart/smartness is the claim that cities can manage their resources and processes in a more coordinated manner. This claim is grounded in some studies through technology and infrastructure integration, in some studies through human and social capital, and in some studies through institutions and governance (Nam & Pardo, 2011). Indeed, studies in the literature show that the adjective "smart" cannot be reduced to a single component in the urban context, and that definitions and dimensions are often established in conjunction with performance, sustainability, quality of life, and governance objectives.

Interpreting intelligence as technological density narrows the concept rather than explaining it. This is because the mere presence of sensors, software, databases, or platforms in a city does not guarantee intelligence. The same technological tools can generate public benefit with well-designed institutions and transparent accountability mechanisms, but they can also lead to closed decision-making, unmeasurable goals, and fragile systems under weak governance (Kitchin, 2014; Hollands, 2008). While some studies in Turkey emphasize that technology triggers transformation in municipal organization, they specifically point out that the real issue is inter-actor cooperation, institutional capacity, and process design (Memiş, 2017; Kaygısız & Aydın, 2017). In this context, smartness should be considered not so much as the city having more technology, but rather as the city's ability to connect its different service areas with data and communication infrastructures and to transform this connection into accountable decision-making processes (Nam & Pardo, 2011; Albino et al., 2015).

Another dimension of the smartness debate is criteria. Questions such as what criteria define smartness and for whom smartness is intended form the basis of this dimension. The smart city discourse often relies on goals such as efficiency, speed, optimization, and security. However, when the values that balance these goals in urban life are not clarified from the outset, smartness can be presented as a technical choice rather than a political one (Hollands, 2008; Kitchin, 2014). Furthermore, a significant portion of smart city projects can be shaped around the solution packages and narratives of large technology companies. This increases the risk of the city's needs becoming intertwined with the priorities of the technology market. Therefore, *smartness* should not be reduced to merely meaning a better-functioning system. It should also encompass normative and institutional questions such as which public issues are prioritized, which data is collected, and who makes decisions and under what oversight. At this point, two practical criteria can be proposed to establish smartness on a more solid foundation. First, the claim of *smartness* must be linked to a concrete problem definition. Otherwise, the concept will become a label that legitimizes technology investments but lacks a clear target. Second, the institutional and social conditions of smart applications should be addressed as a separate area of assessment. This is because when local governments lack preparedness, regulatory capacity, data management competence, and stakeholder coordination, technology investment will not be sustainable (Nohutçu & Akpınar, 2022; Kaygısız & Aydın, 2017). When these two criteria are considered together, smartness refers not to the existence of digital tools for the city, but to the capacity of city management to establish a problem definition–data–decision–implementation–accountability chain.

2.2. Conceptual Framework

As discussed at the beginning of this study, the concept of smart cities—in terms of its "historical label"—has become one of the most popular themes in academic literature, public policy, and technology companies' marketing strategies since the 1990s. However, despite this popularity, there is no universally agreed-upon definition of the concept. A review of the literature reveals that the concept of smart city is often confused with concepts such as "digital city," "information city," "wired city," or "sustainable city"; sometimes it is substituted for these concepts, and sometimes it is treated as a superset of these concepts (Kozłowski & Suwar, 2021). This conceptual confusion creates ontological uncertainty about what a smart city is and gives rise to the problem known as definitional plurality.

One of the most important reasons underlying this plurality of definitions is the multi-stakeholder nature of the concept. Technology companies such as IBM and Cisco tend to define the concept as a technological solution package focused on selling hardware and software for the optimization of urban systems (Hollands, 2008). In contrast, social scientists and urban planners approach the concept in terms of social capital, participation, and quality of life. For example, Yigitcanlar (2016) emphasizes that smart cities are not just about technological infrastructure, but rather an urban development model blended with the principles of the knowledge economy and sustainability. These different perspectives cause the concept's boundaries to constantly expand and become ambiguous.

The difficulty of defining the concept brings with it various problems. First, the lack of a clear definition makes it difficult to measure and compare the performance of cities. Which city is "smart" varies depending on the definition chosen. Second, there is a risk of emptying the concept of its meaning and using it merely as a "label." Hollands (2008) critically states that cities use this label as a marketing tool to portray themselves as progressive and attract investment, even if the content is weak. The third problem area is technological determinism. An excessive focus on technology in definitions creates the misconception that urban problems can only be solved through technological interventions, which can lead to the neglect of social and political dynamics (Neckermann, 2017). Kozłowski and Suwar (2021) characterize this situation as an imbalance between the "technological, human, and institutional" dimensions. As discussed earlier in the study, when the concept is explained solely in relation to technology, the digital realm, or the technical field, it will transform into a structure that serves only the private sector and capital, rather than the dynamics of urban life, society, and the public good.

Therefore, to establish the concept of smart cities on a sound footing, it is necessary to be aware of this plurality of definitions and to move towards holistic definitions that treat the city not merely as a pile of technology but as a socio-technical system.

Early definitions of the concept focused on the physical presence of technology. For example, in a study by Hall et al. (2000), considered one of the pioneering definitions in literature, a smart city was described as a settlement equipped with advanced sensors and computer systems that monitor, optimize, and even self-repair the status of all critical infrastructure, such as tunnels, roads, electricity, and water. This definition views the city as a control mechanism and focuses on the digitization of physical infrastructure. A similar approach is seen in the definition provided by Washburn et al. (2010) on behalf of Forrester Research. According to this definition, a smart city is the process of using smart computing technologies to make urban infrastructure components and services more efficient. The emphasis here is on the optimization and efficiency of urban services. The approach of technology companies to the concept has also been decisive during this period. On behalf of IBM, Harrison and Donnelly (2011) built the smart city on three fundamental pillars: Instrumented, Interconnected, and Intelligent. This approach refers to the chain of collecting data from the physical world (sensing), integrating this data with communication networks (interconnectedness), and processing it with analytical methods to convert it into action (intelligence) (Neckermann, 2017). However, such institutional definitions tend to view/present the city as a smart city as a market for technological products or a pile of hardware. Hollands (2008) criticizes these trends in the literature, noting that most existing definitions are institutional and entrepreneurial marketing discourses. According to Hollands, simply having BIT infrastructure does not make a city smart. A truly smart city should be a progressive city that uses technology not to deepen social inequalities, but to empower citizens, increase democratic participation, and transform urban life.

