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ORIGINAL RESEARCH

Leadership of urban digital innovation for public value: A competency framework

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Abstract

Leading digital innovation projects in smart cities requires the right human resources with the right set of competencies. Such requirement is challenging because city managers and built environment professionals are traditionally trained and work in disciplinary and professional silos. This results in a lack of knowledge, abilities, and tools to produce optimal outcomes for communities across multiple sectors. Guided by a socio-technical and multidisciplinary approach, the DC2-CF framework is proposed to help urban planners identify, develop and expand the competencies they need to effectively steer responsible digital innovation and ensure public value creation. The DC2-CF proposes a digital innovation process model to facilitate the delivery of successful urban digital innovation projects based on the lessons learned from working with city digital leaders. In addition, the DC2-CF provides a delivery structure which identifies specific tasks, competencies, and roles necessary to enable the use off the innovation process model in practice and break down the professional silos currently existing in cities. The framework is envisioned to assist city planners in fostering leadership capacity in local authorities and the private sector in digital city development, contributing to enhancing collaborative working and effective public value creation.

KEYWORDS

competency framework, digital innovation, multidisciplinary, smart city, socio-technical perspective

1 | INTRODUCTION

Cities are required to transform rapidly to respond to complex urban problems and challenges (e.g. climate change, traffic congestion, cost of living, poverty, social exclusion, and inequalities) [1]. Many cities have embraced the smart city label as a global perspective to articulate their transformation [1, 2]. They can take advantage of the integration of emerging digital technologies with urban infrastructures to develop urban digital innovations that help respond to and tackle these problems [3, 4].

Smart cities and their infrastructures are complex and interconnected socio-technical systems [5, 6]. The development of such urban environments is a dynamic change process that involves socio-technical transitions and incremental improvements [7, 8]. Digital innovation is the use and implementation of digital technologies to respond progressively to existing urban problems and challenges (e.g. mobility, energy, water supply, security, housing deprivation, and inclusion) [9, 10].It is a disruptive and continuous process that innovates public services and organisational processes using digital technology platforms to meet the needs of residents, visitors, and local businesses [11, 12]. Digital innovation has the potential to address urban complexity by supporting the development of cities' policy, governance, and management as well as their infrastructure planning and design [13]. Digital innovations use urban data to enable informed decision-making to enhance city planning, management, and public service delivery. Achieving these benefits from digital innovation projects requires the right human resources with the right set of competencies. Such requirement is often challenging to

meet because professionals in public policy and infrastructure management are traditionally trained and work in disciplinary and professional silos. This results in a lack of knowledge, skills, and tools to produce optimal outcomes for communities across multiple sectors [13–15].

Leadership is one area that has faced strategic challenges with the development of smart cities [3]. In particular, there is a need for city planners and built environment professionals with an interdisciplinary background to bridge the technical, societal, and operational aspects of cities and their supporting infrastructure [16]. Policy-makers, industry and academia have recognised the necessity for re-shaping existing roles and competencies required to successfully lead the delivery and implementation of responsible digital innovations in the built environment [13–15]. However, a comprehensive set of interdisciplinary competencies and roles to foster leadership capacity and public value creation through responsible innovation are still missing. These gaps lead to siloed training which is incompatible with the requirement for the cross-disciplinary professional roles needed to deliver responsible digital innovations in the urban built environment.

This paper proposes the DC2-CF, a framework to help city managers and built environment professionals to plan and develop the competencies they need to lead responsible digital innovation. The DC2-CF is one of the main outputs of Digital Cities for Change (DC2),[1] a 5-year flagship project which has been applying a socio-technical approach for identifying competency gaps in the planning, delivery, and evaluation of digital-city projects. This study adopted a qualitative methodological approach in which data was gathered and analysed from multiple sources, including qualitative case studies, literature review, and workshops with a wide range of participants. We draw on key components from various studies [17–19], to define a competency as 'the repertoire of knowledge and abilities describing how an individual should effectively function in a specific role to create public value with responsible digitalisation in the urban built environment'.

As a result, the DC2-CF is designed as a Digital Innovation Process (DIP) model and a delivery structure based on tasks, competencies, and roles to underpin the DIP model. The results will help city managers to identify the knowledge and abilities that enable socio-technical innovation of urban systems by providing a more comprehensive, multi- and interdisciplinary understanding of the required competencies. Moreover, the DC2-CF sets the foundation for designing and delivering educational material following an interdisciplinary approach to help break down the professional silos that currently exist in cities. The usefulness and practicality of the DC2-CF will be validated by conducting semi-structured interviews in multiple case studies addressing various types of digital innovation projects.

The remainder of the paper is organised as follows: Section 2 introduces relevant related work. Section 3 presents the methodology followed by this study and Section 4 details the proposed competency framework DC2-CF. Section 5 illustrates the use of the DC2-CF and Section 6 presents its validation. Section 7 discusses the main findings and Section 8 concludes the paper.

2 | RELATED WORK

Competency Frameworks (CFs) are becoming an important instrument for capacity building, formal education and training, recruitment support, and everyday life in urban built contexts. The Digital Competence Framework for Citizens (DigComp) [20] aims to improve citizens' digital competence and help policy-makers support digital competence building. DigComp has been adapted and often specified to set the relevant digital competence and proficiency levels for a given target population or policy and strategic use. Ministries of education and training and other related agencies at national and regional level have been among the early adopters of DigComp. Policy-makers also develop digital competence in employment, economic development, public administration, information society, and digital agenda. European policy experiences include DESI, ESCO, Europass, DigCompConsumers, and Digital Skills and Jobs Coalition [21]. Whilst a few CFs focus on specific digital tools and platforms such as Digital Twins and Building Information Modelling (BIM) other empathise the governance aspects of cities.

In particular, the Skills and Competency Framework [18] aims to support the development of the Information Management Framework (IMF) and the National Digital Twin (NDT) in the UK guided by the Gemini Principles [22]. It defines the business (e.g., adaptability, business analysis, collaboration, and transformational leadership) and digital skills data fundamentals, lifecycle assurance & quality management, data modelling, analytics and intelligence, and security and ethics needed to develop and adopt the IMF to support the goal of the NDT. This CF also proposes specific roles for the adoption of these programmes at both an organisational level (e.g., cyber security specialist, data architect, data consumer, and process modeller) and the national level (e.g., policy maker, business analyst, industry leader, data regulator, and sector regulator). The framework highlights additional roles needed to address these digital innovation projects in the urban built environment (e.g., data quality analyst, enterprise architect, process owner, and user researcher). Refs. [16, 23] focus on BIM technologies and present CFs for local government to assess and redefine the competencies (e.g., communication, leadership, business management, process management, people management, and technology management) of built environment professionals.

The European e-Competence Framework (e-CF) [24] provides a reference of 40 competences as required and applied at the Information and Communication Technology (ICT) workplace, using a common language for competences, skills and capability levels that can be understood across Europe. As the first sector-specific implementation of the

[1] Digital Cities for Change (DC2)–https://www-smartinfrastructure.eng.cam.ac.uk/projects-and-case-studies/dc2-digital-cities-change

European Qualifications Framework (EQF), the e-CF was created for application by ICT service, user and supply companies, for managers and human resource (HR) departments, for education institutions and training bodies including higher education, for market watchers and policy makers, and other organisations in public and private sectors. With a specific focus on skills for innovation, ref. [17] proposes the Core Skills for Public Sector Innovation in order to improve the competencies of civil servants to enable innovation in public sector organisations. This framework provides six competency areas (e.g., iteration, data literacy, user centricity, curiosity, storytelling, and insurgency) to support increased levels of innovation in the public sector. A more comprehensive review of existing competency frameworks for the urban built environment and their common characteristics from a socio-technical perspective is presented by Bastidas et al. [25].

