

Article

Creativity and Innovation in Civic Spaces Supported by Cognitive Flexibility When Learning with AI Chatbots in Smart Cities

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Abstract: The purpose of this study is to advance conceptual understandings of the cognitive flexibility construct, in support of creativity and innovation in smart city civic spaces, employing the use of large language model artificial intelligence chatbots such as ChatGPT. Based on a review of the research and practice literature, this study formulates a conceptual framework for cognitive flexibility in support of creativity and innovation in AI environments, adaptable to smart cities. A research design is used that employs AI as a design material, in combination with a topical inquiry involving boundary setting and perspective taking, to co-pilot an exploration with ChatGPT-3.5/4. This study operationalizes the framework for applications to learning approaches, addressing flexibility and inclusivity in smart city spaces and regions. With the rapid evolving of chatbot technologies, ChatGPT-4 is used in the exploration of a speculative real-world urban example. This work is significant in that AI chatbots are explored for application in urban spaces involving creative ideation, iteration, engagement, and cognitive flexibility; future directions for exploration are identified pertaining to ethical and civil discourse in smart cities and learning cities, as well as the notion that AI chatbots and GPTs (generative pre-trained transformers) may become a zeitgeist for understanding and learning in smart cities.

Keywords: AI chatbots; creative AI; creativity; innovation; large language models; learning cities; new educational habits; new technologies and developments; smart cities; urban agenda



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1. Introduction and Background

According to the Project for Public Spaces (PPS) (2009) [1], a great civic space is “an extension of the community” that serves “as a stage for our public lives” providing “the settings” for celebrations, social and economic exchanges, encounters with friends, the mixing of cultures, and interactions with each other and local officials. The PPS speaks in terms of “placemaking”, with the invitation to “imagine a world where everyone has the opportunity to shape public spaces” (PPS, n.d) [2]. This study explores whether and how AI chatbot technologies might assist us in the shaping of smart cities and regions. Geirbo, Harboe, Hoelscher, and Petersen (2022) [3] explore urban design in relation to the elements of flexibility and inclusion, where the notion of “interpretive flexibility” is advanced as “an approach to designing inclusive urban space”. Clément (2022) [4] claims that “a broad consensus is emerging on the flexible nature of human cognition to adapt to novelty and unexpected events”. As such, cognitive flexibility is said to be key to learning, as in, enabling “us to adapt to a constantly changing environment” in order “to discover solutions in new and/or unexpected situations, and to transfer knowledge learned in one context to a new context” (Clément, 2022) [4], among other examples. The notion of a “learning city” has been identified as a fundamental component of the smart city in relation to human factors and support for learning and education

(Nam and Pardo, 2011) [5]. Acknowledging the progress being made pertaining to “artificial intelligence (AI) creativity”, Amabile (2019) [6] calls for “organizational researchers of creativity and innovation” to “invest significant energy in studying AI and computer-assisted human intelligence” in support of the potential for “creative breakthroughs”, and as such, large language model (LLM) AI chatbots would seem to provide promising design opportunities for explorations in smart cities and regions. Boudry (2019) [7] points to the beliefs and assumptions that human intelligence is seemingly finite, if not static, as AI is rapidly advancing. And yet, it could be argued that human intelligence is fundamentally expansive and dynamic, where the “tool making species”, *Homo Sapiens*, creates “a range of cognitive tools” (Boudry, 2019) [7], such as LLM AI chatbots. With AI chatbot tools, the interaction between human creativity and creative AI opens the way for another level of human intelligence and creativity, which is what the current study explores in terms of an iterative “conversation” that enables the expansive and dynamic to happen in urban spaces. Batty (2023) [8] argues that, to move forward, the new kind of searching enabled by AI chatbot tools such as ChatGPT will need to be combined with human “knowledge and intuitions”, embodied perhaps in the emerging area of prompt engineering (Oppenlaender, Linder, and Silvennoinen, 2023) [9] and our interactions with AI chatbots as co-pilots (Hendriksen, 2023) [10]. It is worth noting that Burry (2022) [11] calls for a new research agenda for urban design and planning in light of the prevalence of AI, where the notion of “consultation” as a way of involving people is no longer sufficient, and instead, “active participation” is urged, keeping people “in-the-loop” (Streitz, 2018) [12] in support of responsible, safe, and trustworthy AI for good (Shneiderman, 2022) [13]. Concerned with explainable AI (XAI) in the community, Kou and Gui (2020) [14] “theorize how explanation is situated in a community’s shared values, norms, knowledge, and practices, and how situated explanation mediates community-AI interaction” which they explore through an AI-led moderation case study. Sharma (2021) [15] introduces an AI planning method in support of sustainable smart cities for the making of collaborative decisions involving Internet of Things (IoT) devices, “processing the real-time data” generated by such devices when applied to the “adaptive traffic signal” use case. Bokhari and Myeong (2022) [16] introduce a social innovation (SI) perspective to their exploration of AI in smart cities for smart decision making (SDM). Bokhari and Myeong (2023) [17] then explore the impact of AI applications on “smart decision-making” in the context of mediating factors such as the Internet of Things (IoT) and smart governance in smart cities. Chignell, Wang, Zare, and Li (2023) [18] consider the notion of “human augmentation as an alternative to user friendliness” and whether human-computer interaction (HCI) and human factors might inform approaches to addressing concerns with “trust and situation awareness” and associated challenges with human-AI technology interactions. Wang, Lu, and Fu (2023) [19] undertake an exploration of the application of AI to urban planning using generative and ChatGPT-like AI, focusing on “land uses and building configuration for a target area from surrounding geospatial, human mobility, social media, environment, and economic activities” while considering the implications. As such, interactions with chatbots such as ChatGPT are advanced in this study as an approach to exploring the following research question:

Could LLM AI chatbots enable cognitive flexibility in support of creativity and innovation in civic AI-rich smart city environments and, if yes, how?

The objectives of this study are to explore the use of large language model AI chatbots enabling cognitive flexibility in relation to civic spaces in smart cities and regions; formulate a conceptual framework in support of creativity and innovation in civic AI-rich spaces in smart cities and regions; and operationalize the conceptual framework through an exploration of attributes such as flexibility and inclusivity. This work identifies opportunities for further study going forward, and among the contributions of this study are the extension of current knowledge through a review of the research literature; the development of a conceptual framework for cognitive flexibility in support of creativity and innovation in

AI environments; and the demonstrated adaptability of this framework for application to smart cities, learning cities, and smart environments and regions, more broadly.

Definitions

Definitions for key terms used in this work are provided below based on the research and practice literature.

AI Chatbots: a chatbot is described as “a computer program that uses an LLM to simulate conversation with human users, typically through typed text in a software application” (Stanford University, 2023) [20] while AI (artificial intelligence) is described as “the capacity of computers or other machines to exhibit or simulate intelligent behavior”.

AI Creativity: Amabile (2019) [6] defines AI creativity as “the production of highly novel, yet appropriate, ideas, problem solutions, or other outputs by autonomous machines”.

Cognitive Flexibility: citing the work of Scott (1962) [21], cognitive flexibility is defined by Dajani and Uddin (2015) [22] as “the ability to appropriately adjust one’s behavior according to a changing environment”.

LLM (Large Language Model): A large language model (LLM) is described as “a complex model trained on vast amounts of data that generates language that resembles human-generated language” (Stanford University) [20]. Examples of such models include GPT, PaLM, Jurassic, and Claude, to name a few.

Smart Cities: Yan, Jiang, Huang, Zhang, and Zhou (2023) [23] describe a smart city as one that “harnesses the power of artificial intelligence (AI) to revolutionize urban living” with a “shift toward more efficient service models and an elevated standard of living for its inhabitants” while being attentive to “ethical, regulatory, and societal implications”.

Urban AI: according to Luusua, Ylipulli, Foth, and Aurigi (2023) [24], urban AI refers to the integrating of artificial intelligence (AI) technologies into urban areas.

What follows is the development of a theoretical perspective involving a review of the research and practice literature for LLM AI chatbots, creativity and innovation, and cognitive flexibility, all in relation to civic spaces in smart cities and regions, followed by a summary and synthesis. A conceptual framework in support of creativity and innovation in AI-rich environments is then presented, followed by a description of the methodology, where AI as a design material, combined with topical inquiry and perspective taking and boundary setting, are described as an approach to operationalizing the framework for application in civic AI spaces in smart cities and regions. Findings from chatbot interactions are presented, followed by a discussion and the identification of future directions. Limitations and mitigations are then presented, followed by concluding comments.

2. Theoretical Perspective

This study provides an exploration of LLM AI chatbots and cognitive flexibility from the perspective of creativity and innovation in civic spaces in smart cities and regions. A review of the research literature is provided for LLM AI chatbots, creativity and innovation, and cognitive flexibility generally, all in relation to civic spaces in smart cities and regions, enabling the formulation of a conceptual framework for cognitive flexibility in support of creativity and innovation in AI-rich environments.

2.1. LLM AI Chatbots and Civic Spaces in Smart Cities and Regions

Miaillhe, Jain, Jeanmaire, Lannquist, and Png (2018) [25] describe the work of The Future Society in undertaking a global civic debate to “discuss the multi-layered aspects of AI and its governance” in learning about “the impact of AI” and “how it reverberates around the world” with a view to synthesizing the insights that emerged and developing “recommendations for policymakers to shape a positive future for the role of AI”. LLM AI chatbots such as ChatGPT (Chat Generative Pre-trained Transformer) by OpenAI (2023) [26] offer compelling conversational interactions, although limitations are acknowledged. Brandusescu and Reia (2022) [27] provide an overview of a symposium on AI in the city, focusing on civic engagement and public trust that “brings governance and policy conversations to the

local context” along with “hopes to shape the future of technology in urban areas”. While Markauskaite et al. (2022) [28] claim that the challenge of “[r]eimaging what it means to live, learn, and work in partnership with AI is awe-inspiring”, they also acknowledge that it “brings profound responsibilities”. It is worth noting that the AI Objectives Institute (AOI, 2023) [29], concerned with human flourishing and safe AI, is undertaking initiatives such as “Talk to the city” in the form of “a new LLM survey tool to improve collective discourse and decision-making” involving “analyzing detailed qualitative responses to a question instead of limited quantitative data”, which would seem to be a way of keeping people “in-the-loop” (Streitz, 2018) [12]. Introducing a series of papers on urban artificial intelligence (AI), Batty (2023) [30] identifies “strong AI”, as in, the simulation of human-like “problem-solving”, including logic and intuitions, on the one hand, and “weak AI” as in, “searching for coherent patterns in the data that provide it with structure” and predictability potential, on the other hand, where most urban AI initiatives are said to be in the “weak AI” category.

Hendriksen (2023) [10] provides a practical guide to the use of chatbots such as ChatGPT and Bing for students, teachers, and researchers designed to “make AI your research co-pilot and creative partner”, where prompts and instructions play a key role. Oppenlaender et al. (2023) [9] conducted an exploratory study into the “novel creative skill” involved with “prompting AI art” where prompt engineering is described as “the practice of iteratively crafting prompts to generate and improve images”. Prompt engineering, according to the findings of Oppenlaender et al. (2023) [9], “is a learned skill that requires expertise and practice” with speculations on the future of prompt engineering in the form of four scenarios—expert skill, everyday skill, obsolete skill, or curation skill. Also of note is that Yokosuka is the first city in Japan to engage with the use of ChatGPT in the form of “a one-month trial in efforts to improve operations” (Exum, 2023) [31]. The Yokosuka initiative involves 4000 municipal employees with “the aim to . . . free up human resources for things that can only be done in a person-to-person format”, reduce workloads, and “assist in tasks like summarization, copy ideation for marketing and communications, drafting the basis for administrative documents—and perfecting easy-to-understand language” while being attentive to security concerns [31]. Indeed, Pastis (2023) [32] claims, among other things, that “our cultural *zeitgeist* is A.I”, where *zeitgeist* is defined as “the general intellectual, moral, and cultural climate of an era” (Merriam-Webster, 2023) [33]. It is worth noting that a report on events such as London Tech Week (Barber, 2023) [34] refers to generative AI as having captured the *zeitgeist*. Lehtiö, Hartikainen, Ala-Luopa, Olsson, and Väänänen (2023) [35] provide guidance on the importance of understanding the perceptions of citizens pertaining to urban AI with implications for the design of such applications going forward in smart cities and future cities. Cugurullo, Caprotti, Cook, Karvonen, McGuirk, and Marvin (2023) [36] provide a critical commentary on urbanism influenced by AI, as in, AI urbanism as distinct from the theory and practice of smart urbanism in smart cities.

In summary, Table 1 provides an overview of perspectives from the literature review on LLM AI chatbots, generally and in relation to civic spaces in smart cities and regions, by author and year for the time period of 2018 to 2023.

