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Investigating the Effects of the Quadruple Helix on Civic Society Engagement in Smart City Innovation

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Abstract

The Quadruple Helix has received growing attention in smart cities research and policy-making as a means for government, industry, academia and civil society to collaborate in making decisions about urban innovations. However, the effect of involving the so-called fourth helix – members of civil society – in such decision-making remains under-researched. This paper is focused on if and how adoption of a Quadruple Helix approach has impacted on civic engagement in Smart City initiatives. Is there evidence in the public domain that decision-making in these initiatives has been affected? A systematic review of the literature on Smart City initiatives was conducted to discover whether those reported as featuring the Quadruple Helix disclosed whether engaging with members of civil society had impacted on their outcomes. The results of the review suggest that, despite Quadruple Helix's heavy promotion, neither the practical significance of involving the fourth helix in decision-making, nor the 'benefits' of doing so, are currently unpacked in the literature. Effective investigation of Smart City initiatives is required to make clear how Quadruple Helix affects decision-making in them, with adequate attention paid to reporting both their implementation and evaluation of what they have achieved in practice.

Keywords: Quadruple helix; Smart city innovation; Civic society engagement; Decision-making; Impacts.

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1 Introduction

Following on from the original application of the notion of helixes to innovation practices two decades ago, the Quadruple Helix (QH) has been heralded as an innovation model that puts community and citizens in an equal position alongside business, research and government as key stakeholders in innovation management (Carayannis & Campbell, 2022). In Smart City (SC) research, the QH has been widely promoted due to its focus on citizens' participation in decision-making about urban innovation - in smart city policy-making (e.g., Alexopoulos, et al., 2022; Brussels Smart City Office, 2022); service provision (Borkowska & Osborne, 2018; Paskaleva & Cooper, 2017); urban planning (de Bruin, 2017) and regeneration (Hong, 2019); and as a vehicle for smart city sustainability (European Commission, 2021; Kuzior & Kuzior, 2020). In all these domains, the QH's four main groups of actors – government, industry, academia and civil society – have been described as collectively collaborating to address public problems.

In the past five years, the quadruple helix has received a growing attention from researchers and policy makers who have promoted it as both a conceptual framework and a methodological approach for organising and analysing the 'smart city' as an innovation ecosystem (Paskaleva et al. 2021; Wirtz & Müller, 2022). Analytical studies have used the QH model as a reference method for focusing on the challenges of, and for identifying assessment criteria and performance indicators for use in, smart city research. Studies have also begun to pay attention to the outcomes and benefits from the participation of different stakeholder groups in smart cities initiatives (SCIs), particularly the specific role played by citizens as the newly admitted members of the fourth helix into decision-making (Zhou & Lolacono, 2020). For example, Borkowska and Osborne (2018) developed an analytical framework to explore the experiences and needs of citizens in building socially inclusive innovation in SCIs while Paskaleva et al. (2021) used an assessment framework to capture and measure the impacts of sustainable SC solutions. Yet empirically based research focused on the performance and success of the fourth helix remains scarce and has yet to fully demonstrate the multiple benefits QH is claimed to deliver for civil society.

This lack of a strong evidence base for the performance of quadruple helix has been noticed. For example, Borkowska and Osborne (2018), who looked at the role of the QH in Glasgow's Future City Demonstrator, acknowledged that:

> "... although participation can help citizens to appreciate the complexities of urban transformation and feel greater ownership of the outcomes .... There has been little evidence of involving civil society actors in a truly bottom-up approach..." (p. 368).

Paskaleva et al. (2021) were similarly critical of this stark gap in reports about the impact of QH on SC initiatives – which they termed a 'deficit of proof' - concluding that:

> "The lack of concrete evidence raises fundamental questions about the benefits of 'smart' to the city and its residents and prompts the need for new QH governance models to design and manage smart cities." (p. 398).

Likewise, de Sousa (2020), in his study of the implementation of the QH in smart city Living Labs, found that there is:

"Little empirical evidence regarding the benefits of smart cities on the environment and sustainability exists." (p.30).

He concluded that:

> "The main question that remains unanswered is the actual outcome of smart cities, explaining the benefits to the stakeholders." (p.51).

Indeed, Engelberta et al. (2018) judged that citizens remain so excluded from making decisions that claims about the 'inclusive' nature of smart cities remains "an empty policy mantra" (p.347). Abda'oe and Swadhesi (2017) observed that, in practice, citizens often seem to be forgotten as being a major component of a city in smart city initiatives. Likewise, Zhou and Lolacono (2020) also found that citizens' participation is a particular weakness in the deployment of QH in SC initiatives.

Our paper seeks to confront this deficiency by undertaking a detailed review of literature reporting the performance of the QH in SCIs. Simply stated, we have looked for evidence demonstrating the effective implementation of the QH approach as reported in the literature. A critical analysis is offered of what such reports say has already been achieved and of what changes are needed to bring about further improvements in future. Our aim is to indicate whether existing

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reports of QH provide sufficient evidence to validate its use as a vehicle for smart city innovation and as a value-generating tool for innovation by addressing the overarching question:

> *Is there evidence in the public domain about the use of the quadruple helix approach for involving members of civil society members in decision-making about urban innovations in smart city initiatives?*

Section 1 introduces the scope and objectives of the study and explains its value to quadruple helix and smart city innovation research. Section 2 introduces the concept of the 'helix' and teases out what is said to make it special and worth of attention. The rise and implementation of QH is discussed along with the attention it has received in SC literature. The evidence that exists about the delivered benefits arising from QH approach is addressed in more detail. Section 3 describes the analytical approach employed and the methods of data collection and analysis used in the study. Section 4 presents the results of the study and sets up propositions about what current evidence base suggests about the performance of QH. Section 5 offers conclusions and seeks to answer a key question: "What is known about effects of the QH on civic engagement in smart city innovation?"

2 Setting the scene

This section builds on previous research into smart cities innovation and quadruple helix science to investigate the role offered to members of civil society in decision-making about the form and purpose of smart city innovations. The aims are a) to understand the extent to which civil society members are reported to have participated in decision-making, under the QH banner and b) to examine whether their participation has affected the outcomes of SC initiatives, particularly in terms of achieving their own aspirations and concerns.

2.1 The problematic place of the 'helix' in innovation research

Despite the prevalence of the term's use in innovation theory and research, the status of the helix in innovation practice has a contested history. Is the term 'helix' meant as simply a metaphor - a figure of speech that describes something by saying it is something else - or as a more potent model of reality. This distinction has been clear since the term was first introduced into innovation theory a quarter of a century ago. Then Leydesdorff and Etzkowitz (1998:1), who are widely credited with importing the term from the biological sciences, stated:

> "The Triple Helix model is formulated not at the level of the phenomena to be explained, but as a model for helping with the explanation. In this sense, it is a methodological tool: the focus on the recursive overlay of communications among universities, industries, and governments allows for the organization of research questions in relation to the various models and metaphors .... These questions require empirical research and the results of such research demand a framework for theoretical appreciation."