To the best of our knowledge, only a few CFs focus on leadership capacity, and value creation is conceived primarily as value created through urban data platforms rather than public value created with responsible digitalisation in the urban built environment. Additionally, existing CFs consider the digital and governance aspects of cities, missing the ethical and responsible innovation aspects to mitigate social harms. This leads to a lack of interdisciplinary competencies and roles to lead sustained digital innovation and effective public value creation.

3 | RESEARCH METHOD

Drawing inspiration from refs. [26–28], this research follows a qualitative research approach which has been carried out in four phases over 5 years. Figure 1 depicts an overview of the research method applied to the current research and illustrates a flowchart of the research process along the outputs of each phase.

Phase 1 Identify Problem constituted reviewing relevant literature. The first review focused on understanding the potential value, shortcomings and limitations of 'smart' and 'digital' city approaches. The review showed that, in built environment disciplines, the discourse on smartification and digitalisation in cities is, to a large extent, dominated by a focus on technology deployment and driven by supply-side considerations. This helped establish the gap for a much-needed a socio-technical perspective that places the demand side, and societal considerations and challenges, on par with the technology-focused and supply-side-driven approaches. This review is summarised in Ref. [11]. Guided by the sociotechnical view, the second review mapped out the three (digital and technical, governance and management, and ethics and responsible innovation) dimensions of smart city projects, and identified competency gaps related to them. As part of this review, 22 competency frameworks were identified, uncovering 27 competency areas in the: Digital and Technical (10), Governance and Management (13), and Ethics and Responsible Innovation (4) dimensions. The review highlighted the lack of frameworks: (1) underpinned by a sociotechnical understanding of digitalisation initiatives and (2) that consider all three dimensions in addressing competency gaps among city managers and built environment professionals engaged in the delivery of digital innovation projects. This review is summarised in ref. [25].

Phase 2 DC2-CF Design and Develop involved two steps. First, a qualitative case study examining a Cambridge City-scale Digital Twin prototype [6] for the Cambridge city region to identify the overlapping nature of the three dimensions

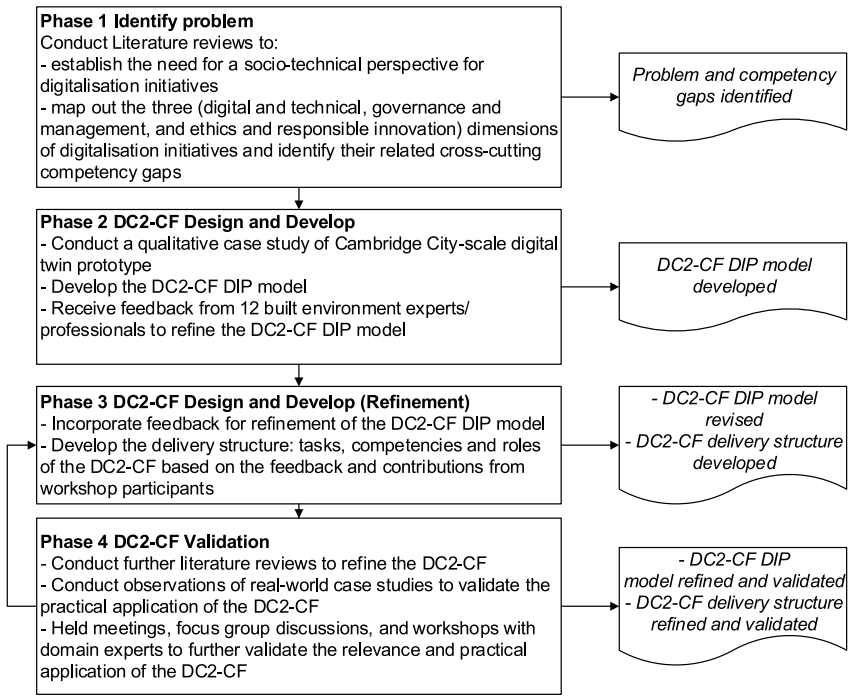

FIGURE 1 Flowchart of the research method and phases followed and adopted in this study.

identified, the multiple parties involved in city management, and the gaps in terms of competencies. Conducting this case study was also relevant for assessing the relevance of taking a socio-technical perspective on the design and deployment of digital technologies for improved city planning, management, and services. Second, developing the first version of the Digital Innovation Process (DIP) model of the DC2-CF. This incorporated insights from the literature reviews, and the Cambridge City digital twin case study undertaken. In the first instance, the initial DIP model was presented to a focus group of 12 city management and built environment professionals, and academic experts involved in city-scale digitalisation initiatives for feedback.

In *Phase 3 DC2-CF Design and Develop (Refinement)*, based on feedback received in *Phase 2*, a revised DIP model of the DC2-CF was presented at a 2-day workshop involving over 40 local UK and international participants comprising academics, built environment professionals, technology developers, and city managers (working with local authorities) to refine and expand insights from the previous steps. Supporting Information S1: Appendix 1 provides a list of the workshop participants and their designations. This mixed cohort of participants ensured that the insights to be generated for developing the DC2-CF were robust and practically relevant. During the workshop, participants were given the opportunity to comment on the revised DIP model of the DC2-CF (from a cyclical to a '9-box' model structure). Participants also contributed to the identification of the competencies, tasks and roles that can be associated with the activities for the stages in the DIP model. This contribution was relevant for developing the development of the first draft of the delivery structure (tasks, competencies, and roles) of the DC2-CF. On Day 1 of the workshop, participants were asked to propose tasks and associated competencies based on their expertise in the context of digitalisation in four example policy dimensions (improving air quality; emergency response and management; planning for liveability; and city-wide information environment). Using Day 1 results as input, Day 2 discussions were focused on identifying roles and role types relevant for undertaking the necessary tasks or possessing relevant competencies. The workshop outputs were used as raw data, analysed using both quantitative (network analysis) and qualitative (discourse analysis) methods, to create the second iteration of the DC2-CF (i.e., refined DIP model and the delivery structure).

Data were gathered digitally from notes that groups of participants made based on workshop discussions. For the 2 days of the workshop, the participants were assigned to five different scenarios of the DIP model that were pre-selected based on their expertise. Working with background information for each scenario, participants were asked to: (i) identify sub-tasks involved in the scenario context based on their professional experience, (ii) specify the relevant competencies required for each of the sub-tasks they identified previously, and (iii) propose specific job roles for different sectors, based on their professional experience, according to the sub-tasks and competencies earlier analysed in the scenarios. The competencies were subsequently categorised under the three dimensions (i.e., Technical/Digital, Governance/Management, and Ethics/Responsible innovation).

