International Journal of Finance, Accounting and Economics Studies6(2), 2025, 121-159.

Print ISSN: 2251-645X Online ISSN: 2383-2517

Islamic Azad University

Science and Research Branch

Faculty of Management and Economics

International Journal of Finance, Accounting and Economics Studies

Journal Homepage: https://sanad.iau.ir/journal/ijfaes

Cognitive-Human Circular Smart Economy in Cognitive-Human Circular Smart Cities (CHCSE and CHCSC)

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Article History

Submission Date: 2024-07-07

Revised Date: 2025-01-29

Accepted Date: 2025-04-04

Available Online: Summer 2025

Abstract

Purpose: The present research aims to identify the concept of Cognitive-Human Circular Smart Economy **(CHCSE)** within the framework of Cognitive-Human Circular Smart Cities **(CHCSC)**. This advanced paradigm, by integrating digital transformation, artificial intelligence (AI), and knowledge-driven economic structures, aims to tackle contemporary urban challenges. **Design/methodology/approach:** This study employs a mixed-methods research approach, including thematic analysis and extraction of hundreds of core, primary, and secondary themes from the literature **(993 scholarly sources),** expert interviews **(48 participants),** consultations with specialists and innovators **(400 participants),** and 7 AI-driven data synthesis to present an intelligent, human-centered paradigm with groundbreaking innovations. To achieve a high degree of validity and reliability, multiple criteria and methodological approaches have been employed: A Triangular Framework of Pluralism and Diversity; Integration of 7 AI Systems; Formation of a Focus Group).**Findings**: One of the major innovations of this study is the introduction of Cognitive Economic Intelligence **(CEI)**—a hyper-networked system, reinforced by Cognitive-Human AI **(HABIQ /** Human-Artificial- Bio-Quantum I), which enables urban hyper-economies. Another one is the extraction of a knowledge-driven paradigm, categorized into **"Eight Realms" (or "Eight Paradises")**. These realms encompass "**Human, Naturified, Intelligent, DIKWiC, HSH-ware, Exponential Hyper-Disruptive (exhD), Meta-ConTwinSphere, and Meta-CoCreation"** knowledge-technologies that shape the future-now urban hyper-ecosystems. **original/value:** By introducing the **CHCSE Model**, **HABIQ, Eight Paradises of KTs**, the findings offer insightful perspectives, strategic roadmaps, and actionable frameworks for policymakers, urban planners, and knowledge-technology developers. Additionally, by enhancing the **ReSOLVE framework,** into **iReSOLVE**, this research highlights the role of hyper-networked, ecosystemic economic infrastructures in shaping the sustainable smart cities of the future.

Keywords: Cognitive-Human Circular Smart Economy, Hyper-Intelligent Ecosystemic Economy, Cognitive-Human Circular Smart Cities, Artificial Intelligence, HABI-Quantum I, Digital Transformation, Future-Now.

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Introduction

The concept of the city is intrinsically linked to the trajectory of human civilization. Currently. Global reports highlight several critical challenges associated with urbanization in the 21st century. The "Global Report on Human Settlements" (2009), along with the "Sustainable City Planning" initiative and the UNCTAD report (2022), indicate that contemporary urban planning frameworks have largely failed to address these multifaceted challenges effectively.

Modern cities are increasingly characterized by complexity, uncertainty, ambiguity, and rapid transformation. The profound and widespread challenges resulting from these dynamics are often interconnected, forming intricate cause-and-effect relationships. Addressing these challenges necessitates a systemic, ecosystem-based approach, embodied in the concept of the smart city (United Nations, 2007).

The notion of "smart cities" has emerged as the most comprehensive and innovative response to contemporary urban challenges. This paradigm encompasses not only the efforts of urban planners and policymakers but also the active participation of citizens in shaping more sustainable, resilient, and human-centered urban environments (United Nations, 2007). As highlighted in the report "The Age of Smart Cities and the Information Era" (2011), "Communities and businesses require smart cities to achieve transformation, sustainability, and growth."

The transition toward smart cities—referred to as "smartification" or "smartening"—entails the integration of technological advancements, human-centered innovations, and institutional reforms. Albino, Berard, and Dagelico (2015) underscore that the smart city concept encompasses multiple dimensions, including human, technological, and institutional aspects, each contributing to the overarching goal of urban transformation. This paradigm shift represents a significant evolution in urban governance, offering a pathway toward more efficient, sustainable, and inclusive urban futures.

Smart City Components and Economic Dimensions

The concept of a smart city encompasses various domains, including smart transportation, smart energy, smart environment, smart economy, smart living, and smart governance. Among these components, the smart economy serves as the foundational pillar, exerting a significant influence on the development, transformation, and sustainability of other smart city elements, such as transportation, energy, environment, living standards, and governance. The effectiveness of the smart economy is assessed through well-defined criteria and indicators that measure its impact on urban development.

Recent advancements in artificial intelligence (AI) over the past fifteen months have considerably expanded both the scope and depth of the smart economy. Understanding these transformations, alongside the findings of multi-year research presented in this study, enables societies to transition into a "future-now" paradigm—where strategic action is aligned with knowledge and visionary foresight.

The Transformative Impact of Artificial Intelligence

In the past two years, AI has experienced unprecedented advancements, surpassing the technological progress of the previous two centuries. This rapid development has introduced innovations previously deemed unattainable, even in the most ambitious human projections. AI has now become a focal point of discussions spanning philosophical, technological, scientific, cultural, and psychological dimensions. Each of these aspects is critical in its own right. However, their integration, combination and the identification of novel and innovative relationships among them offer transformative possibilities and paving-way for human, cultural, and civilizational perspectives and creation a new era of smart urban life and development.

This study examines a cognitive-human smart city model that directly links contemporary global human civilization and cultural paradigms while offering new insights. The interplay among four fundamental elements—city, human, culture, and civilization—forms a dynamic network in which the smart economy and cognitive-human smart economy function as unifying pillars and factors.

Problem Statement

The primary objective of this research is to identify **"the most optimal, effective economic solution and frameworks for contemporary urban challenges".** Specifically, this study seeks to determine the most efficient economic model for resolving urban issues, particularly in the context of smart cities. Given that the economy is an essential component of smart cities, it must itself exhibit intelligent characteristics. This raises fundamental research questions concerning the nature of the smart economy, its defining features, and the knowledge-techs that underpin its structure.

According to United Nations reports (2007), urban environments are increasingly characterized by complexity, uncertainty, ambiguity, and rapid transformation. The deep and interconnected challenges that emerge from these dynamics have rendered conventional urban management and development models insufficient in achieving sustainability and addressing the evolving needs of urban populations. Consequently, a systematic, ecosystem-based approach—embodied in the concept of the smart city—is required to mitigate these challenges effectively.

Thus, a smart city must consist of intelligent components. However, the identification of these components, the determination of their relative importance, and the selection of a core element that drives urban intelligence remain critical issues that warrant further exploration.

Theoretical Framework and Research Concepts

Defining the City

In a broad sense, cities are generally defined by several key characteristics, including their geographical and topographical identities, dense population centers, and the infrastructure that distinguishes them from non-urban areas. They also serve as hubs of economic activity, globalization, and technological progress. Cities are dynamic entities that continuously evolve in response to socio-political and economic transformations, shaping and being shaped by human interactions and technological advancements.

Urban Economy

Similarly, the urban economy can be conceptualized as a dynamic system of financial, credit, and income-generating relationships that influence sustainability across various sectors, including the environment, transportation, and healthcare. It exists within a multi-scalar framework that extends from urban to national and global levels. The urban economy continuously evolves in response to demographic changes, technological innovations, and globalization, serving as both a driver of economic growth and, in some cases, a catalyst for economic disparities.

Research Questions

This study seeks to address the following primary research question:

- What defines a cognitive-human circular smart city (**CHCSC)**, and what are the characteristics of its core components, particularly its economic structure?

Additionally, the study explores the following sub-questions:

1. What are the defining features and Knowledge-technological (KT) foundations of a cognitive-human circular smart city(**CHCSC**?
2. What are the defining features and Knowledge-technological (KT) foundations of a cognitive-human circular smart economy(**CHCSE**?

3. Why is "cognitive-human circular Smartness" the most effective contemporary approach for addressing economic challenges and solution-finding for them, in smart cities?

Conceptual Foundations of Smart Cities

Emerging smart city paradigms offer innovative and efficient solutions for urban management. These models leverage cutting-edge technologies from the Fourth and Fifth Industrial Revolutions, Society 5.0, next-generation AI, and hyper-connected smart environments. The integration of these technologies enables urban centers to optimize resource utilization, enhance sustainability, and improve the overall quality of life for residents.

This study seeks to extract key knowledge-tech advancements that are shaping contemporary civilization. By establishing a conceptual and historical foundation, it aims to provide a deeper understanding of the role of the smart economy within future urban ecosystems. Furthermore, the study explores the potential of AI-driven governance and economic models in fostering sustainable and resilient smart cities, ultimately contributing to the broader discourse on urban intelligence and economic transformation.

Smart City

The concept of a smart city is founded on projects and initiatives that prioritize enhancing efficiency and sustainability. Significant advancements in transportation and mobility, public security, environmental protection, and climate management—including waste management and the optimization of energy and water consumption—have created unprecedented opportunities for leveraging Information and Communication Technology (ICT) to address contemporary urban challenges (Townsend, 2013).

Nam and Pardo (2011) delineated the distinctions between smart cities and related terminologies, such as digital cities, intelligent cities, and ubiquitous cities, through three principal dimensions: technology, people, and society. From a technological perspective, a smart city is characterized by the extensive integration of ICT, which is employed to support critical infrastructure and essential services (Washburn et al., 2010). ICT is embedded within intelligent products and services, incorporating artificial intelligence (AI) and cognitive systems to optimize urban operations (Klein & Kaefer, 2008).

Research Methodology

This study adopts both a fundamental and applied research approach, generating new theoretical insights while also providing practical and developmental applications. It facilitates implementation within existing smart city frameworks and introduces an innovative model, termed the "Cognitive-Human Circular Smart City."

This study employs a mixed-methods research approach, including thematic analysis and extraction of hundreds of core, primary, and secondary themes from the literature **(993 scholarly sources),** expert interviews **(48 participants),** consultations with specialists and innovators **(400 participants),** and 7 AI-driven data synthesis to present an intelligent, human-centered paradigm with groundbreaking innovations. To achieve a high degree of validity and reliability, multiple criteria and methodological approaches have been employed: A Triangular Framework of Pluralism and Diversity; Integration of 7 AI Systems; Formation of a Focus Group)

The literature review underscores the integral relationship between smart urban development and economic transformation, while highlighting the associated challenges and potential strategies for fostering a sustainable, data-driven, and technologically integrated urban economy.

Literature Review

In the following Literature Review, the most important findings are:

"Digital Transformation and Business Performance; Socioeconomic Development in Smart Cities; The Role of Smart Economy in the Global Economic Order; Smart Cities and Urban Resilience During the COVID-19 Pandemic;

Future Development of Smart Cities; Endogenous Growth Models in Smart Cities; The Role of Smart Technologies in Sustainable Manufacturing and Circular Economy; Smart Waste Management in Circular Economies; Digital Transformation and Circular Economy Integration; Circular Economy and Its Impact on the Manufacturing Sector; Business Innovation and the Circular Economy: An Ecosystem Perspective."

- Yalpanyan, Raeisi Vanani, and Taghavi Fard (2024) conducted a study titled "Analysis of the Impact of Digital Transformation Technologies on Business Performance Using Advanced Text Analysis Methods." Their research underscores the profound influence of digital technologies on business operations, emphasizing the growing scholarly focus on information systems, business management, and innovation. The study's primary contribution lies in its innovative thematic network analysis based on text mining, providing deeper insights into the interconnections between critical digital transformation components. Finally, the study offers strategic recommendations for future research and managerial applications.
- Havas Beigi and Moridian (2023) investigated the "Fundamental Structure of Socioeconomic Development in Smart Cities" and emphasized the necessity of strategic urban development planning. According to their findings, cities must pursue two fundamental objectives: (1) creating a high-quality living environment to attract investment and (2) ensuring sustainable development by integrating economic, social, transportation, energy, and environmental models. The study identifies key challenges, including economic modernization, knowledge-driven development, ICT expansion, and sustainable resource utilization. The research underscores the importance of fostering a socially inclusive environment conducive to innovation and highlights the necessity of integrating economic modernization strategies into smart city development frameworks (Shokorkin et al., 2016).
- Shaqaqi Shahrari and Vahed Rasouli (2022) examined "The Role of Smart Economy in the New Global Order with an Emphasis on Power and Wealth." They traced the evolution of economic transformations, noting that the knowledge-based economy emerged in the mid-20th century, evolving into the internet, electronic, and digital economies. The study argues that since the early 21st century, the smart economy has become a defining feature of global economic discourse, reshaping the economic power structure in which knowledge serves as a primary determinant of national wealth. The findings suggest that economic globalization is shifting towards decentralized, micro-entrepreneurial models, characterized by digital microtransactions, AI-driven capitalism, and idea-based investments. Additionally, the study outlines key strategic frameworks for facilitating national transitions toward smart economic ecosystems.
- Hosseini, Farhadi, Joshanpour, and Tayebi (2022) conducted a study entitled "A Multidimensional Analysis of Smart City Indicators During the COVID-19 Pandemic: A Case Study of Mashhad." Their research highlights the critical role of smart cities in enhancing urban resilience by leveraging ICT-based solutions. The study found that digital governance and e-government infrastructure played a pivotal role in facilitating urban resilience during the COVID-19 pandemic. The findings suggest that smart citizens, smart governance, and smart economy exhibited the highest correlations with overall smart city development. Moreover, statistical analysis confirmed that the pandemic accelerated advancements in smart governance, digital citizen engagement, and economic digitalization.
- Sajadian, Firoozi, and Pourahmad (2022) examined the "Future of Ahvaz as a Smart City" through a macroeconomic perspective. Their research employed exploratory factor analysis (EFA) alongside Kolmogorov-Smirnov, Shapiro-Wilk, one-sample t-tests, and Friedman ranking tests to assess key smart city indicators. The findings revealed that smart mobility was the most crucial factor, whereas smart citizenship had the lowest impact on Ahvaz's transformation into a smart city. The study concluded that all six smart city dimensions (smart people, smart living, smart mobility, smart governance, smart environment, and smart economy) remain underdeveloped, necessitating comprehensive urban policy interventions.
- Asayesh and Mahinizadeh (2022) explored the "Endogenous Growth Model in Smart Cities", emphasizing the role of smart city innovation

ecosystems in fostering economic growth. Their study posits that smart cities drive economic expansion through digital innovation and systemic integration. Their theoretical analysis suggests that urban economic growth is directly correlated with smart city advancements, demonstrating that cities exhibiting higher smart technology adoption rates experience accelerated economic expansion.