Previously Etzkowitz and Leydesdorff had stated (1995) that they employed this 'model' to focus on interactions between three 'helices' - universities, industry and government. It was and still is (Lawton-Smith & Leydesdorff, 2022) employed as a basis for looking at how entrepreneurship comes into being. These statements signal the ambiguous nature of the helix. Is it an actual phenomenon that requires empirical investigation as a means of delineating what really happens

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in practice when these different groups of actors seek to collaborate in order to bring about innovations? Or is it an abstract model intended to act as a metaphor for shining a light on the dynamics of how innovation occurs in practice? Or, as Shinn (2002:602) asked, just "a catch phrase nourishing a fleeting fad".

In the two decades that have passed since Shinn asked this question, the continued use of the term, the triple helix, and the subsequent proliferation of its successors – the quadruple, the quintuple and the N- helices (Costa et al., 2022), suggests that the appeal of this 'metaphor' has not receded. But, as Gordon (2000:12052) warned about the use of the term in its original setting, the biological sciences:

> "Metaphors are necessary because we cannot see most of the things we study, but when we believe the thing actually is the metaphor, we are in trouble."

And Gordon's reservations have not receded yet, forming the centre piece of a recent workshop on role of metaphors in biological research (The International Society for the History, Philosophy, and Social Studies of Biology, 2022). There the nature of the helix remains a subject of critical scrutiny and continued empirical examination.

2.2 Membership of the fourth helix

The focus of this paper is on if and how members of 'civil society' - often treated as a synonym for 'citizens' - are engaged in the process of making decisions about innovations in smart city initiatives, specifically those operating under the banner of the Quadruple Helix. Here innovation management practices go beyond involving government, business and academics - to engaging participants drawn from wider sections of society. But just which sections of society are included when the term 'civil society' is used in SCIs operating under the QH banner? Quite who is being admitted as a member of the fourth helix? Answering these questions is far from simple.

Caetano (2013:4) contended that, in its original version, the concept of civil society was close to the concept of citizenship, arguing that:

"... there is not a manifest opposition between them, but their roots were definitely different. The concept of civil society has decisively evolved in order to demarcate the political sphere from the private sphere."

However, Cooper (2018:2) suggested that:

> "Civil society is widely understood as the space *outside the family*, market and state ... and it now signifies a wide range of organised and organic groups ...." (emphasis added).

This description gives preference instead to 'communities' of citizens linked by common interests and collective activity. As these descriptions indicate, used indiscriminately, 'civil society' can be a catch-all term for any potential participants in smart city innovations who are not present a) to represent the interests of government, business or academia and are not b) representing themselves as individuals or family members.

At its narrowest, 'citizen' is a distinctly legal construct dealing with an individual's allegiance to a particular state. In spatial sciences, however, citizen can mean an 'inhabitant' of city or town, as well as 'resident' or simply a 'local'. However, according to the Council of Europe (CoE, 2023: no page number), citizenship:

> "... relates to one's personal sense of belonging, for instance the sense of belonging to a community which you can shape and influence directly".

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Thus the term is now associated with notion of 'active citizenship'. This, the CoE suggests, implies working towards the betterment of one's community through participation to improve life for all its members. The problem here, according to the CoE, is how to increase citizens' involvement and participation in the processes of democratic society.

2.3 Application of the quadruple helix to smart cities

Successful integration of Information and Communication Technologies (ICTs) has come to be seen as 'essential' to city life. They have been heralded as key drivers for redefining both a city's infrastructure and its relationship with its citizens (King-Sing Chan & Anderson, 2015). Citizens themselves have been presented as constituting the core of the Smart City (Vanolo, 2016). Engaging with them will, Oliveira and Campolargo (2015) argued, unlock the potential for increasing economic prosperity, ecological integrity, and social equity. Doing so, according to the European Commission (2021) will benefit a city or a region in the long-term goal of sustainability. Quite how this will occur has not been made equally apparent.

However, over the last decade, it has become common place for those promoting smart cities to stress the importance of collaboration of different types of stakeholders in using ICTs to make cities become smarter, more liveable, and more sustainable. Recently the role of citizens has been made more explicit by the adoption of the Quadruple Helix. This model has begun to appear explicitly in the plans of smart cities (e.g., Brussels Smart City Office, 2022), putting the community and citizens in an apparently equal position alongside business, research and government stakeholders. Unlike the previous triple helix model of innovation, the quadruple helix specifically entails the participation of the citizens not only in service provision, through monitor and engagement, but also involvement in policy-making, leading to a more bottom-up decision-making system (Alexopoulos, et al., 2022). In a QH approach to the innovation of public services (Charalabidis et al., 2019), the community - in its broader sense of the whole of civil society – is presented as working alongside with business, research and government in the new economy. Indeed, as Spil et al., (2017) claimed the quadruple helix structure, of itself, ensures effective participation of citizens, companies, universities and government.

Under the quadruple helix model of innovation, smart cities are viewed as being collaborative environments, as participatory arenas for implementing innovative actions by promoting the contribution of all stakeholders to decision-making. In innovation management literature, smart cities have been referred to as 'place-specific sites' (Nguyen et al., 2022) or 'urban ecosystems' based on a quadruple helix structure (Wirtz & Müller, 2022; Paskaleva et al., 2021) where multiple actors convene to collaborate, collectively addressing public problems. However, the mere presence of a QH approach does not imply that effective forms of locally based innovation can be taken as given. Instead, as Vallance et al. (2020) argued, the collaborative relationships required for transformational interventions in the future of cities need to be actively and, just as importantly, effectively constructed through the successful engagement and management of the diverse sets of actors involved in decision-making.

Along these lines, the quadruple helix model is now being promoted as a preferred underlying principle for smart city design where technological and social innovations result from cooperation by, and seeking synergies from amongst, four groups of stakeholders: city administrations, businesses, the science/research base, and civic society. The overriding goal of these synergies, Kuzior and Kuzior (2020) claimed, should be to shape a 'Smart Sustainable City' that will improve the quality of citizens' lives across the various dimensions of their individual and socio-professional functioning. Indeed, there are examples in critical urban planning literature, (e.g., de Bruin, 2017), which argue that the main purpose of a smart city is the creation of 'public value'. This requires an

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understanding of how viewpoints on the creation of public value differ among QH actors. And this entails, Charalabidis et al. (2019) suggested, an ongoing process of engagement between, and the active participation of, all four stakeholder groups in the conceptualisation, design and implementation of a Smart City. There is emerging evidence now, as Paskaleva et al. (2021) found, that engaging citizens in QH framework development and impacts assessment can be an effective response to the endogenous societal challenges and citizen needs. Seen from this perspective, citizens' preferences, and the degree of their engagement in smart cities initiatives, has become a critical focus of attention. But how has this vision played out in recently reported SCIs and their impacts on urban innovation.

Precisely what significance should be attached to use of the term 'helix' when used in publications reporting such initiatives, especially when preceded by the adjective 'quadruple'. For instance, at its simplest, is use of the phrase 'the quadruple helix' in literature on smart cities just descriptive, coined to herald the enrolment of a fourth group of actors, drawn from civil society, into smart city innovations? Or, at its most ambitious, is the term being employed an analytical category for empirically examining the performance and outcomes of urban activities - once members of civil society are admitted as party to decision-making about what gets innovated, how, and for whose benefit?

