URBiNAT

TOWARDS IMPLEMENTING DIGITAL ENABLERS IN URBiNAT CITIES:

Preparations and Guidelines

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Glossary for the Present Report

The glossary below lists and defines key terms as applied in the present report. Related definitions were introduced in URBiNAT (2021). While compatibility has been aimed for with the mainstream definitions applied in URBINAT, some slight deviations along with additions of specialist terms have resulted from the specialist subject covered here.

Terms	Definitions
Ambient Intelligence	Relates to user experience, draws on user-centric design and depends on unobtrusive, user-friendly hardware, such as miniaturisation, nanotechnology, on smart devices, and human-centric computer interfaces.
Analogue communication	Data transferred from sender to receiver using analogue signalling, possessing continuous varying amplitude with time. Data such as voice, sound etc., can be transferred this way.
Artificial Intelligence (AI)	Machines capable of continuous learning and autonomous problem solving, attaining intelligence of their own, in contrast to the "natural" intelligence displayed by humans and animals.
Attributes	A named quality or characteristic inherent in or ascribed to someone or something. Attributes can include personal qualities (e.g., age, gender, level of education, ethnic group), ambient information such as location, or certifications that serve as proof of a given capability.
Authentication and authorisation	Authentication refers to "who is on the other end of the line", while authorisation refers to "who has "access" or "control" of digital communication.
Building blocks of digital enablers	The present report categorises the main building blocks of digital enablers by way of digital tools, methods, and content, devised for meeting with a particular purpose. These building blocks typically need to match each other/combine to achieve the objective of digital enablers, e.g., by overcoming hurdles or encouraging engagement by citizens and stakeholders.
Challenge-based approach	A central starting point when developing digital enablers is the challenges faced in URBiNAT neighbourhoods.
Citizens	Citizens refer to the individual human beings in this case residing or working in the city, or in the specific neighbourhoods selected for interventions.
Co-creation	Co-creation is a broad term denoting the active participation and engagement of citizens and stakeholders. The term incorporates more specialised activities, such as co-diagnostic, co-design, co-implementation, or co-monitoring.
Co-creation culture	Related to ethics, experiences, human relations, the way people act within a creative environment, process, codes and symbols, behavioural patterns, language and customs, as well as the way communities of practice interact and engage in the world around them.
Co-design	Co-design is about collaboratively establishing action strategies and discussing proposals. Through their facilitation of citizen engagement, digital enablers offer opportunities to enhance urban and NBS co-design.
Community	Refers to a group of individuals making up a collective, generally geographically or culturally co-located, which may be marked by diverse attributes and interests.

Community of interest (CoI)	Group of citizens and/or stakeholders that share a particular interest. In the present context, it refers to a group that may find opportunities to take that interest forward through a joint undertaking.
Community of Practice (CoP)	A CoP represents a framework for collaboration between citizens, stakeholders, partners, or cities, that serves to promote constructive sharing of experience and joint learning.
Content	Content is about turning data into structured meaning that can be framed for messages and interaction.
Cybercrime	Criminal activity either targets or makes use of a computer, a computer network, or a networked device, mostly for profit pursued by cybercriminals or hackers.
Deprived area	Here referring to a district, or sub-area of a city, which is marked by in some sense unfavourable social conditions for its citizens, typically resulting in lower incomes, levels of education, levels of wellness, levels of security, etc.
Digital divide	A persistent gap in the distribution of benefits from digitalisation, extending from issues of access and availability of technology to inclusion and human agency.
Digital enablers	Usage of digital tools along with complementary methods and content, devised for addressing particular purposes, in support of engaging citizens in co-creation processes related to NBS and Healthy Corridors.
Digital networks	Examples of digital networks include the Internet.
Digital Participatory Platform (DPP)	An online platform developed for the objective to support citizens and government interactions such as co-creation, crowdfunding, participatory budgeting etc.
Digital tools	Digital tools include, e.g., apps, social media, websites, blogs, IoT, GIS, virtual reality, video consoles, and SMS-based services. For functionality, digital tools have to operate within a framework of digital infrastructure and with the support of Big Data, cybersecurity, privacy protection, and so forth.
Digitalisation	Also referred to as digital transformation, the process of converting information into a digital format, organised as bits, i.e., a series of numbers used to describe a discrete set of points or samples (objects, images, sound, documents, etc.).
Disadvantaged group	A distinct group as defined by certain attributes, e.g., gender, age, ethnicity, education, or profession, and subjected to a relatively unfavourable economic or social situation.
Disinformation	Information that is false and deliberately created to harm a person, social group, organisation, or country (cf., misinformation, misleading but not deliberately).
Diversity	Refers to the variation in attributes, in contrast to homogeneous (may apply among citizens or in a particular local community, or to another context).
Engagement	Physical or emotional involvement. When engagement is accompanied by action, we refer to active engagement, or participation.
Healthy Corridor	A “green and social articulation” in the urban environment, integrating and linking diverse areas using and combining NBS in support of neighbourhood regeneration and well-being.
Geographical Information Systems (IGIS)	A set of digital tools that allows for analysis and mapping of spatial and geographical data.