- Egeland Nygaard (2023) investigated "The Use of Smart Technologies for Sustainable Manufacturing", focusing on the role of AI, IoT, and blockchain in enhancing circular economy principles. The study employed the ReSOLVE framework, identifying six key circular economy strategies: Regenerate, Share, Optimize, Loop, Virtualize, and Exchange. Key findings indicate that digital twins, AI, and IoT significantly contribute to sustainable production. The study further examines barriers to circular economy adoption, such as financial constraints, technological infrastructure gaps, and workforce resistance, while identifying key enablers such as cost reductions, resource efficiency, and regulatory compliance. The research underscores the importance of collaborative digital platforms and advanced recycling methodologies in achieving circular economic objectives.
- Vaterlund et al. (2023) explored "Smart Waste Management in Circular Economies", analyzing innovative approaches for waste management within a circular economy framework. Supported by the Swedish Research Council, the study adopted a multidisciplinary perspective, incorporating technical, economic, regulatory, and social analyses. The findings highlight critical challenges such as regulatory uncertainty, economic inefficiencies, high technological costs, and public perception issues. The study provides comprehensive insights into leveraging smart waste management technologies for advancing circular economy initiatives.
- Christophersen (2021) examined "Digital Transformation and the Transition to Circular Economy Models", focusing on the role of IoT and big data analytics in facilitating circular economic adoption. Through case study analysis, expert interviews, and survey methodologies, the study demonstrated that digital transformation enhances efficiency in circular economic models, improving environmental, financial, and competitive performance.
- Anis Eldin Gabor (2020), in a study titled "Examining the Circular Economy and Its Impact on the Manufacturing Sector in the UK," explores the circular economy as a dynamic capability within the UK manufacturing sector. The research focuses on identifying new competitive advantages and proposing strategic pathways for managing circular business models effectively.
- Jan Konietzko (2020), in a study titled "Business Innovation Towards the Circular Economy: An Ecosystem Perspective," investigates how businesses can transition towards circular economy models through an ecosystem-based approach. The study also emphasizes the importance of systems thinking in the implementation of circular economy strategies.

Historical Development and Conceptual Framework of Smart City themes and its typology.

Definitions of Smart Cities

The term "smart city" was first introduced in the mid-19th century to describe newly developed, efficient, and self-sufficient cities in the western United States. By the 1990s, the concept had evolved to encompass technological innovations in urban planning, development, and management, including intelligent solutions for traffic control and mobility challenges.

Several authoritative definitions of **smart cities** have been proposed by leading institutions and scholars, highlighting various dimensions of the concept: British Standards Institution (BSI) – PAS 180 Standard, Giffinger (2007), Cohen (2012 , European Parliament (as part of the European Union's 2020 Strategy for Sustainable and Smart Cities), International Telecommunication Union (ITU) & UNESCO (2014), Hibat (2015):

An analysis of above definitions reveals that smart cities consistently incorporate physical, environmental, social, economic, and governance dimensions. However, the emphasis on different aspects has evolved over time. In the initial phases of smart city conceptualization, the focus was primarily on technological infrastructure and physical systems. Over time, the role of citizens, cultural and social dimensions, and bottom-up governance approaches has gained increasing prominence, aligning with contemporary urban sustainability and resilience paradigms.

Dimensions of Cities' Smartness

The **Giffinger Model**, which has been applied to 70 cities across Europe, provides a comparative assessment of smart city indicators, generating statistical insights that inform urban development strategies. Since 2014, several international standardization organizations, including the International Telecommunication Union (ITU), the International Organization for Standardization (ISO), the British Standards Institution (BSI), and the U.S. National Institute of Standards and Technology (NIST), have formally recognized and endorsed the six fundamental dimensions of smart cities.

Classifications of Cities, as evolution of smart Cities

As previously discussed, the definition of a smart city varies depending on the technological infrastructures implemented, as well as the city's objectives and functional dimensions. However, there exist fundamental and historically established urban concepts that, when systematically examined and structured, provide the foundation for a precise definition of smart cities, their evolving generations, and their key components—including economic systems. The most significant conceptual models and classifications in the field of urban studies include:

1. **Mechanical Cities** – Urban environments characterized by mechanized infrastructures and automated industrial systems.
2. **Ancient-Historical Cities** – Cities with historical and cultural significance, often preserving traditional architectural and urban planning principles.
3. **Administrative-Political Cities** – Cities that serve as centers of governance, administration, and political decision-making.
4. **Industrial-Service Cities** – Urban centers that function as hubs of industrial production and service-based economies.
5. **Religious-Pilgrimage Cities** – Cities with religious significance, serving as pilgrimage and spiritual centers.
6. **Electronic Cities** – Urban areas where electronic infrastructures form the basis of governance, services, and connectivity.
7. **Digital Cities** – Cities characterized by digital integration across administrative, economic, and social domains.
8. **Data Cities** – Cities that operate based on extensive data collection, analytics, and real-time decision-making.
9. **Information Cities** – Cities focused on knowledge dissemination, research, and information-based economies.
10. **Knowledge Cities / Knowledge Capitals** – Cities that function as hubs for education, research, and intellectual capital development.
11. **Intelligent Cities** – Urban environments that leverage artificial intelligence, automation, and smart technologies for governance and urban management.
12. **Smart Cities** – Cities that integrate digital technologies, IoT, and ICT-based solutions to enhance efficiency, sustainability, and quality of life.
13. **Ubiquitous Cities (U-Cities)** – Urban systems where ICT is seamlessly embedded in the infrastructure, providing continuous and adaptive digital services.
14. **The 15-Minute Cities** – A concept emphasizing urban planning that enables

residents to access essential services within a 15-minute walk or bicycle ride.

15. **Technological Cities / Hi-Tech Cities** – Cities driven by advanced technological innovation, including AI, automation, and digital ecosystems.
16. **International / Global Cities** – Cities that play a central role in global trade, finance, and international governance.
17. **Industrial / Manufacturing / Factory Cities** – Cities designed primarily for large-scale industrial production and manufacturing activities.
18. **Industry 4.0 / Industry 5.0 / Society 5.0 Cities** – Cities aligned with the principles of the Fourth and Fifth Industrial Revolutions, integrating smart automation, AI, and human-centered technological advancements.
19. **Wired Cities / Infrastructure-Based Cities / Communication-Driven Cities** – Urban areas with advanced telecommunication and ICT infrastructures facilitating digital governance and connectivity.
20. **Green Cities** – Cities that prioritize sustainability, ecological resilience, and environmentally responsible urban planning.
21. **Social Cities** – Urban models designed to enhance community engagement, social cohesion, and participatory governance.
22. **Cultural Cities** – Cities that emphasize the preservation and promotion of cultural heritage, artistic expression, and creative economies.
23. **Socio-Political Cities** – Cities that integrate social and political frameworks to ensure participatory governance and civic engagement.
24. **Socio-Cultural Cities** – Urban environments where cultural development and social interaction are central to urban planning and policy.
25. **Cognitive Cities** – Cities that employ AI, cognitive computing, and smart decision-making systems to optimize urban functionality.
26. **Cognitive-Cultural Cities** – A hybrid model combining cognitive technology with cultural heritage and identity preservation.
27. **Human Cities** – Cities designed with a human-centered approach, prioritizing well-being, inclusivity, and social equity.
28. **Circular Cities** – Cities adopting circular economy principles to minimize waste, maximize resource efficiency, and promote sustainability.
29. **Sustainable Cities** – Urban centers focused on achieving long-term environmental, economic, and social sustainability.
30. **Live Cities / Living Cities** – Cities that continuously adapt to dynamic socio-economic and environmental changes through innovation and resilience.

Theoretical Foundations of the Cognitive-Human Circular Smart City and Economy

The thirty conceptual models previously outlined have been foundational in shaping the discourse on urbanization, smart city development, and digital economies. Some of these models have played a particularly significant role in the evolution of next-generation smart cities, a central focus of this study. These theoretical constructs have been instrumental in the development of the **Cognitive-Human Circular Smart City**, a novel framework introduced and defined within this research.

In its most advanced iteration, the Smart City and Smart Economy, structured under the Cognitive-Human Circular Model, is conceptualized as part of an overarching meta-ecosystem—a highly integrated and interconnected urban paradigm that brings together multiple evolving urban concepts. This section first delineates the conceptual pillars of the Cognitive-Human Circular Smart City and Economy, followed by an examination of the eight core circular knowledge-techs that define its economic structure.

The Evolution of the Smart Economy

The historical trajectory of economic transformations has given rise to a third major economic era, widely recognized as the knowledge-based economy, which emerged in the mid-20th century. This period marked a transition from agricultural and industrial economies to an increasingly technology-driven economic framework, culminating in the advent of the smart economy. The earliest manifestations of this paradigm shift were rooted in the development of information and communication technologies (ICTs), followed by the evolution of internet-based economies, electronic commerce, and digital economies. As the 21st century progressed, these foundational innovations coalesced into the broader concept of the smart economy, now regarded as a key determinant of economic power and national wealth in the global landscape (Shaqaqi Shahrari & Vahed Rasouli, 2022).

Within the smart economic framework, global markets have undergone a structural transformation, moving away from the dominance of multinational corporations and large-scale enterprises toward decentralized, small-scale economic ecosystems. This shift has effectively flattened competitive landscapes, facilitating the rise of individual economic actors and microeconomic networks as primary agents of innovation and economic activity. The defining characteristics of this transformation include the integration of smart economic big data, advanced microchip technologies, and idea-based economic models as the fundamental drivers of the modern economic landscape.

Fundamental Concepts of the "Cognitive-Human Circular Smart" City and Economy

Cognitive Cities and the Cognitive Economy

The Cognitive City represents an advanced stage in the evolution of smart urban environments, distinguished by its reliance on collective urban intelligence as the primary mechanism for governance and decision-making. Correspondingly, the Cognitive Economy emerges as a more advanced and dynamic extension of the smart economy, grounded in collective economic intelligence within cognitive smart cities.

The core objective of the Cognitive Economy is to address economic challenges that extend beyond the capabilities of conventional smart economic models. In other words, where traditional smart economies fail to provide comprehensive solutions, cognitive smart economies aim to bridge those gaps—offering a more responsive and adaptive economic framework.

The Cognitive Economy is fundamentally structured around networked economic interactions, wherein economic relationships are established and maintained through interconnected communication networks, real-time data exchanges, and digital media platforms. This model functions as a continuously integrated system, facilitating instantaneous knowledge transfer, decision-making, and resource allocation within communication, information, and media hubs. By leveraging the cognitive dimensions of human behavior and technological intelligence, the Cognitive Economy serves as the foundation for future economic systems.

As an essential component of smart cities, the Smart Economy operates as a catalyst for urban development, aimed at resolving economic inefficiencies through advanced data collection, analysis, and utilization (Portmann & Finger, 2015). The intelligence of an economic system increases in direct proportion to its capacity to collect high-quality data, analyze it effectively, and provide open access to key economic stakeholders (Hurwitz, 2015). This transition from static economic models to dynamic, data-driven economic systems significantly enhances the ability to address economic challenges in real-time.

In light of these developments, the Cognitive Economy necessitates the integration of Cognitive Economic Intelligence, a collective intelligence framework that optimizes economic interactions within smart urban ecosystems.

Cognitive Economic Intelligence: A Networked System of Collective Intelligence

Cognitive Economic Intelligence functions as a distributed intelligence network, wherein individual cognitive agents—including human actors, AI systems, and digital infrastructures—operate within an interconnected smart economic ecosystem. Within this framework, entities with varying degrees of intelligence, including AI-driven economic systems and digital decision-making infrastructures, interact to create a synergistic intelligence network. The collective output of this network exceeds the sum of its individual components, thereby generating greater economic efficiency and problem-solving capabilities in cognitive smart cities (Malone & Bernstein, 2015).

Furthermore, **Cognitive Economics** investigates the role of cognitive processes—such as perception, memory, learning, and decision-making—in shaping economic behaviors. This interdisciplinary approach emphasizes the intersection between cognitive sciences, behavioral economics, and digital transformation, seeking to understand how knowledge acquisition and information processing influence economic decision-making at both individual and systemic levels.

By integrating collective intelligence mechanisms, AI-driven analytics, and cognitive science principles, the Cognitive Economy introduces a transformative model for economic governance—one that is adaptive, decentralized, and fundamentally knowledge-driven.

Cognitive Smart Economy

In cognitive smart cities, the cognitive and smart economy is omnipresent, with artificial intelligence (AI) serving as the primary mechanism for understanding human behavior and cognition. Smart economic governance is designed to obtain the most accurate and comprehensive knowledge to facilitate optimal decision-making, ultimately leading to an enhanced quality of human life.

The Human City and the Human Economy

In a cognitive city, when the human element is incorporated into the communication network, a human city emerges, with its economy being a human economy. In such urban environments, human interactions occur seamlessly among individuals, between humans and technologies, and among technologies themselves, facilitated by accessible and intelligent communication systems. By nature, cognitive cities are human-centric cities, where all forms of interaction—including information exchange and media communication—are inherently cognitive.

However, there is a distinction: while cognitive cities primarily focus on human brain functions and lower-level cognitive processes, human cities extend beyond this framework, emphasizing higher-order cognitive faculties such as reasoning, imagination, and experiential learning. This expanded perspective makes human cities not only cognitive in nature but also deeply reflective of human creativity and consciousness.