The actual role members of civil society have played in smart city initiatives is a principal focus of this paper. More specifically, we are asking if there is empirical evidence to support the myriad assertions in SC literature that the participation of members of civil society in SC initiatives leads to the benefits claimed by those who have promoted the adoption of the Quadruple Helix. This is a critical knowledge gap in the field of innovation practice as applied to smart cities. This paper starts to fill this gap by undertaking a critical review of what the SC literature in the public domain reveals about the role of civic society in the decision-making on SC initiatives implemented under the QH banner. The study reported below is a first attempt to explore whether civil society has, in practice, been effectively involved in decision-making about the urban innovation in SC initiatives reported as using a QH approach.

3 Method

This section contains a detailed description of the selection criteria employed and the filtering process used in the study. The overarching question explored in this research is:

> *Is there evidence in the public domain about the use of the quadruple helix approach for involving members of civil society members in decision-making about urban innovations in smart city initiatives?*

Evidence was sought for in the form of text in published reports of SCIs that described how, when, where and why members of civil society had been involved in the initiatives' decision-making about the innovations being pursued. To search for this evidence, a systematic review of academic publications and grey literature was conducted.

This review was used to identify publications that reported smart city initiatives which drew specific attention to quadruple helix as part of their implementation. Evidence was sought a) about how CS members had been involved in decision-making and b) to examine what has been reported about the benefits to civil society members that were claimed to have arisen from doing so. Simply stated, evidence was looked for in literature in the public domain demonstrating that the effective implementation of SCIs under the banner of QH had resulted in benefits to the CS members involved. The objective was then to undertake a critical analysis of the evidence

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offered to demonstrate that these benefits have been achieved. The review's purpose was to reveal a) whether reports placed in the public domain provide enough evidence to justify the promotion of QH as a means of improving the engagement of CS members in decision-making and b) that this results in benefits specifically relevant to them. The approach employed was based on the investigative stages previously used when exploring the robustness of evidence about the effectiveness of the performance of Living Labs (Paskaleva & Cooper, 2021) and whether SC initiatives have improved citizens' quality of life (Paskaleva & Cooper, 2022).

Collating publications for the systematic review was conducted in three steps.

1) *Expanding the research question.*

To examine the overarching question asked above, four more detailed research questions were addressed:

> *RQ1. What has been the practical impact of the term, quadruple helix, when employed in SC initiatives that operated under this banner? Has it been used:*
>
> - *simply in passing, as a descriptive term for the involvement of members of civil society in decisions about the innovation of public services or*
> - *in more detail, as an analytic category for empirically investigating the performance and outcomes of co-production activities once such members have been enrolled?*
>
> *RQ2. To what extent have members of civil society, enrolled as the fourth strand of the helix, participated in decision-making about the form and purpose of smart city innovations?*
>
> *RQ3. To what extent have those who managed SC initiatives using a QH approach examined whether their initiative resulted in an outcome which met a need voiced by the civil society members they had enrolled in it.*
>
> *RQ4. What empirical evidence is there that involvement of civil society members in decision-making, under the QH banner, has affected the outcomes of SC initiatives, especially when gauged from the perspective of their own aspirations and concerns?*

2) *Identifying relevant publications and articles.*

Initially, a general review of the literature on SCIs was undertaken. Papers were sought, published in Europe and internationally, containing the terms – 'smart city' or 'smart cities' and 'quadruple helix' – in their titles. Web of Science, Scopus and Google Scholar were scanned for academic literature containing these terms. Google was also scanned to identify grey literature containing them. The intention was to seek an understanding of the range and depth of what had been written about SCIs using the QH banner in research, policy and practitioner publications. Google was specifically scanned for policy documents and municipal/city/government reports – to see what commercial consultants and government officials have said about the effects of using the QH when implementing smart cities initiatives (see metadata available on request from authors).

Many documents on smart cities do mention the words 'quadruple helix' somewhere in their texts. As the narrative offered above recounts, this is not surprising given the rising place of the

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fourth helix in innovation discourse. So there appeared to be reasonable grounds for limiting the search for evidence of a relationship between decision-making on 'SC' initiatives and 'QH' to those titles that explicitly contained both terms. It seemed a rational and practical working assumption that sources which contain both SC and QH in their title would be those that are most likely to explore the relationships under investigation in their texts. Accordingly, searches were undertaken with the goal of identifying sources whose titles contained both terms to search for evidence of the relationships being sought. Using the key identifiers 'smart city/ies' and 'quadruple helix', a total of 48 results were identified of publications which contained both these terms in some combination, within or between their titles and abstract. 12 of these had SC and QH in their titles; 23 had SC in their titles, QH in their abstracts; 3 had QH in their titles, SC in their abstracts; and 10 had SC and QH in their abstracts. Searching the *Web of Science* produced only 16 (9 journal articles, 5 conference papers and 2 book chapters). Searching *Scopus* produced 32 results (18 articles, 10 conference papers, 3 book chapters, and one set of lecture notes). Another 14 results were collated from the first 15 pages listed by Google Scholar when looking for titles containing both phrases. In total, after amalgamation and removal of duplicates, 12 sources which had both SC and QH in their titles were collated for detailed examination (see metadata available on request from authors). Additional 8 references were used for establishing which 'actors' are listed in the fourth helix. As the publication dates indicate, twinned interest in SC and QH would appear to be a recent phenomenon, mainly emerging in the past decade, particularly in the last five years.

3) *Data processing method.*

A sequenced approach was then applied to winnowing the 48 collated publications to identify which of them warranted full analyses of their contents, see Figure 1.

3.1 First screening for eliminating publications with SC and QH only in abstracts.

The 48 publications identified were reviewed. 10 of them only mentioned SC and QH in their abstracts but neither term in their titles. These were discarded, leaving 38 publications for further examination.

3.2 Second screening for eliminating publications with either only SC or QH in the title.

24 publications were identified that had SC in their titles but QH only in their abstracts. 3 more were identified that had QH in their titles but SC only in their abstracts. These 27 were also discarded, leaving 11 publications for further scrutiny.

3.3 Third screening to identify publications reporting on a specific case or project.

The titles and abstracts of the remaining publications were examined to discover whether they reported on specific case studies or described named funded projects. 4 of the remaining publications did not. These too were discarded.