Analysing the largely qualitative data gathered followed a consistent network and analyses [29, 30]. The former helped to structure the tasks identified by the workshop participants. After evaluating each sub-task, they were each labelled and annotated with a description, and used in the DIP model. Identifying the competencies was by network analysis. Raw inputs of competencies from the participants were cleaned and categorised into knowledge-based competencies (i.e., 'what we need to know' to carry out tasks) and action-based competencies (i.e., 'what we need to do' to perform tasks). Network analysis was used to construct network diagrams that identified the degrees of connections between knowledge-based competencies and tasks. Thus, if two nodes are connected in this network, it indicated that the two competencies are simultaneously associated with a same task. The network analysis involved creating nodes from the identified knowledge-based competencies and linking those to the tasks. Nodal degree centralities were indicated by their sizes, reflecting the strength of the co-association (i.e., the bigger the node size, the more central or prominent the competency, as it is commonly shared in multiple tasks). Identifying the key roles associated with many competencies, roles and competencies were all visualised using the same network approach. Instead of a role-role co-existence network, we visualised the data into a role-competency network (cf. refs. [29, 30]). Identifying nodal degree of centrality (i.e., how many neighbour nodes relate to it), the relative central place of the competencies and the relative complexity of the roles (as it associates with many competencies) was as previously described. In effect, larger nodes denoted greater strengths of the association between competencies and multiple tasks, for instance.

From the qualitative data gathered from participant notes and discussions held, a qualitative network analysis approach was adopted to establish relationships between the competencies, and roles [31]. Following this approach, instead of a quantitative analysis, is primarily determined by the nature of the data gathered [32]. Such qualitative analysis offered the benefit of creating network diagrams that reveal an understanding the context-specific data from multiple sources [29, 31]. In the case of this research, following this approach allowed for understanding competencies and their relationships with roles for urban digital innovations that are based on the context-specific experiences and insights from the wide range of professionals engaged. In doing so, the study offers additional evidence in the smart cities literature for how qualitative data can be used in the visualisation of data in a way that is coherent, trustworthy and replete with contextual information (cf refs. [30, 31]).

In *Phase 4 DC2-CF Validation*, we have continue the validatation of the overall competency framework using diverse research methods. In collecting and analysing the relevant data, we have sought to apply a systematic conceptual approach and analytical discipline to offer trustworthy interpretations leading to the development of the DC2-CF [27, 29, 31]. For trustworthiness of the proposed DC2-CF subsequently presented

from our analysis, authors have conducted prolonged persistent observations of developments in academic literature and real-world smart city projects, engaging with practitioners in city leadership and local authorities for feedback, held meetings, and focus groups and workshops to discuss and validate the DC2-CF DIP model and its delivery-structure (tasks, competencies, and roles) (cf. ref. [28]) (see Section 6 for more details).

4 | DC2-CF: A NEW COMPETENCY FRAMEWORK IN THE URBAN BUILT ENVIRONMENT

The DC2-CF outlines the key competencies to lead digital innovation and public value creation through responsible digitalisation in the urban built environment. The adoption of such public value perspective implies professional planners working collaboratively to respond to the needs of citizens and their collective preferences, achieving multiple goals and expected outcomes, using diverse accountability systems, managing advanced digital technologies, and selecting providers pragmatically to deliver enhanced public services [33, 34]. It also requires urban managers to deal with the complexity of digital solutions and the implications to deploy them effectively and safely, considering the emerging risk and negative effects on the society and environment [8, 35]. The DC2-CF proposes the competencies for city managers and built environment professionals that are required to (i) advance the understanding of value, limitations, and risks of data-driven urbanism; (ii) enable city authorities to lead digitalisation; (iii) and improve outcomes for urban communities. This section introduces the DC2-CF addressing the need for multi- and inter-disciplinary competencies across the technical, societal, and operational aspects of cities and their supporting infrastructure to create public value responsibly. The DC2-CF is composed of a Digital Innovation Process (DIP) model and its delivery structure to allow city managers and built environment professionals to use the framework. The design and structure of the DC2-CF are described as follows.

4.1 | DC2-CF digital innovation process (DIP) model

This DC2-CF proposes a process perspective on digital innovation in the urban context in order to achieve the main objective: 'Create public value through responsible digitalisation in the urban built environment'. Figure 2 illustrates the DIP model that consists of the central objective, the three process stages: plan, test and embed and a supporting environment: enable. Specific activities are provided for each stage of the DIP model and its supporting environment as described below.

4.1.1 | Plan (process stage)

DC2-CF proposes a more strategic approach to digital innovation in cities, driven by the central objective of creating public value. Consequently, a more strategic envisioning and planning stage is required to steer innovative experiments and understand their impact and contribution to public value creation. For example, in the 'Plan' stage, the framework proposes that specific activities must be orientated towards activities and goals such as 'Set vision, goals, priorities, and boundaries for

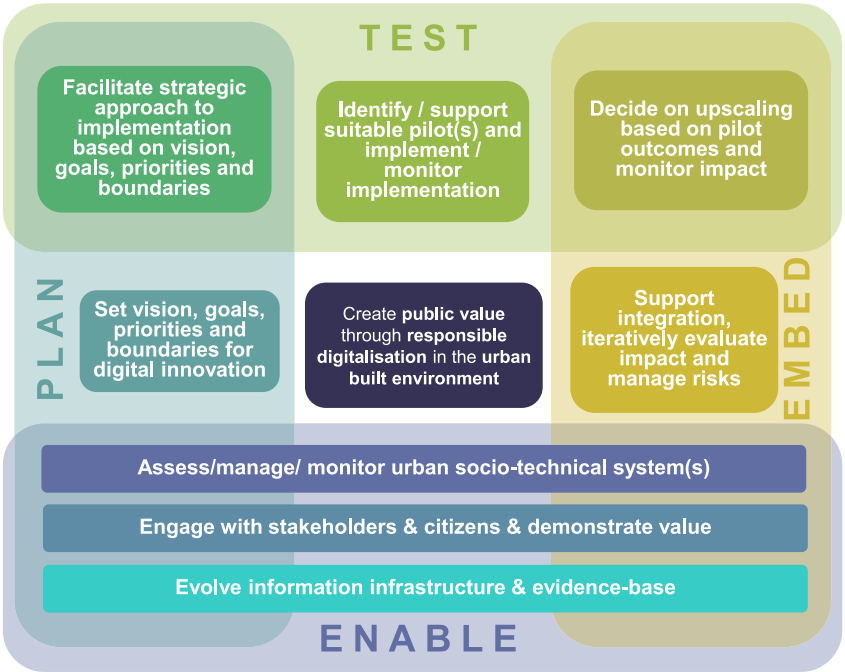

FIGURE 2 DC2-CF digital innovation process (DIP) model. This model outlines a process perspective on digital innovation in the urban context, consisting of three process stages (plan, test, and embed) and a supporting environment (enable).

digital innovation' and 'Facilitate strategic approach to implementation based on vision, goals, priorities, and boundaries'. These activities can enable city managers and built environment professionals to collectively set priorities, objectives, and deliverables for digital innovation, plan digital innovation scenarios, assess implications and risks for each plan and consider collaboration requirements, funding options, legal ramifications, and ethics considerations of urban digital innovations.