Batty et al. (2012) play an important role in the concept's shift from technology-focused to data- and system-focused. According to them, the smart city of the future is a cybernetic structure that uses new data flows and simulation models to understand, plan, and manage urban processes within the context of complexity theory. This definition treats the city as a dynamic organism that continuously produces data and is shaped by this data, rather than a static structure. Kitchin (2014) also defines the city in a similar vein as a measurable and instrumented structure managed by large data flows, ubiquitous sensors, and real-time monitoring technologies. However, Kitchin also points out that this real-time situation carries the risk of transforming the city's governance into a technocratic structure.

With the 2010s, definitions began to emphasize the human factor and social capital. The strongest representative of this transformation was Caragliu et al. (2011), who produced one of the most cited definitions in literature. The authors defined the smart city not only as one with technological infrastructure, but also as one where investments in human and social capital, traditional and modern communication infrastructure, and participatory governance foster sustainable economic growth and high quality of life. This definition is a critical threshold in that it removes technology as an end in itself and transforms it into a means aimed at improving quality of life. Similarly, Nam and Pardo (2011) approached the smart city not as a single dimension— —but as an organic integration of the dimensions of technology, people, and institutions. According to them, technology alone does not make a city smart; smartness is about how this technology interacts with people and institutions (Kozłowski & Suwar, 2021). This human-centered approach has been given a more concrete framework in the six-dimensional model developed by Giffinger et al. (2007) and used to rank European cities. According to Giffinger, a smart city is a city built on the axes of Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, and Smart Living, with citizens' awareness and independence, and performing well for the future. This definition offers a holistic perspective that encompasses not only the economic or technological dimensions of the city, but also its environmental and social dimensions. Neckermann (2017) takes this perspective further, arguing that a smart city must have a soul. According to him, a smart city is one that combines its data, resources, infrastructure, and people to continuously improve livability; it is not just a pile of technology, but a city with passion.

The diversity in definitions also varies according to geographical and sectoral focuses. For example, Dameri (2013) considers the smart city as a defined geographical area and states that advanced technologies such as ICT, logistics, and energy production collaborate in this area to create prosperity, inclusiveness, and environmental quality for citizens. Mosannenzadeh and Vettoriato (2014), on the other hand, view the concept as a process of integration. According to them, a smart city is a sustainable structure that enables the integration of fundamental areas (environment, mobility, governance, etc.), is based on stakeholder collaboration, and aims to overcome urban challenges by investing in social capital. In the case of Turkey, Yalçintaş et al. (2015), in their definition based on water management in Istanbul, consider the smart city as a management model that prioritizes environmental sustainability, using forecasting methods and technology to maintain a sustainable balance between supply and demand. Similarly, Bulu et al. (2014) define the smart city as a structure in which "algorithm-embedded" information technologies are integrated into urban processes to solve problems such as traffic congestion and energy efficiency.

The definitions of international institutions generally coincide with development and sustainability goals. The European Commission (2014), within the scope of the "Smart Cities and Communities" initiative, defines a smart city as settlements that offer solutions for the benefit of citizens and businesses, where digital technologies are integrated with traditional networks for more efficient resource use, lower emissions, and better transportation networks. The OECD (2015), on the other hand, approaches the concept from the perspective of "green growth" and "inclusiveness," describing it as initiatives that promote new management and business models, where digitalization is used to increase citizens' well-being and ensure more sustainable, resilient development. Finally, the International Telecommunication Union (ITU, 2016), affiliated with the United Nations, provides perhaps one of the most comprehensive definitions, describing a "sustainable smart city" as one that as an innovative city that meets the economic, social, environmental, and cultural needs of today and future generations, while using ICT and other tools to improve quality of life, urban service efficiency, and competitiveness. In light of all these definitions, it is clear that the concept of a smart city has evolved from a purely technological infrastructure project to a human-centered, data-driven, participatory, and sustainable urban management paradigm.

As can be seen, the definition of the concept is influenced by many factors, ranging from geographical and sectoral focuses to human/technology-centricity. A summary of the definitions discussed above can be found in Table 1.

Table1. Smart City Definitions

Author/ Institution	**Year**	**Definition Summary / Scope**	**Focus Point**
Hall et al.	2000	A safe and efficient city of the future where all structures (electricity, water, transportation, etc.) are monitored and managed using advanced sensors and networks integrated with databases and decision-making algorithms.	**Technology**
Giffinger et al.	2007	A city built on the awareness and independence of its citizens, demonstrating future-oriented performance based on smart economy, smart people, smart governance, smart	**Dimensions**

Author/ Institution	Year	Definition Summary / Scope	Focus Point
		mobility, smart environment, and smart living features.	
Hollands	2008	Urban areas where networked infrastructure (ICT) is used to increase economic and political efficiency and ensure social, cultural, and urban development.	**Critical / Technology**
Washburn et al. (Forrester)	2010	The use of information technology to make the city's infrastructure components and services (administration, education, health, public safety, real estate, transportation, and public services) smarter, more connected, and more efficient.	**Technology**
IBM (Harrison & Donnelly)	2011	A "system of systems" that uses digital sensors, networks, and complex data analytics algorithms to optimize the operation of the city's core systems and turn information into action.	**Technology**
Caragliu et al.	2011	A city where investments in human and social capital, as well as traditional (transportation) and modern (ICT) communication infrastructure, foster sustainable economic growth and high quality of life through participatory governance.	**Hybrid**
Nam & Pardo	2011	A smart city is an organic integration of technology, human factors (creativity, diversity, education), and institutional factors (governance, policy). Technology alone does not make a city smart.	**Governance / Human**
Batty et al.	2012	The city of the future is a structure that uses new data flows and simulation models to understand, plan, and manage urban processes within the context of complexity theory.	**Systems**