What emerges from this review is a focus on the local and global; policy and governance; civic engagement and trust; initiatives such as “talk to the city” involving the voices of people in support of improving collective discourse and decision making; the responsibilities associated with reimagining how we live, learn, and work in relation to AI; citizen perception; creativity and collaboration; *zeitgeist*; and the testing of chatbot tools such as ChatGPT in a Japanese city (Yokosuka) to explore the potential for improving city operations. Indeed, the Japan Times (2023) [37] reports that ChatGPT was adopted based on findings from the trial while acknowledging limitations. As such, “the city will seek experts’ advice and hold case competitions on how to create effective prompts for the chatbot to get precise responses” (Japan Times, 2023) [37].

Table 1. Perspectives on LLM AI chatbots in civic spaces in smart cities and regions.

Authors	Year	Perspectives: LLM AI Chatbots in Civic Spaces
Miailhe et al. [25]	2018	Global civic debates, multi-layer, AI policy and governance
Brandusescu and Reia [27]	2022	AI and civic engagement and public trust; local governance and policy-shaping tech
Markauskaite et al. [28]	2022	Responsibility, reimagine how to live, learn and work in relation to AI
AOI [29]	2023	AI future—human flourishing, safe AI—talk to the city survey (improve collective discourse and decision making)
Exum [31]	2023	One-month trial of ChatGPT to improve city operations (Japan)
Cugurullo et al. [36]	2023	AI urbanism as distinct from smart urbanism
Hendriksen [10]	2023	Chatbots for education as a co-pilot and creative partner
Lehtiö et al. [35]	2023	Citizen perception and human-centered AI
OpenAI [26]	2023	ChatGPT conversational interactions; limitations acknowledged
Oppenlaender et al. [9]	2023	Prompting AI art—exploration of the novel creative skill of prompt engineering
Pastis [32]	2023	Zeitgeist

2.2. Creativity and Innovation and Civic Spaces in Smart Cities and Regions

McKenna (2018) [38] conducted an exploration of creativity and serendipity in smart cities in relation to aware people and aware technologies involving the notion of ambient urbanizing. The exploration (McKenna, 2018) [38] focused on people and their ways of adapting to, interacting with, and utilizing embedded and pervasive technologies for everyday activities in civic spaces and regions. Researchers have been concerned with keeping people “in-the loop” (Streitz, 2018) [11] of smart and aware technologies (McKenna, 2019) [39] in urban contexts and regions. Amabile (2019) [6] also encourages explorations into how resulting “creative breakthroughs” could “impact—and be impacted by—workers, consumers, organizations, and society”. Park, Niu, Cheng, and Allen (2021) [40] point to the evolving nature of the definition of creativity over time from divergent thinking, to “a person’s ability to generate an idea or product that is deemed as both novel and appropriate by experts in a field of human activity”, citing the works of researchers such as Amabile (1996) [41] and Csikszentmihalyi (1999) [42], among others. More recently, definitions of creativity include the importance of the environment (Amabile, 2013) [43], and, citing the work of Corazza and Lubart (2021) [44], Park et al. (2021) [40] describe creativity as a “context-embedded phenomenon that is tightly related to the cultural and social environment”. According to Park et al. (2021) [40], another 21st century skill, said to be essential, citing the work of the National Education Association (2012) [45], is that of critical thinking, which has similarly evolved over time. From the perspective of psychology, Park et al. (2021) [40] describe critical thinking as “often defined in tandem with scientific thinking, which places significance on hypothesis-testing and problem-solving in order to reduce bias and erroneous beliefs”, citing the work of researchers such as Halpern (1984) [46], Lamont (2020) [47], and others. Accordingly, Park et al. (2021) [40] claim that “measures of critical thinking should assess cognitive skills”, including evaluation and logical reasoning, as well as “the ability to use scientific methods for problem-solving”. Mohan and Shrivastava (2023) [48] address generative AI as aggregative, derivative, and creative in relation to human creativity.

Clément (2022) [4] explores links between flexibility, creativity, and academic performance, while Harrison, Rouse, Fisher, and Amabile (2022) [49] remind us of the potential for machine learning and AI to be “drivers of creativity” (Amabile, 2019) [6] and also to “induce the attributes of creative products in new ways”. Creativity is identified by Markauskaite et al. (2022) [28] as being among a number of competencies required in the 21st century, and in a world of AI, and using a dialogical knowledge-making approach, fostering human creativity is one of several capabilities explored. Han, Park, Shi, Chen, and Childs (2019) [50] explore combinatorial creativity from a design perspective in terms of three approaches, namely the problem-driven approach, the common-driven approach, and the inspiration-driven approach, in seeking to improve “comprehension of human creativity in design”. Han et al. (2019) [50] draw on the work of Boden (2004) [51], who describes three approaches to creativity as exploratory, transformational, and combinational, where combinational creativity is said to be “achieved through associating ideas which were previously indirectly linked”. However, in digital environments, Decker and Hauswirth (2008) [52] point to the importance of networked knowledge through “exploiting semantics” and “bridging the gap” between the virtual and physical worlds, forming an “integrated information space” in support of “collective problem solving”. Such integrated information spaces are said to give way to “creating solutions to problems that were previously thought insolvable” while “enabling innovation and increased productivity on individual, organisational and global levels”. The notion of insolvable problems is reminiscent of the wicked problems described by Okwechime, Duncan, Edgar, Magnaghi, and Veglianti (2021) [53] as characteristic of the complex challenges in smart cities. Thomas and Tee (2022) [54] provide a systematic review of the generativity concept from an information management perspective, claiming that it “facilitates combinatorial innovation”. Frosio (2023) [55] addresses the notion of “artificial creatives” in relation to the emergence of “combinatorial creativity” in AI “from Dall-E to GPT-3” and “the impact of generative AI on artists and creatives” on the one hand and “the provision of incentives to protect AI-generated creativity” on the other hand.

Regarding innovation, Amabile and Pratt (2016) [56] define the concept as “the successful implementation of creative ideas within an organization”. Indeed, Amabile and Pratt (2016) [56] “view creativity and innovation as different parts of essentially the same process, when innovation is understood as organic (arising from activities within the organization) and not as externally-acquired innovative products or services (arising from mergers and acquisitions)”, and creativity is “the production of novel and useful ideas by an individual or small group of individuals working together”. Amabile and Pratt (2016) [56] describe two key features of the definitions provided as (a) “subjective constructs” and (b) “value-free”, whereby “a creative idea may be useful for attaining either an evil aim or a morally good aim, and a fully implemented innovation could do harm or good or both”. As such, to ensure “constructive outcomes”, the need for “social consensus” arises and upon being “successfully implemented”; innovations “must be linked to a socially positive system of values, morals, and ethics” (Amabile and Pratt, 2016) [56]. Bringing the creativity and innovation model more up to date, Amabile and Pratt (2016) [56] identify several revisions, introducing a more dynamic approach “comprising cycles of creativity (and innovation)”; the inclusion of the notion of the “progress principle” involving “meaningful work in the creative process”; the emotional dimension of creativity, contributing “an affective element to the existing attitudinal, cognitive, and behavioral elements of the model”; and lastly, “the potential role of extrinsic motivation”. In an interview (Simonton and Lebuda, 2019) [57], Simonton comments that creators “will often encounter obstacles along the way to solving some problem” contributing to an “incubation period” and “a fine time for diversion”. Such diversion may involve “switching to another problem” or “having the cognitive flexibility not to persist when persistence doesn’t pay, that’s the key”, and as such, “creative productivity is associated with engagement in multiple projects” (Simonton, 2004) [58], and indeed, “even a simple walk in the park can stimulate creativity”. Also important to smart city explorations in this study is the theory advanced by

Simonton (2004) [58] of an interplay between chance, logic, genius, and zeitgeist as the source of creative breakthroughs in scientific exploration. It is worth noting that Yogesh et al. (2023) [59] employ the use of ChatGPT to provide insight into the use of the diffusion of innovation theory in terms of the acceptance and adoption of AI technologies such as AI chatbots. While ease of access to unstructured and re-structured questions emerge, responses give rise to ways of informing creative output feasibly, assuming that LLM AI chatbot accuracy improves, and this may relate to work pertaining to the notion of “frictionless learning” (McKenna and Chauncey, 2014) [60] in smart cities and learning cities on the one hand and productive struggle (Sriram, 2020 [61]; Maslyk, 2019 [62]; Markman, 2015 [63]) on the other, or indeed, such ease in retrieving answers to questions could impede deep thinking and the networking associated with creative thinking (Beaty, 2018) [64].

Bibri, Alexandre, Sharifi, and Krogstie (2023) [65] provide a literature review of environmentally sustainable smart cities, revealing innovative solutions associated with converging AI, IoT (Internet of Things), and big data technologies. Luusua et al. (2023) [24] speak in terms of urban AI, providing an interdisciplinary perspective on the evolving role of AI in smart cities, in relation to urban contexts such as built environments, infrastructures, places, and people and their practices in support of “more inclusive, creative, and ethical AI futures”. Gaio and Cugurullo (2023) [66] address mobility in urban spaces and the potential for AI to respond to challenges such as those associated with cyclists and autonomous vehicles. Van Beek, Giaccardi, Boess, and Bozzon (2023) [67] engage creatively and innovatively with everyday life “in the more-than-human home” using a co-performance lens to explore ways of responding to the challenges, conflicts, and crises that occur.

In summary, Table 2 provides an overview of perspectives by author and year of the research literature on creativity and innovation generally and in relation to civic spaces in smart cities and regions, for the time period of 2004 to 2023.

Table 2. Perspectives on creativity and innovation in civic spaces and smart cities and regions.

Authors	Year	Perspectives: Creativity and Innovation in Civic Spaces
Boden [51]	2004	Exploratory, transformational and combinatorial creativity
Simonton [58]	2004	Diversion (e.g., walk in the park to stimulate creativity)
Decker and Hauswirth [52]	2008	Collaborative access to networked knowledge—problem solving
Amabile and Pratt [56]	2016	Innovation as successful implementation of creative ideas
Amabile [43]	2013	Importance of the environment
McKenna and Chauncey [60]	2014	Frictionless learning in smart cities and learning cities
Amabile and Pratt [56]	2016	Socially positive; dynamic, progress principle, and affective elements
Beaty [64]	2018	Deep thinking and the networking associated with creative thinking
McKenna [38]	2018	Creativity and serendipity in technology-pervasive urban spaces
Amabile [6]	2019	AI creativity—novel yet appropriate ideas, problem solutions
Han et al. [50]	2019	Combinatorial creativity in design; problem, inspiration-driven
Simonton and Lebudá [57]	2019	Incubation period
Corazza and Lubart [44]	2021	Creativity as context-embedded, related to the cultural and social

Table 2. Cont.

Authors	Year	Perspectives: Creativity and Innovation in Civic Spaces
Park et al. [40]	2021	Evolving definition of creativity; critical thinking, problem solving
Clément [4]	2022	Creativity as a competency in a world of AI; flexibility
Harrison et al. [49]	2022	Potential for ML and AI as drivers of creativity
Thomas and Tee [54]	2022	Generativity and combinatorial innovation
Bibri et al. [65]	2023	Environmentally sustainable smart cities
Frosio [55]	2023	Artificial creatives, combinatorial creativity, and generative AI
Gaio and Cugurullo [66]	2023	Mobile spaces—application of AI to cyclists and AV challenges
Mohan and Shrivastava [48]	2023	Generative AI as aggregative, derivative, and creative and human creativity
Luusua et al. [24]	2023	Urban AI and inclusive, creative, and ethical AI futures
Yogesh et al. [59]	2023	Diffusion of innovation theory, acceptance/adoption of AI chatbots

What emerges from this review about creativity and innovation in civic spaces is a focus on the evolving combinations; collaborations; the environment and context, including the cultural and social; critical thinking, flexibility, networked knowledge, and problem solving; diversion, emotion, the frictionless, and incubation time; ML and AI as possible drivers of creativity; generativity and combinatorial innovation; generative AI creativity; environmentally sustainable smart cities; artificial creatives; applications of AI to cyclist and autonomous vehicle challenges; the evolving role of AI in smart cities for inclusive, creative, and ethical AI futures; creative and innovative engagement with the more-than-human home; and successful implementation.

2.3. Cognitive Flexibility and Civic Spaces in Smart Cities and Regions

Wu and Koutstaal (2020) [68] argue that while “creativity is pivotal to solving complex problems”, exploration is needed into “how cognitive flexibility dynamically supports creative processes”. To this end, Wu and Koutstaal (2020) [68] advance “a new operationalization of cognitive flexibility” in the form of “process-based Self-Guided Transition (SFT) measures”. Ardeshiri, Esteghlal, and Etesam (2017) [69] describe the flexibility concept and its realization in urban spaces in relation to permeability, adaptability, and legibility involving activities, places, and people where spaces may feature multimodal or multiuse elements, to name a few, and where context classifications include versatility, convertibility, and expansibility. Landman (2020) [70] argues that in order to achieve the elusive notion of inclusive public spaces given the many, varied, and seemingly intractable challenges, “urban designers need to rethink practices of mitigation, adaptation and transformation of public space, both in terms of process and product”. Rethinking such practices contributes to the making of connections, whether tangible (e.g., street furniture, cycle paths, etc.) or intangible (e.g., “imaginary paths, nodes of convergence and collective memories”), as reconnection (Landman, 2020) [70]. Geirbo et al. (2022) [3] describe the generativity of interpretive flexibility as “the capacity to inspire practices, attract users, or set in motion processes that were not an expected or intended outcome of a design”, serving to create many connections.