4.1.2 | Test (process stage)

DC2-CF recognises the potential and importance of experimentation and prototyping in delivering successful digital innovation. Experimentation is however also seen as a testing stage for the knowledge and ideas developed and negotiated in the planning stage, providing new evidence for the negotiations. As such, the planning and testing stages are expected to run parallel to one another and to be iterative rather than as a sequence. For this 'Test' stage, the framework proposes the activity 'Identify/support suitable pilot(s) and implement/monitor implementation'. This stage and the associated activity can allow city professionals and planners to develop evidence-base on pilot implementation and evaluate and reflect on pilot implementation and associated impact and risk via collective deliberation.

4.1.3 | Embed (process stage)

It is expected that not all experimentation will be deemed successful. The outcomes of the pilot experimentation therefore must be evaluated in order to reach a decision whether a particular digital innovation can be embedded into the broader urban context, the experiment needs to be reframed to improve outcomes, or terminated (e.g., due to unintended adverse effects that represent harm to public value). For instance, in the 'Embed' stage, the framework proposes activities such as 'Decide on upscaling based on pilot outcomes and monitor impact' and 'Support integration, iteratively evaluate impact and manage risks'. These activities can assist city administrators and implementers to support the integration of digital innovation into wider workflows and decision-making processes and assess the impact of digital innovation on internal workflows, including data sharing requirements and open data.

4.1.4 | Enable (supporting environment)

A supporting environment is needed to enable the process cycles to kick-off and deliver results. The supporting environment must assist a variety of parallel digital innovation processes. In turn, digital innovation processes must also contribute to the evolution of the supporting environment. As part of the 'Enable' supporting environment, the framework proposes three activities than can assist city managers and built environment professionals in various ways. The activity: 'Assess/manage/monitor urban socio-technical system(s)' can allow city planners to develop a systems understanding of urban built environment sectors and their interdependencies and anticipate social and technological demand for digital innovation in the urban built environment. The activity: 'Engage with stakeholders & citizens & demonstrate value' can help city managers to establish participatory mechanisms and communication channels among interested/affected parties (e.g. public sector, private sector, and citizens). Finally, the activity: 'Evolve information infrastructure & evidence-base' can enable city managers to develop processes to deal with uncertainties, risks, unintended consequences, and develop and maintain evidence-base to support evidence-driven decision-making culture.

To use the proposed DIP model and allow city managers and built environment professionals to carry out the above activities in the different phases of digital innovation, the DC2-CF proposes more specific tasks, competencies and roles framed in a delivery structure described as follows.

4.2 | DC2-CF delivery structure

The DC2-CF provides a delivery structure to enable city managers and built environment professionals to use the DIP model. The delivery structure is based on the definition and interrelationship among tasks, competencies and roles as illustrated in Figure 3 and explained below.

4.2.1 | Tasks

Are more specific actions considered particularly important to the activities of the Digital Innovation Process (DIP) model to fulfil the objectives of public value creation and responsible innovation. Table 1 presents some of the tasks identified and their descriptions for each stage (i.e. plan, test, and embed) of the DC2-CF DIP model. For instance, in the 'Plan' stage, the task: 'Setting requirements and boundaries' is described as 'Identify the scope of digital innovation based on potential

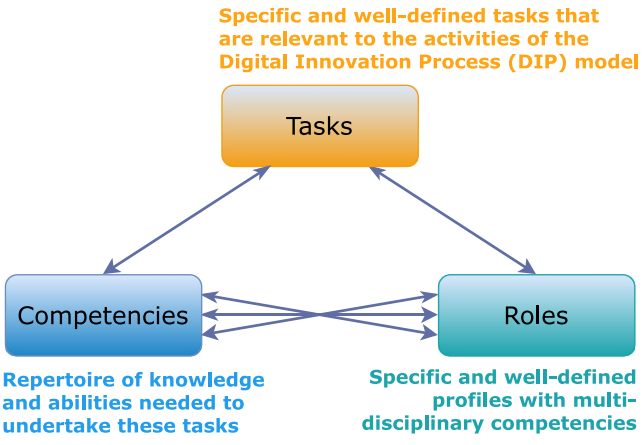

FIGURE 3 DC2-CF: Delivery structure.

TABLE 1 Tasks identified at each stage of the DC2-CF digital innovation process (DIP) model.

Plan	Test	Embed
Analysing causes, factors, and effects:	**Testing causes, factors, and effects:**	**Evaluating causes, factors, and effects:**
Analysing the mechanisms (causes, factors, and effects) of public value creation	Testing the mechanisms (causes, factors, and effects) of public value creation	Reflecting on the mechanisms (causes, factors, and effects) of public value creation
Framing problems:	**Framing pilot experiments:**	**Evaluating experiments and collecting learnings:**
Framing societal needs to identify public value(s) and opportunities for public value creation	Framing pilot experiment(s) based on public value goals and priorities	Assessing and deliberating on the 'real-world' public-value-creation potential of experiments as instances of digital innovation
Setting requirements and boundaries:	**Setting requirements and boundaries for pilot experiments:**	**Assessing context and requirements for city-wide digital innovation:**
Identify the scope of digital innovation based on potential harm to public value(s)	Identify the scope of pilot experimentation based on potential harm to public value(s)	Take responsive action to embed/reframe/terminate digital innovation based on public value creation potential
Framing objectives and solution options:	**Experimenting:**	**Implementing decision on city-wide digital innovation:**
Align goals and priorities for public value creation through digital innovation	Implement pilot experiments and prototyping	Implementing the embedding/reframing/termination of digital innovation
Creating incentives for participation and collaboration:	**Facilitating participation and collaboration for delivery:**	**Evaluating and maintaining/redesigning innovation ecosystem:**
Engaging diverse publics and creating incentives for deliberation and co-creation	Engaging stakeholders and managing participation and collaboration for delivery	Iterative design of inclusive and collaborative mechanisms for implementation and democratic oversight
Communicating digital innovation in urban policy, management, and services:	**Communicating process and results of experimentation:**	
Translating and communicating innovation outputs into public value outcomes	Communicating the experimentation process and translating pilot outputs into public value outcomes	

Note: Bold text is used to represent task names, followed below by their task descriptions.

harm to public value(s).' At the 'Test' stage, the task: 'Setting requirements and boundaries for pilot experiments' is described as 'Identify the scope of pilot experimentation based on potential harm to public value(s)'. During the embed stage, the task: 'Assessing context and requirements for city-wide digital innovation' is described as 'Take responsive action to embed/reframe/terminate digital innovation based on public value creation potential'.

4.2.2 | Competencies

Cover the repertoire of knowledge and abilities needed to deliver particular tasks. The DC2-CF proposed both action- and knowledge-based competencies. *Action-based competencies* indicate 'what we need to do' to perform particular tasks, while *knowledge-based competencies* outline 'what we need to know' to carry out the tasks. Figure 4 presents an overview of the action-based competencies (i.e. abilities needed to undertake a particular task) identified in this study. The figure depicts the central objective of public value creation, the three stages (plan, test, and embed) of the DIP model, the identified tasks for each stage (as presented in Table 1), and the action-based competencies for the particular tasks: 'Setting requirements and boundaries' and 'Framing objectives and solution options'. For instance, the task: 'Setting requirements and boundaries' includes action-based competencies such as 'AC-04 Analyse data and its dependencies', 'AC-05 Scope boundaries of socio-technical systems', and 'AC-08 Design and build inclusive governance'. In the same way, the task: 'Framing objectives and solution options' includes action-based competencies such as 'AC-09 Engage communities and citizens' and 'AC-12 Monitor and validate anticipatory governance processes'. The full list of action-based competencies can be found in Supporting Information S2: Appendix 2.