Author/ Institution	Year	Definition Summary / Scope	Focus Point
Kourtit & Nijkamp	2012	Cities with modern production factors that increase competitiveness in the information society by combining advanced ICTs with social and environmental capital.	**Economy**
Dameri	2013	A defined geographical area where advanced technologies such as ICT, logistics, and energy production collaborate to create prosperity, inclusiveness, and environmental quality for citizens.	**Environment / Technology**
European Commission (Manville et al.)	2014	Settlements where digital technologies are integrated with traditional networks to enable more efficient resource use, lower emissions, and better transportation networks; offering solutions that benefit citizens and businesses.	**Corporate**
Mosannenzadeh & Vettoriato	2014	A sustainable city that aims to overcome urban challenges by investing in social capital ( ) through stakeholder collaboration and enabling the integration of key areas (environment, mobility, governance, etc.).	**Systems**
Kitchin	2014	A city managed through big data flows, ubiquitous sensors (ubiquitous computing), and real-time monitoring technologies, making it measurable and instrumented.	**Data**
OECD	2015	Initiatives that promote new management and business models, using digitalization to enhance citizens' well-being and ensure more sustainable, inclusive, and resilient development.	**Corporate**
ITU (UN)	2016	An innovative and sustainable city that meets the needs of today and future generations; using ICT and other tools to improve quality of life, service	**Corporate**

Author/ Institution	Year	Definition Summary / Scope	Focus Point
		efficiency, and competitiveness.	
Neckermann	2017	A city that combines its data, resources, infrastructure, and people to continuously improve "livability"; not just a pile of technology, but a city with a "soul" and passion.	**Human**

2.3 Theoretical Framework

The problem of consensus in defining the concept of a smart city has led to the emergence of different theoretical approaches that vary depending on which component of the city (technology, people, or governance) is centered, rather than a single application model. These approaches determine how we define the city, how we frame problems, and what tools we mobilize for solutions. In the literature, these approaches can be broadly classified as views based on technological determinism, views that prioritize human capital and quality of life, and views that focus on institutional governance processes (Kozłowski & Suwar, 2021). In this section, these approaches will be discussed in relation to the city examples discussed in the previous section.

Technology-Centric Approach

This " " approach, which was dominant in the early literature on smart cities and is still advocated today by major technology companies (IBM, Cisco, Siemens, etc.), views the city as a stack of hardware and software that needs to be optimized (the city as a system of systems). Kozłowski and Suwar (2021) refer to this approach as technologically oriented, noting that its primary focus is on Information and Communication Technologies, sensor networks, and digital infrastructure. According to this approach, the smart city is a massive technological infrastructure project consisting of sensors, fiber optic networks, data centers, and smart devices. Yigitcanlar (2016) states that this model generally follows a supply-side strategy. In other words, technology is presented to the city as a modernization movement by technology companies or technocratic administrations, rather than in response to an urgent demand from citizens or the city at that moment. In this approach, the city is conceived not as a social organization made up of people, but as a machine whose efficiency needs to be increased, or, in Neckermann's (2017) critical words, an "open-air computer."

The most concrete example of this approach is Songdo (South

Korea). Songdo was built from scratch on reclaimed land, not on top of an existing social fabric, with every point equipped with fiber optic networks and sensors. Yigitcanlar (2016) states that projects such as Songdo are a product of the "U-City" vision, which removes technology from its role as a facilitator of urban life and makes it the raison d'être of the city. In this model, intelligence is measured by how much data the city produces and how quickly it processes that data.

Human-Centered Approach

The human-centered approach, which emerged as a reaction to technological determinism and "hardware" focus, argues that it is not technology that is smart, but the people who use, produce, and improve their quality of life with that technology. Nam and Pardo (2011) state that technology alone cannot make a city smart, and that a smart city is only possible through the organic integration of technology, people, and institutions. This approach focuses on human capital, creativity, education, and social inclusiveness. Neckermann (2017) emphasizes that the ultimate goal of a smart city should be livability, not efficiency. According to him, a smart city is an organism with a soul, sharing passions and improving the well-being of its citizens. Similarly, Yigitcanlar (2016) states that in the age of the knowledge economy, the success of cities depends not only on fiber optic cables but also on their capacity to attract and retain knowledge workers.

This approach, as seen in the example of Amsterdam (Netherlands), is centered on citizen participation and co-production. This is because the Amsterdam Smart City initiative has made citizens and local businesses part of the process through projects, rather than imposing technology on the city (Yigitcanlar, 2016). Here, smartness is sought not in the number of sensors, but in citizens' behavioral changes in terms of energy saving or reducing their carbon footprint. Neckermann (2017) states that the Amsterdam model humanizes technology and uses the city as a Living Laboratory.

Governance-Centered Approach

This approach, which argues that smart cities are not merely technical projects but also political and administrative processes, centers on the concept of governance. This approach focuses on how the city is managed, how decisions are made, how stakeholders are involved in the process, and who controls the data (Kozłowski & Suwar, 2021). In this context, the strongest model that stands out in literature is the Triple Helix model. Yigitcanlar (2016) states that this model is based on the harmony between the University, Industry, and Government. Today, this model has evolved into a Quadruple Helix, also including civil society. This approach, as seen in the example of Barcelona (Spain), is centered on strategic cooperation and urban transformation. This is because Barcelona's "22@Barcelona" innovation district project is not just a physical renewal but an institutional structure where universities, technology companies, and the municipality act with a shared vision (Yigitcanlar, 2016). The Barcelona model demonstrates that the success of a smart city, depends not on purchasing technology, but on having smart management capabilities that can bring together different actors around a common goal.