Maintenant and Bodi (2022) [71] address cognitive flexibility in everyday life, as in, “when we need to adapt to a new route to get to work in the event of traffic works taking place on our usual route”. In considering the capabilities required for learning in “a world with AI”, Markauskaite et al. (2022) [28] advance “a need to move beyond AI-centered views of capabilities” and think more broadly to “consider the ecology of technology,

cognition, social interactions, and values". Preiss (2022) [72] claims that "managing the interaction between metacognition and mind wandering is the main role of cognitive flexibility in creativity". The definition of metacognition by Kaufman and Beghetto (2013) [73] as self-knowledge (Kaufman, Beghetto, and Watson, 2016) [74] and contextual knowledge is complemented, according to Preiss (2022) [72], by "adding to the metacognitive processes" associated with these categories of knowledge, "the generative and exploratory stages of creativity". In the context of infrastructures for future smart cities, Menon, Khosravi, Jolfaei, Kumar, and Vinod (2022) [75] address the notion of the "cognitive city", said to be "one that learns and adapts its behaviour based on the past experiences and can sense, understand and respond to changes of a smart environment with human and robotic elements". As such, Menon et al. (2022) [75] point to the need for flexible approaches to accommodate the processing of large volumes of data where the implementation of urban projects must be attentive to context, technologies, and digital design principles encompassing people, inclusivity, and flexibility, among many other considerations.

It is also worth noting that adaptability, a key component of cognitive flexibility, emerges in the study of the creative skill of prompt engineering in AI art by Oppenlaender et al. (2023) [9]. In Section 2.2, Amabile (2019) [6] refers to AI creativity and the "outputs of autonomous machines" as innovations or "creative breakthroughs". Berkeley and Berlin (2023) [76] employ the notion of pseudocognition in the context of a world with AI that is said to "think better and act quicker than humans and their institutions". However, Berkeley and Berlin (2023) [76] point to the need for caution when considering that "the idea that there are reasons why people do things of which they are not conscious is part of the world's mental furniture". This is because "the unconscious is probably not a great model for whatever it is that provides LLMs with an apparent sense of meaning or an approximation of agency" (Berkeley and Berlin, 2023) [76]. And yet, Berkeley and Berlin (2023) [76] argue that "the sense that there might be something below the AI surface which needs understanding may prove powerful". Kagan (2023) [77] directs attention to the notion of spaces of possibilities (SoPs) in urban environments and a broadening of the view to include cities as SoPs while addressing sustainability challenges. Such challenges are said to necessitate "innovative solutions" that "will only succeed through creative impulses, experiments, trying out innovative ideas, and making alternatives visible (Kagan, 2023) [77] in the face of emergence, unpredictability, and uncertainty. Chen et al. (2023) [78] consider the challenges and opportunities associated with "geographical (physical) space" and "cyberspace" from the perspective of "data analytics and visualization, including extended AI capabilities and virtual reality representations", noting the potential "to improve sustainability and solve complex problems with geospatial applications (e.g., GeoAI, GeoVA (geovisual analytics))". While AI may be important to the development of smart cities, Rjab, Mellouli, and Corbett (2023) [79] provide a systematic review of the literature on the barriers to adoption in terms of a "novel mapping" pertaining to technology, environment, and organization followed by the development of a research agenda for moving forward. Yan et al. (2023) [23] highlight the "interconnectedness of technological progress and urban development", where "a concerted effort to cultivate AI capabilities can propel cities into a future marked by sustainable growth, resilience, and innovation".

In summary, Table 3 provides an overview of perspectives by author and year of the research literature on cognitive flexibility, generally and in relation to civic spaces in smart cities and regions, for the time period of 2017 to 2023.

What emerges from this review of cognitive flexibility in smart cities is the focus on flexibility in relation to permeability, adaptability, and legibility in the contexts of versatility, convertibility, and expansibility; inclusive public spaces requiring a rethinking of practices as reconnection; creative processes; the generativity of interpretive flexibility contributing to many connections; adaptations to everyday life; the movement from AI centrality to thinking in terms of an ecology of technology, cognition, social interactions, and values; cognitive cities; spaces of possibilities (SoPs) in a challenging world; the

adaptability afforded by the creative skill of prompt engineering; AI and data analytics and visualization (geophysical space and cyberspace); barriers to AI adoption in smart cities; and technological progress and urban development involving AI capabilities.

Table 3. Perspectives on cognitive flexibility in civic spaces in smart cities and regions.

Authors	Year	Perspectives: Cognitive Flexibility in Civic Spaces in SCs
Ardeshiri et al. [69]	2017	Flexibility; permeability, adaptability, and legibility; versatility, convertibility, and expansibility
Amabile [6]	2019	AI creativity as creative breakthroughs
Landman [70]	2020	Inclusive public spaces—rethink practices of mitigation, adaptation, and transformation as reconnection
Wu and Koutstaal [68]	2020	Cognitive flexibility and creative processes
Geirbo et al. [3]	2022	Generativity of interpretive flexibility creating many connections
Maintenant and Bodi [71]	2022	Adaptations in everyday life (e.g., rerouting of traffic)
Markauskaite et al. [28]	2022	Ecology of technology, cognition, social interactions, and values
Menon et al. [75]	2022	Cognitive city
Preiss [72]	2022	Generative and exploratory stages of creativity
Berkeley and Berlin [76]	2023	Pseudocognition in the context of a world with AI
Kagan [77]	2023	Spaces of possibilities and sustainability amid uncertainties
Oppenlaender et al. [9]	2023	Adaptability—creative skill of prompt engineering in AI art
Chen et al. [78]	2023	Geophysical space and cyberspace, AI data analytics, and visualization
Rjab et al. [79]	2023	Barriers to adoption of AI in smart cities
Yan et al. [23]	2023	Technological progress and urban development with AI capabilities

2.4. Synthesis of the Literature Review

The focus of our literature review points to the following essential areas for consideration in the development of the effective use of AI in urban spaces in smart cities. Creativity and the potential for innovation in urban spaces are shaped by our ability to think critically, solve problems, and work collaboratively. Creating urban spaces that are welcoming and open to diverse points of view that are valued and shared through varied supportive networks has the potential to support creativity in designing flexible, innovative urban spaces. Such spaces should be easy to navigate (permeable), allow for varied venues and needs (adaptable), and support the flow of information, enabling flexible, critical thinking (metacognition). Partnering with AI can support research efforts that require creativity, cognitive flexibility, and openness to bringing varied constituents or stakeholders into problem solving, planning, and civic debate. It is critical that AI policies allow for innovation while ensuring that these new technologies are foundationally ethical, secure, free from bias, and trustworthy—the essence of supporting cognitive flexibility in information seeking and decision making.

Figure 1 illustrates the triangulation of these essential areas of consideration and the synergies between them.

Triangulating what emerged from the literature review on LLM AI chatbots, creativity and innovation, and cognitive flexibility in civic spaces and smart cities and regions, the notion of flexibility is highly evident, as are adaptability, collaboration, and inclusion. The importance of making connections is highlighted along with cognitive flexibility for keeping us open to ideas in exploring how AI, as our co-pilot (Hendriksen, 2023) [10], may help us to gather diverse ideas, engage in idea generation, and begin to see new interconnections and possibilities in support of creativity and innovation. The creative skill

of prompt engineering is emphasized and noted as a key area requiring development in the case of the Japanese city of Yokosuka where ChatGPT was trialed and is now adopted for use. In relation to the research question, we begin to understand that LLM AI chatbots could enable cognitive flexibility in support of creativity and innovation, and the city of Yokosuka may begin to show how. As such, this review of the literature contributes to the formulation of the conceptual framework developed in Section 2.5, guiding the exploration in this study.

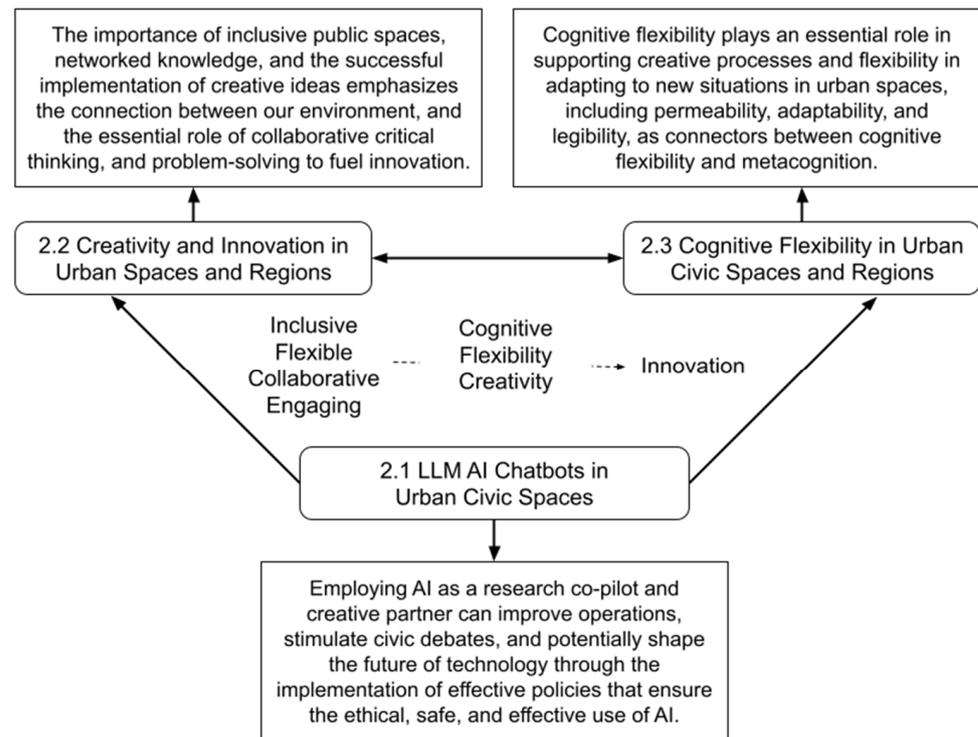


Figure 1. Triangulation of the literature review.

2.5. Conceptual Framework for Cognitive Flexibility in Support of Creativity and Innovation

The conceptual framework for cognitive flexibility in support of creativity and innovation formulated in this study, based on the literature review, is shown in Figure 2 and begins with the identification of a *problem space* for exploration in step 1. The framework consists of eight steps: problem space exploration, prompt design, boundary setting and perspective taking, response evaluation, and creative ideation, including idea evaluation, leading to innovative application, with iteration enabled between some steps in support of cognitive flexibility.

Engaging with chatbot technology as a co-pilot to assist with the exploration and use of prompt engineering (Oppenlaender et al., 2023) [9] is used in step 2, where *prompt design* involves the iterative development of questions based on the chatbot responses received and the discerning of the quality and value of the information provided. Prompt design may require revisiting the problem space and refining the exploration and the resulting prompts. A further layer of questioning is developed in step 3 for *boundary setting*, step 4 for *perspective taking*, and step 5 for the combination of *perspective taking* and *boundary setting*. Step 6 involves *response evaluation*, leading to step 7, *creative ideation* and/or *cognitive flexibility*, and a return to the problem space exploration. Step 7, creative ideation, may also lead to *idea evaluation* and/or to Step 8 and iterative *innovative application*.

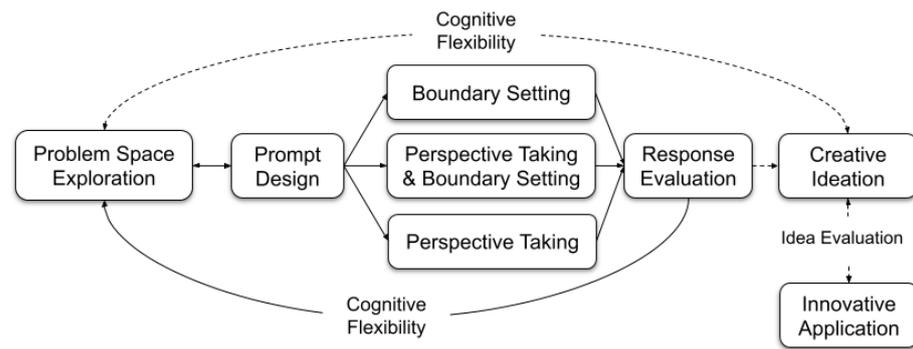


Figure 2. Conceptual framework for cognitive flexibility in support of creativity and innovation in AI-rich environments.