Governance	The word “governance” originates from the Greek, “*kubernaein*”, which means “to steer”, thus referring to the manner of steering or directing a group of people, typically referring to significant number and over an extended period of time. Governance is different from “Government”, leaving it open “who” steers, or to what degree control is exercised.
Information and Communication Technologies (ICT)	Refers to all devices, networking components, applications and systems that combined allow people and organisations to interact in the digital world. ICT components include computers, telephones, smartphones, digital TVs, and robots.
Internet of Things (IoT)	The Internet of Things refers to the applications of communicating chips and artificial intelligence leading to all kinds of goods and products being wired, i.e., connected to the Internet, and starting to interact more or less autonomously with other things, and with people.
Methods	Methods include, e.g., voting, surveys, competitions, games, interviews, motivational interviewing, rewards, photo-voice, etc.
NBS	URBiNAT’s catalogue integrates territorial and technological Nature Based Solutions, comprising products and infrastructures, but also participatory, social, and economic solutions, comprising processes and services, putting in dialogue the physical structure and the social dimensions of public space.
Network	Interconnected group of individuals or organisational unities that may not be geographically co-located but are digitally connected.
Online	The state of being “wired” and thus able to connect and communicate digitally with people, networks, systems, computers, subjects, or components in real time through the Internet and/or social media.
Participation	Refers to the active engagement of citizens and stakeholders in influencing or developing processes or decisions with a bearing on their neighbourhoods, implicating: i) a spatial dimension; ii) an actual impact (going beyond the mere provision of information); iii) interactivity (involving two-way exchange), and; iv) exchange that is structured in some sense (not just coincidental).
Participatory Geographic Information Systems (PGIS)	Building on geographic information systems, PGIS aim to access data and technology while promoting capacity building and bringing together different stakeholders through participatory approaches. PGIS can be applied in spatial planning as well as communication management of geographical areas.
Platform economy	The platform economy is a concept denoting a business model that serves to link supply and demand more effectively, typically through the application of digital means, bypassing traditional middlemen and leading to reduced transaction costs.
Privacy-online	The right of an individual to control or influence what information related to him/her and appearing online, may be collected and stored, and to whom that information may be disclosed.
Participatory Design (PD)	Participatory design is not a design style but an approach to design featuring processes and procedures that aim to involve all stakeholders to help ensure the result is usable and meets their needs or interests.
Public Participatory Geographic Information Systems (PPGIS)	The term implies broad-based informed citizen participation in decision-making, using PGIS. PPGIS focus especially on inclusion and empowerment of marginalised populations with a limited voice in the public arena.

Purpose	Refers to the objective in terms of outstanding challenges or needs that the NBS and Healthy Corridors aim to address.
QR code	Quick Response (QR) is a type of matrix bar code which is a machine readable optical label that contains information about the item to which it is attached.
Sharing economy	When assets or services are shared between private individuals, either free or for a fee, typically by means of the Internet. Examples of sharing economy applications include BlaBlaCar and Intervac HomeExchange.
Smart	The term ”smart”, in conjunction with “city”, has been applied since 2008/2009, to denote the adoption of digital tools, sensors, etc., to arrive at solutions that are more relevant and efficient in the local context. “Smart” may also be used to refer to “citizens”, “industry”, “places”, “buildings”, “transport”, and so forth. The concept of “smart city” may, however, be viewed as an extension of previous approaches to applying “modernism” in urban development, with ancient origins.
Stakeholders	An actor with an interest or concern in a particular subject, here referring to “others” than the citizens themselves, whose engagement one way or the other may influence what solutions can be achieved or maintained.
Strengths-based approach	Focus on the strengths of individuals, social and community networks rather than their deficits. A strength-based approach is typically holistic and multidisciplinary and works with the individual to promote wellbeing.
Surveillance	The observation of individuals, communities, or populations at large for the purpose of information gathering.
Tailoring	Adapting a solution to the specific situation, also referred to as “custom-making”.
Urban Regeneration	A programme or set of activities to reverse decline by both improving physical structure and revitalise social and economic well-being in the urban environment, including deprived areas and for disadvantaged groups.
User-Generated Content (USG)	Content generated by users online.
Virtual Community of Practice (vCoP)	A vCoP is a Community of Practice basically run by virtual communication.
Web platform	Web platforms support virtual interactions between multiple members of CoPs, or VCoPs (if entirely based on digital communication).
Web 5.0	Following the previous generations of the web, Web 5.0 is predicted as the (emotional) interaction between humans and computers.

Purpose of Deliverable

The objective of the present deliverable is to examine conditions for Digital Enablers in URBiNAT cities, prepare and initiate new use and draw lessons for their continued advancement on terms relevant for the co-creation of Nature-Based Solutions (NBS) and Healthy Corridors. The title has been slightly adjusted from the Grant Agreement, to appropriately reflect that the advance of these programmes has been subjected to some delay due to the COVID-19 pandemic.