The technological foundation of cognitive cities and the cognitive economy is built upon cognitive computing systems, which possess the ability to detect patterns within vast datasets and continuously learn through interaction with users (Portmann & Wilke, 2016; Hurwitz, 2015). These cognitive computing systems enhance their understanding through constant engagement with human users, learning from human emotions, preferences, and needs. This ongoing interaction results in the development of human-centered computing systems, which are more intuitive and responsive, ultimately forming human-computer symbiotic systems.

Integration of Cognitive and Human Cities with Smart City Frameworks

The concepts of cognitive cities and human cities—along with their corresponding economic models, cognitive and human economies—are not intended to replace existing smart city or smart economy frameworks. Instead, they complement and expand these frameworks by emphasizing multidimensional interactions and interconnectivity between economic stakeholders and urban systems. The design of cognitive/human cities and economies is therefore fundamentally about facilitating intelligent and multidirectional communication, integrating ICT, cognitive sciences, and advanced technologies with urban infrastructures and citizen engagement.

In this context, the cognitive and human economy is not merely an additional sector, like smart transportation, smart energy, or even the broader smart economy. Instead, it represents a holistic perspective that shapes the entirety of the smart city ecosystem. The principles, techniques, and technologies of the cognitive-human economy can be applied across all smart city domains, particularly in areas concerning interaction, participation, and communication.

The Future of Human-Cognitive Cities and Economies

The primary objective of the human-cognitive city and economy is to address the evolving needs of future urban environments, which cannot be met solely through efficiency and sustainability. These cities must also accommodate flexibility, adaptability, and the cognitive-human needs of citizens, including participation, individuality, personal development, and intelligent personalization. In doing so, human-cognitive cities transcend traditional smart urban models, paving the way for a more dynamic, participatory, and human-centered future.

Living City and Living Economy

A city should be perceived as a living entity, rather than a machine-like structure. A city ceases to thrive when it is reduced to a mechanical system, operating solely under rigid, top-down planning. Cities and their economies are highly complex systems, consisting of millions of individuals with diverse aspirations and needs. A Living City and Living Economy evolve organically, continuously adapting and optimizing to serve the needs of their inhabitants in a bottom-up manner. This economic model is inherently flexible, with modular and adaptable components, allowing for repurposing of urban spaces and economic functions. Additionally, such cities are sustainably designed, integrating multi-functional urban spaces, ensuring efficient resource use, and maintaining resilience in the face of change.

Mechanical City and Mechanical Economy

The Mechanical City is a fundamental concept in understanding the evolution of cognitive-human cities. It encompasses characteristics that should be avoided when designing future cognitive-human cities. These features include: “A machine-like urban system; A top-down, highly regulated structure; A model where any change requires institutional approval; A standardized approach to urban development; A greater reliance on professionals and centralized authorities, rather than allowing citizen participation”.

Similarly, the Mechanical Economy refers to an economic system heavily dependent on physical processes, machinery, and early industrial methods. This model is typically associated with the Industrial Revolution and early stages of economic development, where production and service delivery relied primarily on mechanical technologies and human labor.

Moreover, the Mechanical Economy embodies an overly "engineering-centric" mindset, often disregarding social, cultural, and human dimensions. It treats the economy as a machine-like system, governed by predictable inputs, outputs, and institutionally controlled interactions, rather than an adaptive, human-centered network.

15-Minute City and 15-Minute Economy

This decentralized urban model integrates all essential socio-economic functions within local neighborhoods. Proponents of the 15-Minute City and 15-Minute Economy argue that fostering neighborhoods where residents can access all essential services within 15 minutes—via walking, biking, or public transport—significantly enhances overall quality of life. This model requires the development of mixed-use neighborhoods, replacing segregated zones for work, living, and recreation. The result is a reduction in unnecessary travel, strengthened local communities, and improved urban sustainability—particularly from an economic perspective.

Currently, many cities are designed with separate zones for commercial, residential, and recreational activities, often forcing residents to commute long distances. By contrast, compact cities of the future or "hyper-localized urban models" prioritize integrated infrastructure, bringing together all elements of work and life within localized, neighborhood-driven economies. The underlying principle of this model is a "return to local living."

Circular City and Circular Economy

A Circular City applies circular economy principles to resource management, waste reduction, and urban sustainability, aiming to replace traditional linear economic models—characterized by "produce, consume, discard"—with circular systems focused on "reduce, reuse, recycle."

Key Features of Circular Cities and its Circular Economy

1. **Smart Resource Management** – Optimizing water, energy, and material consumption; reusing and recycling resources (e.g., utilizing greywater for irrigation in green spaces).
2. **Circular Design Principles** – Designing buildings, infrastructure, and products with extended lifecycles and high recyclability (e.g., constructing buildings using recycled and modular materials).
3. **Waste Reduction and Recycling** – Implementing waste separation at the source, developing advanced recycling infrastructure, and repurposing organic waste for composting or energy production.
4. **Renewable Energy Integration** – Expanding the use of solar, wind, and other renewable energy sources in urban planning (e.g., installing solar panels on residential and public buildings).
5. **Sharing Economy Initiatives** – Encouraging resource and service sharing, such as shared mobility (car-sharing), co-working spaces, and product-sharing platforms.
6. **Sustainable Transportation Systems** – Promoting efficient public transit networks, cycling, and pedestrian-friendly urban spaces, while reducing reliance on private vehicles and encouraging electric transportation solutions.
7. **Citizen Engagement and Awareness** – Educating communities on sustainable practices, fostering civic participation in waste reduction and resource management programs.
8. **Technological Innovation** – Leveraging smart technologies, IoT sensors, and data analytics to enhance urban efficiency (e.g., intelligent waste management and energy optimization systems).

Benefits of Circular Cities and the Circular Economy

1. **Environmental Sustainability** – Reducing **natural resource depletion** and **minimizing pollution**.
2. **Economic Sustainability** – Creating new job opportunities in recycling, remanufacturing, and circular business models while improving economic efficiency by reducing waste-related costs.
3. **Enhanced Quality of Life** – Expanding green urban spaces, improving public awareness of sustainability, and fostering healthier living environments.
4. **Climate Change Mitigation** – Reducing greenhouse gas emissions through renewable energy adoption and waste reduction strategies.

Amsterdam, Netherlands; Copenhagen, Denmark; San Francisco, USA; Helsinki, Finland; and Singapore are Examples of Leading Circular Cities

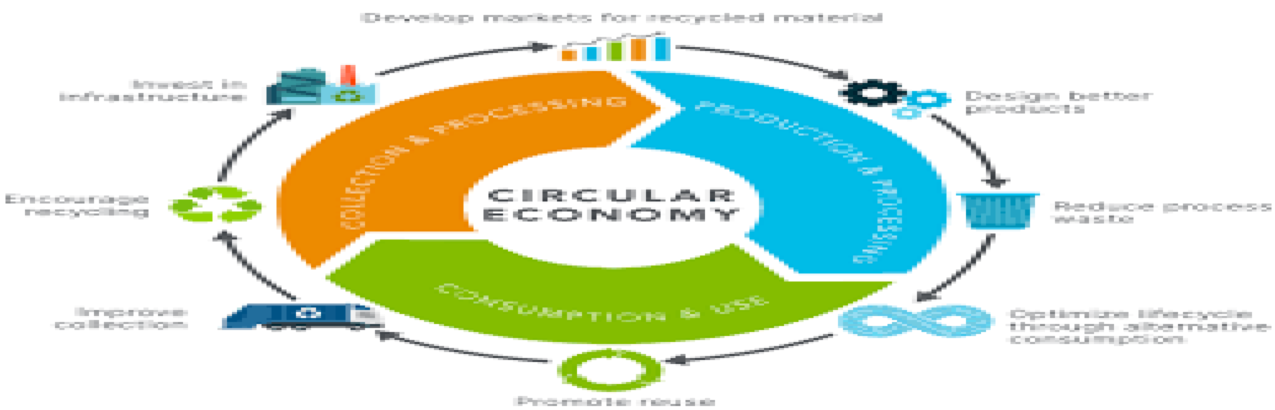
Circular Cities represent a paradigm shift in urban resource management and sustainable development. By integrating emerging technologies, sustainable economic practices, and citizen participation, they offer a viable response to modern urban challenges and climate change concerns.

Circular Economy

The Circular Economy is a sustainable economic model that emphasizes a closed-loop system in design, production, consumption, and recycling. The primary objective of this model is to minimize waste, maximize resource efficiency, and promote long-term sustainability by keeping products, materials, and resources in continuous use for extended periods. The utilization of materials and energy must be aligned with planetary limitations, and the circular economy approach represents a paradigm shift aimed at addressing unsustainable consumption rates.

Distinction Between the Circular Economy and the Linear Economy

In a traditional linear economy, resources are extracted, manufactured into products, consumed, and then discarded—following the "take, make, dispose" model. However, the circular economy seeks to prevent resource depletion and waste generation by closing the loop through strategies such as recycling, reuse, repair, remanufacturing, sharing, and reintegration into the economic cycle.



Sourse:https://circularinnovation.ca/circular-economy/

Core Principles of the Circular Economy

1. **Design for Longevity** – Products are engineered to be durable, repairable, and upgradeable, reducing the need for frequent replacements.
2. **Reduce, Reuse, Recycle** – Minimizing waste generation through the reuse and recycling of materials at the end of their lifecycle.
3. **Resource Efficiency** – Optimizing resource use by maintaining materials within the economic cycle, thereby reducing dependence on virgin resources.
4. **Regenerative Systems –** Emphasizing renewable energy and restorative methods that contribute to ecosystem regeneration.
5. **Product-as-a-Service Model –** Transitioning from ownership-based models to rental or subscription-based approaches, wherein manufacturers remain responsible for product lifecycle management.

Benefits of the Circular Economy

- **Environmental**: Conservation of natural resources, reduction of waste, mitigation of greenhouse gas emissions, and minimization of environmental degradation.

- **Economic**: Enhancement of economic sustainability, creation of new business opportunities, cost reduction through resource efficiency, and promotion of innovation.

- **Social**: Generation of employment in recycling, repair, and remanufacturing sectors, along with fostering sustainable consumption practices.

Examples of Circular Economy Initiatives

- **Recycling**: Transforming waste materials into new products (e.g., converting plastic bottles into textiles and garments made from recycled materials).

- **Remanufacturing**: Restoring used products to a near-original condition (e.g., refurbishment of electronic devices).
- **Modular Design and Upgradability**: Designing products with interchangeable and recyclable components (e.g., modular smartphones with replaceable parts).
- **Sharing Economy**: Platforms that facilitate shared use of resources, such as car-sharing services and tool-sharing programs, reducing individual ownership requirements.
- **Composting**: Converting organic waste into nutrient-rich soil amendments for agricultural use.
- **Industrial Symbiosis**: Repurposing industrial byproducts as raw materials for other industries (e.g., utilizing industrial waste for furniture production).

The circular economy is increasingly recognized as a pivotal strategy for addressing global challenges such as climate change, resource scarcity, and pollution, while simultaneously fostering sustainable economic growth.

Research Findings and Analysis

This section presents the findings and analyses derived from the study, addressing the research questions. The discussion begins with an exploration of conceptual frameworks and innovative classifications, followed by a detailed examination of the results.

Cognitive-Human Circular Smart Cities and its Cognitive-Human Circular Smart Economies

A **Cognitive-Human Circular Smart City** embodies the integration of advanced technological, economic, and socio-cultural systems, incorporating the most effective characteristics of various urban paradigms, including:

"Mechanical, Ancient-Historical, Administrative-Political, Industrial-Service, Religious-Pilgrimage, electronic, digital, Data-driven, information, Knowledge / Knowledge capital, intelligent, Smart, ubiquitous/ U- , The 15-minute, Technological/ hi-Tech, International/Global, Industrial / Manufacturing / Factory, Industry 4.0 / Industry 5.0 / society 5.0 , wired, Green, Social, Cultural, Socio-Political, socio cultural, Cognitive, Cognitive-cultural, Human, Circular, Sustainable, Living/Live." CITIES.

Within this framework, the **Cognitive-Human Circular Smart Economy** operates as an intelligent and integrated system that embodies the same attributes as the city itself, leveraging: "Mechanical, Ancient-Historical, Administrative-Political, Industrial-Service, Religious-Pilgrimage, electronic, digital, Data-driven, information, Knowledge / Knowledge capital, intelligent, Smart, ubiquitous/ U- , The 15-minute, Technological/ hi-Tech, International/Global, Industrial / Manufacturing / Factory, Industry 4.0 / Industry 5.0 / society 5.0 , wired, Green, Social, Cultural, Socio-Political, socio cultural, Cognitive, Cognitive-cultural, Human, Circular, Sustainable, Living/Live." ECONOMIES.

The above "Hard-Soft-Human"-Ware concepts, in "Cognitive-Human Circular Smart Cities, establish a particular economy—referred to as the 'Cognitive-Human Circular Smart Economy'—operates as an intelligent, interconnected, and sustainable system that integrates "**circular, cognitive, human-centric, synergistic, co-creative, transformative, and holistic / universal hyper-network".** It is a "**'Cognitive-Human Smart Economy**" and "**'Cognitive-Human Circular Smart Economy"**.

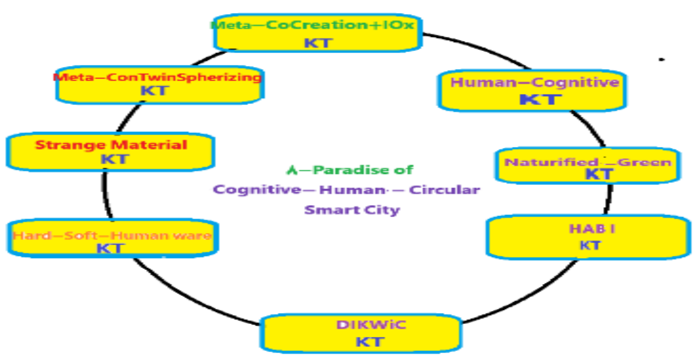
Based on the aforementioned discussion, the "Cognitive-Human Circular Smart City" is an advanced smart city that is cognitive, human-centric, knowledge-Tech driven, and circular. It has been developed by drawing upon the entirety of human urban experiences, integrating the most advanced cognitive-human, knowledge-Techs in a circular framework. This design and implementation approach aims to create the most human-centric and high-quality form and content of urban life for its residents.