Knowledge-based competencies represent the knowledge and concepts needed to undertake a particular task. They are divided into three competency clusters: Governance and Management, Digital and Technical, and Ethics and Responsible Innovation. Each cluster of competencies is further divided into a number of competency units and associated competencies. Figure 5 illustrates the central objective of public value creation, the proposed competency clusters, competency units, and associated competencies. For instance, the 'Governance and management' cluster includes competency units such as '1.3 Stakeholders and collaboration' and its associated competencies '1.3.1 Structure of governance networks', '1.3.5 Accountability', and '1.3.6 Data ownership and

FIGURE 4 DC2-CF action-based competencies to support the overall objective of public value creation through responsible digitalisation in the urban built environment.

FIGURE 5 DC2-CF knowledge-based competencies to support the overall objective of public value creation through responsible digitalisation in the urban built environment.

accessibility'. Similarly, the 'Governance and management' cluster includes competency units such as '1.4 Citizen engagement and participation' and its associated competencies '1.4.1 Citizen science', '1.4.2 Vulnerability and marginalisation effects', and '1.4.7 Privacy (concept, value)'. The full list of knowledge-based competencies can be found in Supporting Information S3: Appendix 3.

4.2.3 | Roles

Are a different method of grouping competencies, informed by an outlook on institutional settings as well as tasks. They represent combinations of competencies, needed to successfully undertake various tasks. It is important to note that roles do not define 'job roles' for individuals—roles can be

undertaken by teams or individuals, while certain individuals may undertake multiple roles. For the DC2-CF, portfolio clusters are put forward: Sponsor, Champion, and Catalyst and Implementer. A 'Sponsor' portfolio could be occupied by those possessing political authority and can deploy resources and give legitimacy to collaborations and innovative ideas. A local government official or City Mayor could play the role of a sponsor. 'Champions' comprise those having the capabilities to leverage informal authority to mobilise capacities in their organisations to organise, facilitate, and energise collaborations. A city's Chief Information Officer could play the role of a champion for a digitalisation initiative with support from a sponsor. 'Catalysts' comprise those having (in)formal authority to create appropriate disruptions in a collaborative network to drive 'out-of-the-box' innovative thinking. A city's Infrastructure Portfolio Directors may be well placed to act as catalysts, disrupting how digitalisation projects with implications for city-wide infrastructure may be approached. Finally, the portfolio of 'Implementers' refers to those who get things done by converting visions/plans into reality. In other words, those who 'get things done' on the ground. This portfolio may include a Digital Service Manager responsible for delivering an initiative - from plans into reality.

The relationships between the three components of the DC2-CF delivery structure (i.e. tasks, competencies and roles) illustrated in Figure 3 are explained as follows.

- *Task* ↔ *Competencies*: The execution of a specific well-defined task under an activity for any stage (plan, test, and enable) of a digitalisation initiative requires relevant competencies. The nature of tasks and desired outcomes from an activity would inform the competencies needed, which would in turn shape how a task is executed.
- *Tasks* ↔ *Roles*: Effectively undertaking tasks for various activities at any given stage in a digitalisation project requires identifying or developing (new) roles equipped with requisite competencies. The suitability of roles in undertaking a task is linked strongly to the task-specific competency needs they address.
- *Competencies* ↔ *Roles*: The competencies needed to complete a task successfully may be found in existing roles, or demand the creation of new roles possessing missing competencies. Competencies and roles do not have a one-to-one relationship; the competency needs for a particular task can be met by more than one role because of cross-disciplinary elements.

5 | DC2-CF: CASE EXAMPLE APPLICATION

The example scenario presented in this section illustrates the use of the DC2-CF. The example is situated using the scenario of a transport infrastructure improvement initiative where the engagement and participation of citizens is crucial to maximise potential benefits and minimise any adverse impacts, particularly on protected characteristic groups. See Figure 6 for a summary.

5.1 | Case example description

A city local authority (LA) seeks to roll out an initiative to develop better and environmentally friendly transport networks that will connect people to jobs, homes and socio-cultural and economic opportunities has been launched. This initiative comprises proposals from the LA to create new bus routes, increase services and extend operating hours, expanding the cycling network and prioritise road space for sustainable transport. The initiative also entails creating a sustainable travel zone (comprising a parking levy, a pollution charge, or a road user charge). All these form part of the LA's strategic plan to create wider prosperity and improve the quality of life of

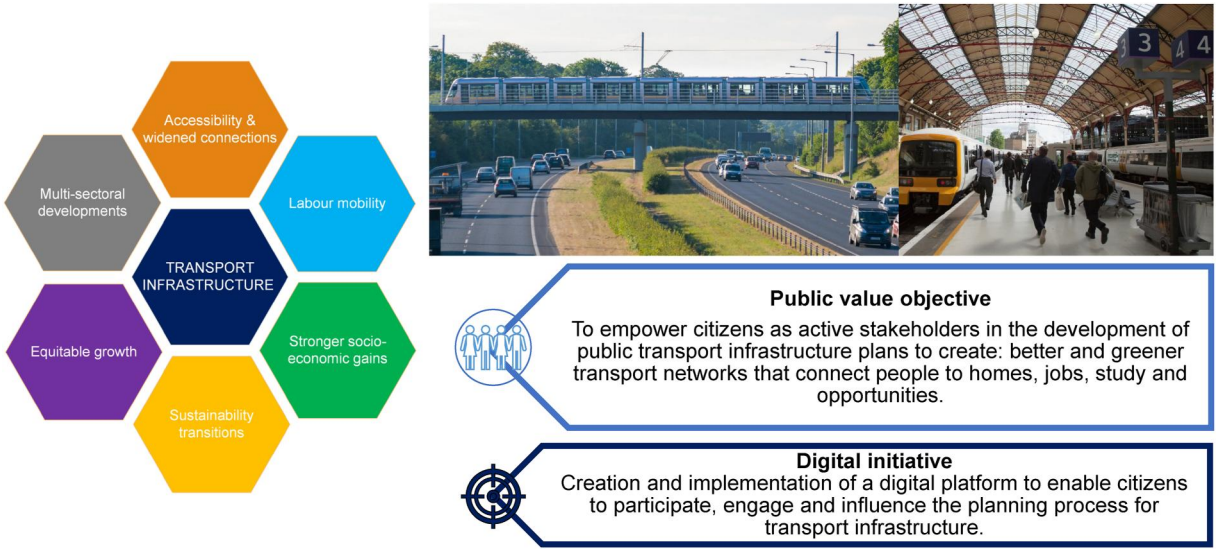

FIGURE 6 DC2-CF application scenario: Transport.

citizens. Central to the successful implementation of this initiative and raft of proposals is effective and wider citizen engagement and co-creation. The public value objective, therefore, is to empower citizens as active stakeholders in the development of public infrastructure plans (see Figure 6). The question remains open as to how to achieve this objective effectively by receiving input from as diverse a collection of citizens as possible, and to obtain representative feedback across various demographic representations in the city. A digital platform could be utilised as a tool to achieve the public value objective. However, choosing this approach only would exclude a significant section of the population who are already 'victims' of under-representation, exacerbated by the digital divide.