Holistic Approach

The most widely accepted approach in academic literature today and the one recommended for the city of the future is the holistic approach, which combines the three perspectives mentioned above (technology, people, governance). Kozłowski and Suwar (2021) define this approach as hybrid or integrated. According to this framework, a smart city cannot be reduced to a single dimension; rather, it is a balanced combination of social, economic, and environmental factors. This approach is embodied in the Six-Dimensional Smart City Model developed by the Vienna University of Technology (Giffinger et al., 2007). These six dimensions are: Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, and Smart Living.

According to this holistic perspective:

- Technology is the backbone of the smart city.
- People are the brain and soul of the smart city.
- Governance is the nervous system of the smart city.

Yigitcanlar (2016) states that a successful smart city must connect these three layers. For example, Amsterdam's success lies not only in its technological infrastructure but also in combining it with the goal of reducing carbon emissions and citizen participation. Conversely, in the case of Rio, technology is not seen as a holistic smart city success because it only addresses the consequences of social problems without addressing their root causes. It remains merely a smart security system (Neckermann, 2017).

Critical Approach

The critical approach removes the smart city from the narrative of "better functioning technical systems" and positions it within urban power relations. The fundamental claim of this approach is that "while the smart city discourse is often presented with the assumption of technological neutrality, in practice it carries a strong political-economic content regarding how cities will be managed, which problems will be prioritized, and which actors will shape the public sphere." (Hollands, 2008; Kitchin, 2014). Critical literature attempts to make this claim more visible. In doing so, it discusses the potential costs of smart city promises rather than simply opposing smart cities (Hollands, 2008; Albino et al., 2015).

The first line of critical approach discusses the relationship between the smart city and the discourses of entrepreneurial city and city competition. Hollands' work argues that the smart city label often reinforces a vision of an entrepreneurial city built on high technology, a process in which the agenda of social justice and equality can easily be pushed into the background (Hollands, 2008). In this context, while the smart city offers new tools for city management, it can also become the language of city branding and investment attraction strategies. Precisely for this reason, the critical approach keeps the question of what interests the adjective "smart" carries and for whom it is meaningful constantly on the agenda (Hollands, 2008; Ünsal & Avcı, 2023).

The second strand is platformization and political economy. Since the 2010s, smart cities have become increasingly intertwined with the data economy and platform logic. The platform society debate examines how the organization of public services through platform interfaces can affect public values and democratic control. Srnicek's analysis of platform capitalism, meanwhile, notes that platforms function not merely as technology companies but as carriers of a specific regime of accumulation, with data collection and economies of scale occupying a central place in this regime (Srnicek, 2017). From this perspective, the smart city is not merely the digitization of the municipality, but also a transformation that carries the risk of reorganizing urban life through data extraction and platforms (Srnicek, 2017).

The third dimension is surveillance and privacy. Kitchin argues that big data and smart city applications can produce panoptic outcomes, making city residents more visible within surveillance and classification practices (Kitchin, 2014). This debate is not limited to the number of cameras and sensors. It also concerns the increasing capacity for data accumulation, profiling, and behavior steering. Zuboff's surveillance capitalism approach argues that platforms and data-based systems establish a new form of power through their capacity to predict and steer human behavior (Zuboff, 2019). In the context of smart cities, this line strengthens the possibility of expanding surveillance/monitoring practices legitimized by security and comfort discourses (Kitchin, 2014; Zuboff, 2019).

A key contribution of the critical approach is that it forces us to re-examine the technical, human, and governance dimensions of the smart city. For example, a technology-centered project may generate efficiency, but the same project may also generate new inequalities and dependencies in terms of data ownership and decision transparency (Kitchin et al., 2015; Söderström et al., 2014). A human-centered discourse may emphasize participation, but if the inequalities that platformization will bring about are not discussed, the limits of participation may remain narrow (Kaygısız & Aydın, 2017). Governance-centered designs may claim accountability, but when corporate and marketing discourse is strong, corporate decisions may be tied to numerical performance indicators rather than the public good (Hollands, 2008; Kitchin et al., 2015). Therefore, a critical approach is also important for discussions of definitions, indicators, and the legal-political framework. Without completely rejecting the promises of smart cities, it will provide the opportunity to discuss more realistically the conditions under which these promises can produce social benefits and the conditions under which they can increase the risks of surveillance, corporate dependency, and inequality.

2.4 Systems

Smart cities emerge not only through the assembly of physical structures but also through the integration of digital layers built upon these structures, functioning like the city's nervous system. This section will address the fundamental systems and infrastructure components that make the smart city operational, measurable, and manageable.

2.4.1 Urban Information Systems and Data Architecture

The information systems that form the foundation of smart cities represent the digital backbone necessary to understand and manage the city's complex structure. According to a definition by MIT, a smart city is described as "*a system of systems with digital nervous systems, intelligent responsiveness, and system integration optimization*" (Neckermann, 2017). Urban information systems developed to make this complexity manageable have evolved from static data repositories to dynamic, real-time, and context-aware structures. The development of Web 2.0 technologies has played a critical role in this evolution. The transition from the one-way information flow of Web 1.0 to Web 2.0, where users produce content and interact, has enabled city dwellers to become "voluntary geographic information" producers within the system (Yigitcanlar, 2016). Batty et al. (2012) predicted that the smart cities of the future would be built on systems capable of modeling and simulating such complex data flows. Today, this prediction has begun to be partially realized, as can be seen in digital twin city examples.