Within such a smart city, the economy follows the same principles, forming a Cognitive-Human Circular Smart Economy. This economic system is also cognitive, human-centric, knowledge-driven, and circular, shaped by the cumulative experiences of urban economic development. By incorporating cutting-edge cognitive-human advancements in a circular manner, it seeks to establish the most human-centric and high-quality economic system for the city's inhabitants.

Based on the findings of this research, urban **,** knowledge-Techs, which have exceeded 444 by the beginning of 2025, have been innovatively categorized into 8 main thematic groups. These 8 categories are referred to in this study as the "Eight Paradises of Civilization-Building and Culture-Building Knowledge-Techs", or, based on this research literature, could be called: *Civilizification* or *civilification* & *Culturification*. Here, "paradise" is a metaphor for the outcomes of implementing such knowledge-Techs in these cities, leading to the formation of a human "civilizational and cultural paradise." The term " knowledge-Techs " emphasizes the centrality of knowledge and technology in this categorization. The phrase " *Civilizification* and *Culturification* " indicates the role and impact of these knowledge-Techs on the life and destiny of contemporary humanity. The result of any country's utilization of these knowledge-Techs will be the creation of a worldly civilizational and cultural paradise for that nation. In the discussion of this research, the civilization and culture that will be built in contemporary smart cities, and the degree of intelligence and circularity of the city in the future-now, have a direct relationship with the extent of applying these 8 categories of knowledge-Techs (all 444) and future design based on them:

The Eight Paradises or eight categories of knowledge-Techs constructing cognitive-human circular smart cities are:

> "Human, Naturified, Smart, DaiFoTics/DIKWiC, Hard-Soft-Human Ware, Advanced/Strange Materials, Meta-ConTwinSpherizing, MetaCoCreation" knowledge-Techs



A very important point in this eightfold categorization is that these realms are not discrete; rather, they form an integrated super-network or urban super-sphere. While each "paradise" (or category) possesses its own unique dynamics, on a macro level the ensemble of all eight paradises is governed by an overarching super-dynamic that presides over this "super-sphere of eight Sub-spheres."

Moreover, in a circular economy, a circular city, or even a circular nation, if we begin at any point—or paradise—on this circle, in order to return to that very same point, one must sequentially traverse all eight paradises (or Sub-spheres) through practical and operational processes. Furthermore, the placement of each of the eight paradises, situated along the circumference of the circle, is identical.

At the macro and governance level, the concept of this super-sphere or "eight paradises" implies that any country which better, more completely, and more precisely understands and implements this super-dynamics will, in turn, possess a superior and more globally oriented civilization and culture.

Each category of these epistemic constructs possesses two fundamental characteristics that define its unique dynamics:

1. They are constructs that embody the "Common attributes indicated in the title of that category/paradise."
2. They are constructs that constitute the "shared attributes indicated in the title of that category/paradise."

For example, when we refer to "human KT / Humanitic KT /genetic + memetic KT," (we mean those KT(Knowledge-Techs) that either inherently possess human attributes or actively form the characteristics of a human being. The combined influence of genes and memes creates the physiological and cultural traits (i.e., religious, political, social, economic, artistic, linguistic, etc.) of an individual—and, by extension, of a city, a nation, or an entire society. Examples of these KT(Knowledge-Techs) include those related to "Genetics 2.0, gene therapy, memetics, etc.," which will be discussed further. These Knowledge-Techs provide us with a means to achieve the most precise representation of individual and societal characteristics.

Moreover, the Knowledge-Techs related to the brain and mind—classified under cognitive sciences and technologies (another term for this category)—can reveal the intrinsic human features and inner dynamics of this group; examples include Knowledge-Techs derived from fMRI studies or mind mapping. In addition, Knowledge-Techs pertaining to social networks and media illustrate how memetic human attributes are generated, such that in our contemporary world one can readily demonstrate the genetic modifications influenced by these Knowledge-Techs and their role in shaping the genetic characteristics of human beings.

Here, detailed explanations and the outcomes for each "paradise" (or category) will be provided:

1. Human-Cognitive Knowledge-Techs:

This category of Knowledge-Techs can be referred to by various terms that are nearly equivalent—or at least yield results and indicators that are more or less similar. For example, one may encounter designations such as:

"Human-Cognitive Knowledge-Techs; Human Knowledge-Techs; Humanistic/Humanity Knowledge-Techs; Anthropo-centric/Humanitic Knowledge-Techs; 'Genetic + Memetic' Knowledge-Techs; Cognitive Knowledge-Techs; 'Neural + Mental' Knowledge-Techs; Medical and Body-Mind Health Knowledge-Techs; 'Physiological + Cultural' Knowledge-Techs; Knowledge-Techs of Influence and Receptivity Operations; Cognitive Brain-Mind Knowledge-Techs; Quantum Brain-Mind Knowledge-Techs; Fundamental/Basic Knowledge-Techs; Insight-Generating Knowledge-Techs; Strategic Knowledge-Techs; Educational Knowledge-Techs; Cultural Knowledge-Techs; Governance Knowledge-Techs; and so forth."

Human-Cognitive Knowledge Technologies (HCKTs) are the knowledge, tools, and systems that enhance, simulate, or extend human cognitive processes—such as reasoning, learning, problem-solving, memory, and decision-making. These Knowledge-Techs act as a bridge between human cognition and artificial intelligence or other computational systems, with the aim of expanding both the scope and efficiency of human intellectual capabilities and obtaining highly accurate, near-perfect insights into human behavior.

In this context, all these terminologies essentially point to the same sphere of inquiry and are used to denote Knowledge-Techs that capture both the human and cognitive dimensions—encompassing aspects from genetic and memetic influences to the physiological, cultural, and strategic factors that shape human behavior and societal dynamics.

Comprehensive/Key Themes of Human-Cognitive Knowledge Technologies (HCKTs):

"Knowledge Representation; Interactive Interfaces; Automation of Cognitive Tasks; Learning and Adaptability; Primary Themes of Human-Cognitive Knowledge-Techs"

1. **AI Assistants:** *Example:* Virtual assistants like ChatGPT, Siri, or Alexa that utilize natural language processing (NLP) to comprehend and respond to human queries. These tools enhance human capabilities by providing rapid access to extensive information.
2. **Knowledge Management Systems:** *Example:* Platforms such as Confluence or SharePoint that enable organizations to manage, organize, and share knowledge effectively, thereby supporting collaborative decision-making and problem-solving.
3. **Cognitive Enhancement Tools:** *Example:* Brain-Computer Interfaces (BCIs) like Neuralink, which allow for direct interaction between human cognitive processes and digital systems.
4. **Machine Learning-Based Recommendation Systems:** *Example:* Platforms like Netflix or Spotify that analyze user preferences using artificial intelligence to suggest content tailored to individual tastes.
5. **Decision Support Systems:** *Example:* Healthcare tools like IBM Watson Health, which leverage vast medical databases and patient information to assist in accurate diagnosis and effective treatment planning.
6. **Interactive Augmented Reality (AR) Systems:** *Example:* Devices such as Microsoft HoloLens that enable users to interact with virtual elements in real time, thereby integrating enhanced visualizations with human decision-making.
7. **Cognitive Automation in Business Processes:** *Example:* Robotic Process Automation (RPA) tools like UiPath that automate repetitive tasks, streamline operations, and boost overall productivity.
8. **Educational Technologies:** *Example:* Adaptive learning platforms like Duolingo or Khan Academy, which personalize the learning experience based on individual performance and preferences.

Applications:

Healthcare, Education, Business, Research and Development.

The integration of human "Innovation, creativity, awareness, and exponential abilities" with advanced computational capabilities plays a crucial role in reshaping our understanding of knowledge and technology. This synergy not only expands the boundaries of human cognition but also helps establish an extensive and precise super-network of human data/DIKWiC, driving forward the (r)evolution of our society and its technological landscape.

Human-Cognitive Circular Economy (HCCE

Human-Cognitive Circular Economy (HCCE), based on Knowledge-Techs, is an approach that employs advanced cognitive tools and systems to reinforce the principles of the Circular Economy (CE). This approach leverages Human-Cognitive Knowledge-Techs (HCKTs) to optimize resource utilization, extend product lifecycles, and create sustainable systems through improved decision-making, innovation, and collaboration.

Comprehensive /Core Themes of HCCE:

1. **Principles of the Circular Economy:** Emphasizing waste reduction, resource reuse, and material recycling to complete the production–consumption cycle.
2. **Cognitive Technologies:** Utilizing artificial intelligence, machine learning, and related tools to support data-driven, intelligent decision-making in resource management.
3. **Human-Centric Approach:** Prioritizing human involvement in problem-solving, knowledge sharing, and sustainable innovation through technological means.

4. **Human-Centered Economic Approach:** At the core of the Human-Cognitive Circular Economy lies the pivotal role of human beings. According to the unique findings of this research, individuals are not external agents but are inherently integrated into the cyclical processes of the economy. Within this framework, people occupy diverse positions, roles, and professions determined by factors such as age, experience, education, and the projected needs of the economic cycle. This approach underscores that the human element is not only fundamental to the structure of a circular economy but also serves as its primary catalyst for sustainable innovation and development.

The Role of Knowledge-Techs in HCCE

- **Comprehensive human–economic Data Provision:**
  Delivering the most accurate and extensive human–economic data repository possible—ensuring that every piece of data needed for both major and nuanced human-centered decisions is accessible.
- **Data Analytics and Insight Generation:** Facilitating real-time monitoring and predictive analytics to optimize resource utilization.
- **Collaboration and Knowledge Sharing:** Utilizing digital platforms that connect stakeholders across various industries, fostering an environment of shared expertise and collaborative solutions.
- **Automation and Efficiency:** Applying artificial intelligence and automation to streamline circular processes—such as sorting, separation, and recycling—to enhance overall system efficiency.

Primary (Applied) Themes of HCCE

1. **Intelligent Waste Management:** *Example:* AI-driven platforms like Rubicon utilize IoT sensors and machine learning to optimize waste collection routes, analyze recycling trends, and reduce reliance on landfill sites.
2. **Product Lifecycle Management (PLM):** *Example:* Tools such as SAP S/4HANA provide manufacturers with comprehensive insights regarding product design, usage, and end-of-life options, thereby facilitating design for recycling and refurbishment.
3. **Digital Twin Technology:** *Example:* Platforms like Siemens Digital Twin simulate a product or system's lifecycle to reduce resource consumption and predict maintenance needs.
4. **Blockchain for Circular Supply Chains:** *Example:* Systems like Provenance employ blockchain to ensure supply chain transparency by tracking materials from sourcing through recycling, thus supporting ethical and sustainable practices.
5. **Sharing Economy Platforms:** *Example:* Applications such as Airbnb or Turo promote the shared use of housing and vehicles, thereby reducing the demand for new production.
6. **Circular Design Platforms:** *Example:* Software like Granta Design integrates materials science expertise to assist engineers in selecting sustainable and recyclable materials for product design.
7. **Industrial Symbiosis Networks:** *Example:* The Kalundborg Symbiosis project in Denmark enables industries to share resources—such as excess heat or water—in order to minimize waste and maximize resource efficiency.
8. **Cognitive Recycling Systems:** *Example:* Robotic sorting systems developed by companies like AMP Robotics use machine vision to accurately identify and separate recyclable materials.

Applications and Benefits of HCCE

- **Enhanced Sustainability:** Maximizing resource use and reducing environmental impacts.
- **Improved Efficiency:** Streamlining processes through automation and real-time insights.

- **Innovation in Circular Business Models:** Creating new paradigms, such as Product-as-a-Service, which reimagine traditional production and consumption methods.
- **Global Collaboration:** Connecting stakeholders worldwide to facilitate knowledge sharing and co-develop sustainable solutions.

The Human-Cognitive Circular Economy, by merging human creativity with advanced technology, fosters sustainable development through intelligent resource management and human-centric circular design.

Comprehensive Themes of Human-Cognitive Knowledge-Techs

1. **Human-Cognitive Focus**
2. **Machine Learning**
3. **Natural Language Processing (NLP)**
4. **Robotic Process Automation (RPA)**

By integrating these domains, Human-Cognitive Knowledge-Techs can analyze vast amounts of data, identify meaningful patterns, and facilitate informed decision-making—thereby enhancing efficiency and effectiveness across various economic sectors. For example, IBM's cognitive solutions help businesses define optimal outcomes and select appropriate strategies, easing the implementation of programs that capitalize on cognitive capabilities.

In summary, Human-Cognitive Knowledge-Techs represent a suite of technologies that emulate human cognitive functions. They create more intuitive and intelligent systems that augment human expertise and simplify complex processes, ultimately driving forward sustainable economic practices and innovation.

Core Themes of Human-Cognitive Knowledge Technologies (HCKTs)

The key themes of Human-Cognitive Knowledge Technologies (HCKTs), derived from research findings, encompass various domains that integrate cognitive science, artificial intelligence, and human-centric applications. These themes serve as foundational pillars for advancing cognitive-driven knowledge systems and technologies.