As such, the research question for the study developed in this study forms the problem space under exploration, as follows:

RQ: Could LLM AI chatbots enable cognitive flexibility in support of creativity and innovation in civic AI-rich environments in smart cities and, if yes, how?

The operationalization of this conceptual framework is described in the Methodology section and depicted graphically.

3. Methodology

This study advances the use of AI as a new design material (Knemeyer and Follett, 2020) [80], drawing on the attributes of flexibility and inclusivity (Geirbo et al., 2023 [3]; Wu and Koutstaal, 2020 [68]), said to be important for creativity and innovation. AI as a new design material is employed here in the exploration of co-piloting a re-thinking and re-imagining of educational habits and the urban agenda in civic spaces in smart cities in responding to challenges and uncertainties in the third decade of the 21st century. As such, this study explores how tools and technologies in the form of networked knowledge and AI chatbots make us “smarter” and more curious, leading possibly to more creative and innovative thinking. To this end, ChatGPT 3.5 is used to discern whether such tools/technologies help us to engage more productively in topical inquiry (McGinley and Tierney, 1989) [81] and knowledge acquisition. And, by employing perspective taking and boundary setting in our inquiry, this work also explores whether we gain a broader and deeper understanding. Where earlier work (Chauncey and McKenna, 2023) [82] explored the importance of cognitive flexibility with LLM AI chatbots, this study looks at connecting the dots, wherein some new understandings emerge, potentially cultivating a more flexible and adaptable mindset that is essential for creative thinking and innovative applications in smart city contexts.

Starting with the end in mind, creative ideation is fostered through the development of a rich, comprehensive knowledge base enabling individuals to draw upon diverse insights and perspectives, offering opportunities to generate creative ideas. These ideas are further refined through a collaborative (AI–human) and iterative process of inquiry. Our framework serves as a visual guide for engaging in AI–human partnerships to develop a broad and deep understanding of a problem space. The prompt–response iterations and evaluation tease out content, concepts, and connections more efficiently, allowing the human partners to develop a comprehensive understanding of the problem space, to engage in critical thinking during the iterative evaluation, and potentially recognize new connections and possibilities for innovative applications. Our framework serves as a guide to support this process. The appendices offer examples of engaging in this process while demonstrating the role of AI chatbots such as ChatGPT. Figure 3 iterates around a focus on inclusivity and flexibility that emerged from our initial prompts and initial problem space exploration. Finally, our framework offers points for pausing as you follow paths

and iterate. Ideation and innovation emerge in the spaces (arrows) as well as in the design, iteration, and evaluation phases.

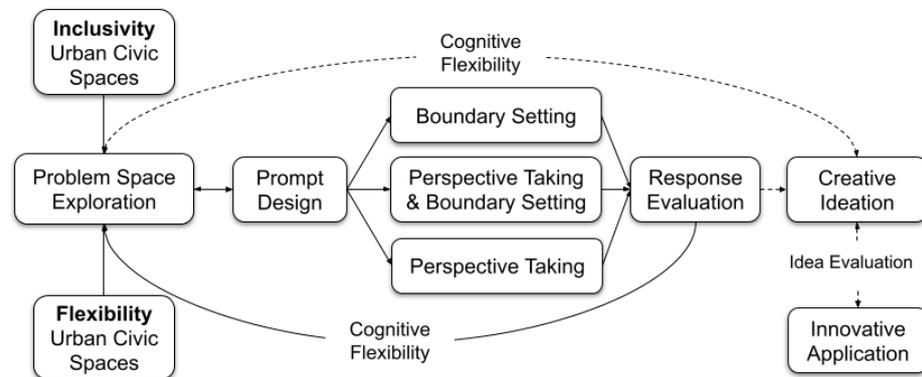


Figure 3. Conceptual framework for cognitive flexibility in support of creativity and innovation in civic AI-rich spaces in smart cities.

As depicted in Figure 3, the conceptual framework for cognitive flexibility in support of creativity and innovation is operationalized for use in civic AI-rich spaces in smart cities and regions focusing on *inclusivity* and *flexibility*.

Problem space exploration: In step 1, the goal is to ask open-ended, thought-provoking prompts that provoke responses that cover numerous aspects related to the problem or topic under consideration. In this step, we are seeking a holistic view and understanding, provoking suggestions for related questioning, essential in perspective taking, boundary setting, problem solving, and innovative and creative thinking. LLM AI chatbots, with their extensive knowledge base and ability to generate diverse ideas, are particularly adept at supporting this exploratory step. They can assist in broadening the scope of inquiry by suggesting additional prompts for further investigation, suggesting varied perspectives, and offering a richer understanding of the problem space. Understanding the problem space might include both ChatGPT probes and Google [Scholar] searches. In our conceptual framework exemplar (Figure 3), we submitted several prompts to ChatGPT (Appendix A). The response to our first question, “What attributes create a civic spaces identity?”, returned a list of seven attributes. Focusing on these attributes, and requesting additional attributes, offers a starting point for civic engagement, conversation, and thought-provoking collaboration in urban settings, particularly if participants have different areas of expertise and interest from which new connections across attributes might emerge. In our exemplar, we selected *flexibility* and *inclusivity* as attributes of particular interest where the *flexibility* response was as follows:

“A civic space should be flexible enough to accommodate a variety of activities, events, and programs, and should be adaptable to changing community needs and interests” (AI Chatbot response, Appendix A—see the others identified).

And the *inclusivity* response was as follows:

“A civic space should be designed to accommodate a wide range of activities and interests and should be welcoming to people of all ages, genders, races, and cultures” (AI Chatbot response, Appendix A).

Considering flexibility, we entered the following broad search phrase in Google Scholar with a date constraint of 2022 or later:

“supporting flexibility in urban civic spaces”

A few titles shown in Table 4 suggest both keywords and phrases that might be useful for step 2, *prompt design*.

Table 4. Google Scholar response.

Citations
Szemző, H.; Mosquera, J.; Polyák, L.; & Hayes, L. (2022). Flexibility and adaptation: Creating a strategy for resilience. <i>Sustainability</i> 14, 2688. https://doi.org/10.3390/su14052688
Geirbo, H. C., Harboe, L., Hoelscher, K., & Petersen, S. A. (2022). Interpretive flexibility as an approach to designing inclusive urban space: Learning from Medellín and Beirut. <i>Nordic Journal of Urban Studies</i> 2(2): 141–160. https://doi.org/10.18261/njus.2.2
Pinto, F., & Mina Akhavan, M. (2022). Scenarios for a post-pandemic city: Urban planning strategies and challenges of making “Milan 15-minutes city”. <i>Transportation Research Procedia</i> , 60: 370–377, https://doi.org/10.1016/j.trpro.2021.12.048

Prompt Design: A broad understanding and exploration of the problem space, undertaken in step 1, supports the development and design of more targeted prompts which are focused on key aspects of the problem. This focus is shaped not only by the responses in step 1, but by the conversation and collaboration of those invested in tackling the problem. As prompts become more targeted, we are seeking responses that focus on critical aspects of the problem and investigating potential solutions. During this step, we expect further conversation and collaboration in support of prompt development and design. AI prompt engineering (Oppenlaender et al., 2023) [9] is said to be “the process of designing and creating prompts, or input data, for AI models to train them to perform specific tasks”, and such prompts “in large language models (LLMs) like GPT-3 and ChatGPT can range from a simple query . . . to a complex problem with a wide variety of facts placed into the prompt” (Eliacık, 2023) [83]. The prompts and responses shared in Appendix A exemplify the iteration between *problem space exploration* (step 1) and *prompt design* (step 2).

Boundary setting and perspective taking: A series of perspective-taking and boundary-setting prompts were posed to ChatGPT-3.5 (Appendix A) with the goal of acquiring a breadth and depth of understanding that positively impacts creativity and innovation in relation to flexibility and inclusivity in urban civic spaces.

Response evaluation: Understanding the problem at hand, broadly first and then deeply, requires a careful evaluation of responses. Response evaluation and iteration benefit from conversation and collaboration between those who have varied expertise related to the problem space. Each step in our framework is designed with the expectation that human collaboration acts as a moderator and driver for subsequent steps and iterations fostering further inquiry, with the goal of inciting innovation and creativity. AI chatbot responses are not always accurate, as noted in the limitations identified by OpenAI (2023) [26] about ChatGPT, in the FAQ section of Google’s BARD (2023) [84], and also notably when posing questions that require computational intelligence ascribed to WolframAlpha (2023) [85]. It is imperative that responses are evaluated against trusted sources. For example, evaluating responses with Google Scholar searches could form part of the evaluation. At this time, asking the chatbot to share references used to generate its responses is not a reliable way to evaluate. Understanding best practices in prompt design can also improve the accuracy of responses (Oppenlaender et al., 2023 [9]; Eliacık, 2023 [83]).

Creative ideation: Our premise, revealed through the steps in our framework, is that the potential for creative ideation is enhanced when we leverage the varied experiences and expertise of collaborators. This collaborative approach serves to extend, enrich, and innovate around both the breadth and depth of content and concepts under consideration. Our framework underscores the importance of AI–human partnerships in fostering and promoting this process. AI–human and human–human partnerships are instrumental in provoking connection making, innovative thinking, and creative ideation. By combining the varied experiences and diverse perspectives of human collaborators with the content generation capabilities of AI, we create an environment where novel ideas can emerge.

The dashed line to creative ideation reflects the complexity of moving from information gathering to creative ideation. Improving and developing a broader understanding of

a topic by supporting cognitive flexibility may be beneficial, even if creative ideas and innovative applications do not emerge. The ease of iterating over the prompt–response–evaluation cycle may facilitate the generation of numerous, varied, and possibly novel ideas leading to innovative applications to solve new problems, improve on existing processes, and develop products, to name a few. The iterative process from creative ideation to revisiting the problem space exploration suggests that, during the creative ideation phase, additional questions may arise. Perhaps our creative ideas have already been studied and have already informed innovative solutions.

Idea evaluation: The leap from creative ideation to innovative application requires an understanding of the problem space, current processes, products, and solutions. According to Bushnell (2022) [86], who studied inventions in industrial settings, the user must “evaluate and triage them [ideas] for efficacy in the real world”, since “historical industrial experience is that some 3000 ideas are required to yield a single viable new product in the marketplace”. Perhaps we could do better with the aid of ChatGPT-like tools.

Innovative application: Identify a clear understanding of the objectives and outcomes desired. In our example, we seek to address flexibility and inclusivity in urban civic spaces. Our exploration of the problem space using ChatGPT-3.5 (Appendix A) offered some applications of these two attributes in urban settings. Further probing using perspective taking and boundary setting offered additional insights. Each response led to additional, more focused questions.

Building on the potential identified by the AOI (2023) [29] for collective discourse, a speculative example of the application of chatbot technology to a real-world city environment is provided in Appendix B, with ChatGPT-4 acting as a moderator in a city council meeting focusing on the rewilding of city areas as ethical and civil discourse. As such, this study delves into how AI chatbots like ChatGPT (version 4) can be leveraged to foster ethical interactions and civil discourse in urban spaces, with implications for potential impacts of AI in urban environments. We also identify this as an area requiring further research going forward (Future Direction 3).

In summary, a process flow for practical applications of the conceptual framework for cognitive flexibility in support of creativity and innovation in civic AI-rich spaces in smart cities includes the following:

- (a) Identify the problem to be addressed; assemble a team whose varied experiences and diverse knowledge will ensure a solid grasp of the issue and the capacity to critically assess AI responses; and select AI tools (such as ChatGPT-4, among others) that are best suited to the problem space and the issue being addressed (e.g., rewilding a specific urban area);
- (b) Interact with AI tools through iterative cycles of prompts and responses, considering relevant, related prompts suggested by the AI to develop a comprehensive—broad and in-depth—understanding of the issue (e.g., inclusivity, flexibility, etc.); ensure that perspective taking and relevant boundary setting are considered during each prompt–response cycle, relying on the expertise and varied understanding of team members;
- (c) Undertake a critical evaluation of AI tool responses and make adjustments to your problem space and/or prompt design, accordingly;
- (d) With satisfactory response evaluation, creative ideas may begin to emerge for team discussion and consideration. Further adjustments to your problem space and/or prompt design may be required;
- (e) Creative ideas in turn contribute to opportunities for innovative application discussion, testing, and implementation.