Urban data architecture is based not only on data collection but also on the integration of data points (Neckermann, 2017). When considered individually, data points are merely pieces of information. However, integrating these points enables the creation of comprehensive results about the city's users. One of the most important components of this architecture is Geographic Information Systems (GIS) technologies. As previously discussed in this study, GIS is an indispensable tool for capturing and analyzing spatial data in areas such as urban planning and resource management. In addition, sensing technologies such as Radio Frequency Identification (RFID) and Ubiquitous Sensor Networks (USN) connect the physical assets of the city to the digital world within the framework of the Internet of Things (IoT) (Yigitcanlar, 2016). This technological infrastructure should go beyond the "corporate smart city" model, which Hollands (2008) approached critically and argued was solely marketing-oriented, and create a foundation for the effective use of data in solving urban problems. Data architecture should be designed as a multi-layered structure where data from different sources is integrated, processed, and transformed into meaningful services through semantic web technologies (Yigitcanlar, 2016).

2.4.2 Infrastructure Systems

In smart cities, infrastructure systems are evolving beyond traditional engineering solutions to become structures integrated with information and communication technologies. This transformation is directly related to the Smart Mobility and Smart Environment dimensions of the smart city model proposed by Giffinger et al. (2007) (Kozłowski & Suwar, 2021). Moving away from the silent nature of traditional infrastructure to structures that report their status through sensors is a significant turning point in resource efficiency. In transportation systems, this transformation is grouped under the umbrella of Intelligent Transportation Systems (ITS). ITS optimizes traffic flow and increases safety through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication (Yigitcanlar, 2016). Neckermann (2017) summarizes the basis of smart mobility with the "three zeros" vision: zero emissions, zero accidents, and zero ownership. In line with this vision, electric vehicles and the concept of "Mobility as a Service" (MaaS) are coming to the fore. MaaS refers to a system where individuals use different modes of transportation in a hybrid manner rather than owning private vehicles (Neckermann, 2017).

In the energy infrastructure, Smart Grids enable the management of the entire process from energy production to consumption through two-way digital communication (Yigitcanlar, 2016). Unlike traditional one-way grids, smart grids allow for the integration of renewable energy sources and distributed generation. Smart meters, a small component of this system, encourage energy savings by providing consumers with real-time consumption data (Neckermann, 2017). Similarly, sensor technologies are also used in water and waste management. For example, RFID tags in waste management increase the efficiency of separating recyclable materials (Yigitcanlar, 2016).

The most critical process in the operation of smart cities is the conversion of data collected from the field into meaningful information and, ultimately, action. Monitoring of urban operations is usually provided through city dashboards that visualize real-time data (Yigitcanlar, 2016). The most concrete and controversial example of this system is the Intelligent Operations Center in Rio de Janeiro. Designed by IBM, this center integrates data from more than 30 public agencies, enabling real-time intervention in situations such as floods or security incidents (Neckermann, 2017; Yigitcanlar, 2016). The center processes data from different layers of the city, providing decision support mechanisms to managers. However, this approach has been criticized for reducing the city to a technocratic control room that views it as an open-air computer and excludes civil participation (Neckermann, 2017).

This technological development necessitates a managerial transformation. Monitoring and analysis should facilitate a shift to a proactive, rather than reactive, operating logic. For example, predicting traffic congestion in advance using data from sensors is one such example. Hollands (2008) warns that managing the city like a company could lead to social issues being overlooked . Therefore, the monitoring-intervention chain should be designed with an inclusive approach, not just one focused on efficiency.

2.4.4 Data Governance

The sustainability of smart city systems depends on a robust data governance framework. Smart Governance, as defined by Giffinger et al. (2007), provides a fundamental perspective on how data should be managed within the principles of transparency and participation. A critical dimension of data governance is data sharing and open data policies. For example, Transport for London (TfL) has created a model in which data is the new currency by opening its data to the private sector, thereby enabling the development of new urban applications (Neckermann, 2017). However, data collection processes also raise concerns about security and privacy. The monitoring of every corner of the city with cameras or the tracking of household behavior through smart meters has increased criticism of surveillance societies. Martinez-Balleste et al. (2013) propose a five-dimensional privacy model that includes dimensions such as identity privacy, location privacy, and query privacy to protect citizen privacy in smart cities (Yigitcanlar, 2016).

Data governance is responsible for striking a balance between technological capabilities and citizens' rights. Neckermann (2017) emphasizes that sharing data and connecting the dots is a fundamental capability of a smart city, while also noting that this process must be carried out in accordance with secure and ethical standards, such as anonymizing the data. As indicated in Hollands' (2008) study, the ownership of data and who can access which data are political responsibilities rather than technological ones.

2.5 Smart City Applications

Although the concept of a smart city is defined in theory as the convergence of technology, people, and governance components, its practical implementation varies greatly depending on geographical contexts, levels of economic development, and urban management visions. This section will examine five cities representing different application models that can be characterized as design patterns in the smart city literature. The selected examples were chosen because they embody the dilemma of building from scratch versus transforming the existing city, top-down versus bottom-up governance models, and the tension between technology-centric and human-centric approaches discussed in the previous sections of the book.

Rio de Janeiro, Brazil

Rio de Janeiro is an example of a "top-down" and technocratic management model in smart city applications. Rio, a concrete manifestation of the Monitoring-Analysis-Intervention Chain discussed earlier, demonstrates how the city is monitored as a system of systems. This Brazilian metropolis established the Intelligent Operations Center in collaboration with IBM, particularly to address urban security and disaster management issues ahead of the 2014 World Cup and 2016 Olympics (Neckermann, 2017). This center is a structure equipped with screens, bringing together data from more than 30 public institutions, such as the police, traffic, and fire departments, under one roof. Yigitcanlar (2016) defines Rio's initiative as a security and emergency response system developed to combat chronic problems such as crime rates, traffic congestion, and flooding. The center analyzes sensor data and video streams from different points in the city, enabling real-time intervention in incidents. For example, the evacuation of areas at risk of flooding during heavy rainfall or the coordination of ambulance and police teams after a traffic accident are managed from this center (Neckermann, 2017).