Table 1 – Core Themes of Human-Cognitive Knowledge Technologies

No.	Theme	No.	Theme	No.	Theme
1	Cognitive Education	2	Cognitive Computing	3	Cognitive Media
4	Cognitive Security	5	Cognitive Economy	6	Cognitive Banking
7	Cognitive Internet of Things (CIoT)	8	Cognitive Governance	9	Cognitive Government
10	Cognitive Neuroscience	11	Cognitive Psychology	12	Cognitive Systems
13	Cognitive Operations	14	Cognitive Business	15	Cognitive Energy
16	Cognitive Reversibility	17	Cognitive Semantics	18	Cognitive Health
19	Cognitive Processing	20	Cognitive Functioning	21	Cognitive Content
22	Cognitive Behavior	23	Cognitive Therapy	24	Cognitive Behavioral Therapy (CBT)
25	Cognitive Linguistics	26	Cognitive Choice	27	Cognitive Catalysts
28	Cognitive Immune Systems	29	Cognitive Change	30	Cognitive Digitalization
31	Cognitive Skills	32	Cognitive Work	33	Cognitive Meaning-Making
34	Cognitive Automation	35	Cognitive Services / Cognitive API Services	36	Cognitive Assessment & Evaluation
37	Cognitive Systems Engineering	38	Metacognition	39	Cognitive Solutions
40	Cognitive Role-Playing	41	Cognitive Robotics	42	Cognitive Organizations
43	Sustainable Cognitive Computing	44	Cognitive Modeling	45	Cognitive Theory of Everything
46	Cognitive Storage	47	Natural Learning Processing	48	Cognitive Internet of Everything (CIoE)

No.	Theme	No.	Theme	No.	Theme
49	Cognitive Collaboration	50	Cognitive Business Disruption	51	Cognitive Cyber-FIT
52	Cognitive RPA / Cognitive Robotic Process Automation	53	Cognitive Triad (TEB – Thought, Emotion, Behavior)	54	Cognitive Radio Networks / Cognitive Business Media / Business Cognitive Media

Core Themes of Humantics or Gene-Memetic Knowledge-Techs:

1 Gene Therapy 2.0
2 Cellular Atlas
3 Human Organ-on-a-Chip
4 Optogenetics
5 Memetic Engineering
6 The Sphere of Converging Sciences & Technologies (Nano, Bio, Information, and Communication)

Comprehensive and Core Themes of Human-Cognitive Knowledge-Techs

Comprehensive Themes of Human-Cognitive Knowledge-Techs	Core Themes of Humantics or Gene-Memetic Knowledge-Techs
1. Human-Cognitive-Centered Approach	1. Gene Therapy 2.0
2. Machine Learning	2. Cellular Atlas
3. Natural Language Processing (NLP)	3. Human Organ-on-a-Chip
4. Robotic Process Automation (RPA)	4. Optogenetics
	5. Memetic Engineering
	6. The Sphere of Converging Sciences & Technologies (Nano, Bio, Information, and Communication)
	7. Internet of Health – Smart Health – Cloud Health
	8. Bio-Computing
	9. Bio-Pharmaceuticals – Robo-Drugs

This table presents a structured comparison between Human-Cognitive Knowledge-Techs and Humantics or Gene-Memetic Knowledge-Techs, highlighting their interdisciplinary integration in cutting-edge research and technology development.

This category of knowledge-techs, provides the most precise datasets and data repositories for societies and macro-level governance, particularly within cognitive-human cities or circular cognitive-human economies. These knowledge-techs play a transformative role in political, cultural, economic, strategic, scientific, and knowledge-technological "governance, planning, and advancements". Their defining characteristic is the synergistic integration of three forms of intelligence—natural, human, and artificial—across one by one components of a city, including individuals, knowledge-technologies, institutions and their **"Meta-convergent collective intelligence."**.

Knowledge-techs of the first category/paradise are those that combine and integrate with the other seven categories/paradises—such as intelligences, **DIKWiC,** and co-creation paradises—to initiate and fasten circular phases, including the circular economy (Categories/Paradises 5–7).

In the first knowledge-tech category, data repositories are derived from genetic and memetic sources, as well as physiological and cultural characteristics, leveraging the most advanced smart hardware and software tools. These cognitive-human **DIKWiC-sets** can be collected directly—without intermediaries—from genetics, memetics, nature, wearable smart devices, IOT networks, and social platforms, ensuring the highest level of accuracy and precision in cognitive-human DIKWiCs.

By integrating these Cognitive-Human DIKWiCs, with **individual and collective intelligence—**natural, human, and artificial (Categories 1–3), the most extensive and sophisticated data structures and algorithms, are formed. It leads to the emergence of a **data singularity**—an intelligent convergence of **natural-human-artificial big-bang-data** or, it can be called intelligent-Humarithm (Category 4).

At this stage, further -cognitive-human **DIKWiC-sets** are synergized with Advanced/breakthrough technologies such as quantum, graphene and perovskite materials, and sustainable, clean, alternative, and zero-carbon energy sources.

In the next phase and at a higher level, through metaconvergent knowledge-techs, in an urban and national **metasphere /ecosystems, metadigital twins** of individuals, businesses, and cities/countries, can be established. These digital counterparts operate within a **Meta-IOX hyper-network**, enabling intelligent collaboration across all knowledge-tech domains, disciplines, institutions (both public and private), policymakers, entrepreneurs, and thought leaders/elite experts**.** As the result, the "Future-Now" of cities and nations will be **co-created.**

In this process of intelligent co-creation, humans, knowledge-techs, and institutions shape the future of cities and nations in a manner that is qualitatively superior, deeply human-centered, naturally integrated, highly intelligent, synergistic, and optimally networked. This evolving system ensures that urban and national development is in a continuous state of refinement and transformation.

Thus, by harmonizing and integrating all eight categories/paradises of knowledge-techs, and by leveraging the most advanced and intelligent hardware, software, and human-interface systems, policymakers gain access to ultra-precise, hyper-personalized, and globalized-localized DIKWiC-sets. These DIKWiC-sets, free from errors and bias, enable urban and national leaders to govern and innovate for a higher quality, more human-centric future.

2. Universal Knowledge-Techs / Naturified Knowledge-Techs/ Green Knowledge-Techs:

Concepts and themes of Universal//Natural/Green Knowledge-Techs and Their Relationship with the Circular Economy

1. **The Fundamental Concept:**

   Naturified or nature-inspired knowledge-techs—whether termed Universal knowledge-techs, nature-centric knowledge-techs, biomimetic knowledge-techs, or green knowledge-techs —seek to **reconnect humanity with nature** (connect first paradise to second one). This concept envisions a return to an integrated, sustainable way of living, reminiscent of an idealized natural equilibrium. Essentially, "Naturification" (a process of harmonizing human life with nature) represents a transformative effort to rebuild humanity’s relationship with the natural world, fostering a shift toward a sustainable and ecologically conscious existence.

2. **Nature-Inspired Knowledge-Techs and Biomimicry:**
   A second interpretation of Naturified or green knowledge-techs refers to Knowledge-Techs that draw inspiration from nature and natural processes. This approach draws insights from natural processes to enhance human cognitive and knowledge-techs applications across various disciplines. The concept of *biomimicry* refers to the practice of imitating natural systems, elements, structures, and processes to develop advanced technologies and address complex

human challenges. For instance, the structure of bird wings has influenced the design of more efficient aircraft wings. Similarly, artificial elastin proteins, inspired by the elasticity of human skin and tissues, have been developed to prevent post-surgical adhesions.

3. **Environmental DNA (eDNA):**

   Another emerging field within Naturified knowledge-techs is the application of environmental DNA (eDNA). This technique enables scientists to monitor biodiversity by analyzing genetic materials found in environmental samples such as soil or water. Without the need for direct observation, eDNA analysis provides critical insights into species presence and ecosystem health, advancing conservation efforts.

4. **Smart Nature Observation Platforms:** An additional dimension of Naturified knowledge-techs involves integrating artificial intelligence (AI) with nature observation platforms, such as the *iNaturalist* application. This synergy allows urban residents to actively participate in *citizen science* by using AI-powered image recognition to identify and document species. Such collaborations between technology and nature enthusiasts generate valuable ecological data, supporting environmental research and conservation initiatives.
5. **Driving Force of Human-Centered Knowledge-Techs:** Naturified knowledge-techs can also be viewed as an essential driver for advancing human-centered knowledge-techs. By leveraging fundamental principles derived from nature and the broader universe, this KTs fosters sustainable solutions to address environmental and societal challenges.

6. **Intelligent and Sentient Nature:** Historically, one of the fundamental theories has been that nature possesses inherent intelligence and consciousness. According to this perspective, everything in nature embodies a level of awareness. In this context, the development, controle, and refinement of artificial intelligence (AI) requires the complementary integration of natural and human intelligence. A *synergistic intelligence*—a fusion of *natural, human, and artificial intelligence*—is essential to ensuring a high-quality and human-centered future-now for global sustainability and KTs progress.

Hence; within the cognitive-human circular economy, greenizing or greenification and the adoption of knowledge-techs that support sustainability serve as fundamental pillars. Key concepts such as naturified economy, nature-friendly economy, and nature-centric economy act as primary drivers of a human-cognitive circular intelligent life in "Future-Now."

Every circular economic activity—ranging from data collection to design, planning, decision-making, supply chain formation, transportation, financial transactions, and beyond—must be built upon the following principles:

- Belief in the intelligence and consciousness of nature
- Integration of human life with nature
- Biomimetic problem-solving and nature-inspired innovation
- Implementation of environmental DNA (eDNA) for biodiversity monitoring
- Creation of AI-powered nature observation platforms
- Harnessing data directly from nature for informed decision-making

The Paradigm of a Unified Cognitive-Human Naturified Smart Economy

This envisioned paradise of sustainable knowledge-techs, when integrated with cognitive-human advancements and the synergy of natural, human, and artificial intelligence, generates the most precise and large-scale DIKWiC-sets and big-bang-quantum DIKWiC-sets (Paradise 1–4). By incorporating intelligent infrastructures—both hardware and software—alongside breakthrough materials like graphene and perovskite, and by leveraging these knowledge-techs across all eight paradises, a comprehensive digital twin of the entire supply chain, marketplace, and even end-users emerge. This digital ecosystem, embedded within a universal circular-holistic hyper-network, lays the foundation for a truly cognitive-human circular smart city (Paradise 4–8).

A crucial insight from Paradise 1 and 2 is that human behavior results from a complex interaction between genetics and the environment (nature). While genes provide the blueprint for human behavior, it is ultimately the interaction between an individual's genetic structure and their surrounding natural environment that shapes their identity. This realization underscores the importance of aligning technological and economic developments with the deep-rooted dynamics of nature itself.

Core Concepts and Themes of Naturified Knowledge-Techs in the Circular Economy

Based on the findings of this study, the core meanings and themes of universal-nature-inspired knowledge-techs within the circular economy include:

1. **Naturification and deep integration between human life and nature**
2. **Nature-Inspired Innovation**
3. **Biomimetic complex Problem-Solving**
4. **Biodiversity Monitoring via eDNA**
5. **AI-Enhanced Nature Observation Platforms**
6. **Data Extraction from Nature**
7. **The Intelligence and Consciousness of Nature**

Secondary Themes of Naturified Knowledge-Techs in the Circular Economy

Beyond the primary/core themes, this study identifies **Secondary** concepts in Universal- Naturified Knowledge-Techs, have been influenced by nature, the following technologies can be mentioned:

1. **Butterfly Wings & Full-Color Displays**
2. **The Eye & Camera Lenses**
3. **Spider Silk & Bulletproof Fabrics**
4. **Bat Navigation & Radar Systems**
5. **Shark Skin & Antibacterial Coatings**
6. **Lotus Flower & Self-Cleaning Surfaces**
7. **Elastic Human Skin & Artificial Elastin Proteins**
8. Here is the translated table:

Core Themes of Natural Knowledge-Techs	Secondary Themes of Natural Knowledge-Techs
1. Integration with Nature	1. Butterfly Wings & Full-Color Displays
2. Inspiration from Nature	2. The Eye & Camera Technology
3. Problem-Solving through Biomimicry	3. Spider Silk & Bulletproof Fabrics
4. Biodiversity Monitoring via eDNA	4. Bat Anatomy & Radar Systems
5. AI Integration with Nature Observation Platforms	5. Shark Skin & Antibacterial Coatings
6. Data Extraction from Nature	6. Lotus Flower & Self-Cleaning Surfaces
7. Intelligent and Conscious Nature	

3. Intelligent Knowledge-Techs / Smart Knowledge-Techs / Triple Intelligence Knowledge-Techs / HABI- Intelligence Knowledge-Techs / "Human Intelligence – Artificial Intelligence – Bio/Natural Intelligence " Knowledge-Techs / HABIQ Knowledge-Techs

Intelligent Knowledge-Techs and the Integration of Triple Intelligence

Intelligent Knowledge-Techs, or Smart Knowledge-Techs, are technologies that directly engage with intelligence. For centuries, humanity has recognized human intelligence, but since the emergence of AI—especially with the introduction of GPT-3 in 2022—

AI has taken on an increasingly central role in daily life and technological advancements. Within less than a year, it became evident that mitigating AI-related risks requires a symbiotic relationship between AI and human intelligence. Instead of simply referring to "AI," discussions began to emphasize "HI + AI" or even "HAI."

By early 2024, there was also a growing recognition of natural intelligence, leading to the introduction of "BI" (Bio/Natural Intelligence) alongside human and artificial intelligence. This triad formed what we now refer to as "HABI"—a model integrating Human Intelligence (HI), Artificial Intelligence (AI), and Bio/Natural Intelligence (BI).

However, in the final months of 2024 and the early days of 2025, the intersection of quantum computing and intelligence created an even more profound shift. As a result, this study proposes the expanded concept of **HABI-Q**—where quantum intelligence further enhances and revolutionizes the integration of intelligence.

Thus, Triple Intelligence Knowledge-Techs **(HABI)** or Quantum-Integrated Triple Intelligence Knowledge-Techs **(HABI-Q)** represent the most comprehensive framework for understanding and developing intelligence-enhanced technologies. These innovations not only define the landscape of AI but also create a paradigm shift in how intelligence—whether human, artificial, or natural—is leveraged for problem-solving, sustainability, and economic transformation.

When Quantum-Integrated Triple Intelligence Knowledge-Techs **(HABI-Q)** –3rd paradise - are embedded within the circular economy and interconnected with seven other KTs' paradises, they become one of the most powerful forces shaping the **"Future-Now World."**

HABI-Q Knowledge-Techs elevate the DIKWiC, derived from human-cognitive and nature-inspired KTs, providing humanity with unprecedented tools for intelligent planning, managing, decision-making, and economic sustainability. Cities of the future-now will utilize HABI-Q to enable circular economic planning, smart governance, and AI-driven sustainable solutions.

HABI-Q is not merely a technological concept—it is a **mega-paradigm,** represents a **mega- shift** that will reshape individuals, societies, and all aspects of life. It introduces a quantum leap in intelligence-based transformation, redefining economies, governance, and human progress in ways never before imagined.