3.4 Identification of qualifying publications

As a result of this successive filtering and exclusions, only 7 (about 1 in 7 of the original 48) publications were deemed suitable for deeper scrutiny. These are listed in Table 1 which also shows the cases and/or projects they reported. These 7 publications were then subjected to the

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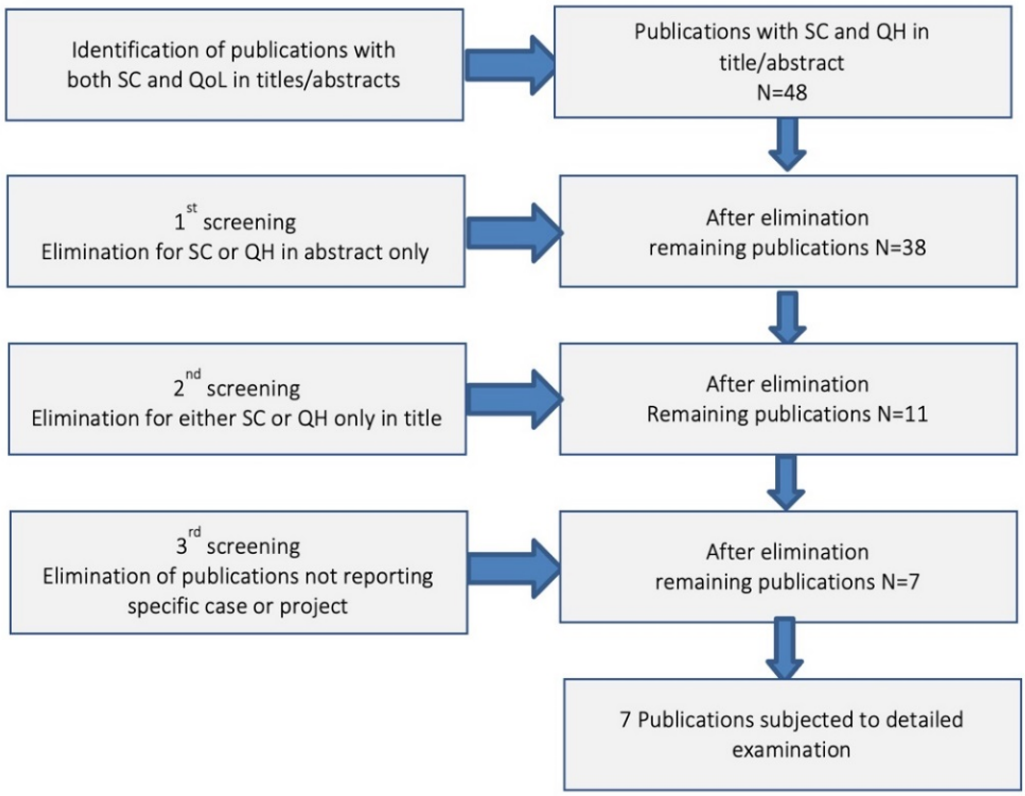

Figure 1. The sequence of the stages employed in data mining for this paper.

full and detailed content analyses reported below.

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Case Number	Publication (author, date and title)	Case location(s)/projects

Table 1. The 7 publications identified for full investigation.

Case Number	Publication (author, date and title)	Case location(s)/projects
1	Borghys, K., Walravens, N., van der Graaf, Sh., & Van Compernolle, M. (2020). Multi-Stakeholder Innovation in Smart City Discourse: Quadruple Helix Thinking in the Age of "Platforms".	13 Flanders 'smart cities', Belgium
2	Borkowska, K.,& Osborne, M. (2018). Locating the fourth helix: Rethinking the role of civil society in developing smart learning cities.	Future City Demonstrator, Glasgow, Scotland
3	De Bruin, J. (2017). Shared agendas or problematic partners? Perspectives of quadruple helix actors on public value creation in smart cities.	Amsterdam, The Hague, Utrecht, Rotterdam and Eindhoven, Netherlands
4	Gasco-Hernandez, M. Xiaoyi Yerden, G., Burke, B., & Gil-Garcia, J.R. (2020). The Potential Role of Public Libraries in a Quadruple Helix Model of "Smart City" Development: Lessons from Chattanooga, Tennessee.	Public libraries, Chattanooga, Tennessee, USA
5	Paskaleva, K., Evans, J., & Watson, K. (2021). Co-producing smart cities: A Quadruple Helix approach to assessment.	Manchester, England; Eindhoven, Netherlands; and Stavanger, Norway
6	De Sousa (2020). Living labs contributions to smart cities from a quadruple-helix perspective.	Living Lab Florianopolis, Living Lab of Itaipu Technological Park, and Porto Digial, Brazil
7	Suzic, B., Ulmer, A., & Schumacher, J. (2020). "Complementarities and Synergies of Quadruple Helix Innovation Design in Smart City Development".	QH clusters in Austria, Germany, Italy, Slovenia, Slovakia, Croatia, Poland and Hungary

4) *Data analysis method.*

The 7 publications listed above were analysed in detail using assessment criteria derived from the research questions listed previously. The full texts of these publications were examined to discover whether they contained text referring to:

- QH as a descriptive term and/or analytical category
- the involvement of specific types of CS members in decision-making about urban innovation
- the benefits to CS members from engaging in such decision-making, or
- empirical evidence that involvement of CS members had affected the SCIs' outcomes.

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For the first of these assessment criteria, the whole text of each publication was read to see if i) QH was simply used as a term for describing the range of participants involved in the case/project reported or ii) whether it was intended to operate as a category for analysing its results. Text relating to the other three assessment criteria were searched for using conjunctions between key words:

b) involvement/engagement/participation, decision-making, and citizen(s)/civil society
c) benefits, decision-making, and citizen(s)/civil society,
d) evidence, outcomes/impact, and citizen(s)/civil society.

The key statements in each publication employing these terms were extracted and collated for analysis (see metadata available on request from authors). These content analyses were conducted manually. Each document was closely read, marking up the use of the key terms (and their synonyms) to gain a direct and overarching understanding of how these issues were dealt with in the literature collated. Extracted statements were then analysed to identify, for example, what benefits were claimed as arising from the involvement of members of civil society in decision-making about innovative public services in SCIs under scrutiny. In this example, the extracted texts were searched for mentions of 'benefits' – or their near synonyms 'results, advantage, merit, strength, value and impact'.

While scrutinising the texts, the focus was on preserving what those reporting on SCIs themselves said that they were intended to do, rather than attempting to impose any predetermined framework, performance measures or indicators on them – an approach informed by social constructionism (as initiated by Berger and Luckmann, 1966), and reinforced by grounded theory (Charmaz, 2005), where research methods are focused on generating analytical frameworks and categories through inductive analysis of data gathered directly from the participants under scrutiny. The aim here was to let the authors reviewed speak for themselves – and then to comment critically on the extent to which their reports of their SCIs provided sufficient evidence that they had achieved what they said they had set out to deliver. What the authors of these publications had to say about the issues under scrutiny is shown as verbatim statements: (see metadata available on request from authors).

The original intention was then to identify what 'evidence' these remaining 7 publications contained about achievement of their purposes. The plan was then to examine their texts to see if they reported attempting to assess whether there was any causal relationship between the outcomes of SCIs and the implementation of the QH. For synonyms of 'causal' relationship, the terms used were 'causality, causative, cause, effect, determining, resulting'. Accordingly, the results/discussion/conclusion sections of the 7 publications were examined for mention of 'benefits' and 'outcomes' (plus synonyms) and about 'evidence' and 'causal relations' (plus synonyms).

4 Analysis and results

The following analyses are based on the statements extracted from the 7 publications whose contents were analysed in detail. These extracts were located using key identifiers, described above, as drawn from the previously listed research questions.