While the example of Rio demonstrates the potential of smart cities to deliver on their promises of efficiency and security, it also raises concerns about a surveillance society, a topic frequently discussed in critical literature. In this model, where the city is managed like a computer, citizens are often seen as passive data sources, and participation mechanisms are overshadowed by technocratic decisions. Neckermann (2017) criticizes Rio's approach as a model where every corner of the city is monitored 24/7 but civil participation is lacking. In this context, Rio represents the technology-centered and institutional face of the smart city, with a crisis management-focused design.

Songdo (Incheon), South Korea

The Songdo International Business District, located in Incheon, South Korea, has been selected as a prototype for Greenfield (built from scratch on vacant land) projects in smart city literature. This example serves as a physical laboratory for the topics of spatial intelligence and the concentration of network infrastructure discussed earlier in the study. Songdo was designed from the outset on reclaimed land with the vision of a "U-City" (Ubiquitous City) . Yigitcanlar (2016) defines Songdo as a project that claims to be the world's most wired and technological city, where information and communication technologies are embedded in every point of the urban infrastructure. In this model, streets, buildings, and even devices inside homes are interconnected. There are no garbage trucks in the city. Instead, waste is transported directly from homes to processing centers via pneumatic (air-pressurized) pipe systems through underground tunnels. This represents the most advanced application of smart grids discussed in the study to date.

Songdo was chosen as an example because it demonstrates how smart cities can be used as a national economic development strategy. The Korean government developed this project to foster the growth of the country's IT and construction sectors. Yiğitcanlar (2016) points out that this project was developed using a top-down approach. The project, which also involves technology giants such as Cisco, envisions the city as a service platform. However, this technological perfectionism has been criticized in terms of social vitality and organic city life. Neckermann (2017) emphasizes that cities built from scratch, such as Songdo and others (like Masdar), carry the risk of misjudging human nature, as clean and perfect can also be sterile and soulless. Therefore, Songdo represents an example where technology dominates space, but the social fabric is attempted to be created later.

Amsterdam: The Participatory "Living Lab" ([5]) Model

Amsterdam was selected due to the transformation of its existing urban fabric and the relative success of its human-centered approach. This example is an ideal application field for governance-centered and human-centered approaches.

Unlike Rio and Songdo, the Amsterdam Smart City initiative is not a single central authority or a large construction project, but a multi-

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[5] "Living *Labs are environments designed to involve users in innovation and development processes and are seen as a way to overcome the innovation challenges faced by information and communication technology service providers.*" (Følstad, 2008) For more examples, see: ENoLL and Başakşehir Living Labs

stakeholder platform. The Amsterdam model is considered a successful application of the "Quadruple Helix"[6] collaboration model, which brings together businesses, local government, research institutions, and citizens. The project views the city as a Living Lab (or life lab) and positions technology as a tool and citizen behavior as the main transformative force for achieving sustainability goals (Yiğitcanlar, 2016).

One of the prominent applications in Amsterdam is the Climate Street project. In this project, solutions such as smart meters, energy-efficient lighting, and waste management logistics were tested in collaboration with shopkeepers and residents on a busy shopping street. Additionally, the "Ship-to-Grid" project has reduced carbon emissions by enabling ships in the port to use grid electricity instead of diesel generators. Neckermann (2017) noted that Amsterdam's success lies not only in embedding technology into its infrastructure but also in programs such as "City-Zen" (City Zero Carbon Energy), which actively engage citizens in energy conservation and renewable energy production. Kozłowski and Suwar (2021) also ranked Amsterdam among the smartest cities in Europe and the world according to IESE Business School indices, emphasizing that this success is related to governance and social inclusiveness. Amsterdam is a strong representative of bottom-up innovation and open data culture.

Barcelona, Spain: Urban Transformation and the Internet of Things

Barcelona is significant in demonstrating how a historic city can be revitalized through technology and how urban transformation can be integrated with smart city strategies, as exemplified by the "22@Barcelona" innovation district. This example sheds light on discussions regarding integration in the areas of urban information systems and infrastructure systems.

Barcelona is one of the European cities that widely uses Internet of Things technologies to optimize urban services. Yigitcanlar (2016) describes Barcelona's transformation into a knowledge city, particularly through the conversion of Poblenou, a former industrial area, into an innovation and technology district called 22@Barcelona. This area is designed as a mixed-use space where universities, technology companies, and residences are intertwined.

Among the smart solutions implemented throughout the city,

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[6] "(...) *the quadruple helix model argues that the integration of industry, academia, government, and society is essential for the development of organizations. This has created challenges for organizations in responding to a dynamic environment."* (Parveen et al., 2015)

sensor-equipped street lighting stands out. These lamps not only save energy but also collect environmental data such as temperature, noise, and humidity via their sensors. In addition, each lamp serves as a Wi-Fi hotspot. Another important application is the smart parking system. Thanks to sensors placed on the roads, drivers can see available parking spaces via mobile applications, which reduces traffic congestion and carbon emissions. Kozłowski and Suwar (2021) also highlight Barcelona's social dimension, noting that digital health and support services such as "Telecare," developed to increase the participation of elderly and disabled individuals in social life, are an important part of the city's smart vision. Barcelona is a hybrid model where the existing infrastructure has been transformed into a structure that "communicates" with sensor networks (Yiğitcanlar, 2016).

San Francisco, USA: Open Data and Innovation Ecosystem

San Francisco is an important example of how the entrepreneurial ecosystem and open data policies can be used to solve urban problems. This example is one of the best cases reflecting the principles of transparency and data sharing under the heading of data governance.