4. Findings and Discussion

In our research, we investigated whether LLM AI chatbots, such as ChatGPT, could facilitate cognitive flexibility to support creativity and innovation in civic environments. Our framework involved engaging with ChatGPT-3.5 in an iterative question–answer cycle,

allowing us to analyze prompt responses, which in turn motivated additional prompts. One prompt, “What attributes create a civic spaces identity?” returned the following: accessibility, safety and security, inclusivity, identity and character, flexibility, sustainability, and connectivity. Each of these attributes motivated a set of prompts wherein ChatGPT generated substantive subsequent responses encouraging us to think more broadly, nudging our own thinking and expanding our boundaries as we tackled the challenging overarching objective of seeking innovative ideas and solutions to address issues in the context of urban civic spaces. By using varied iterative prompts, we gained a better understanding of the problem space and the desired outcomes. It was the human–AI collaboration that supported ChatGPT’s perspective-taking capability, which would likely have been even more pronounced had varied stakeholders’ perspectives been used to develop even more nuanced, targeted prompts related to potential areas where flexibility and inclusivity could be enhanced in urban civic spaces. Our pilot exploration revealed that our framework clearly highlights the importance of iterative interaction, wherein each response triggers more focused and probing questions, for delving deeper into the problem space and considering different perspectives and boundaries identified in our prior prompts. From a creativity and innovation perspective, this iterative process not only expanded our understanding but also revealed additional insights and potential avenues for future exploration. Most importantly, we are learning that ChatGPT has the potential to support an inclusive, synergistic, flexible approach to tackling complex problems through human–AI interaction with diverse stakeholders as partners who bring multiple perspectives to the prompt generation and response analysis process—indeed supporting cognitive flexibility across inquiries by a range of stakeholders.

The process of posing prompts to LLM AI chatbots is reminiscent of information-seeking strategies employed by researchers and librarians in pre-digital brick-and-mortar times; in the early days of research databases; and when querying search engine interfaces which are on the cusp of incorporating AI chatbots. Some key features of AI chatbots that make them more sophisticated include the following:

- (a) Their understanding of natural language questioning;
- (b) Persistence—building on previous responses in response to new, related prompts;
- (c) Offering responses that are on the periphery of, or related to the prompt—serendipity;
- (d) Learning from positive and/or negative reinforcement based on users’ evaluations of responses.

Together, these features bring a conversational feel to the prompt–response human–AI chatbot interaction. This level of sophistication and feel suggests that AI chatbots may lead to more sustained user engagement, cognitive flexibility, deeper learning, and the potential to experience creative ideation. Such elements lead to innovation, encouraging the approaching of problems from multiple angles, integrating different perspectives, and generating new insights that can lead to novel solutions and advancements. And this is particularly important when considering what are said to be highly complex and wicked problems in the context of smart cities (Okwechime et al., 2021) [53].

While the findings did not lead to an adjustment of the conceptual framework, validation of the framework did occur and we believe it is sufficiently flexible to accommodate extensibility to many and varied urban civic spaces and regions.

1. First, the conceptual framework (Figure 3) was used to develop the prompts shared in Appendix A to explore and understand how LLMs such as ChatGPT have the potential to support collaborative, safe, secure, and inclusive opportunities for civic engagement. The incorporation of perspective taking and boundary setting is designed to encourage cognitive flexibility and more expansive thinking with the goal of motivating creativity and innovation.
2. We then shared the conceptual framework with new and experienced teachers in an educational setting wherein a professional learning opportunity introduced LLM chatbots, specifically ChatGPT. The staff worked collaboratively in small groups to design prompts, review responses, and iterate the process to develop a curriculum focused

learning experiences and challenging assignments for students with a specific goal of having students engage in argumentation writing and debates. Staff had a depth of knowledge related to the curriculum, allowing them to critically evaluate responses and pose targeted prompts that incorporated perspective taking and boundary setting. We consider this collaboration in an educational setting to be a proxy for the type of engagement that could be fostered in a community setting around challenging issues and opportunities that one might encounter in urban spaces that would encourage civic argumentation and debates.

Regarding other practical examples and empirical data, a real-world speculative example of moderating a civic discussion on the issue of rewilding city areas is provided in Appendix B, using ChatGPT-4. And while the speculative urban example we present in Appendix B, using ChatGPT-4, is not at the level of sophistication envisioned by Burry (2022) [11], who suggests that, “[r]apidly evolving AI is speeding up our capability to deep-dive into data and extract valuable fresh and often unexpected insights . . . with wholly new ways to share data for absorption between groups of individuals made up from disparate disciplines and interests”, our example does illustrate AI’s potential to enhance collaboration by moderating a civic discourse session and presenting content, concepts, and insights. This human–AI interaction might offer new perspectives that could positively shape idea generation and the decision-making process. As such, this work provides guidance on how the *conceptual framework for cognitive flexibility in support of creativity and innovation in AI-rich environments* (Figure 2) is extensible to *civic AI-rich spaces* (Figure 3), where interacting with ChatGPT (Appendix A), a snapshot emerges of urban civiness pertaining to inclusivity and flexibility. Given the evolving nature of AI chatbot technologies, this snapshot contributes to a rendering of concerns in cities in relation to flexibility and inclusivity, enabled by human–AI (ChatGPT-3.5) creativity interaction at this moment in time.

The following challenges are notable for implementing the framework (Figure 3) in this study. Assembling a team with varied expertise related to the problem space is critical to the evaluation of responses. This ensures a thorough evaluation of the chatbot’s responses in terms of accuracy, varied perspectives, and impartiality. Another implementation challenge is identifying and accessing LLM AI chatbot tools trained on datasets that are relevant to the problem space. Several have emerged that provide citations to articles, including ChatGPT Plus research plugins, Perplexity (2024) [87], and Elicit (2024) [88]. Furthermore, there are chatbots trained on domain-specific datasets, for example, law and medicine. However, accessing these sophisticated tools can be costly and not accessible to teams lacking the financial resources for subscriptions. Such challenges raise significant concerns about equitable access.

Regarding our key findings, while tools have evolved and emerged over the course of this study, our framework remains relevant and clearly supports our efforts to put forth a design and process that leads to collaboration, elaboration, and the potential to productively engage with AI tools. Central to our focus is fostering the development of a breadth and depth of knowledge, connecting content across domains, and recognizing varied perspectives with the goal of provoking creative ideation and innovative applications to solve problems and create new possibilities for engagement and for contributing to efficiencies. Our AI interactions returned several areas for consideration in support of urban civic spaces. Based on our interests, we selected two focus areas, inclusivity and flexibility, in these spaces. We have invested in professional versions of ChatGPT and Elicit. We have posed prompts across multiple tools—ChatGPT Plus, Elicit, Perplexity, Claude, and Bing—and compared responses. As noted under the challenges outlined above, access to pro versions of general tools as well as domain-specific tools is costly, creating barriers for researchers and practitioners who do not have access to significant funding.

It should be noted that the inquiries conducted in this work (Appendix A) are based on the understanding by the authors of this paper of learning cities, smart cities, and smart environments. This understanding contributed to all steps in the conceptual framework

advanced in this work, most importantly using our knowledge to thoughtfully iterate from problem exploration through response evaluation, using varied prompts that extended and expanded on prior responses. This study builds on and extends earlier work by Chauncey and McKenna (2023) [82] that focused specifically on perspective taking and boundary setting to sustain cognitive flexibility and forestall cognitive rigidity during topical inquiry.

5. Future Directions

While significant effort is required during the creative ideation, idea evaluation, and innovative application process, the efficacy and efficiency of engaging in topical inquiry through problem exploration and the prompt–response–evaluation cycle suggests a positive contribution to creative ideation and innovative application. As such, future directions requiring further study based on the exploration conducted in this study with AI in the form of ChatGPT-3.5, ChatGPT-4, and emerging GPTs (a customizable ChatGPT) as our co-pilot include the following:

Future Direction 1: A key direction emerging from this study, giving rise to further study opportunities, is to determine if AI chatbots might promote creative ideation, potentially resulting in innovative application, drawing on guidance by Bushnell (2022) [86] about creativity and innovation, who shares the following: “[c]reativity is the capacity of an individual or organization to conduct effective ideation, and create new inventions, solutions to issues, problems, or provision of new capabilities. If/when inventions become effective in the marketplace, they are termed innovations. . . .The information required for knowledgeability is now far more readily available at far more coverage and detail than was the case in the days of libraries *vice* [sic] [versus] the web in the last century”.

Future Direction 2: A second direction requiring further study would be to determine if the number of iterations between the problem exploration and response evaluation suggests a level of engagement and cognitive flexibility that would contribute to creative ideation and potential innovative application.

Future Direction 3: A third direction would be to engage in further study to understand the implications of AI for smart cities and urban civic life; as in, how might AI chatbots that enable cognitive flexibility in support of creativity and innovation impact citizen engagement in ethical and civil discourse wherein equitable access to LLM AI tools could help us in rethinking the notion of learning cities and smart cities?

Future Direction 4: A fourth direction would be to undertake an exploration of AI chatbot technologies as a *zeitgeist*, contributing to evolving understandings of cities, smart cities, and the notion by Cugurullo et al. (2023) [36] of AI urbanism, in the third decade of the 21st century and beyond.

6. Limitations and Mitigations

Limitations of this work include the use of ChatGPT-3.5, as early comparisons with ChatGPT-4 suggest the latter to exhibit more powerful capabilities. However, we understand that AI chatbots are operating as experimental platforms at this time. The response evaluation step will change as chatbots become, for example, more stable, provide transparency in identifying sources used to generate responses, offer options to filter the knowledge base used to generate responses, and interact with other chatbots that are trained in specific domains (WolframAlpha for math) [85], to name a few anticipated developments. While the use of a proxy (Section 4, item 2), involving collaboration in an educational setting, for the type of engagement that could be fostered in a community setting around challenging issues and opportunities in urban spaces may be a limitation of this study, it nevertheless serves to demonstrate an approach that would encourage civic argumentation and debates.

The next phase of our study will seek to qualitatively and quantitatively evaluate the impact of AI LLM tools to impact cognitive flexibility and, in turn, creativity and innovation. Identifying and segmenting populations that have the requisite skills to engage in this study may be helpful. While Bushnell (2022) [86] focuses on the knowledgeable user

engaging in creative ideation, idea evaluation, and innovation, it may be that emerging AI-mediated human–technology collaborations might elevate the opportunity for less skilled and knowledgeable individuals to engage in sophisticated problem exploration of innovation scenarios.

7. Conclusions

In conclusion, this study proposes the use of LLM AI chatbots as tools to support a cycle of problem exploration, prompt design, and response evaluation, encouraging cognitive flexibility and sustained engagement with the goal of generating creative ideas and possible innovative applications of those ideas to address problems or needs in specific contexts in urban civic spaces. This study considered AI chatbots as a means to engage in inquiry around urban civic space attributes of flexibility and inclusion with the goal of creatively ideating to identify innovative applications related to these attributes.

This study contributes to the nascent urban AI chatbot literature by considering how the natural language prompt–response interface of this technology might encourage engagement in the exploration of topics (topical inquiry) through the refining of questions (multiple iterations). This approach is designed to sustain cognitive flexibility and potentially contribute to the creation of new ideas (creative ideation) and innovative problem solving. While a substantial body of research is focused on large language model training, accuracy, and possible negative outcomes, our focus is on the possibilities beyond such current limitations. The framework developed in this study and modified for application to civic spaces demonstrates the potential to use these AI tools to explore and innovatively address issues that could positively impact the lives of diverse communities. For the study design developed herein, we are specifically interested in how AI chatbots such as ChatGPT can be used to inquire into flexibility and inclusivity in urban civic settings through asking questions (prompts) that incorporate various perspectives (perspective taking) and contexts (boundary setting). While the findings of this study are encouraging, using ChatGPT-3.5 and a speculative real-world urban example using ChatGPT-4, opportunities for further exploration are also identified.

The important thing about this research is that it seeks to understand how an emerging technology may impact how individuals explore problem spaces in “collaboration” with a “knowledgeable, engaging partner” (AI chatbot), that is, an AI chatbot that efficiently supports topical inquiry through prompting scenarios that encourage cognitive flexibility and the making of connections, contributing to creative thinking and the potential for applications of innovative solutions. Using ChatGPT-3.5, we submitted over 100 prompts, reviewed responses, and iterated to learn more. We found our conceptual framework to be relevant and accurate in depicting the potential for AI chatbots to support our research question (RQ): *Could LLM AI chatbots enable cognitive flexibility in support of creativity and innovation in civic AI-rich environments and, if yes, how?* Early iterations of prompts and responses triggered ideas that encouraged the exploration of a topic more deeply, with subsequent prompts and responses sparking new ideas and urging further investigation. This was the case for the examples shared in this study and our ongoing use of AI chatbots in relation to our research question.

The contributions of this study include the literature review and the conceptual framework for cognitive flexibility in support of creativity and innovation in AI-rich environments; the adaptation of the framework for application in the civic AI-rich spaces of smart cities and regions; and proposed future directions for research. All of these contributions take into consideration how AI-driven inquiry and design give rise to urban futures involving people–technology interactions and synergies, enabling cognitive flexibility, in realization of new ways of flourishing, while evolving educational habits in the civic spaces of smart cities and regions.

This work will be of interest to urban planners, designers, local governments, and community members, as well as anyone concerned with evolving human creativity, in-

novation, and cognitive flexibility and the notion of creative AI for good in smart cities and regions.