Core KTs' themes Driving Intelligent Circular Economies

Within a circular economy, intelligence-driven KTs' core themes, play a crucial role in enhancing sustainability, resource optimization, and efficiency. Below is a list of key Intelligent Knowledge-Techs and their contributions to the circular economy:

The Role of HABI-Q in the Circular Economy

Intelligent Knowledge-Tech	Function in Circular Economy
Artificial Intelligence (AI)	AI—more accurately termed "human-made intelligence"—continuously evolves, optimizing business models, infrastructure, and resource management in circular cities. It accelerates prototyping and decision-making for designing reusable and repairable products.
Bio/Natural Intelligence (BioI)	The inherent intelligence in nature, complementing human and artificial intelligence. It plays a fundamental role in structuring economic relationships and sustainable processes.
Human Intelligence (HI)	The highest form of intelligence, responsible for advancing, overseeing, and ethically guiding both AI and BioI. Despite AI's rapid expansion, human intelligence remains the core driver of the circular city/economy, for ever.

Intelligent Knowledge-Tech	Function in Circular Economy
AI-powered Internet of Things (AI-IoT)	Smart IoT devices monitor product usage and environmental conditions, collecting data that enhances recycling, maintenance, and efficient resource utilization.
Blockchain Technology	Ensures transparency and traceability in supply chains, reducing fraud and verifying the authenticity of recycled materials, enabling a fully circular economy.
AI-Enhanced Augmented & Virtual Reality (AI-XR)	Facilitates visualization and design of circular economy systems, enabling immersive sustainability planning.
AI-Powered Waste Management Systems	Smart waste bins equipped with sensors optimize collection routes, reducing fuel consumption and carbon emissions. Digital platforms enhance waste sorting and recycling efficiency.
Digital Twins	Creates virtual models of physical assets, enabling real-time monitoring and predictive maintenance, thus extending product lifespans and optimizing resource use.
Advanced Smart Data Analytics	Analyzes big data to forecast demand, optimize resource allocation, and identify opportunities for reuse and recycling.
Machine Learning (ML) Optimization	ML algorithms monitor and optimize energy consumption, detect inefficiencies, and propose corrective actions to minimize waste.
Smart 3D Printing (Additive Manufacturing)	Enables production with minimal waste, utilizing recycled materials and facilitating on-demand manufacturing to reduce excess production.
Intelligent Sensors	Embedded sensors in products and infrastructure collect data on usage patterns, wear, and environmental conditions, informing maintenance and end-of-life recycling.

The Future-Now of Intelligent Circular Economies

These Intelligent Knowledge-Techs, when working in synergy, create a highly efficient, sustainable, and intelligence-driven circular economy. By optimizing resource use, minimizing waste, and promoting smart automation across industries, they pave the way for a future where economic growth aligns seamlessly with environmental and social well-being.

As we transition into **HABI-Q-**powered smart cities and economies, we move beyond conventional sustainability models toward a new era of intelligence-driven circular **ecosystems**—where human, artificial, and natural intelligence converge to shape the most advanced, human-centric, and environmentally conscious world ever envisioned.

Here is the translation in an academic and humanized English tone, formatted in a table:

J-5: Core Themes of Intelligent Knowledge-Techs

Core Themes of Intelligent Knowledge-Techs	Core Themes of Intelligent Knowledge-Techs
1. Artificial Intelligence (AI)	**7. Bio/Natural Intelligence (BioI)**
2. Human Intelligence (HI)	**8. AI-powered Internet of Things (AI-IoT)**
3. Blockchain Technology	**9. AI-Enhanced Augmented & Virtual Reality (AI-XR)**
4. AI-Powered Waste Management Systems	**10. Digital Twins**
5. Advanced Smart Data Analytics	**11. Machine Learning (ML)**
6. Smart 3D Printing (Additive Manufacturing)	**12. Intelligent Sensors**

 Core Themes of Intelligent Knowledge-Techs

4. Data Knowledge-Techs / DIKWiC Knowledge-Techs / "Data – Information – Knowledge – Wisdom – Universality" Knowledge-Techs

"Data" is the foundation of modern cities, economies, and the human world. According to the United Nations, every dollar invested in strengthening data systems generates **$32** in economic benefits. Data shapes the present-future of individuals, companies, organizations, nations, and humanity itself—especially in the economy. It serves as the driving force behind progress, leadership, innovation, renewal, and New-Co-creation.

Smart data fuels the **future-now** of markets, consumers, users, businesses, and every aspect of economic advancement.

From "Data" Knowledge-Techs to "DIKWiC" Knowledge-Techs

A more fitting term for modern **data knowledge-techs** is **" DIKWiC " Knowledge-Techs.** The term **DIKWiC** is derived from the initials of: **D**ata; **I**nformation; **K**nowledge; **W**isdom; **Crowd.**

This shift reflects the **evolution of data and intelligence** over recent years, highlighting three major transformations:

1. The Evolution of Data Concepts – Expanding in Depth & Scope

Traditional data concepts have expanded into new data-concept-levels, in depth and **Scope**, including:

- **Data - DIKWiC**
- **Big Data - Big DIKWiC**
- **Big-Bang Data (BBD) – BBDIKWiC**
- **Intelligent BBDIKWiC**
- **Augmented BBDIKWiC**
- **HABIQ-ABBDIKWiC – Data hyper-Singularity**

These transformations mark a new era for the circular smart economy **(CSE).** For example, the HABIQ-ABBDIKWiC or Data hyper-Singularity goes beyond risk assessment, predictive, and analysis—it enables **"Meta-CoCreation"** of the future.

2. The Evolution of Data's Nature & Definition

Data has evolved from a static entity into **a dynamic force** that seamlessly integrates into the intelligent circular economy. This transformation unfolds in three stages:

- **Data → Information ("Daifo")**: The boundary between data and information disappears. Any data that enters the circular economy **immediately transforms** into actionable **information.**
- **Data → Information → Insight ("Daifotics**"): When Daifo, integrated with analytics, data transitions into deeply insightful intelligence**/analytics.**
- **Data → Information/analytics → Knowledge → Wisdom → Crowd ("DIKWiC") :** In its most advanced form, data becomes "**DIKWiC ",** continuously evolving within a global hyper-sphere/net interconnected system.

This shift represents the most fundamental transformation in the entire **knowledge-tech circular ecosystem.**

3. The Complete Dependence of all Urban Life aspects on Data

With these transformations, data has become the **backbone of modern/smart cities.** Every economic, social, and technological function relies on **data-driven intelligence** to operate efficiently.

Core Themes of Data Knowledge-Techs in the Circular Economy

Data-driven and data-related Knowledge-Techs are fundamentals data of Circular Economy, power the circular economy by optimizing resources, reducing waste, and improving decision-making. These Knowledge-Techs collect, store, process, analyze, and visualize raw data—converting it into **DIKWiC**. Core Themes of Data Knowledge-Techs in Circular Economy:

1. Data Storage Knowledge-Techs (KTs)
2. Data Integration & ETL (Extract, Transform, Load) KTs
3. Data Processing & Analytics KTs
4. Data Mining Platforms & KTs
5. Machine Learning KTs
6. Advanced Data Analytics KTs
7. Statistical Data Analysis KTs
8. Data Visualization KTs
9. Business Intelligence (BI) Platforms & KTs
10. Big Data KTs & Platforms
11. Cloud-Based Data Services KTs
12. Data Governance & Quality KTs
13. Data Cataloging KTs
14. Data Security & Privacy KTs

Secondary Data Knowledge-Techs:

- Data Warehouses
- Data Lakes
- Presto
- RapidMiner
- Elasticsearch
- Apache Spark
- R Programming Language
- Tableau
- Power BI

The Strategic Role of Data in the Circular Economy

Data-driven KTs empower organizations **to transition from linear economic models to sustainable circular systems.** Their key roles include:

1. **Enhancing Resource Efficiency:**
   - **Demand & Inventory Management** – By analyzing real-time and historical data, businesses can accurately predict demand, optimize inventory, and minimize waste.
2. **Improving Decision-Making:**
   - **Data-Driven Insights** – Advanced analytics generate actionable insights that align business strategies with circular economy principles.
3. **Optimizing Processes:**
   - **Predictive & Prescriptive Analytics** – Machine learning algorithms forecast trends and recommend optimal actions, improving efficiency across production and supply chains.
4. **Real-Time Performance Monitoring:**
   - **Live Data Tracking** – Continuous monitoring allows for **instant adjustments**, ensuring operations remain **efficient and resource-conscious.**
5. **Ensuring Transparency & Traceability:**
   - **Supply Chain Visibility** – Data technologies provide **end-to-end traceability**, allowing stakeholders to track materials and products **throughout their lifecycle.**

The Future of Data in Circular Smart Economies

By leveraging **DIKWiC Knowledge-Techs,** businesses and governments can shift from traditional linear models to intelligent circular economies. These technologies not only enhance environmental sustainability but also drive economic resilience and innovation.

5. HSH-Ware Knowledge-Techs / Hard-Soft-Human Ware / The Infrastructure Triangle of Civilization

This category -paradise- of knowledge-techs forms the threefold infrastructure of modern civilization**.** In the

smart circular economy, these three elements serve as fundamental pillars and driver forses, even forming the core engine of this economic model.

In the realm of knowledge-techs, there are three primary interacting components, HSH-Ware:

1. **Hard-Ware (H-Ware):** Physical infrastructure and computational power
2. **Soft-Ware (S-Ware):** Digital intelligence and operational frameworks
3. **Human-Ware (H-Ware):** Human intelligence, agency, and decision-making

The **synergy** among these three domains creates the foundational **dynamics** for both **smart cities** and the **circular smart economy.**

The Three Pillars of HSH-Ware

1. Hard-Ware (H-Ware): The Physical Infrastructure

Hard-Ware refers to tangible, physical computing components, including: "Processors (CPUs, GPUs, AI chips); Memory & Storage Devices; Input/Output Equipment (sensors, displays, IoT devices); Network & Communication Infrastructure".

2. Soft-Ware (S-Ware): The Digital Intelligence

Soft-Ware consists of systems and programs that enable hard-ware to function efficiently. It includes: "System Software (Operating Systems, Middleware); Application Software (Business Applications, AI Algorithms, Data Platforms)".

3. Human-Ware (H-Ware): The Human Intelligence

Human-Ware represents the human element in KT ecosystems. It includes:

- **Users, designers, developers, decision-makers, and all individuals interacting with computing infrastructures.**
- **The strategic thinking, ethical considerations, and creativity that drive KTs progress.**
- **The capacity to influence and shape the evolution of hardware and software systems.**

Human-Ware is the driving force that determines the purpose, application, and direction of Hard-Ware and Soft-Ware—not only at the city and economic level but also on a national and global scale.

The Interdependent Dynamics of HSH Ware

These three elements operate in a highly integrated, interdependent, and dynamic system:

- **Hard-Ware & Soft-Ware** → Hard-Ware is ineffective without Soft-Ware, and Soft-Ware cannot function without Hard-Ware.
- **Soft-Ware & Human-Ware** → Soft-Ware must be designed to be user-friendly, accessible, and adaptable to human needs.
- **Hard-Ware & Human-Ware** → Hard-Ware must be engineered for optimal human interaction to maximize usability and efficiency.

Key Roles of Human-Ware in the HSH Ecosystem

Understanding the impact of Human-Ware is essential in technological evolution. Some critical roles include:

"User Experience (UX/UI) Designers; Software Developers & Engineers; System Administrators; End-Users & Consumers; Technical Support Specialists; Data Scientists & Analysts; Network Engineers & Cybersecurity Experts; Project Managers & Business Leaders; Technology Educators & Trainers; Innovation Strategists & Policymakers".

In essence, every technological transformation is guided by human insight, decision-making, and strategic vision.

The Circular Interaction of HSH Ware in the Circular Smart Economy

Beyond their internal interplay, Hard-Ware, Soft-Ware, and Human-Ware also operate within a circular, systemic model. Any advancement, disruption, or transformation in one of these three areas directly impacts the other two.

This interdependent ecosystem is essential for the development of an efficient and sustainable circular smart economy.

For example:

- Breakthroughs in **AI hardware** enhance machine learning software capabilities, which in turn reshape **human expertise** and decision-making**.**
- **New technological skills** in the workforce create demand for more **sophisticated digital infrastructures,** pushing advances in both software and hardware.
- **Innovative software solutions** redefine how humans interact with technology, influencing **economic models** and **societal structures.**

The Role of HSH Ware in Digital & Economic Transformation

Digital transformation is fundamentally driven by the evolution of Hard-Ware, Soft-Ware, and Human-Ware. This transformation is not just technological—it also has the potential to address global challenges, such as: "Climate Change & Environmental Sustainability, and Resource Scarcity & Circular Economy Optimization".

HSH -Ware technologies offer a strategic advantage in accelerating the transition to a circular economy (CE). However, no digital or economic transformation can be fully realized without the synergy of HSH Ware.

6. Exponential Hyper-Disruptive Knowledge-Techs (exhD) / Disruptive Knowledge-Techs / Radical Breakthrough Knowledge-Techs /Material + Energy + Human | The Triangle of Disruptive Innovation

Exponential Hyper-Disruptive Knowledge-Techs **(exhD)**—also known as Radical Breakthrough Technologies—are transformative innovations that trigger exponential, paradigm-shifting milestones in urban life, local economies, and the global economic landscape. These Smart Knowledge-Techs (HSH Ware) operate across three fundamental dimensions, forming the Triangle of Disruptive Innovation: **Revolutionary Materials; Breakthrough Energy Systems; Visionary Humans.**

1. Revolutionary Materials: The Core of Disruptive Change

Breakthrough materials serve as direct catalysts for historic economic transformations, particularly within the Intelligent Circular Economy. Some of the most groundbreaking materials include:

- **Graphene** – A revolutionary material with unmatched electrical, thermal, and mechanical properties.
- **Perovskite** – A next-generation compound redefining solar energy efficiency.
- **Gallium Nitride (GaN)** – Powering high-efficiency electronics and semiconductor technologies.
- **Carbon Nanotubes** – Offering extraordinary strength and electrical conductivity.
- **2D Materials** – Enabling advances in miniaturized and flexible electronics.
- **Shape Memory Alloys** – Transforming biomedical and aerospace applications.
- **Hydrogels** – Expanding possibilities in bioengineering and medical research.
- **Metamaterials** – Engineering properties beyond conventional material science.
- **Aerogels** – Super-light, high-performance materials revolutionizing insulation and aerospace.
- **Conductive Polymers** – Bridging the gap between organic compounds and electronic systems.