5.2 | Case example application

One of the key activities to undertake in the 'Plan Stage' of the DC2-CF Digital Innovation Process (DIP) model will be: 'Set vision, goals, priorities and boundaries for digital innovation' (see Figure 2). An important task (see Table 1) to realise that activity will be: 'Creating incentives for participation and collaboration' from the city's residents by engaging diverse publics and incentivising them to engage actively in deliberations and co-creation. The successful execution of the task rests upon the LA and their delivery partners possessing relevant multidisciplinary competencies. Such competences must be transversal to the digital and technical, governance and management, and ethics and responsible innovation clusters according to the proposed transport improvement initiative and the associated public value objective. A key question here, therefore, is: 'What are the action- and knowledge-based competencies needed to successfully undertake the task?' Per the example scenario, a snapshot of competencies relevant to the identified task is summarised in Table 2.

Table 2 presents the multi-dimensional nature of both action- and knowledge-based competencies required to deliver the task. The task involves engaging diverse publics and creating incentives for participation and collaboration. One of the action-based competencies identified is knowing how to 'AC-15 Assess stakeholder engagement needs'—this is central to the engagement piece of the public value objective. Other action-based competencies required are to 'AC-16 Translate and communicate complex technical knowledge' and to 'AC-18 Build trust with stakeholders and citizens'–these competencies become critical for ensuring that solid trust-based relationships are formed with city residents to enable a collective buy-in. In addition, for each action-based competency, knowledge-based competencies are identified. For instance, city authorities and built environment professionals to undertake the action-based competency 'AC-18 Build trust with stakeholders and citizens' require the knowledge-based competencies, among others, '1.3.7 Engagement methods and mechanisms (citizens)' from governance and management, '2.5.1 Cybersecurity Policy, Governance and People' from digital and technical, and '3.1.2 Bias in data collection and sampling' from ethics and responsible innovation.

Following the DC2-CF, after identifying the competencies required, the next step for the LA would analyse and review which roles within their organisation, and/or in their delivery partners possess those competencies. Here, a useful guiding question is: 'What roles possess the required competencies to complete the task?' This would mean that a single or combination of roles may be identified as possessing the repertoire of capabilities, knowledge and abilities needed to undertake the plan-stage task. Several roles, under different portfolio clusters, may therefore be identified as relevant for the task based on the competencies possessed, or new roles may be defined based on the missing competencies in the LA and/or their delivery partners.

Table 3 provides some examples of the required roles and related knowledge-based competencies. All specific competencies are relevant to each role and those highlighted in bold are strongly required to perform the role and realise the aforementioned task 'Creating incentives for participation and collaboration'. For the example scenario, we briefly expand on the role 'Engagement Expert(s) (Implementer)'. This role may need to cover the competencies identified and may be filled by more than one person. For instance, Engagement Experts need to have relevant knowledge of ways to engage citizens to ensure that any potential bias that might arise from consultations based on digital platforms alone is anticipated and addressed (e.g., through additional engagement tools). This role also needs strong competencies in using the right mechanisms to clearly communicate any proposed plans/drawings in ways that will establish transparency about the engagement processes. This engagement process must consider the macro environment of culture and practices that affect society's basic values, preferences and behaviour. People in this role need to assure city residents that the proposed initiative by the LA is to ensure the ultimate benefit of the public. For the above, knowledge of legislation and regulations mandated to guide such processes, and best-in-class co-creation methods and practices will be relevant.

It is worth noting that the examples of roles and their categorisations in Table 3 are representative, and not exhaustive. Each of these roles are representative of specific portfolio clusters (i.e., sponsor, champion, catalyst, or implementer–see Section 4.2.3 for more details). Such clustering is put forward as a way for decision-makers to determine the various clusters under which there is much need to address competency gaps, for example, for hiring and reorganisation purposes. Owing to the socio-technical approach underpinning this research, the DC2-CF is designed to be context-sensitive and therefore competencies and roles can be re-establish based on the understanding of the needs, issues, constraints, interconnections and relationships in a place (organisation, city, and country). Such a re-establishment implies both refining existing competencies and roles and developing new ones in organisations responsible for the delivery of digital innovation projects to create public value [25]. Therefore, context is important to understand the competency needs rather than simply use the competencies in an isolated manner to describe job requirements or role profiles. This is helpful for taking into

TABLE 2 DC2-CF application scenario: transport. Snapshot of competencies.

Task (plan stage)	Action-based competencies	Knowledge-based competencies	Competency cluster
Creating incentives for participation and collaboration: *Engaging diverse publics and creating incentives for deliberation and co-creation*	**AC-15** Assess stakeholder engagement needs	**1.3.8** Engagement methods and mechanisms (stakeholders)	G&M
		2.1.1 Landscape of digital tools and technologies	D&T
		2.4.2 Boundary spanning and management	D&T
		3.3.4 Consensus seeking and conflict resolution	E&RI
		3.4.1 Empowerment for responsiveness	E&RI
		3.4.2 Risk management concept	E&RI
		3.2.5 Macro environment of culture and practices	E&RI
	AC-16 Translate and communicate complex technical knowledge	**1.3.7** Storytelling	G&M
		1.4.5 Co-creation methods and good practices	G&M
		2.4.1 System performance indicators	D&T
		3.1.3 Public value concept	E&RI
	AC-18 build trust with stakeholders and citizens	**1.1.3** Legislative and regulatory landscape	G&M
		1.3.7 Engagement methods and mechanisms (citizens)	G&M
		1.4.4 Transparency of governance processes	G&M
		1.4.7 Privacy (concept, value)	G&M
		2.5.1 Cybersecurity policy, governance and people	D&T
		2.5.3 Cybersecurity data Administration	D&T
		3.1.2 Bias in data collection and sampling	E&RI

Note: Bold text is used to link the table with the competencies presented in Figure 4 and 5. This is also important to link the content of Appendix 3 and 4.
Abbreviations: D&T, Digital and Technical; E&RI, Ethics and Responsible Innovation; G&M, Governance and Management.

TABLE 3 Example of DC2-CF roles and knowledge-based competencies.

Role example (portfolio cluster)	Snapshot of competencies
Engagement expert(s) (implementer)	2.1.1; 2.5.1; **1.1.3; 1.3.8; 1.3.7 3.1.2; 3.3.4; 3.2.5**
Programme manager (champion)	**2.1.1; 2.4.1; 2.5.3; 2.5.1; 1.1.3;** 1.3.8; 1.3.7; **3.1.2**; 3.3.4; 3.2.1; 3.2.5
Local government representative (sponsor)	2.1.1; 2.4.1; 2.5.1; **1.1.3; 1.3.7; 3.3.4; 3.4.1; 3.1.2;** 3.2.5

Note: Bold text is used to demonstrate that competencies are strongly required to perform the role and realise the aforementioned task 'Creating incentives for participation and collaboration'.

consideration the variety of digitalisation initiatives that are rolled out in various places, and the differences in organisations engaged in their design and implementation.