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Appendix A

Creativity and Innovation in Civic Spaces with AI: Perspective Taking and Boundary Setting—ChatGPT-3.5

Appendix A offers a detailed exemplar of prompts and responses modeling our framework steps. Prompts for problem space exploration, perspective taking, and boundary setting are shared. The exemplar highlights how iterative prompt–responses enrich our understanding and insight into the content and concepts presented. The exemplar models the use of our framework to navigate complex issues and the benefits of iterative prompt–response AI–human dialogue to achieve a deeper understanding of the issue at hand.

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Problem Space Exploration: Responses from ChatGPT 3.5

1. What attributes create a civic spaces identity?

Civic spaces are public spaces that are designed to facilitate civic engagement, community building, and democratic participation. The following attributes can help create a strong identity for civic spaces:

- **Accessibility:** A civic space should be easily accessible to all members of the community, regardless of their social or economic status.
- **Safety and security:** A civic space should be safe and secure for people to gather and engage in civic activities without fear of harassment or violence.
- **Inclusivity:** A civic space should be designed to accommodate a wide range of activities and interests, and should be welcoming to people of all ages, genders, races, and cultures.
- **Identity and character:** A civic space should have a unique identity and character that reflects the values and culture of the community it serves.
- **Flexibility:** A civic space should be flexible enough to accommodate a variety of activities, events, and programs, and should be adaptable to changing community needs and interests.
- **Sustainability:** A civic space should be designed and maintained in a sustainable manner, with consideration for environmental impact and resource conservation.
- **Connectivity:** A civic space should be well-connected to the surrounding community and transportation infrastructure, to encourage easy access and participation.

Overall, a strong identity for a civic space is created when it is designed with the needs and interests of the community in mind, and when it fosters a sense of belonging, engagement, and empowerment among its users.

2. How can flexibility be supported in civic spaces?

Flexibility is an important attribute for civic spaces, as it allows the space to accommodate a wide range of activities and events, and adapt to changing community needs and interests. Here are some ways flexibility can be supported in civic spaces:

- **Multi-use design:** Civic spaces can be designed with a multi-use approach, incorporating features such as movable furniture, modular structures, and adaptable infrastructure that can be easily reconfigured to accommodate a variety of activities and events.
- **Programming:** Civic spaces can be programmed with a diverse range of events and activities, including festivals, concerts, farmers' markets, and community gatherings. These programs can be planned and scheduled in advance, or be open to spontaneous events and activities.
- **Collaborative partnerships:** Civic spaces can form partnerships with community groups, non-profit organizations, and local businesses to support and promote a wide range of events and activities, fostering a sense of community ownership and involvement.
- **Technology integration:** Civic spaces can be equipped with technology, such as Wi-Fi, projection screens, and sound systems, to support a range of activities, including digital media presentations, performances, and interactive exhibits.
- **Green infrastructure:** Civic spaces can incorporate green infrastructure, such as rain gardens, bioswales, and permeable pavement, to manage stormwater and improve air and water quality. These features can also be designed to be adaptable and flexible, supporting a range of activities and events.

Overall, supporting flexibility in civic spaces requires a thoughtful approach to design, programming, and community engagement, with a focus on adaptability, collaboration, and sustainability.

3. How can inclusivity be supported in civic spaces?

Inclusivity is an essential attribute for civic spaces, as it ensures that all members of the community feel welcome, valued, and respected. Here are some ways inclusivity can be supported in civic spaces:

- **Universal Design:** Civic spaces can be designed using universal design principles, which prioritize the needs and abilities of a diverse range of users, including people with disabilities, seniors, and children. This approach can include features such as ramps, accessible seating, and sensory gardens.
- **Cultural sensitivity:** Civic spaces can be designed with cultural sensitivity in mind, recognizing and celebrating the diverse cultures and traditions of the community. This can include public art, cultural festivals, and educational exhibits.
- **Community engagement:** Civic spaces can engage with the community to identify their needs and preferences, and to ensure that the space is designed and programmed in a way that is responsive to the community's diversity. This can include community meetings, surveys, and participatory design processes.
- **Programming:** Civic spaces can offer a range of programs and activities that appeal to a diverse range of interests and abilities, including intergenerational activities, cultural events, and educational programs.
- **Outreach and communication:** Civic spaces can use outreach and communication strategies that are inclusive and accessible, such as multilingual signage, social media, and community ambassadors.

Overall, supporting inclusivity in civic spaces requires a collaborative and community-centered approach, with a focus on recognizing and responding to the diverse needs, interests, and abilities of all community members.

4. Can ChatGPT provide a practical example of inclusivity based on everyday life in the city?

Sure, here's a practical example of how inclusivity can be supported in a civic space based on everyday life in the city. Let's say there is a city park that is popular among residents of all ages and backgrounds. To support inclusivity, the city could take several steps:

- **Universal Design:** The park could be designed using universal design principles to ensure that it is accessible and welcoming to people of all abilities. This could include features such as paved paths, accessible restrooms, and playground equipment that is usable by children with disabilities.
- **Cultural Sensitivity:** The park could feature public art and educational exhibits that celebrate the diverse cultures and traditions of the community. This could include murals, sculptures, and interpretive signage that tells the stories of the community's history and culture.
- **Community Engagement:** The city could engage with the community to identify their needs and preferences for the park, and to ensure that the park is designed and programmed in a way that is responsive to the community's diversity. This could include community meetings, surveys, and participatory design processes.
- **Programming:** The park could offer a range of programs and activities that appeal to a diverse range of interests and abilities, including fitness classes, cultural festivals, and educational programs.
- **Outreach and Communication:** The city could use outreach and communication strategies that are inclusive and accessible, such as multilingual signage, social media, and community ambassadors, to ensure that all members of the community feel welcome and informed about park activities and events.

Overall, by implementing these strategies, the city could create a park that is truly inclusive, and that provides a welcoming and accessible space for all members of the community to enjoy.

5. Can ChatGPT provide a practical example of flexibility based on everyday life in the city?

Certainly! Here's a practical example of how flexibility can be supported in a civic space based on everyday life in the city. Let's consider a community center in a busy urban area. To support flexibility, the center could take several steps:

- **Multi-Use Design:** The community center could be designed with a multi-use approach, with features such as movable furniture, modular walls, and adaptable infrastructure that can be easily reconfigured to accommodate a variety of activities and events. For example, the center could have collapsible walls to create a larger or smaller space depending on the event.
- **Programming:** The center could be programmed with a diverse range of events and activities that appeal to a wide range of interests and ages, including music performances, cooking classes, yoga sessions, and community gatherings. This could include both scheduled events and open spaces for impromptu activities.
- **Collaborative Partnerships:** The center could form partnerships with local community groups, non-profit organizations, and businesses to support and promote a wide range of events and activities. For example, a local dance school could use the space for rehearsals or a nearby restaurant could use the space for cooking demonstrations.
- **Technology Integration:** The center could be equipped with technology such as Wi-Fi, projectors, and sound systems, to support a range of activities, including digital media presentations, conferences, and performances.

- **Green Infrastructure:** The center could incorporate green infrastructure such as indoor plants, energy-efficient lighting, and a rainwater harvesting system, to improve air quality and energy efficiency while creating a more pleasant environment.

Overall, by implementing these strategies, the community center could become a flexible and adaptable space that can accommodate a variety of events and activities, respond to changing community needs, and provide a welcoming and dynamic space for people of all ages and interests.

6. Can you provide a practical example of the intersection of flexibility and inclusivity based on everyday life in the city?

Certainly! Here's a practical example of how the intersection of flexibility and inclusivity can be supported in a civic space based on everyday life in the city. Let's say there is a community center in a diverse urban neighborhood. To support flexibility and inclusivity, the center could take several steps:

- **Universal Design:** The community center could be designed with universal design principles in mind, ensuring that it is accessible to people of all abilities. This could include features such as ramps, wide doorways, and accessible restrooms.
- **Multi-Use Design:** The community center could be designed to accommodate a wide range of activities and events, with features such as movable walls, modular furniture, and adaptable infrastructure. This would allow the space to be easily reconfigured to accommodate different types of events, such as cultural festivals, cooking classes, and fitness classes.
- **Cultural Sensitivity:** The community center could be designed to be culturally sensitive, celebrating and recognizing the diversity of the neighborhood. This could include public art, cultural festivals, and educational exhibits.
- **Programming:** The center could offer a range of programs and activities that appeal to a diverse range of interests and abilities, including intergenerational activities, cultural events, and educational programs. This could include both scheduled events and open spaces for impromptu activities.
- **Outreach and Communication:** The center could use outreach and communication strategies that are inclusive and accessible, such as multilingual signage, social media, and community ambassadors. This would help to ensure that all members of the community feel welcome and informed about center activities and events.

Overall, by implementing these strategies, the community center could become a flexible and inclusive space that accommodates a diverse range of activities and events, responds to the changing needs and preferences of the community, and provides a welcoming and accessible space for people of all ages, backgrounds, and abilities.

7. How might one design "spaces of possibility" and "infrastructures of possibility" in support of creativity and innovation in the city?

Designing "spaces of possibility" and "infrastructures of possibility" in support of creativity and innovation in the city can involve several strategies, such as:

- **Embrace Diverse Perspectives:** Create spaces that are inclusive of diverse perspectives, backgrounds, and experiences. This can be achieved by designing spaces that promote collaboration and interaction, encouraging dialogue and the exchange of ideas.
- **Foster a Culture of Creativity:** Encourage experimentation and innovation by fostering a culture of creativity. This can be achieved by providing opportunities for people to engage in creative activities and events, such as hackathons, design competitions, and artist residencies.
- **Flexible and Adaptable Spaces:** Design spaces that are flexible and adaptable, with features such as movable walls, modular furniture, and adaptable infrastructure that can be easily reconfigured to accommodate different types of events and activities.

- **Technology Integration:** Integrate technology into the design of spaces and infrastructure to support creativity and innovation. This can include features such as high-speed internet, digital media displays, and virtual reality tools.
- **Public-Private Partnerships:** Foster public-private partnerships to promote creativity and innovation in the city. This can involve collaborations between government, academia, and private industry to create programs, events, and funding opportunities that support creativity and innovation.

Overall, designing “spaces of possibility” and “infrastructures of possibility” in support of creativity and innovation in the city requires a multifaceted approach that embraces diversity, fosters a culture of creativity, and provides flexible and adaptable spaces and infrastructure that are supported by technology and public-private partnerships. By doing so, cities can create an environment that supports creativity and innovation, which can in turn lead to economic growth and social progress.

8. What other environmental options might be considered to support creativity and innovation?

In addition to the strategies I mentioned earlier, there are several other environmental options that can be considered to support creativity and innovation in the city. Some of these options include:

- **Green Spaces:** Creating green spaces, such as parks and community gardens, can provide opportunities for people to connect with nature and engage in creative activities, such as painting or photography.
- **Artistic Installations:** Installing artistic installations, such as sculptures or murals, can add visual interest to the cityscape and inspire creativity and innovation.
- **Co-Working Spaces:** Designing co-working spaces that are affordable and accessible can provide entrepreneurs and small business owners with the resources they need to bring their ideas to life.
- **Maker Spaces:** Creating maker spaces, which are collaborative workspaces that provide access to tools and equipment, can support innovation by enabling people to experiment with new ideas and technologies.
- **Walkable Neighborhoods:** Designing neighborhoods that are walkable and bike-friendly can encourage interaction and collaboration among residents, which can spark creativity and innovation.
- **Smart Infrastructure:** Implementing smart infrastructure, such as sensors and data analytics, can provide valuable insights into how people use and interact with the city, which can inform design decisions and support innovation.

Overall, there are many environmental options that can be considered to support creativity and innovation in the city, from green spaces and artistic installations to co-working and maker spaces, walkable neighborhoods, and smart infrastructure. By creating an environment that supports creativity and innovation, cities can unlock the full potential of their residents and foster economic growth and social progress.

9. Connect the following features of public civic spaces to think creatively and propose innovative ideas that could be presented to city developers—accessibility, safety and security, inclusivity, identity and character, flexibility, sustainability, and connectivity.

- **Accessibility:** One innovative idea could be to create a mobile civic space that could travel to different areas of the community to provide access to those who may not be able to travel to a centralized location. Another idea could be to use technology such as virtual reality to create a virtual civic space that can be accessed from anywhere.
- **Safety and security:** One innovative idea could be to incorporate advanced surveillance technology such as facial recognition or AI-powered cameras to deter and prevent crime. Another idea could be to create a community ambassador program where trained volunteers monitor the space and report any suspicious activity.
- **Inclusivity:** One innovative idea could be to incorporate universal design principles in the space, such as adding ramps and elevators for accessibility, and offering programs

that cater to a diverse range of interests and abilities. Another idea could be to create a space for cultural exchange, where different cultural groups can share their traditions and experiences with each other.