In material science, these emerging and advanced compounds possess unique, game-changing properties that position them as cornerstones of future technologies. Without such innovations, the intelligent, human-centered, cognitive circular economy would remain incomplete.

2. Breakthrough Energy Systems: The Lifeblood of a Sustainable Future-Now

Disruptive energy Knowledge-Techs are the foundation of the future economy. Given global energy imbalances, environmental concerns, and pollution crises, these pioneering energy solutions play an irreplaceable role in shaping a clean, self-sustaining, and intelligent economic system. These breakthrough energy solutions span across renewable, alternative, and interplanetary energy systems, such as:

- **Green Hydrogen** – Leading the hydrogen-based energy revolution.
- **Advanced Solar Energy** – Redefining photovoltaic efficiency and applications.
- **Marine Energy (Tidal, Wave, Ocean Currents)** – Tapping into oceanic energy potential.
- **Innovative Bioenergy** – Driving next-generation biofuels and synthetic energy carriers.
- **Smart Energy Grids** – Enabling decentralized, intelligent energy distribution.
- **Advanced Energy Storage Technologies** – Revolutionizing grid reliability and energy accessibility.
- **Enhanced Geothermal Systems** – Expanding the use of underground thermal energy.
- **Offshore Wind Power** – Scaling up high-efficiency wind generation.
- **Carbon Capture, Utilization, and Storage (CCUS)** – Transforming industrial sustainability.
- **Next-Generation Nuclear Energy** – Advancing beyond traditional fission reactors.

3. Visionary Humans: The Architects of Exponential Transformation

At the heart of disruptive innovation are the visionary humans—the **scientists, engineers, inventors, and decision-makers** who conceive, create, and implement these transformative materials and energy systems. These are individuals who do not think in conventional, linear terms but embrace exponential, paradigm-shifting, and hyper-disruptive mindsets.

They challenge the status quo, redefine industries, and shape the trajectory of civilization, ensuring that the **Intelligent Circular Economy** remains dynamic, adaptive, and forward-looking.

The Disruptive Triangle at the Core of the Future Economy

The synergy between breakthrough materials, transformative energy systems, and visionary human intellect forms the foundation of the Intelligent Circular Economy. Each radical advancement in one domain directly influences the other two, creating a self-reinforcing cycle of exponential technological evolution.

This triangle of disruption will drive the next era of urban life, economic prosperity, and planetary sustainability, shaping a future that is both human-centric and technologically advanced.

Table 6 : Core Disruptive Energy Knowledge-Techs

AI and Predictive Analytics for Energy Production, Distribution, and Consumption
Tidal and Wave Energy Technologies
Energy-Efficient Buildings and Advanced Insulation
Electric Vehicle (EV) Infrastructure
Smart Grid and Energy Management Systems
Advanced Solar Technologies
Hydrogen Energy Technologies
Carbon Capture, Utilization, and Storage (CCUS)
Advanced Nuclear Fission Reactors
Renewable Energy Storage Solutions

7. "Meta-ConTwinSphere" Knowledge-Techs (Meta-Convergence + Meta-Digital Twins + Meta-Sphere)

"Meta-ConTwinSphere" Knowledge-Techs integrate three core concepts within the circular smart economy framework:

- **Meta-Convergence** Knowledge-Techs
- **Meta-Digital Twins** Knowledge-Techs

- **Meta-Sphere** Knowledge-Techs

The term **"Meta-ConTwinSphere"** is derived from:

- **"Meta"** from all three terms (**Meta-Convergence, Meta-Digital Twins, and Meta-Sphere**),
- **"Con"** from **Meta-Convergence**,
- **"Twin"** from **Meta-Digital Twins**,
- **"Sphere"** from **Meta-Sphere.**

This concept represents the deep interconnection, fusion, and evolution of advanced Knowledge-Techs into an inseparable, intelligent, and hyper-integrated ecosystem.

1. Meta-Convergence

Convergence is a fundamental pillar of a circular smart economy and city. Without it, circularity cannot be fully realized. Meta-Convergence ensures that all eight categories/paradises of Knowledge-Techs are so deeply interconnected that they become inseparable.

Another key aspect of Meta-Convergence is the hyper-integration of hardware, software, and human-ware, forming a seamless smart ecosystem. In a circular smart city and economy, Meta-Convergence ensures that all forms, contents, and their interactions are unified, creating adaptive and continuously evolving systems. Even divergence, when it occurs, acts as a precursor and catalyst for a higher level of convergence.

Within the circular smart economy, **Meta-Convergence** refers to the harmonization and unification of cutting-edge Knowledge-Techs, leading to innovative, sustainable, efficient, and intelligent systems that drive the evolution of the future economy.

2. Meta-Digital Twins

Meta-Digital Twins Knowledge-Techs facilitate the co-creation of tools, processes, individuals, cities, and entire economic systems, enabling the realization of the future-now.

Unlike traditional forecasting or simulation, Meta-Digital Twins allow real-time observation of future states of any component, dimension, or process. This provides unmatched precision in evaluating strengths, weaknesses, opportunities, and risks, enabling optimized decision-making and strategic improvements.

Meta-Digital Twins represent the evolution of traditional digital twins, which create virtual replicas of physical assets or systems for real-time monitoring, simulation, and optimization. By integrating semantic intelligence and advanced analytics, Meta-Digital Twins offer highly accurate simulations and predictions, significantly improving resource management, process efficiency, and economic sustainability.

3. Meta-Sphere

Meta-Sphere Knowledge-Techs, also referred to as Meta-Ecosystem Knowledge-Techs, represent the ultimate fusion of Meta-Convergence and Meta-Digital Twins into a vast, dynamic, and intelligent ecosystem.

In this paradigm, the entire Circular Smart Economy is envisioned as a Meta-Sphere, composed of interconnected **Micro-Spheres or Sub-spheres**. Each Micro-Sphere is meta-convergent, and its success is ensured through Meta-Digital Twins.

One of the key applications of Meta-Sphere Knowledge-Techs is the creation of immersive, intelligent, and interconnected virtual environments that accurately mirror and enhance real-world systems. This involves integrating Meta-Digital Twins within a cohesive metaverse, enabling collaborative decision-making, advanced simulations, and intelligent system management.

Within a Circular Smart Economy, Meta-Sphere Knowledge-Techs provide a powerful framework for designing, testing, and optimizing sustainable economic models in virtual spaces before real-world implementation.

By embracing **"Meta-ConTwinSphere" Knowledge-Techs** (Meta-Convergence, Meta-Digital

Twins, and Meta-Sphere), organizations and cities can develop next-generation intelligent solutions aligned with the principles of a Circular Smart Economy. This leads to sustainable growth, optimized resource utilization, waste reduction, and environmental preservation, ensuring a future-proof, intelligent economic ecosystem.

8. Meta-CoCreation Knowledge-Techs (Hyper-Co-Creation + IOX + Metaverse)

Meta-CoCreation Knowledge-Techs enable the formation of a **Hyper-CoCreation** ecosystem within a Circular Smart Economy. This is achieved through **IOX (Internet of X)** and **Metaverse**, fostering a synergistic environment where all stakeholders collaborate to drive innovation, sustainability, and efficiency.

1. Meta-CoCreation: The Future of Collective Innovation and Creation Future by All.

Meta-CoCreation is a transformative process of collaborative value creation, where multiple stakeholders leverage advanced technologies and methodologies to enhance innovation, efficiency, and sustainability.

These stakeholders can belong to: "A single organization (cross-departmental collaboration); A network of interconnected organizations; A broader societal ecosystem, including public and private sectors, non-profits, and policymakers".

The prefix **"Meta"** highlights the scale, diversity, and interconnectedness of participants, fostering an inclusive and highly dynamic co-creation framework.

Unlike conventional innovation models, **Meta-CoCreation** goes beyond simple collaboration; it represents the collective creation of the future, rather than just predicting or simulating it. **Hyper-CoCreation** is embedded across all dimensions, including:(**Strategy & Management; Goals & Definitions; Market & Customers; Products & Services; Real-World & Virtual Worlds (Metaverse).**

2. IOX (Internet of X) in the Circular Smart Economy

In a **Circular Smart Economy**, **IOX** plays a crucial role in facilitating seamless interactions between all participants. This involves integrating:

- **Internet of X (IOX)** – Beyond IoT, connecting people, processes, data, and things into an intelligent, adaptive, and self-optimizing ecosystem.
- **AI-Driven Decision-Making**, leveraging real-time data and predictive analytics.
- **Decentralized and Distributed Collaboration Models**, ensuring equitable participation and contribution.

These intelligent, interconnected systems empower stakeholders to co-create sustainable products and services while optimizing resource efficiency and reducing waste.

3. Metaverse-Driven Co-Creation

One of the most disruptive aspects of **Meta-CoCreation** is its integration with **Metaverse**, where stakeholders can:

- **Design, test, and iterate new economic models in virtual environments** before real-world implementation.
- **Collaborate in real-time** across geographical and institutional boundaries.
- **Leverage Digital Twins, AI, and Virtual Reality** to enhance decision-making and problem-solving.

Within a **Circular Smart Economy**, the Metaverse enables the creation of **Meta-CoCreation Labs**, where:

- Sustainable solutions are co-developed and stress-tested in digital ecosystems.
- Stakeholders dynamically interact with AI-powered economic models.
- Scalability and adaptability of innovations are ensured before physical deployment.

The Impact of Meta-CoCreation in the Circular Smart Economy

By embracing **Meta-CoCreation Knowledge-Techs**, organizations and cities can:
✓ **Enhance collaborative intelligence** through shared knowledge and distributed innovation.
✓ **Optimize resource utilization** by aligning technological and human capabilities.
✓ **Reduce waste and environmental footprint** via sustainable co-designed solutions.
✓ **Build resilient and adaptive economic models**, capable of evolving with environmental and market dynamics.

Ultimately, **Meta-CoCreation** is the engine of collective intelligence and innovation, shaping a self-sustaining, highly efficient, and future-ready Circular Smart Economy.

? Final Findings & Analysis

This research addressed three fundamental questions, and in the previous sections, we have detailed the steps leading to the answers. In this section, the final findings and analysis are discussed:

Research Questions & Answers

1. What is the nature of a Circular Cognitive-Human Smart City? What are its key characteristics, and what Knowledge-Techs (scientific and technological innovations) shape it?
2. What is the nature of a Circular Cognitive-Human Smart Economy? What are its key characteristics, and what Knowledge-Techs shape it?
3. Why is a Circular Cognitive-Human Smart System the best solution for addressing today's economic challenges in smart cities?

Nature & Characteristics of Circular Smart Cities and Economies

The nature and characteristics of circular cities and economies, extracted from this research and its literature, include the following:

1. Derived from 30 Urban Experiences and Models

Circular cities and economies are the outcome of 30 urban experiences and models throughout human history, where four key attributes—cognitive, human-centered, Smart, and circular—are uniquely and innovatively integrated.

2. Three Core Principles of Circular Smart Cities & Economies

The foundation of circular cities and economies is based on three core principles: Closing, Slowing, and Narrowing Loops— Closing loops through recycling; Slowing loops by extending the lifespan of materials and products; Narrowing loops by reducing the use of raw materials.

3. Key Circular Strategies

Circular cities and economies are built upon five core strategies:

- **Narrow (Reducing Consumption and Wear)**: Using fewer resources from the **Triad of Intelligence** (Natural-Human-Technological)—such as materials, energy, and human capital. A more precise approach would be to balance the use of these three categories of resources while achieving greater and higher-quality results with minimal consumption.
- **Slow (Extending Lifespan)**: Reducing wear and tear, increasing longevity—including extending the lifespan of humans and the environment. A new interpretation of this concept emphasizes enhancing quality at an optimal speed, rather than prioritizing speed without quality—thus ensuring a high-quality, long-lasting impact.
- **Close (Recycling and Reintegrating)**: Returning materials and products to the economic cycle, ensuring they are not lost from the circular system. A key contribution of this research is the concept of **zero waste**, where from the initial design phase of any product, waste elimination and the transformation or evolution of every component are considered and planned.
- **Regenerate (Restoration and Reproduction)**: Utilizing renewable and non-toxic resources to enable the creation of new materials and products from every element of goods and economic services.

- **Inform (KTs & "DaiFoTics" and "DIKWiC"-Driven Smartness)**: Harnessing KTs-powered systems to optimize all processes. This research introduces a threefold technology approach (communication, information, and media), alongside the "DaiFoTics" (Data-info-analytics) and "DIKWiC" (Data-Information-Knowledge-Wisdom-Crowd) as superior alternatives to traditional data, ensuring smarter, real-time adaptation in all economic processes.

4. Hyper-Ecosystem Perspective: Multi-Stakeholder, Multi-Player, Multi-layered

A Circular Smart Economy thrives on multilateral, multi-Player, multi-layered, multi-stakeholder collaboration, generating **collective value** across the entire ecosystem. This research introduces **five groundbreaking concepts** for ecosystem innovation:
֍ **8 Paradises/Categories**,
֍ **Meta-ConTwinSphere** (Meta-Convergence + Meta-Digital Twins + Meta-Sphere),
֍**Meta-CoCreation** (Hyper-Co-Creation + IOX + Metaverse),
֍**HSH-ware** (Hard-Soft-Human Ware)

֍**HABIQ** (Comprehensive Intelligence: Convergence of Human, Artificial, and Bio Quantum Intelligence).

5. Operational Framework for Circular Ecosystem

A structured framework has been developed to: " Analyze and develop Circular Innovation Ecosystems; Guide organizations in implementing circular strategies; Enhance sustainable economic growth within smart cities".

6. Circularity Deck: An Innovation Tool for Circular Ecosystems

A Circularity Deck tool has been designed for analyzing and generating innovative ideas within circular ecosystems. This tool has been evaluated in various workshops involving city managers and designers. Circularity Deck has been designed to: Generate innovative circular economy ideas; Facilitate collaborative innovation workshops; Support decision-makers, designers, and ecosystem stakeholders in co-creating sustainable solutions.