6 | DC2-CF VALIDATION: DOMAIN EXPERT FEEDBACK

Focus group discussions and a workshop with domain experts were held to further validate the DC2-CF, focusing on the relevance and practical use of the proposed framework. Overall, the DC2-CF has been highly appreciated by domain experts, receiving both positive feedback and feedback for improvement.

The first focus group involved an in-depth 2.5-h discussion with experienced international practitioners (3) and academics (3) with relevant experience from the UK, Germany, Austria, Canada, and Egypt. The participants in the focus group discussion comprised experienced researchers in urban-scale digitalisation projects, and director-level professionals with over 10 years of experience delivering digital innovation projects in European, North American, and African cities involving the public and private sectors. In addition to internal deliberations by the research team, feedback from this focus group discussion contributed to revisions made to the delivery structure depicting the connections between roles, competencies and tasks (see final version in Figure 3), and the visual representation of the knowledge-based competencies presented in Figure 5.

The second focus group discussion was held with a digitalisation programme manager for a UK local government authority, lasting 1-h. The final step in the validation process comprised a 2-h long workshop with 10 participants comprising local government and city management officers, technology suppliers, city planners, and researchers with expertise in 'smart cities' from the Republic of Ireland. During the focus group discussions, the DC2-CF was presented to participants, highlighting: the motivation (i.e., challenges of delivering city-scale digitalisation initiatives), followed with a detailed description of its components (i.e., DC2-CF DIP model, and the three-pronged tasks-competencies-roles framework), and complementary examples of use cases to illustrate practical utilisation of the DC2-CF. Discussions were held after presenting on each of the sections above to receive feedback from the domain professionals and experts. This session was guided by sets of questions that sought to validate the findings from the research that underpinned the development of the competency framework, establish the relevance of the three (digital/technical, governance and management, and ethics/responsible innovation) dimensions of the competency framework, establish the usefulness of the competencies identified and identify any missing elements, and to validate the applicability of the framework in practice. Through the workshops, we obtained relevant insights and feedback from individuals with both practical experience and research-based knowledge in city-scale digitalisation initiatives to ascertain the robustness and usefulness of the competency framework (DIP model and its delivery structure) developed.

Furthermore, a workshop was held in Ireland to introduce the novel DC2-CF and validate its practical relevance for city leaders and their smart city delivery and supply partners. The aim of this workshop was to bring together city managers and built environment professionals with responsibility for delivering digital innovation projects to discuss challenges faced in successfully planning and executing smart city projects, with an emphasis on competency gaps. The event attracted local authorities of Ireland and stakeholders involved in the planning, delivery, and implementation of digitalisation initiatives in the urban context. The workshop participants highlighted the relevance of the multi-disciplinary emphasis of the DC2-CF and the importance of the DC2-CF portfolio clusters in real-world projects (e.g., the importance of the Champion role and its accountability in a project). During the workshop, in examining the scenario example presented in this paper (see Section 5 for more details), it became evident that participants prioritised competencies that related closely to their professional backgrounds and experiences. While a professional with a planning background advocated for the need for strong public engagement competencies, those with computer engineering backgrounds emphasised the need for competencies with a digital/technical focus. Such an observation underscores the need to take a multi-disciplinary approach in tackling competency gaps related to urban-scale digitalisation initiatives. The DC2-CF is designed to help promote the adoption of this multi-disciplinary view.

7 | DISCUSSION

7.1 | Theoretical contribution

In this paper we have taken a socio-technical perspective to offer a dynamic view of the innovation process related to urban-scale digitalisation and propose a multi-disciplinary competency framework. In doing so we offer three key contributions. First, this contributes to knowledge about competencies that are defined with a socio-technical understanding and cut across the three key dimensions of digitalisation in the urban built environment. The multi-perspective review presented in this paper reveals biases in the focus of existing competency frameworks in favour of either the digital and technical or governance and management dimensions. Furthermore, fewer frameworks consider the ethical and responsible innovation dimension despite this being increasingly important in discussions for holistic digitalisation initiatives [37–39], and even core to the failure of the ambitious largescale Sidewalk project in Toronto [40]. The need to embrace this dimension as a central component for the delivery of public value through urban scale digitalisation cannot be ignored.

Second, we have proposed competencies that cut across the three dimensions of digitalisation in the urban built environment. In existing literature, the three main dimensions are neither comprehensively brought together, nor jointly referenced and discussed in relation to the process of digital innovations. Hence, approaches to defining competencies and associated roles remain siloed. There is also no specific competency framework for city managers and firms involved in digitalisation initiatives in the urban built environment (for example, ref. [18]). The proposed DC2-CF DIP model and delivery structure address these gaps, contributing to knowledge of how multi-dimensional and cross-disciplinary competencies can be developed, underpinned by socio-technical principles of digitalisation in the urban built environment.

Third, we have delineated the interrelatedness of the digital innovation processes, while identifying the nature of socio-technical tasks, competencies and roles needed to effectively deliver them. In the reviewed literature, there is no clear definition at which stage of the urban digital innovation process certain competencies are required. Consequently,

competencies needed to deliver specific roles which perform particular tasks are ill-defined. These issues identified are potentially due to the complexity of integrating the three dimensions in developing multidisciplinary competencies, making the adoption of narrow discrete lenses more attractive in existing studies. While convenient, such lenses fail to address the socio-technical practicalities of planning, delivering, testing, implementing and continuously enabling digitalisation in the urban built environment, and fall short when seeking to develop multidisciplinary competencies for city managers. Building on previous studies (for example, refs. [6, 41, 42]), this paper has extended growing socio-technical views for the study of urban scale digitalisation initiatives and demonstrated the value of bringing together the three interrelated dimensions of such projects for understanding how varied interdisciplinary competencies and roles can be identified for practical applications.

Table 4 presents a comparison between existing competency frameworks and the DC2-CF proposed by this study. The table compares the main objective of the framework oriented towards public value creation, the digital innovation process model in the urban built environment, the delivery structure (i.e. the presence of tasks, competencies and roles within the frameworks), and the socio-technical dimensions of the competencies: digital and technical, governance and management and ethics and responsible innovation. The DC2-CF is the only framework created with the central objective of creating public value responsibly and the only one that proposes a digital innovation process that outlines a model (with practical activities) on digital innovation in the urban context. From the perspective of the delivery structure (with a focus on the practical application), DC2-CF covers the associated tasks, competencies and roles required for city managers to deliver the big block of activities of a digital innovation process in urban contexts. Regarding the competency dimensions, DC2-CF covers inter- and multi-disciplinary competencies required by city managers and their delivery partners to tackle interrelated issues considering their multifaceted and cross-cutting nature.

7.2 | Practical contribution

The proposed DC2-CF, with a socio-technical underpinning, shows a dynamic DIP model and delivery structure based on tasks, competencies and roles relevant for successful digitalisation. The DC2-CF and its components offer three immediate practical contributions for city managers and their development partners for the delivery of digital innovations in the urban built environment.