Neckermann (2017) emphasized San Francisco's leadership in the field of smart transportation. The city implemented a dynamic pricing model with the "SFpark" project. In this system, prices change instantly according to parking demand, thus minimizing the traffic and emissions created by drivers looking for parking spaces. Furthermore, being the birthplace of ride-sharing platforms such as Uber and Lyft has enabled the concept of Mobility as a Service (MaaS) to take root in the city.

San Francisco's most defining feature is its view of data as a public resource. Yigitcanlar (2016) notes that the city makes transportation, crime, zoning, and environmental data available to the public and developers through its "DataSF" platform. This approach encourages civic software developers and entrepreneurs to develop applications for urban problems rather than the municipality producing solutions on its own. The smart economy dimension defined by Kozłowski and Suwar (2021) refers to the creation of new data-driven business models in San Francisco. The city enables technology to be seen not only as a tool used by the municipality, but also as a dynamic force that paves the way for economic and social innovation.

The five examples examined show that there is no single correct model for smart city applications. Examples such as Rio de Janeiro and Songdo represent a centralized and infrastructure-focused approach, while Amsterdam and San Francisco highlight people-centered, participatory, and software/data-focused approaches. Barcelona offers a hybrid model integrating physical transformation with digital layers. Furthermore, Rio stands out in governance and security, Songdo in infrastructure and economy, Amsterdam in sustainability and participation, Barcelona in the Internet of Things and urban transformation, and San Francisco in data governance and mobility. The success of future smart cities will depend on synthesizing these different design patterns in the most appropriate way for the local context.

CONCLUSION

The comprehensive studies conducted within the scope of this work reveal that the city cannot be reduced to a mechanism consisting solely of its physical structure; rather, it is a complex socio-technical system that is constantly evolving, with the dynamics of technology, people, environment, and governance intertwined. This research, centered on the concept of Smart City, has explored a broad perspective spanning from historical processes to today's connected world and future urban scenarios. The main objective of the study was to eliminate the conceptual ambiguities frequently encountered in literature and in practice, to discuss the possibilities of a human-centered smart city vision by overcoming the limitations imposed by technological determinism, and to provide the reader with a solid theoretical foundation in this field. At this point, it is essential to make a comprehensive assessment of the connections established between the chapters of the book and the fundamental outcomes obtained, to offer a projection for the future of the subject.

Relationship Between Cities and Technology, addressed at the beginning of the study, has been examined in a historical context, since technology is not a phenomenon unique to the present day. The analysis conducted has shown that cities have always strived to be "smart" throughout history, within the possibilities of their time. It has been determined that every new technological advancement, from aqueducts to sewage systems, railways to telegraph networks, has changed the metabolism of the city and claimed to make it more efficient. However, the process that began with the Industrial Revolution and gained momentum in the Information Age has fundamentally transformed this relationship. When examining the socio-technical nature of cities, it has been seen that infrastructure and network logic are not only an engineering success but also a tool of power and governance that regulates social relations. With the acceleration of digitalization, especially since the 1990s, cities have become visible, measurable, and traceable. It has been observed that the journey of digitalization, which began with Geographic Information Systems (GIS), has now taken on a new dimension with the Internet of Things, big data, and artificial intelligence. A historical reading reveals that technology alone cannot solve urban problems; however, it can become a meaningful tool only if it is compatible with the historical accumulation and social fabric of the city. In this context, it has been concluded that the concept of smart cities is not a historical break but a natural next step in urban evolution.

The Smart City section, which forms the backbone of the study, questions the ontological structure of the concept. A literature review and numerous definitions examined reveal that there is no single reality of a smart city, but rather a fragmented structure that varies according to context. While some approaches treat the smart city as a technological hardware project equipped with fiber optic networks and sensors, others define it as a human-centered development model that invests in human capital, education, and creativity. The table of definitions prepared not only concretized this diversity but also revealed how the concept can be emptied of meaning through marketing rhetoric. At this point, the most critical conclusion reached is this: Intelligence is not synonymous with technological intensity. Equipping a city with technological infrastructure does not make it smart. True smartness is related to how this technology is used to increase the city's livability, ensure environmental sustainability, and improve the well-being of its citizens. Therefore, the approach adopted in the study has been a holistic perspective that positions technology as a tool, not an end.

When drawing up the theoretical framework, the classification of approaches in literature is of vital importance for understanding the multidimensional nature of the subject. The efficiency-focused structure of the technology-centered approach, which views the city as a machine that needs to be optimized, has been critically examined. It has been argued that this approach carries the risk of creating sterile cities lacking social fabric, especially in projects built from scratch. In contrast, the human-centered approach has been seen to use technology as a lever to enhance citizens' capabilities and quality of life. The fact that it is not buildings or roads that are smart, but the people who live, work, and participate in decision-making in that city, formed one of the fundamental arguments of the study. The governance-centered approach reminded us that the smart city is not just an engineering project, but also a political and administrative process. The importance of collaboration between universities, industry, government, and civil society has been emphasized through the Triple and Quadruple Helix models. Under the heading of critical approaches, attention has been drawn to the risks of smart city projects creating surveillance societies, violating privacy, and deepening social inequalities. The tendency of technology companies to view the city as a marketplace and the trap of technological solutionism are among the important warnings highlighted in this section.

The Systems section examines the functioning layers of the smart city. It details how urban information systems and data architecture work like the city's nervous system. It explores how the processes of collecting data through sensors, transmitting it through networks, and transforming it into meaningful information through analysis transform urban management from a reactive to a proactive structure. However, the focus is not solely on technical details; the importance of data integration is also emphasized. The potential created by the integration of infrastructure systems such as transportation, energy, water, and waste in terms of resource efficiency and sustainability was discussed. Concepts such as "Mobility as a Service" and smart grids indicate that the concept of ownership will be replaced by the access and sharing economy in the city of the future. Under the heading of the monitoring-analysis-intervention chain, the paper examines how urban operations centers and dashboards are changing management practices, noting how critical data transparency and open data policies are for the development of democracy. Regarding data governance, it was concluded that establishing a balance between security and privacy is an indispensable prerequisite for the legitimacy of smart cities.