- **Identity and character:** One innovative idea could be to incorporate public art installations that reflect the history and culture of the community. Another idea could be to involve community members in the design process to ensure that the space reflects their values and needs.
- **Flexibility:** One innovative idea could be to use modular, movable furniture that can be reconfigured for different events and activities. Another idea could be to create a “pop-up” civic space that can be quickly set up and taken down for temporary events.
- **Sustainability:** One innovative idea could be to incorporate green infrastructure such as rain gardens, green roofs, and permeable pavements to manage stormwater runoff and improve air quality. Another idea could be to use renewable energy sources such as solar or wind power to generate electricity for the space.
- **Connectivity:** One innovative idea could be to incorporate smart technology such as Wi-Fi hotspots and mobile charging stations to encourage digital engagement and connectivity. Another idea could be to create partnerships with transportation providers to offer discounted or free transportation to and from the space.

10. Consider the intersection of accessibility, safety and security, inclusivity, identity and character, flexibility, sustainability, and connectivity to come up with an innovative feature for urban civic spaces.

One innovative feature for urban civic spaces that could address multiple intersections could be a modular, multi-functional community hub. This hub would be a flexible space that can be easily reconfigured to accommodate a variety of activities and events. It would be designed to be accessible to all members of the community, including those with disabilities, and equipped with state-of-the-art safety and security features.

The hub would reflect the unique identity and character of the community it serves, with public art installations and other design elements that reflect the history and culture of the area. It would also be designed and maintained in a sustainable manner, incorporating green infrastructure and renewable energy sources.

To enhance inclusivity, the hub would offer a variety of programs and events that cater to a diverse range of interests and abilities, including cultural exchange programs, educational workshops, and community gatherings. Additionally, it would be well-connected to the surrounding community and transportation infrastructure, making it easily accessible to all.

Overall, this multi-functional community hub would serve as a central gathering place for the community, where people can come together to engage in civic activities, build relationships, and strengthen the fabric of their community.

Perspective Taking and/or Boundary Setting: Responses from ChatGPT 3.5

1. How might one design “spaces of possibility” and “infrastructures of possibility” in support of creativity and innovation in a rural space of 1100 people with more than fifty percent who are senior citizens?

Designing “spaces of possibility” and “infrastructures of possibility” in support of creativity and innovation in a rural space with a large senior population requires a tailored approach that takes into account the unique needs and challenges of the community. Here are some suggestions on how this could be done:

- **Foster Inter-Generational Interaction:** Encourage interaction and collaboration between different age groups in the community. This can be achieved by creating community spaces that cater to the interests of both seniors and younger generations, such as community gardens, art studios, or technology labs.
- **Utilize Existing Community Infrastructure:** Make use of existing community infrastructure, such as libraries, community centers, and schools, to provide spaces for

creative and innovative activities. These spaces can be repurposed and modified to accommodate different types of activities, such as workshops, classes, or exhibitions.

- **Collaborate with Local Artists and Entrepreneurs:** Foster partnerships between local artists and entrepreneurs to provide mentorship and resources to community members who are interested in pursuing creative and innovative endeavors. This can include programs that provide training, networking opportunities, and access to funding.
- **Promote Access to Technology:** Provide access to technology and digital tools that can support creativity and innovation, such as computers, tablets, and 3D printers. This can be achieved by establishing technology hubs or mobile technology centers that can be brought to different parts of the community.
- **Celebrate Community Heritage and Culture:** Celebrate the heritage and culture of the community by creating opportunities for community members to share their stories, traditions, and artistic expressions. This can be achieved by organizing festivals, cultural events, and exhibitions that showcase local talent.

Overall, designing “spaces of possibility” and “infrastructures of possibility” in support of creativity and innovation in a rural space with a large senior population requires a community-centered approach that emphasizes intergenerational collaboration, access to technology, and celebration of community heritage and culture. By doing so, the community can foster a culture of creativity and innovation that benefits all members, regardless of age or background.

2. Can you provide a practical example of the intersection of flexibility and inclusivity based on everyday life in a rural space of 1100 people with more than fifty percent who are senior citizens?

Sure! Here’s a practical example of the intersection of flexibility and inclusivity in a rural space with a large senior population:

The community of Smithville, with a population of 1100 people and over 50% senior citizens, wants to create a community garden where residents can come together to grow vegetables, socialize, and learn new skills. To ensure that the garden is both flexible and inclusive, the community takes the following steps:

- **Flexible Design:** The garden is designed to be flexible and adaptable to the needs and abilities of different users. Raised garden beds are installed at different heights to accommodate people with mobility issues, and paths are designed to be wide enough for wheelchairs and walkers. The garden also includes a shaded area where people can rest and relax.
- **Intergenerational Collaboration:** To encourage intergenerational collaboration, the garden is open to people of all ages, and workshops are held to teach people of different ages and abilities about gardening and related topics. Seniors are encouraged to share their knowledge and experience with younger generations, while younger people help with tasks that may be more physically demanding.
- **Inclusive Policies:** Policies are put in place to ensure that the garden is inclusive and welcoming to all members of the community. For example, no one is turned away from the garden because of their age, income, or ability to pay. Community members are also encouraged to bring their cultural traditions and practices to the garden, which helps to promote diversity and inclusion.
- **Community Engagement:** The garden is designed to be a community space where people can come together to socialize and learn from each other. Regular community events, such as potlucks, picnics, and harvest festivals, are organized to foster a sense of community and belonging.

By taking these steps, the community of Smithville is able to create a flexible and inclusive community garden that brings people of all ages and abilities together to grow, learn, and connect. This is an excellent example of how the intersection of flexibility and inclusivity can be applied in everyday life in a rural space with a large senior population.

3. Consider the intersection of accessibility, safety and security, inclusivity, identity and character, flexibility, sustainability, and connectivity in a city setting with a significant homeless population to come up with an innovative feature for urban civic spaces.

One innovative feature for urban civic spaces in a city setting with a significant homeless population could be the creation of multi-functional, modular structures that serve as both public gathering spaces and temporary housing for homeless individuals.

These structures would be designed to be easily accessible to all members of the community, including those with disabilities, and equipped with state-of-the-art safety and security features to ensure the safety of both housed and unhoused individuals. The structures would be designed to be flexible and adaptable, allowing them to be easily reconfigured to accommodate different needs and uses.

To enhance inclusivity, the structures would be designed to reflect the unique identity and character of the community they serve, with public art installations and other design elements that reflect the history and culture of the area. Additionally, the structures would be designed and maintained in a sustainable manner, incorporating green infrastructure and renewable energy sources to minimize their environmental impact.

To ensure connectivity, the structures would be well-connected to the surrounding community and transportation infrastructure, making them easily accessible to all. Additionally, the structures would offer a variety of programs and services to meet the diverse needs of their residents, including job training, mental health services, and addiction support programs.

Overall, this innovative feature would serve as a bridge between housed and unhoused members of the community, providing temporary housing while also serving as a gathering place for all members of the community. It would reflect the values and culture of the community while also promoting accessibility, safety, inclusivity, flexibility, sustainability, and connectivity.

4. Consider the intersection of accessibility, safety and security, inclusivity, identity and character, flexibility, sustainability, and connectivity from the perspective of young people who are seeking their first jobs to come up with an innovative feature for urban civic spaces.

One innovative feature for urban civic spaces that could address the needs of young people seeking their first jobs could be the creation of a multi-functional youth employment center.

This center would be designed to be easily accessible to all members of the community, including young people from low-income families, and equipped with state-of-the-art safety and security features to ensure the safety of all visitors. The center would be designed to be flexible and adaptable, allowing it to accommodate a variety of programs and events.

To enhance inclusivity, the center would be designed to reflect the unique identity and character of the community it serves, with public art installations and other design elements that reflect the history and culture of the area. Additionally, the center would be well-connected to the surrounding community and transportation infrastructure, making it easily accessible to all.

The center would offer a variety of programs and services to help young people gain the skills and experience they need to succeed in the workforce, including job training, resume building workshops, and career counseling. Additionally, the center would partner with local businesses and organizations to provide job shadowing opportunities, internships, and other employment opportunities for young people.

To promote sustainability, the center would be designed and maintained in an environmentally-friendly manner, with green infrastructure and energy-efficient systems to minimize its carbon footprint.

Overall, this multi-functional youth employment center would serve as a central hub for young people seeking their first jobs, providing them with the resources and support they need to succeed in the workforce. It would promote accessibility, safety, inclusivity,

flexibility, sustainability, and connectivity, while also reflecting the unique identity and character of the community it serves.

5. What about affordable housing and transportation?

Affordable housing and transportation are both important factors that intersect with the features of urban civic spaces outlined in the original prompt. Here are some additional innovative features that could be incorporated to address these issues:

Affordable Housing:

- Develop mixed-income housing units adjacent to or within walking distance of urban civic spaces. This can promote accessibility, connectivity, and inclusivity by ensuring that people of all income levels have access to these spaces.
- Incorporate affordable housing units into the design of urban civic spaces themselves. For example, a multi-use building with commercial space on the ground floor and affordable housing units on the upper floors could provide affordable housing while also promoting economic activity and community building.
- Partner with local housing organizations to provide job training and employment opportunities for residents in affordable housing units near urban civic spaces, helping to promote economic opportunity and social mobility.

Transportation:

- Incorporate bike lanes, walking paths, and public transit stops into the design of urban civic spaces to promote active and sustainable transportation options. This can also promote connectivity by providing easy access to other parts of the city.
- Integrate technology, such as bike share programs and electric car charging stations, to support sustainable transportation options and reduce reliance on private vehicles.
- Partner with transportation providers to offer discounted or free transit passes to residents living near urban civic spaces, promoting accessibility and reducing transportation costs for low-income residents.

By incorporating features that address affordable housing and transportation, urban civic spaces can become more accessible, inclusive,

Resolving Flexibility Constraints in the Use of Civic AI: Responses from ChatGPT 3.5

1. What highly novel yet appropriate ideas would assist with resolving flexibility constraints in the use of urban civic AI?

There are several highly novel yet appropriate ideas that can assist with resolving flexibility constraints in the use of urban civic AI:

- Adaptive algorithms: One approach to enhancing flexibility in the use of urban civic AI is to develop adaptive algorithms that can adjust their behavior in real-time to changing conditions. These algorithms could be designed to respond to changes in traffic patterns, weather conditions, or other environmental factors that affect the operation of urban infrastructure.
- Edge computing: Another approach is to leverage edge computing, which involves deploying computing resources closer to the data source. By processing data closer to where it is generated, edge computing can reduce latency and improve the responsiveness of urban civic AI systems.
- Hybrid AI: A third approach is to use a combination of AI techniques, including machine learning and rule-based systems. Hybrid AI can be used to create more flexible systems that can adapt to changing conditions while still maintaining a high degree of reliability and accuracy.
- Multi-modal data fusion: Another approach is to use multi-modal data fusion, which involves combining data from multiple sources to create a more complete picture of the urban environment. This approach can help to identify patterns and trends that might not be apparent from individual data sources.

- Human-in-the-loop systems: Finally, it may be useful to develop human-in-the-loop systems that allow human operators to provide input and feedback to urban civic AI systems. This approach can help to ensure that these systems remain flexible and responsive to changing conditions, while also providing a human perspective on their operation.

2. Will you share more highly novel yet appropriate ideas that would assist with resolving flexibility constraints in the use of urban civic AI?

Certainly, here are a few highly novel ideas that could help resolve flexibility constraints in the use of urban civic AI:

- Virtual Urban Assistant: Develop a virtual assistant that can assist city planners and officials in understanding the impact of different decisions on the city's infrastructure and services. This could include analyzing traffic patterns, predicting the demand for public transportation, and identifying areas where infrastructure improvements are needed.
- Smart Traffic Control System: Implement a smart traffic control system that uses real-time data to optimize traffic flow and reduce congestion. This system could use AI algorithms to analyze traffic patterns and adjust traffic signals in real-time to reduce wait times and improve overall traffic flow.
- Automated Public Transportation: Develop an automated public transportation system that uses AI algorithms to optimize routes and schedules based on demand. This system could also use real-time data to adjust routes and schedules in response to changing traffic conditions, ensuring that passengers can get to their destination quickly and efficiently.
- Predictive Maintenance: Use AI algorithms to predict when city infrastructure and services are likely to fail, allowing city officials to perform preventative maintenance and reduce downtime. This could include analyzing data from sensors installed in buildings and other infrastructure to detect signs of wear and tear.
- Smart Waste Management: Develop a smart waste management system that uses AI algorithms to optimize waste collection and disposal. This system could use real-time data to adjust collection schedules based on demand, ensuring that waste is collected when and where it is needed. It could also use machine learning algorithms to identify areas where illegal dumping is likely to occur, allowing city officials to take proactive measures to prevent it.

These are just a few examples of highly novel ideas that could help resolve flexibility constraints in the use of urban civic AI. With the right tools and technologies, cities can use AI to improve their infrastructure and services, making them more efficient, sustainable, and resilient in the face of changing conditions.