Theme 1. Use of the quadruple helix as a descriptive term

All 7 of the publications examined in detail used QH as a descriptive term. But they did so for different purposes and with contrasting emphases. For example, Borghys et al. (2020:2) did so

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dismissively, focussing on "quadruple helix thinking" as the basis for what they labelled as "the current smart city rhetoric". They used this latter phrase, they suggested, because:

> "While the quadruple helix concept continues to be promoted in the smart city discourse, the examples of impactful cases that positively influence services provided to citizens are few and far between."

In de Bruin's thesis (2017:3), QH was embedded in her research question as a descriptive term for identifying the range of actors to be interviewed. Four types of actors were identified (p. 38), although actual citizens involved in certain smart city projects were not presented which the author described as "a significant shortcoming".

Borkowska and Osborne (2018:359) were more acceptive of the value of the term. They used it as a descriptor for linking top-down and bottom-up approaches to innovation since, they argued:

> "(QH) ... recognis[es] that civil society plays an active part in the innovation system .... [as] a driving force with the capacity to move innovation from a narrow focus towards becoming a tool for addressing urban challenges in a sustainable manner."

Gasco-Hernandez et al. (2020:420) also accepted the QH 'model' at face value, precisely because "... [it] stresses the role of citizens in the development of smart cities". Like de Bruin, Paskaleva et al (2021:396) also used QH as a descriptor for identifying the stakeholders to be involved in assessing smart city innovations, arguing that "...involving QH stakeholders in co-producing impact assessment improves the ability of projects to deliver and measure impacts that matter to cities and citizens". Like de Bruin, de Sousa (2020:72) used QH as a key identifier term in his PhD where he used it to select which living labs cases to examine and as a guide to implementation of quadruple-helix procedures. Suzic et al. (2020:2) also used QH descriptively, expressly stating that:

> "Quadruple helix is a terminology that describes a model of how university, industry, government and citizen interact as equal partners in a knowledge-based society",

as well as claiming that:

> "For the implementation of this co-creative process, we argue that using a quadruple helix approach can be a possible solution for transforming cities through systemic innovation." (p.1).

The brief extracts listed above indicate that all the authors of the publications examined in detail used QH as a descriptive term. However, the emergence of two distinct camps amongst them can be discerned. In one, (5/7) authors used the term neutrally or promotionally, seemingly accepting it at face value. In the other, (2/7) authors distanced themselves from such promotion on the grounds that the claims being made for involving the fourth helix in smart city innovations have yet to be demonstrated.

Theme 2. Use of the quadruple helix as an analytical category

With one exception, all the publications examined in detail (6/7) contained claims that the QH had been used with analytical intentions. However, the purposes they suggested for applying this analytical category were disparate. For example, Borghys et al. (2020:5) argued that QH can be used by local governments for "critical self-reflection" arguing that:

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> "The need for this constant reflection in urban innovation is what ties platformization and quadruple helix thinking together ... influencing [cities'] view on collaboration, especially with regard to the role of technology in society or processes of innovation."

Borkowska and Osborne (2018:355) also reported the use of QH for analytic objectives. They used the quadruple helix model as:

> "... a starting point and develop an analytic framework composed of four strands: (1) supporting participation of citizens in decision-making; (2) implementing technological innovation which positions citizens as active users; (3) implementing technological innovation to benefit the community; and (4) evaluating technological innovation in the light of the experiences and needs of citizens".

Gasco-Hernandez et al. (2020:421) framed the place of QH in their research question analytically, asking "What is the potential role that public libraries may play in a quadruple helix model of smart city development?" And their case study of the Chattanooga Public library led them to conclude that:

> "... it seems legitimate to suggest that further research is needed to expand our understanding of the quadruple helix model from a double perspective: first, by analyzing the fourth helix and, therefore, the set of actors (both individual and organizational) that are not represented by the three other helixes and, second, by spaces of interaction, exchange of information and collaboration among the four helixes." (p. 422).

Paskaleva et al. *(2021*:397) explicitly argued that the QH model can be employed analytically, in their case for undertaking impact assessments, stating that:

> "We provide a connection between QH innovation and impact assessment at the project level. This is a relevant topic to both academic researchers in smart city and assessment studies, especially in terms of methodology, and to policy-makers keen to incorporate evidence to demonstrate the societal impact of their work."

Assessment was also the stated purpose of employing QH in de Sousa's PhD (2020:13) where he used it to " ... assess the living lab's contribution to smart cities from a quadruple-helix perspective" "... to unveil answers to our primary goal to gain awareness of how living labs enhance smart cities." (p.62). Suzic et al. also reported (2020:1) that the purpose of their study was to increase understanding, in their case "... on how quadruple helix urban innovation strengthens competitiveness of regions [in Central Europe] by improving its local smart areas." The authors argued that using the QH **"**... provide[s] a conceptual framework for managing such collaborative environments, where symbiotic relationship between innovation actors is taking place."

Almost all of the publications (6/7) reported above signalled that they had used the QH with some kind of analytical intent. Just one did not. For, although QH appears in its title, it was not part of the analytical framework employed in De Bruin's thesis. Instead, in her study of Dutch Smart Cities, she employed (2017:13) an analytical framework that did not include the QH but was instead grounded in the concept of urban governance.

The brief extracts listed above illustrate that it was common, but not universal (6/7), amongst the publications whose contents were subjected to detailed scrutiny for authors to claim that the QH had been used to support a variety of analytical ends. However, as shown below, little evidence was offered about precisely how it had been applied to pursue these.

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Theme 3. The involvement of members of CS in decision-making about smart city innovations

All seven of the publications discussed, to varied extents, the involvement of CS members in the cases or projects they reported. This is unsurprising because, as Borghys et al. (2020:1) noted:

> "The predominant rhetoric in smart city debates puts the emphasis on collaboration. Conceptualizing, designing, implementing, validating, and evaluating solutions to urban challenges with all relevant stakeholders around the table are perceived as the optimal modus operandi in these perspectives."

But, they also added that when cities involved in SCIs:

> "... are asked to operationalize quadruple helix collaboration, they mostly refer to living lab setups, structural and ad hoc meetings with different stakeholders, or triple helix projects. Although this [QH] approach has been touted as the best modus operandi in so-called smart city projects, in most cases, cities remain disillusioned with the results of their efforts. Very often, practical and budgetary concerns are the most important bottlenecks, together with limited knowledge of the often technical topics, uncertainty on how to allocate budget to these initiatives, the goal of the collaboration being insufficiently clear." (p. 4).

As a consequence, they reported (ibid), cities would "... much prefer other actors to take up this coordinating role." Likewise, de Bruin (2017:37) also raised a note of caution, despite decision-making processes in the Netherlands being characterised by:

> "... [the Dutch] polder model ... which emphasises a strong desire for consensus, in which it is important that all parties are heard." For, as she reported, in the cases she examined, there was an "apparent lack of citizen viewpoints" which she said was "mitigated by engaging four citizen-oriented NGOs, and one citizen-oriented start-up."

This led her to conclude that "... further research should include the citizen view of the quadruple helix actors by investigating a population of citizens involved in smart city projects" (p.38).