7. Principles for Successful Circular Ecosystem Innovation

Success in circular ecosystem innovation relies on: Cross-Sector Collaboration among diverse stakeholders; Experimentation with New Business Models; Shared Digital Platforms for managing data, knowledge, and AI-driven decision-making.

8. Industrial & Economic Impacts

Findings reveal that organizations (The Circular Cognitive-Human Smart Economies) adopting ecosystem-driven strategies can: Reduce environmental impact; Enhance sustainability & resilience; Develop adaptive and future-ready economic models; Leverage AI & digital twins for optimized decision-making.

Knowledge-Techs of Circular Smart Cities & Economies

According to the findings of this research, all modern **Knowledge-Techs** can be categorized into **eight domains/categories/paradises**, which are the foundation of **contemporary civilization and culture**. Since urbanization and economic structures are **built upon these Knowledge-Techs**, they represent the **best approach for diagnosing challenges and developing innovative solutions** due to their **Cognitive-Human** nature.

The Eight Domains/categories/paradises of Knowledge-Techs (KTs) in Circular Smart Cities & Economies:

1. **Human-Cognitive** Knowledge-Techs
2. **Bio/Naturified** Knowledge-Techs
3. **Intelligent** Knowledge-Techs
4. **DIKWiC-Hub** Knowledge-Techs
5. **HSH-ware** Knowledge-Techs
6. **Exponential Hyper-Disruptive (exhD)** Knowledge-Techs
7. **Meta-ConTwinSphere** Knowledge-Techs
8. **Meta-CoCreation** Knowledge-Techs

Smart Synergies of Knowledge-Techs

These Knowledge-Techs do not function in isolation but rather **interact intelligently and dynamically**, forming an **integrated Exponential Hyper-Disruptive (exhD) ecosystem**. For example, AI, IoT, Blockchain, and Digital Twins are enabling organizations, institutions, and enterprises to implement Circular Smart Cities & Economies successfully.

Additionally, this research advances the well-known **ReSOLVE** framework—originally developed by the Ellen MacArthur Foundation for Circular Economy (CE)—by enhancing it into the **iReSOLVE** Framework:

The iReSOLVE Framework

֍ **iRegenerate** (Regenerative Systems)
֍ **iShare** (Collaborative Resource Utilization)
֍ **iOptimize** (Smart Optimization via AI & Automation)
֍ **iLoop** (Circular Resource Flows)
֍ **iVirtualize** (Digital-Physical Integration via Metaverse & Digital Twins)
֍ **iExchange** (Smart Resource Exchange Mechanisms)

The **intelligent transformation** of these strategies creates a **new meaning and perspective for circularity**, where iReSOLVE is combined with the **"8 Paradises of Circular Smart Knowledge-Techs" (8P of CSKT)**. ֍֍**93.7%** of experts and specialists surveyed in this research identified this combination as the **best strategy** for achieving fully **Circular Smart Cities & Economies**.

Multi-Dimensional Circularity in This Research

The concept of **circularity** was considered in **all aspects** of Smart Cities & Economies:

☐ **Material & Natural Resource Management** (Sustainable production & consumption).
2⃣ **Design, Governance, Policy-Making, and Controle** (Holistic circular strategies).
3⃣ **Innovation & Creation of new Concepts based on Circularity** (Circular thinking & practices).
4⃣ **Urban Ecosystem Integration** (Circularity in all smart city components).
5⃣ **Thematic Structuring of Circular Knowledge-Techs** (The "8 Paradises" framework).
6⃣ **Redefining Circularity Beyond Linear Concepts:**

- Circularity is **not just a cycle** but **a dynamic process of continuous growth & evolution**.
- Each "end-point" is actually a **new starting point**, meaning **zero waste, zero carbon, and zero energy loss**—resulting in higher quality of life, economic sustainability, and environmental protection.

Merging Cognitive-Human and Smart-Circular Concepts:

- By **integrating "Cognitive-Human" aspects with "Smart-Circular**" dimensions, this model advances previous generations of Smart & Circular Cities and Economies into a new paradigm.

Practical & Research Recommendations

Based on these findings and answers to research questions, the following practical and research-oriented proposals are suggested:

Practical Recommendations for Implementing Circular Cognitive-Human Smart Cities & Economies (SCE)

☐ **Immediate Adoption of the Circular Smart Model**

- Urban and economic managers (at both city and national levels) must learn, teach, implement, and develop the circular framework proposed in this research urgently.
- With the rapid advancement of Knowledge-Techs, especially **Human-Artificial-Bio- Intelligence Quantumic (HABIQ)**, failure to act will result in significant setbacks for cities and their economies—especially for smart cities, where the gap will be much wider than in traditional cities.

2 Future City Design Based on the Cognitive-Human Circular Smart Model

- The design of future cities, their development models, and all urban components—especially the economy—should be structured around the proposed Circular Smart Cognitive-Human Model.

3 Finding a Balance Between Sustainability Goals & Circular Economy Strategies

- Urban planners and policymakers should identify a balance point between sustainability goals and Industry 4.0-driven circular economy strategies, using **hyper-ecosystemic or "Spheral"** design approaches, tailored to the local culture, historical civilization, and regional capabilities.

4 Enhancing Urban Circular Economy Through Advanced Technologies

- Stakeholders in urban development and economics should strengthen SCE practices by integrating: Collaborative platforms; Advanced recycling techniques; Big Bang Data analytics for decision-making and planning

5 Multi-Stakeholder Collaboration for Circular Industry Adoption

- Industrial stakeholders, policymakers, and researchers must work closely together to foster collaborative environments for adopting Smart Circular Economy **(SCE)** principles, advancing sustainability and resource efficiency in the production sector.

6 Five Key Actions for Cities & Municipalities to Implement and Enhance Circular Smart Economy

- **Boosting Citizen Engagement**: Creating spaces for citizens to share resources and skills.
- **Empowering Local-Circular Markets**: Establishing procurement protocols that encourage local circular economy innovation.
- **Continuous Monitoring & Evaluation**: Developing metrics and goals for waste reduction and increased recycling.
- **Smartening Urban Infrastructure**: Advancing intelligent infrastructure, communication, education, and governance.
- **Supporting National Circular Policies**: Cities can advocate and align with national and regional policies that promote circular economic transformation.

Future Research Recommendations

1. In-Depth Exploration of Cognitive-Human Smart Knowledge-Techs Dimensions

- Future studies should focus on detailed research on Cognitive-Human Smart Knowledge-Techs, tailored to specific cities and their unique economic models.

2. Investigation of Inner Dynamics & Interactions of the "Eight Paradises"

- Research should explore the internal dynamics of each domain ("Paradise") and its mutual interactions with the overall dynamics of the Eight Paradises framework.

3. Expanding Data Collection & Policy-Oriented Studies

- Future research should emphasize broader data collection, longitudinal studies, and policy frameworks to provide valuable insights and policymaking recommendations for Smart Circular Cities & Economies.

4. AI-Driven Research for Fully Automated Circular Smart Economy Studies

- New research should design end-to-end AI-powered frameworks to execute all aspects of Smart Circular Economy studies from 0 to 100 using various AI-driven methodologies.

Conclusion

This research presents a comprehensive roadmap for Circular Cognitive-Human Smart Cities & Economies (SCE), integrating Knowledge-Techs, circular economy strategies, and intelligent governance models.

By implementing the proposed practical recommendations and advancing future research directions, cities and economies can achieve sustainable, intelligent, and resilient urban futures.

References:

1. Shaqaqi Shahri, Vahid; Vahed Rasouli, Shirin (2022); "The Role of Smart Economy in the Geometry of the New World Order with Emphasis on Power and Wealth Components"; Defense Economy Journal; Winter, Vol. 7, No. 26, pp. 103–117.
2. Havas Beigi, Fatemeh; Moridian, Ali (2023); "The Basic Structure of Socio-Economic Development in the Smart City"; International Conference on Investment Opportunities; Tabriz, Iran. Available at: https://civilica.com/doc/1972454
3. Hosseini, Ali; Farhadi, Ebrahim; Joshanpour, Mohammad; Tayebi, Azam (2022); "Multidimensional Analysis of Smart City Indicators During the COVID-19 Pandemic: Case Study of Mashhad City"; Urban Planning and Environmental Development; Vol. 7, pp. 81–94.
4. Sajadian, Firoozi; Pourahmad (2022); "Exploring the Future Smart City of Ahvaz from the Perspective of Macro-Components of Formation"; Urban Foresight; Summer, Vol. 5, pp. 18–35.
5. Asayesh, Fatemeh; Mehini Zadeh, Mansour (2021); "Explaining the Endogenous Growth Model Based on the Smart City"; Urban Economy, Vol. 6(1), pp. 95–114. doi: 10.22108/ue.2023.134737.1225
6. Yalpanyan, Mohammad-Amin; Raeisi Vanani, Iman; Taghavi Fard, Mohammad Taghi (2024); "Analyzing the Impact of Digital Transformation Technologies on Business Performance Using Advanced Text Analysis Methods"; Studies in Intelligent Business Management, Vol. 9, pp. 15–34. doi: 10.22054/ims.2024.77611.2421
7. Bolger, Kathleen & Doyon, Andréanne (2019): Circular cities: exploring local government strategies to facilitate a circular economy, European Planning Studies, DOI: 10.1080/09654313.2019.1642854
8. Clark, W. W. (2018). Sustainable cities and communities design handbook: Green engineering, architecture, and technology. Oxford: Butterworth-Heinemann.
9. Downes, J. (2018, October). The planned national waste policy won't deliver a truly circular economy. The Conversation. Retrieved from https://theconversation.com/the-planned-national-waste-policy-wont-deliver-a-truly-circular-economy-103908
10. Ellen Macarthur Foundation. (2017). Cities in the circular economy: An initial exploration. Ellen Macarthur Foundation. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Cities-in-the-CE_An-Initial-Exploration.pdf
11. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – a new sustainability paradigm? Journal of Cleaner Production, 143, 757–768. doi:10.1016/j.jclepro.2016.12.048
12. Hobson, K. (2015). Closing the loop or squaring the circle? Locating generative spaces for the circular economy. Progress in Human Geography, 40(1), 88–104. doi:10.1177/0309132514566342
13. Horne, R., & Moloney, S. (2018). Urban low carbon transitions: Institution-building and prospects for interventions in social practice. European Planning Studies, 27(2), 336–354. doi:10.1080/09654313.2018.1472745
14. Kennedy, C., Cuddihy, J., & Engel-Yan, J. (2007). The changing metabolism of cities. Journal of Industrial Ecology, 11(2), 43–59. doi:10.1162/jie.2007.1107
15. Pomponi, F., & Moncaster, A. (2017). Circular economy for the built environment: A research framework. Journal of Cleaner Production, 143, 710–718. doi:10.1016/j.jclepro.2016.12.055
16. von Wirth, T., Fuenfschilling, L., Frantzeskaki, N., & Coenen, L. (2019). Impacts of urban living labs on sustainability transitions: Mechanisms and strategies for systemic change through experimentation. European Planning Studies, 27(2), 229–257. doi:10.1080/09654313.2018.1504895
17. Winans, K., Kendall, A., & Deng, H. (2017). The history and current applications of the circular economy concept. Renewable and Sustainable Energy Reviews, 68, 825–833. doi:10.1016/j.rser.
18. Blomsma, Fenna; Peroni, Marina; Kravchenko, Mariia; Pigosso, Daniela; Hildenbrand, Jutta; Kristinsdottir, Anna Rùna; Kristoffersen, Eivind; Shabazi, Sasha; Nielsen, Kjartan Due; Jönbrink, Anna-Karin; Li, Jingyue; Wiik, Carina; McAloone, Tim C. *Developing a circular strategies framework for manufacturing companies to support circular economy-oriented* innovation. Journal of Cleaner Production 2019 ;Volum 241. https://doi.org/10.1016/j.jclepro.2019.118271
19. Kristoffersen, Eivind; Blomsma, Fenna; Mikalef, Patrick; Li, Jingyue. The smart circular economy: A digital-enabled circular strategies framework for manufacturing companies. Journal of Business Research 2020 https://doi.org/10.1016/j.jbusres.2020.07.044 This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
20. Kristoffersen, Eivind; Omotola, Oluseun Aremu; Blomsma, Fenna; Mikalef, Patrick; Li, Jingyue. Exploring the Relationship Between Data Science and Circular Economy: An Enhanced CRISP-DM Process Model. Lecture Notes in Computer Science (LNCS) 2019 ;Volum 11701 LNCS. s. 177-189 https://doi.org/10.1007/978-3-030-29374-1_15
21. Kristoffersen, Eivind; Mikalef, Patrick; Blomsma, Fenna; Li, Jingyue. Towards a business analytics capability for the circular economy. Technological Forecasting and Social Change 2021 https://doi.org/10.1016/j.techfore.2021.120957 This is an open access article under the CC BY license (CC BY 4.0)
22. Kristoffersen, Eivind; Mikalef, Patrick; Blomsma, Fenna; Li, Jingyue. The effects of business analytics capability on circular economy implementation, resource orchestration capability, and firm performance.

International Journal of Production Economics 2021 ;Volum 239. s. 1-19 https://doi.org/10.1016/j.ijpe.2021.108205 This is an open access article under the CC BY license (CC BY 4.0).

23. Ellen MacArthur Foundation (2013). *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition.*
24. Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). *A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems.* Journal of Cleaner Production.
25. Lopes de Sousa Jabbour, A. B., et al. (2019). *Unlocking the circular economy through IoT: A new approach for smart waste management.* Resources, Conservation and Recycling.
26. Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). *Blockchain technology and its relationships to sustainable supply chain management.* International Journal of Production Research.
27. Gao, J., et al. (2021). *Artificial intelligence in achieving sustainable circular economy: Insights and future directions.* Journal of Cleaner Production.

HOW TO CITE THIS ARTICLE:

Zarei,N , Abtahi,A, Vafaee,F, Cognitive-Human Circular Smart Economy in Cognitive-Human Circular Smart Cities (CHCSE and CHCSC), International Journal of Finance, Accounting and Economics Studies, 6(2): 121-159.

Journal homepage: https://sanad.iau.ir/jou