3. I am looking for an exhaustive list. Are there any other highly novel yet appropriate ideas that would assist with resolving flexibility constraints in the use of urban civic AI?

Certainly, here are some additional ideas for addressing flexibility constraints in the use of urban civic AI:

- Modularity: Develop modular AI systems that can be easily reconfigured and adapted to different use cases and contexts.
- Dynamic resource allocation: Use AI to dynamically allocate resources, such as energy or transportation, based on real-time demand.
- Human-in-the-loop: Incorporate human input into AI decision-making processes, allowing for greater flexibility and adaptability.
- Multi-agent systems: Develop AI systems that consist of multiple agents that can work together to solve complex problems and adapt to changing conditions.
- Robustness and resilience: Build AI systems that are resilient to failures and able to recover quickly from disruptions.

- Explainability and transparency: Ensure that AI systems are transparent and explainable, so that users can understand how they work and have confidence in their results.
- Interoperability: Develop AI systems that can communicate and exchange data with other systems, enabling seamless integration with existing infrastructure.
- Data privacy and security: Ensure that AI systems are designed with strong data privacy and security protections to maintain public trust.
- Human-centered design: Adopt a human-centered design approach to AI development, which focuses on the needs and preferences of users, and enables greater flexibility and customization.
- Continuous learning and improvement: Design AI systems that can learn and improve over time, allowing for greater flexibility and adaptability as new data and knowledge become available.

4. What questions could we ask related to highly novel yet appropriate ideas regarding resolving flexibility constraints in the use of urban civic AI?

- What are some highly novel ideas for resolving flexibility constraints in the use of urban civic AI?
- How can urban civic AI be designed to be more flexible and adaptable to different contexts and situations?
- What are some potential benefits and drawbacks of using highly flexible urban civic AI systems?
- What role can stakeholders such as city planners, policymakers, and citizens play in shaping the development and implementation of flexible urban civic AI?
- How can we ensure that flexible urban civic AI is designed and implemented in an ethical and equitable manner?
- What are some examples of successful implementations of flexible urban civic AI in other cities or contexts?
- How can we measure the effectiveness of flexible urban civic AI systems in resolving flexibility constraints?
- What challenges might arise in implementing highly flexible urban civic AI, and how can they be addressed?
- What are some potential risks associated with using highly flexible urban civic AI, and how can we mitigate them?
- How can we involve diverse stakeholders in the development and implementation of highly flexible urban civic AI to ensure that it meets the needs of all members of the community?

Using Civic AI to Assist in Overcoming Wicked Challenges: Responses from ChatGPT 3.5

1. How could urban civic AI assist in overcoming wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility?

Urban civic AI has the potential to help overcome wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility in several ways:

- Data-driven decision making: Urban civic AI can help decision-makers to make data-driven decisions that are informed by real-time data. This can help to ensure that urban initiatives are implemented in a way that is inclusive and flexible, as decisions can be based on up-to-date information about the needs and preferences of different stakeholders.
- Predictive analytics: Urban civic AI can be used to develop predictive analytics models that can anticipate future trends and help decision-makers to plan for them in advance. This can help to ensure that urban initiatives are implemented in a way that is flexible enough to adapt to changing circumstances.
- Personalization: Urban civic AI can be used to personalize the delivery of urban services and initiatives based on individual preferences and needs. This can help to ensure that initiatives are inclusive and accessible to everyone, regardless of their background or circumstances.

- **Real-time monitoring:** Urban civic AI can be used to monitor the implementation of urban initiatives in real-time, allowing decision-makers to quickly identify and address any issues or challenges that arise. This can help to ensure that initiatives remain flexible and responsive to changing circumstances.
- **Public engagement:** Urban civic AI can be used to facilitate public engagement and participation in the implementation of urban initiatives. This can help to ensure that initiatives are inclusive and reflect the needs and preferences of the community, while also promoting transparency and accountability in decision-making processes

2. Will you share more ways urban civic AI could assist in overcoming wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility?

Certainly, here are some additional ways that urban civic AI can assist in overcoming wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility:

- **Data-driven decision making:** Urban civic AI can help decision-makers to make more informed and data-driven decisions. By analyzing large amounts of data, AI systems can identify patterns and trends that may not be apparent through traditional methods. This can help to ensure that decisions are based on objective evidence rather than subjective opinions.
- **Personalization:** AI systems can be used to personalize urban civic initiatives to the needs and preferences of individual residents. For example, AI-powered mobility solutions can provide personalized transportation recommendations based on a user's location, destination, and preferences.
- **Real-time feedback:** AI systems can provide real-time feedback to residents and decision-makers about the effectiveness of urban civic initiatives. This can help to identify problems early on and make adjustments as needed.
- **Accessibility:** AI systems can help to make urban civic initiatives more accessible to all residents, including those with disabilities. For example, AI-powered navigation systems can provide customized directions and accessibility information for individuals with mobility impairments.
- **Community engagement:** AI systems can facilitate community engagement by providing opportunities for residents to provide feedback and input on urban civic initiatives. For example, AI-powered chatbots can be used to gather input from residents on issues such as transportation, housing, and public safety.

Overall, urban civic AI can assist in overcoming wicked challenges to the successful implementation of urban civic initiatives by providing data-driven decision making, personalization, real-time feedback, accessibility, and community engagement.

3. I am looking for an exhaustive list; are there even more ways urban civic AI could assist in overcoming wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility?

Certainly! Here are some additional ways that urban civic AI could assist in overcoming wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility:

- **Predictive modeling:** By analyzing data on demographic trends and patterns of resource use, predictive modeling can help urban planners anticipate future needs and design more inclusive and flexible urban infrastructure.
- **Natural language processing:** Natural language processing can be used to analyze public feedback and engagement, allowing urban planners to better understand the needs and preferences of local communities.
- **Sentiment analysis:** Sentiment analysis can be used to assess public opinion on urban initiatives, allowing planners to identify areas of concern and address them proactively.

- Collaborative decision-making: By providing stakeholders with real-time access to data and analytics, urban civic AI can facilitate more collaborative decision-making processes and help build consensus around key issues.
- Smart sensors: Smart sensors can be used to collect real-time data on traffic patterns, air quality, and other environmental factors, providing urban planners with a more accurate picture of the urban environment.
- Social network analysis: Social network analysis can be used to identify and map relationships between different stakeholders, allowing urban planners to develop more targeted and effective engagement strategies.
- Augmented reality: Augmented reality can be used to provide stakeholders with a more immersive and engaging experience of proposed urban initiatives, helping to build public support for these initiatives.
- Blockchain technology: Blockchain technology can be used to improve transparency and accountability in the implementation of urban initiatives, helping to build trust between stakeholders and ensure that resources are being used effectively.
- Autonomous systems: Autonomous systems, such as self-driving cars and delivery drones, can help to increase the flexibility and inclusivity of urban infrastructure by providing more efficient and accessible transportation options.
- Open data platforms: By making data on urban infrastructure and resource use more accessible to the public, open data platforms can help to build trust and encourage greater collaboration between different stakeholders in the urban planning process.

4. What questions could we ask related to how urban civic AI could assist in overcoming wicked challenges to the successful implementation of urban civic initiatives involving inclusion and flexibility?

- What are some examples of wicked challenges that could arise in the implementation of urban civic initiatives involving inclusion and flexibility?
- How can urban civic AI be used to address these wicked challenges and promote successful implementation?
- What are some potential benefits and drawbacks of using urban civic AI to address wicked challenges related to inclusion and flexibility in urban initiatives?
- How can stakeholders such as city planners, policymakers, and citizens be involved in the development and implementation of urban civic AI solutions for addressing wicked challenges?
- How can we ensure that urban civic AI solutions for addressing wicked challenges are designed and implemented in an ethical and equitable manner?
- What are some examples of successful implementations of urban civic AI in addressing wicked challenges related to inclusion and flexibility in urban initiatives?
- How can we measure the effectiveness of urban civic AI solutions for addressing wicked challenges?
- What challenges might arise in implementing urban civic AI solutions for addressing wicked challenges, and how can they be addressed?
- What are some potential risks associated with using urban civic AI to address wicked challenges related to inclusion and flexibility in urban initiatives, and how can we mitigate them?
- How can we involve diverse stakeholders in the development and implementation of urban civic AI solutions for addressing wicked challenges to ensure that they meet the needs of all members of the community?

Appendix B

Speculative Real-World Example of Using Chatbot Technologies in Civic Spaces: ChatGPT-4

Appendix B presents a detailed exemplar where AI takes on the role of moderator for a debate centered around the scenario: *a city council is engaged in a discussion about rewilding*

parts of their city. AI is prompted to moderate the debate and initiate the conversation by providing a clear definition of “rewilding in urban settings”. AI successfully navigates the role of an impartial moderator, facilitating the exchange of ideas and ensuring the representation of both pro and con viewpoints. AI suggests relevant follow-up content and aids in the exploration of innovative, creative solutions.

PROMPT: Consider the following scenario: A city council is debating options for rewilding areas of their city. There are both pro and con opinions and efforts to identify creative, innovative solutions that will satisfy all members of the council. Will you be the moderator for the debate and the solution innovation discussion? Start by summarizing what rewilding is.

ChatGPT: Rewilding is an ecological restoration strategy aimed at restoring and protecting natural processes and core wilderness areas, often by reintroducing native species that have become extinct in specific areas due to human activities. It focuses on enhancing biodiversity, improving ecosystem health, and often involves the removal of human-made barriers to nature.

Alright, council members, as we dive into this debate on rewilding areas of our city, let's explore both the pros and cons as well as innovative solutions to ensure a balanced approach. We want to hear from both sides, so let's maintain respect and open-mindedness throughout the discussion. Who would like to start with the benefits of rewilding?

Participant 1: Thank you Mr. Moderator, As the chair of the environmental committee, I would like to start. Rewilding a two-acre space in our community makes sense for community members of all ages. We have the space, our research revealed many benefits of our proposal including physical and mental health.

ChatGPT: Thank you, Chair of the Environmental Committee. Benefits of Rewilding:

- **Physical Health:** Natural spaces can provide areas for exercise and recreational activities. Access to natural areas has been shown to encourage physical activity which reduces the risk of obesity, heart disease, and other related ailments.
- **Mental Health:** Studies have shown that being in nature can reduce stress, anxiety, and depression. Natural spaces can serve as a refuge from the hustle and bustle of urban life, offering citizens a place of tranquility and relaxation.
- **Biodiversity:** Rewilding can increase the biodiversity of an area, bringing in more species of plants, insects, and animals. This not only strengthens the ecosystem but also brings in species that can be beneficial for controlling pests.
- **Educational Opportunities:** A rewilded area can be used as a living classroom, where schools and community groups can learn about local ecology, conservation, and sustainable living.
- **Climate Benefits:** Natural spaces can serve as carbon sinks, absorbing CO₂ and thus playing a role in combatting climate change.
- **Economic Boost:** Natural spaces can increase property values in surrounding areas. Additionally, they can become attractions, drawing in visitors, tourists, and even potential residents who value proximity to green spaces.

Would anyone like to present the challenges or concerns regarding the rewilding proposal? Or perhaps offer some innovative solutions to address potential drawbacks?

Participant 2: I respect my colleague and her passion for bringing green spaces to our community. However, you have to consider the ongoing effort to care for this space. Rewilding requires maintenance. We don't have the funds or personnel to take on this task.

ChatGPT: Thank you for sharing that perspective.

Challenges of Rewilding:

- **Maintenance:** While the aim of rewilding is to let nature take its course, some level of management is often required, especially in the beginning. This can include controlling invasive species, ensuring reintroduced species thrive, and managing any human-made structures or pathways in the area.

- **Cost:** Initial investment for reintroducing species, removing existing structures, and setting up protective measures might be significant. Plus, as mentioned, ongoing maintenance can also come with associated costs.
- **Human-Wildlife Conflicts:** As the area gets rewilded and attracts more wildlife, there's potential for conflicts between humans and animals, especially if the area is in or near residential zones.
- **Use of Space:** There might be alternate development ideas or needs for the land, which could serve other pressing community requirements.

Possible Innovative Solutions:

- **Community Engagement:** Engage local schools, colleges, and community groups in the maintenance. For instance, they can adopt portions of the land for their eco-projects, which would reduce the need for city funds and personnel.
- **Grants and Partnerships:** Explore state, federal, or private grants aimed at supporting urban green spaces or conservation projects. Partner with local environmental NGOs who may offer support in terms of expertise, volunteers, and even funds.
- **Revenue Generation:** Create certain areas within the rewilded space where minimal impact activities can be hosted, such as eco-tours, workshops, or even small cafes that align with the ethos of the space, generating revenue for maintenance.
- **Technological Interventions:** Use technology to monitor the space efficiently, like drone surveillance to keep an eye on larger areas and assess needs periodically rather than constant manual oversight.

Would anyone like to expand on these solutions or offer alternate ideas to address the concerns raised?

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