Borkowska and Osborne (2018:363) also acknowledged that:

> "Civil society is often seen as a sector that lacks the political power and authority of government and academia and the economic power of industry .... Nonetheless, it is recognised that without the involvement of local communities, urban challenges cannot be fully addressed."

Despite this, they reported that in the Glasgow Future City Demonstrator Initiative:

> "... while gathering complex information that aimed to benefit the city, [it] largely ignored citizens' involvement, participation and common purpose at the level of decision-making."

Indeed, they further argued that the Initiative's "... top-down rhetoric of smart urbanism was framed to satisfy the funder; consequently, the technological visibility of proposed interventions

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overshadowed the principles of community development, regeneration of neighbourhoods or building community cohesion." (p.365).

Gasco-Hernandez et al. (2020:419) stressed that the Chattanooga Public Library project was committed to a) developing smart citizens by b) enabling citizen participation through c) providing an innovation environment. But they provided no information about if and how such participation was enabled or what it achieved. Paskaleva et al. (2021:400) identified that:

> "Citizens might play a spectrum of roles in a smart city. At the deeper and more engaged end, these range from providing feedback on project proposals, directly proposing visions and ideas, participating in decision-making and playing an empowered role as a co-creator."

But, in spite of arguing that their paper "... shows how the QH approach fared on the ground in local projects with an explicit people-centric commitment to tackling urban problems and improving public service delivery through ICT and data analysis" (p.409), they too did not provide a detailed analysis of how such deeper engagement was achieved in any of the three cases they examined.

De Sousa (2020:64) agreed that engaging citizens in !"groundbreaking processes" is a central issue in the QH model since "... citizens aggregate as co-creators of products and services implemented in urban life." In investigating what he called 'the elusive concept' of smart cities, he asked his interviewees "Did the local citizens play a role or offer contributions to the incubated projects? If so, could you highlight some examples?" (p.81). From their answers, he concluded that "... in the three Brazilian Living Labs considered in this study the society or citizens are not co-creators of the innovations. Rather, they are just members involved in the experiments to provide feedback without participating in their design or having a voice in the process." (p.86)

Suzic et al. (2020:1) subscribed to the view that **"**Quadruple helix innovation systems provide a conceptual framework for managing such collaborative environments, where symbiotic relationship between innovation actors is taking place." And they reported that the nine city regions they examined "... developed in close collaboration among diverse stakeholder groups covering all four helices." Yet, despite their emphasis on benchmarking in which "... the collaborative process was evaluated and lessons learned shared through knowledge transfer" (p. 4), they did not detail how, or if, stakeholders were, in practice involved in this.

The extracts listed above illustrate that it was universal for the authors scrutinised to draw attention to the importance of the engagement of stakeholder groups, especially members of civil society, in the activities they reported. However, as previously, the authors can once again be seen to fall into two groups. There are those (2/7) who endorse this principle but remain silent on how it was practised in the cases they reported. And there is a second larger group (5/7) who disagreed, explicitly suggesting that, in practice, CS members were not involved in decision-making about SC innovations in the cases they recounted.

Theme 4. Benefits to members of CS from engaging in decision-making about smart city innovations

It is unusual for the authors of the examined publications to remark on the benefits accruing to CS members from their participation in the innovation activities described. Indeed, this is a topic on which there is a surprising silence. For instance, Suzic et al. (2020) make no mention of any specific benefits generated in the nine small-medium sized urban regions involved in SCIs which they examined in Central Europe. Borghys et al. (2020:4) described examples of 'innovation setups' in the Flemish cities they examined. But they did not report the nature of these projects,

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the innovative solutions flowing from them, nor any benefits to CS members from being involved in them.

De Bruin (2017:10) too made no mention in her thesis of benefits accruing to CS members. She limited her comments on this front solely to private sector members of the QH:

> "... within the corporate sector there is significant uncertainty about how "smart" in smart cities might be developed, what role it should play in corporate strategy and what its potential benefits and profitability are in an urban context."

Gasco-Hernandez et al. (2020:431) did refer to benefits to CS members, but restricted these only to those actually involved in the innovation process itself stating that:

> "Our findings ... show that the CPL [Chattanooga Public Library] may be considered part of the fourth helix civil society actors with the key role of contributing to the development of smart citizens through training and education programs thus enabling their participation in city issues. As part of the fourth helix, the CPL is building the knowledge that citizens need to participate in smart city development—that is, to be democratic participants, cocreators, and ICT users in smart cities."

But, beyond these claimed educational gains, they remained silent about how CS members benefitted from any intended concrete outcomes generated by such participation.

Other authors adopted more skeptical stances. For example, Borkowska and Osborne (2018:360) specifically referred to using:

> "... four indicators to evaluate the benefits (if any) of introducing the fourth helix into technological initiatives", one of which was "... supporting participation of citizens in the process of decision-making (e.g., through traditional methods such as surveys and interviews, with dialogue events including virtual forums, events and living lab environments)." (p.368).

They observed that:

> "Whilst in theory, a wide range of innovations became accessible to individual citizens and organisations, in practice, these have limited [undisclosed] benefits to citizens if not supported through the provision of learning opportunities."

This led them to conclude (ibid) that:

> "It is clear that for smart city initiatives to be translated into social and economic benefit, there needs to be a focus on learning that pervades everyday life; not only do citizens have to be actively engaged, they also need the means to support the effective use of the new smart technologies if they are to improve the quality of their lives",

a focus reportedly missing in the cities they studied.

Of all the publications scrutinised in detail, Paskaleva et al. (2021:398) focused most explicitly on the issue of who benefits from involvement in smart urban innovations because, the authors said: "... it is vital to get a comprehensive understanding of the impacts of these projects on people, places and city challenges. Such projects tend to struggle to articulate social benefits." From their study of 27 European smart city demonstration projects, they concluded (ibid) that:

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> "Of the detailed case studies found on smart cities initiatives that discuss their benefits, none of them offers information on how and if these benefits were accounted for as well as the type of assessments undertaken."

This led them to argue that:

> "The lack of concrete evidence raises fundamental questions about the benefits of 'smart' to the city and its residents, and prompts the need for new modes of cross-sectorial collaboration, problem-solving and Quadruple Helix governance models to design and manage smart cities." (p. 396).

They concluded that such governance models are needed in order to put "... citizens to the front in evaluating technological innovation and benefits from smart city actions, as they can be the first to define urban life and opportunities and their participation enables social inclusion and learning." (p. 400). In his PhD, de Sousa (2020:44) also recommended caution about accepting the benefits arising from innovations generated by SC initiatives, suggesting that:

> "Although there is uncertainty about the outcome of smart cities, governments everywhere in the world are investing vast amounts of money even though they do not know precisely their practical results."

He argued that "The main question that remains unanswered is the actual outcome of smart cities, explaining the benefits to the stakeholders." (p. 51).

The extracts above reveal similar divisions to those seen previously. Some authors (4/7) appear to have felt no need to unpack the benefits arising from attempting to implement the QH – as if these could be taken for granted. Only 1/7 pointed to named benefits, suggesting that these consisted of the increased knowledge of stakeholders who had directly taken part in SCIs in question. Other authors (2/7) were more critical, pointing to the lack of confirmation that claimed benefits have actually been achieved in practice.