The Applications section, examined to concretize theoretical discussions, has demonstrated how different geographical and economic contexts shape smart city practices. The selected examples have proven that smart cities are not uniform but offer different design patterns. The Rio example showed how technology can be used for urban security and disaster management with centralized control room logic, but it was found that this model carries the risk of excluding citizen participation. The Songdo example revealed the challenges faced by a city built from scratch and equipped with technology at every point due to its lack of social fabric and organic life. In contrast, the examples of Amsterdam and Barcelona demonstrate the success of transforming the existing urban fabric and adopting citizen-focused, participatory approaches. These cities have been observed to use technology not as an end in itself, but as a tool to achieve sustainability and quality of life goals, spreading technological innovation to the grassroots by establishing living laboratories. The San Francisco example, meanwhile, has demonstrated the potential of open data policies, and the entrepreneurial ecosystem to generate civic solutions to urban problems. The most important lesson drawn from the case studies is that the most successful smart cities are not those with the most expensive technology, but those that best integrate technology with local needs and place citizens at the center of the process.

The overall picture revealed by the study shows that the concept of smart cities is at a crossroads. On one side stands a technology-focused and centralised vision that views the city as computer hardware and codes citizens as passive sensors that merely produce data. While promising efficiency, this vision may require sacrificing social participation and privacy. On the other hand, there is a democratic vision that humanizes technology, uses digital tools to solve urban problems, views data as a public value and makes it available for sharing, and empowers citizens to become "smart." The model advocated in this book and proposed for the cities of the future is undoubtedly the second path.

The vision presented for the cities of the future requires an approach that preserves the spirit of the city, beyond goals such as "three zeros" (zero emissions, zero accidents, zero ownership). A smart city cannot be defined as merely a place where autonomous vehicles circulate or streetlights turn on by themselves. A smart city is one that derives its energy from renewable sources, transforms its waste into resources based on circular economy principles, prioritizes shared and integrated systems over private vehicle ownership in transportation, operates direct democracy through digital platforms in decision-making processes, and ensures social justice while doing all this. Technological infrastructure is necessary to achieve these goals, but it is not sufficient. The real determining factors are the governance approach and human capital that are built upon this infrastructure.

Considering the topics covered in this book, a set of criteria can be proposed for researchers, decision-makers, and implementers evaluating smart city projects. To understand the quality of a smart city project, the following questions must be asked: What chronic problem in the city does the project address? Does technology address the root cause of the problem or merely suppress the symptoms? Who owns the data produced, and who has access to it? Does the project increase social division or promote inclusivity? And most importantly, does this project make people happier and the city more livable? If technology isolates people and keeps them under surveillance instead of connecting them to each other and the city, then there can be no talk of true intelligence.

Ultimately, the relationship between the city and technology is one of the most dynamic and transformative processes in human history. What is discussed today under the label of "smart city" essentially represents a new phase in the city's evolution over thousands of years. Whether this stage will turn into a dystopian surveillance society or a sustainable and equitable living space depends not so much on technology itself, but on how that technology is designed and managed. This work serves as a guide to asking the right questions in this critical process and steering the direction toward a human-centered, sustainable, and democratic city. The smart city of the future will be possible not with concrete and steel, nor with data and silicon, but only with "smart citizens" who live in harmony with nature, are connected to each other, are highly aware, and actively participate in decision-making processes, using the possibilities offered by technology. Technology is only a tool; the goal should always be a better life.

FROM THE AUTHOR: WHICH ONE IS THE SMART CITY?

Based on the approaches, definitions, historical dilemmas, and applications discussed throughout the book, it is difficult to understand which urban policy or application constitutes a smart city policy/application and to determine how many types of smart cities there are. In other words, the concept of "Smart City" is not a single reality but a multifaceted concept that emerges with different motivations in different geographical areas. A researcher or practitioner interested in the field will rightly ask the following question in the face of the multitude of definitions in the literature and the diversity of applications in the field: "How many types of smart cities are there, and which one is the 'real' smart city?" It is essential to draw up a roadmap in light of existing readings and studies.

I believe that approaching the issue from an ordonomic perspective is necessary; it is essential to understand what stakeholder participation truly means and to protect the rights of all parties. While it may be impossible to create a litmus test, the following criterion is essential to determine whether a project is merely a dazzling technology show or a genuine smart city initiative: economic sustainability. After all, an application that does not support the financial foundations on which it is built, no matter how much it improves urban life or how reliably it processes data, will eventually lose its "smartness" if it cannot stand on its own feet economically. As Neckermann warns, "perfect" cities built solely for the sake of technology and disconnected from economic reality (as in the case of Masdar) risk becoming sterile ghost towns rather than living organisms. In other words, if an application consistently costs the municipality or investor money, that city is not smart, it is just an expensive hobby.

The second and perhaps most important criterion is "political and human reality." An application created without regard for political and legal foundations (human rights, democracy, participation) will not be sustainable, even if it manages the city's infrastructure perfectly. As we saw in the example of Rio de Janeiro, managing the city like NASA's control room and viewing citizens merely as data points to be monitored may ensure security, but it kills the city's "soul." As Neckermann said, a smart city must have a soul; that is, technology should be there not just to monitor people, but to improve their quality of life.

So, look at a project labeled "smart city" with this perspective: Does this project take social, economic, political, and environmental factors into account? Are all stakeholders part of this endeavor? Or is it just a technology company selling its product and moving on?

In conclusion, a truly smart city is not the one with the most expensive sensors; it is the city that uses technology not as an end in itself, but as a means to human happiness and the protection of nature. The most appropriate approach for today and tomorrow is that holistic approach that blends technology with people and institutions.

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