First, the DIP model, from a socio-technical perspective, highlights the overlapping processes embedded in the interrelated stages of digitalisation projects. This is useful for expanding the understanding of city managers when conceiving a digitalisation project, helping them approach such initiatives with a dynamic view (cf. ref. [11]). The model also brings forward the need for city managers to make decisions about tasks entailed in the planning, testing, and embedding stages with the bigger picture in mind to ensure a successful implementation and avoid the common trap of digitalisation projects terminating at pilot stages [6]. The focus for each of these stages outlined in the DIP model offer guidelines for city managers' decision-making to adopt socio-technical and overarching lenses, potentially helping avoid viewing and

TABLE 4 Comparison between the DC2-CF and existing competency frameworks (Key: ✓ = Covered, – = Partially covered, = Not covered).

Competency frameworks			Delivery structure			Competency dimensions		
Reference	Main objective: public value creation	Digital innovation process	Tasks	Competencies	Roles	Digital and technical	Governance and management	Ethics and responsible innovation
Digital competence framework for citizens (DigiComp) [20]			–	✓		✓	–	–
Skills and competency framework [18]			–	✓	✓	✓	✓	–
Competency framework for local government [23]			✓	✓		–	✓	–
Competencies and the Penetration status of BIM [16]				✓	–	–	✓	
Core skills for public sector innovation [17]			✓	✓	–	–	✓	
European e-competence framework (e-CF) [24]			–	✓		✓	–	
IAM competences framework [36]			–	✓	✓		✓	–
Digital cities for change (DC2)–competency framework (CF)	✓	✓	✓	✓	✓	✓	✓	✓

approaching the implementation of digital innovations as merely a static development of a digital technology to gather data. Adopting the proposed process perspective holds the potential to improve how public value is conceived, created and continuously improved using digital innovations that are modified to suit evolving societal needs.

Second, the delivery structure comprising tasks, competencies and roles provide a guiding framework for local governments involved in digitalisation initiatives to evaluate their internal capabilities and develop missing ones. It is increasingly apparent that local governments and city leaders lack cross-disciplinary competencies that are needed to create public value ethically and responsibly in this 'digital age' [39, 43]. The tasks and competencies identified from the DC2-CF cut across the three main dimensions of digitalisation initiatives in the urban built environment (digital and technical, governance and management, ethics and responsible innovation). This is novel and addresses the often-siloed disciplinary training of professionals working as city managers who must address multi-faceted ethical, governance, legal, management and technical issues that arise in society when digital innovation projects are being implemented (cf. refs. [44, 45]). Accordingly, the proposed roles—characterised by clusters of competencies and not individual disciplines of professionals –provide guidance for how local governments could begin restructuring their teams to be better equipped for delivering digitalisation that would lead to the desired improvements in society.

Finally, the combined application of the socio-technical digital innovation process and the tasks-competencies-roles model holds the potential for managers of the urban built environment in cities and their 'smart city' delivery partners to identify and address capacity gaps internally and on projects. With digitalisation increasingly being seen as a tool to address key challenges facing society (e.g., climate emergency and growing inequalities), local authorities are being given public funding to undertake digital innovation projects to solve such issues in their localities. Limited availability of public funds calls for effective oversight of such project for the delivery of the desired public value. For this to happen, competency gaps existing in local governments need to be tackled to begin the transformation of such bodies into digitally competent ones [46], ready to design and implement systemic changes through digital innovation projects. Here, possessing the right competencies entails having the capacity to identify the nature of digital solutions (if) needed to tackle an urban problem, situating the solution within the complex network of a city and its governance framework and identifying the best option to implement cf. ref. [44]. According to refs. [47–49], most local authorities around the world do not have such competencies and often rely on external parties to give them the needed guidance—at the risk of not developing their own internal capacity [50]. The DC2-CF proposed in this paper offers the framework needed by local governments to begin understanding in detail the tasks and competencies required to implement a digital innovation successfully, and to define new roles/augment existing roles needed across technical/digital, governance and management, and ethical/responsible innovation dimensions to deliver public value.

8 | CONCLUSION

This paper proposes the DC2-CF, a framework to help city managers and built environment professionals to plan and develop the competencies they need to lead responsible digital innovation, following a socio-technical approach. The DC2-CF is designed as a Digital Innovation Process (DIP) model and its delivery structure based on tasks, competencies, and roles needed to create public value through responsible digitalisation in the urban built environment.

The contributions in this paper address existing theoretical and practical gaps in knowledge about the delivery of public value using digitalisation as a tool in the urban context. Drawing on a socio-technical understanding of urban digitalisation, the competency framework highlights the often siloed, yet inter-related, technical and digital, governance and management, and ethics and responsible innovation dimensions of urban digital innovations (e.g., the deployment of city scale digital twins). In doing so, in the DC2-CF, cross cutting competencies across these dimensions are identified through a rigorous qualitative approach involving representatives from diverse backgrounds involved in urban digitalisation initiatives. The relationship between tasks, competencies and roles presented as part of the framework offers a practical tool for application by city managers and their delivery partners. There is evidence to suggest that investment into digitalisation tools to tackle growing urban challenges will keep growing. To ensure that these investments yield the desired outcomes it is crucial that city managers possess the right sets of competencies to oversee the effective delivery of digitalisation projects. To this end, the framework is useful for conducting internal competencies reviews and begin identifying where gaps exist, and implement measures on how to address them - whether by new role definitions and future hiring, outsourcing, or long-term internal restructuring. The example scenario presented in this paper demonstrates how the DC2-CF may be used by local governments, for instance, who seek to effectively lead or oversee the delivery digitalisation initiatives to create public value. We have sought to demonstrate how the DC2-CF may be used to evaluate specific competency needs for specific activities and tasks at any given stage (plan, test, embed, and enable) of a digital innovation initiative, identify existing roles to meet those needs, or consider ways to address the competencies gaps.

Overall, results presented in the competency framework will help city managers to identify the knowledge and abilities that enable socio-technical innovation of urban systems by providing a more comprehensive, multi- and inter-disciplinary understanding of the required competencies. The DC2-CF presented in this paper opens up avenues for future practical training and research. The framework is currently used to underpin the designing and delivering of a master-level course in a leading UK higher education institution, following an

interdisciplinary approach to help break down the professional silos that currently exist in cities. A future avenue for research based on the findings presented in this paper include a multi-case study validation of the proposed DC2-CF through semi-structured interviews and qualitative document analysis of various types of digital innovation projects implemented across different geographies. This is critical for enhancing the robustness of the competency framework developed. Additionally, it is important to help identify the strategies city managers and their delivery partners could devise to close their competency gaps and determine how revised or new role definitions would help them transition to becoming well equipped to deliver public value using digitalisation. This line of research would set the basis for a quantitative analysis of multiple local governments in different countries to understand shared competency gaps and role (re)definitions needed to address them.

AUTHOR CONTRIBUTIONS

Viviana Bastidas: Conceptualization; data curation; formal analysis; investigation; methodology; visualization; writing – original draft. **Kwadwo Oti-Sarpong**: Conceptualization; formal analysis; investigation; methodology; writing – original draft. **Timea Nochta**: Conceptualization; data curation; formal analysis; investigation; methodology; resources; validation. **Li Wan**: Conceptualization; investigation; resources; validation. **Junqing Tang**: Conceptualization; data curation; formal analysis; investigation; methodology; validation. **Jennifer Schooling**: Conceptualization; funding acquisition; investigation; methodology; project administration; resources; supervision.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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