Theme 5. Empirical evidence offered that involvement of CS members affected outcomes of SCIs

This aspect of the performance of SCIs scrutinized was under-reported in the publications examined. There were authors who were clearly aware of the need for evidence to underpin the claims about CS engagement being made for SCIs in general, and for those operating under the banner of the QH in particular. For instance, Borghys et al. (2020:2) commented that:

> "The idea of participation is not new but gained momentum as evidence of the so-called "participatory turn" associated with the Web 2.0, offering users an easy-to-use creative infrastructure to actively engage in digital development practices".

But, they argued (ibid) that:

> "...the growing theorization and body of empirical evidence that engages with "platforms," particularly in media studies and geography, tends to focus on (often, rigid) accounts of power that seem to downplay or exclude users (or, citizens) and the significance of the surroundings in everyday life",

but without signposting to where this 'body of evidence' can be found. Despite this, they claimed that those who operate the 'platforms' used in SCIs:

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> "... have proven exceedingly successful in attracting citizens to create value on both (and multiple) sides of the platform .... these privately operated platforms do succeed in generating user involvement, be it by recharging e-scooters at night, renting out their apartments, or reporting accidents on their routes." (p. 5).

However, it is unclear from their paper on what these claims are based. But they did add a note of caution, stating:

> "... a more critical approach is [would be?] potentially beneficial in this context, as quadruple helix collaboration is more likely to be sought out only when it is relevant to all involved stakeholders, [so] increasing its potential impact."

Borkowska and Osborne (2018:360) were unusual in being explicit about the evidence base of their paper – content analysis of secondary documents recording the Glasgow Future City Demonstrator. Their analysis led them to conclude that "Glasgow's rhetoric of smart urbanism, while aspiring to problem-solving, devalues certain principles of human agency" (p. 355). They examined the documents for involvement of the fourth helix in the Demonstrator – considering how citizens participated in decision-making, how communities benefitted, and how the initiative was evaluated. This examination led them to conclude that:

> "... there has been limited civil society and citizen involvement. There has been little evidence of involving civil society actors in a truly bottom-up approach, which distinguishes the quadruple from the triple helix." (p. 368).

While acknowledging that "... participation can help citizens to appreciate the complexities of urban transformation and feel greater ownership of the outcomes", they stressed (ibid) that:

> "... the importance of our analysis lies in the acknowledgment that soft factors, such as community engagement and empowerment through learning, have to be accounted for in smart city developments to ensure sustainable outcomes." (p. 369).

This they regarded as particularly important because:

> "Glasgow's biggest challenges relate to social equity and linked outcomes, notably class-related disparities in health and employment in different parts of the city. Possibly, technological solutions have been overstated and have little capacity to deliver significant change."

The term 'evidence' is surprisingly missing from de Bruin's own account of the work undertaken for her 2017 thesis. It occurred there only once. And then it was used not by her but by one of her 19 interviewees – (four from knowledge institutions, four citizens, five private and six public sector actors). An interviewee from a knowledge institution responded to one of her interview questions saying:

> "Complete nonsense! There is clear empirical evidence that this is not always the case. It is not the number of rules which hinders innovation, but a lack of knowledge as to how to use these rules in their field." (p. 16).

Gasco-Hernandez et al. (2020) were also silent on this topic. The term 'evidence' – and its synonyms – are entirely missing from their paper. This is also the case in Suzic et al.'s 2020 paper about benchmarking performance in Central European SCIs. Despite reporting that:

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> "... the collaborative process was evaluated and lessons learned shared through knowledge transfer, with the goal to ensure sustainability of quadruple helix urban innovation solutions in wider regional and smart specialization milieu" (p. 4),

they neither shared the evaluations they had made, nor what they termed the lessons learned.

In his PhD, de Sousa (2020:30) concluded that there is "Little empirical evidence regarding the benefits of smart cities on the environment and sustainability exists." Paskaleva et al. (2021:396) were highly critical of this stark gap in reports of SC initiatives – which they termed a 'deficit of proof':

> "Cities are increasingly expected to bring urban stakeholders together to deploy smart solutions that address urban challenges and deliver long-term positive impacts. Yet, existing theory and practice struggle to explain how such impacts can be achieved, measured or evidenced."

They reported that:

> "Of the detailed case studies [we] found on smart cities initiatives that discuss their benefits, none of them offers information on how and if these benefits were accounted for as well as the type of assessments undertaken. [None that] report on the desired and achieved benefits of projects ... provide evidence that proves the validity of the reported benefits." (p. 398).

This led them to conclude (ibid) that:

> "The lack of concrete evidence raises fundamental questions about the benefits of 'smart' to the city and its residents, and prompts the need for new modes of cross-sectorial collaboration, problem-solving and Quadruple Helix (QH) governance models to design and manage smart cities."

Once again, the extracts reported above reveal similar groupings to those seen for previous themes. Some of the authors (2/7) scrutinized appear to have felt no need to provide evidence to substantiate claims being made for SCIs operating under the banner of the QH. However, a larger group (5/7) were more critical. They pointed to a deficit of proof about the performance of these SCIs, noting that there is a lack of evidence that the benefits and outcomes claimed for them have actually been achieved in practice.

Because of the small number of publications explored in detail above, the other 41 sources identified by our key word searches as also using the terms Quadruple Helix and Smart City were also explored. One or other of these key terms was employed in different combinations in titles, key words, abstracts, and texts (see metadata available on request from authors). They were used for quite different purposes. QH was presented as a "reference model", a way of "thinking", an "approach", a "perspective" or "theory" in conference papers (e.g. Klasinc, 2016; Schiavone et al., 2020; Van Waart et al., 2015). It occurred in introductory texts or in abstracts about specific cities' initiatives (Bee Smart City, 2020). It was identified as being present in cities' policy statements (Zakengids, 2022). And it was variously referred to in academic publications for the purposes of: a) communication among actors towards next smart city developments (Alexopoulos, et al., 2019; 2022); b) democratisation of decisión-making (Calzada, 2020); c) acting as a vehicle for introducing innovative partnerships for citizen's integration and participation (Abda'oe and Swadhesi, 2017; Clement et al., 2022); and d) for supporting smart city design (Kuzior & Kuzior,

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2020). However, none of these authors discussed any concrete benefits to CS members arising from being engaged in such decision-making. Nor did they offer any empirical evidence that involvement of e CS members had affected the outcomes of the SCIs they reported as meeting citizens' aspirations. Vallance et al. (2020), who claimed to have illustrated key features of the QH framework for supporting processes of interactive knowledge co-production and systemic innovation, did not report the practical outcomes or added value to innovation processes arising from involving CS members in decision-making. The RiConfigure project, funded under the EU's Horizon Europe research and innovation programme, focused on the 'collaboration dynamics' of QH in smart cities. This project was claimed (RiConfigure, n.d.) to provide new evidence for policymakers about the do's and don'ts of supporting new forms of collaboration. Yet, despite this claim, no actual benefits of adopting a QH approach for making decisions about innovations were reported despite QH being promoted as having the potential "to help address grand societal challenges".

The findings of the study unearth a myriad of practices to involving citizens in decision-making about SCIs, yet they also point to the co-existence of common approaches to involving QH visions and approaches in smart city innovations. The results have been thematically analysed and synthesised to provide insights and learning about the effectiveness of the process, highlighted below.

5 Conclusion

This paper is based on a detailed review of literature on SC initiatives that have operated under the QH banner. Publications were examined to determine a) what evidence has been reported about the application of the QH approach to the participation of members of civil society in decision-making about urban innovations and b) what effect, if any, this participation has had on initiatives' outcomes.

Perhaps because of the comparatively recent introduction of the notion of the QH to theorising about smart cities, there does not yet appear to be a standardised or generally accepted definition of who comprises the fourth helix. Instead, this term seems to have the status of a catch-all for an undifferentiated (social, economic and political) space that represents those 'community' interests that lie outside (or perhaps stand in opposition to) of those of government, business or academia.

Despite this vagueness, the QH has been promoted, especially over the past five years, as a means of increasing the engagement of members of civil society in SCIs. In this paper we have sought to uncover whether the literature in the public domain, recounting SCIs that have been reported as operating under the QH banner, contains empirical evidence validating the claims made for including the fourth helix in urban innovation. The findings reported above allow an answer to the main query pursued in this study: *Is there evidence in the public domain that promotion of the quadruple helix approach has increased the involvement of members of civil society in decision-making about urban innovation in smart cities initiatives?*

Based on the analysis reported above, a concise but not conclusive answer can be given to this question. The verdict is negative. There isn't currently evidence in the public domain that deployment of the QH perspective has increased CS engagement. Despite systematic trawling of academic and grey literature, scant published evidence has been found reporting the practical implementation of the fourth helix, let alone about its impact on decision-making in pursuit of smart city innovations. However, this judgement cannot be conclusive because 'absence of evidence is not evidence of absence' (Housman, 1891). There may be information about this and

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hence about relationships between QH and stakeholder involvement in decision-making and its impact on innovation outcomes that have yet to be publicly reported.

Behind this verdict lie three deeper and more important questions about how the term 'Quadruple Helix' has been used on smart city initiatives. First, has the introduction of the fourth helix been an implementation instruction that requires further empirical investigation as a means of uncovering what really happens in practice when civil society actors are invited to take part in initiatives designed to produce smart city innovations. Second, has it been offered just as an abstract model intended to act as a metaphor for shining a light on how the dynamics of decision-making are intended to occur in the conduct of multi-stakeholder innovations. And third, has it been employed as a rally crying in the promotion of smart city initiatives by seeking to ally them with what is currently deemed good practice in innovation management? A positive answer to last of these questions has been demonstrated by the results reported in this paper. Answering the other two requires further investigation.

In focusing on how adoption of the Quadruple Helix impacts civic engagement in urban innovations, this paper has made two significant contributions to this field. Firstly, we have shown how the Quadruple Helix innovation approach is held to be a basis for smart city projects to be capable of delivering practical benefits for members of civil society. In doing so, we present a synthesis of current QH and smart city innovation literatures to argue that QH approaches have to be adopted in the front-end research design of such initiatives and that subsequently, sufficient attention has to be given to reporting on their implementation and to evaluations of what they have achieved in practice. Our findings suggest that adopting QH may increase the involvement of members of civil society in decision-making in smart city innovations. But the paper also indicates that, to date, literature in the public domain on QH in SCIs is weak on reporting that successful engagement of members of civil society has, in practice, affected innovation outcomes. As a result, the actual effects of involving the fourth helix – members of civil society – in SCIs remains an under-researched area. It has yet to be demonstrated what, in practice, SCIs operating under the banner of QH have accomplished in terms of improving the engagement of civil society members in decision-making about smart city innovations.

The results of the investigation reported suggest that, despite its heavy promotion (Paskaleva and Cooper, 2022), there is a deficit of proof available about the performance of, and outcomes from, SCIs conducted under the QH banner. Neither the practical significance of involving the fourth helix in decision-making in SCIs, nor the 'benefits' delivered from doing so, are currently unpacked in the literature. This is only partly due to the dearth of published evidence about these issues. The lack of reported effects of the quadruple helix on civic engagement in smart city initiatives is compounded by the inadequate research design adopted for such initiatives, especially by the insufficient attention given to reporting on their implementation or to evaluations of what they have achieved in practice The paper's significance arises from breaking new ground in what ought to be a central concern not just for those who fund SCIs but for those who manage and report them, as well as for those who research their efficacy.

As Vallance et al. (2020) warned, the success of smart city innovations conducted under the QH banner should not be taken as given. Evidence about the efficacy of this approach is needed if the field is to grow robustly. We especially encourage scholars to engage in research focusing on how to involve citizens in how to create smart cities through democratic decision making. As Kummitha (2019) argued, we believe that research questions focused on this issue can serve as trigger for a much needed push in augmenting our knowledge concerning the role of QH plays in smart cities.

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Because if its emphasis on achieved effective citizens' engagement in SCIs, our study can be used by policy makers and practitioners involved in managing smart city innovations to highlight the need to design not just their initial engagement practices but how they subsequently intend to involve citizens in decision-making throughout their engagement in the implementation and evaluation stages of urban innovations under the banner of QH. The findings of this paper can also be of value to those actors, including members of civil society, seeking to participate in smart city innovations. It can add to their understanding of their role and effects of their engagement in decision-making so that is capable of delivering distinctive benefits for both a city and its citizens. Movement in this direction will require managers of SCIs to reconfigure what they take to be the underlying role and contribution of civic actors in the Quadruple Helix and to reassess their potential impact on such initiatives (as raised by Paskaleva et al., 2021).

Limitations and further research

This study needs to acknowledge a limitation. Although the above analysis is based on extensive and systematic data collection and analysis, not every published source in this burgeoning field could be covered. A selection strategy was adopted intended to single out publications focused directly on the relationship between QH and SCIs. Publications were only chosen for analysis if both terms occurred in their title. However, this did not guarantee that such articles did discuss either QH or whether it improved stakeholder engagement in SCIs. It is possible that there are articles, without both phrases in their titles, which do contain such discussion. However, it is not clear what research design and search strategy would be necessary to winnow them from the myriad and constantly growing number of articles in this field. And, equally difficult, how could unpublished reports covering the relationship between QH and stakeholder engagement in SCIs be identified for scrutiny?

Hopefully, precisely due to its limited ability to draw incontrovertible conclusions, this study will inspire more empirical investigations for understanding the performance of SCIs and the extent to which they deliver the benefits claimed for them. The scope of future research on SCIs operating under the QH banner needs to: (a) include the precise characterisation of members of CS involved in SCIs; (b) provide evidence about the level of their engagement in decision-making about SC innovations; and (c) examine what benefits, if any, have been achieved through such engagement.

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7 Appendix

The literature review metadata is available upon request. Readers who wish to access this material should send their requests directly to the authors.

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