The report aims for in-depth examination and progression on how to usefully apply and combine the main building blocks of digital enablers under varying circumstances. This includes characterising the purpose, whether to work out a solution to fundamental challenges or realize untapped opportunities, devise suitable methods, arrange with value-enhancing content, as well as apply digital tools. It aims to pursue adaptation both to different user categories and to special conditions on the ground, while considering the presence of risks and the need of mitigation efforts. The latter include methods that ensure protection of privacy and the integrity of users.

The report further sets out to select and introduce two specific digital enablers. One, centring on food and related spatial activities, links dynamic Communities of Interest (CoI), suitable for parallel targeting and linking across the participating cities. The second represents a novel network connecting individuals for exchange and collaboration, launched with students and researchers already involved in NBS or related activities at the core. In parallel, based on the available experience and key lessons of our work thus far we formulate a set of guidelines for digital enablers in support of co-creation. The purpose here is to provide recommendations and initiate a process of developing a practically useful manual of more generic applicability, work which will continue to evolve as a "living" document.

Roles and Objectives in Relation to Other Work Packages

The report draws on several completed or ongoing URBiNAT activities. In Work Package 1 (WP1), the Handbook (D1.2), elaborating the theoretical and methodological foundations of URBiNAT, provided useful background. The report takes account of the local diagnostic (WP2 and WP5), the deliberations and consultations that have taken place in the Task Forces set up in the Frontrunner cities of URBINAT city to prepare for Living Labs (WP2), the advance of NBS to be implemented and integrated in Healthy Corridors (WP4), how digital tools can support participation at different stages of co-creation, drawing on WP2 and WP4, and conducted in coordination with WP5 on Data analysis and the URBiNAT Observatory. Meanwhile, the report forms an inherent part of WP3 and builds on the previous reports, most recently the examination and review of digital enablers in D3.3, as well as the previous D3.2 and D3.1. The conclusions have fed into work on a knowledge-based collaborative platform in T3.5, aiming to create a participatory process toolkit for Healthy Corridors. This will subsequently enrich T3.6 on the amplification of participatory solutions. Further, the results are to be fed back to the Task Forces and Community of Practice (WP2), supporting the uptake and benefits of NBS (WP4), diffused (WP6) and built upon in analysis of viable business models and value-creation more broadly in WP7.

Finally, through its hands-on coordination, parallel implementation and comparison of results and lessons between the participating cities and other organisations, as well as creation of joint platform for exchange and cooperation, the report contributes to progressing the URBiNAT Community of Practice (CoP).

Executive Summary

The present report advances the preparations and describes the initialisation of digital enablers to support urban regeneration through enhanced citizen participation in NBS and Healthy Corridors. Although the focus is on the URBiNAT cities, the report is framed with a view to generating insight and lessons of more general validity.

Extending from previous URBiNAT reports, digital tools are linked to associated elements – or building blocks - to establish digital enablers capable of tailoring support of participatory processes capable of adjusting to specific user attribute as well as conditions on the ground. Applications should be framed for taking advantage of the high scope for experimentation, adjustment and evaluation in real time, that accompany digital enablers. Meanwhile, account should be taken of risks and plans for mitigation efforts, e.g., to protect privacy and user integrity.

Differentiating between a strengths-based and a needs-based approach, the report elaborates on ways for digital enablers to leverage the motivation and engagement of users. Focusing on the districts selected within the URBiNAT framework for urban regeneration, the so-called “study areas”, the report adds to the previously pursued local diagnostic by strengthening the access to information on citizen perspectives. In addition to the Frontrunner cities of Nantes, Sofia, and Porto, substantive progress has been achieved in the Follower cities of Brussels and Siena.

Considering potential fields for application, two specific digital enablers have been identified and initiated. Of these. “My Edible Neighbourhood”, plugs into the process of developing and linking parallel Communities of Interest (CoI), featuring an interactive mobile application currently under development. The second digital enabler, “Circular Cities Café” connects users via a participatory platform framed to induce exchange of experience in regard to participation and NBS as well as active collaboration on new initiatives.

Drawing on wider experience as well as the advance of specific digital enablers outlined in the report, recommendations are summed in the form of guidelines for digital enablers in support of co-creation and urban regeneration. This work is envisaged to initiate a process and the gradual maturing of a “living document”, resulting in a practically useful manual and recommendations of more general relevance.

1. Introduction

Information and Communications Technology (ICT), and its extension to what we today refer to as "digitalisation", brings about a multitude of potential benefits, for individuals, organisations and society as a whole. Some of these have been further magnified by the enhanced reach in communication and interactivity made possible with the Internet, mobile telephony, and social networks. The impetus of ICT further evolves with new functionalities as brought about by smart sensors, IoT, big data analytics, and AI. Ambient intelligence, meanwhile, facilitates linking to people's feelings and perceptions.

Notwithstanding the opportunities at hand, digitalisation has been shown to have drawbacks and bring challenges as well. Already decades ago, many studies underlined that the use of ICT is pivotal, for what purposes it is applied, and that it is accompanied by skills upgrading and organisational change (OECD, 2001*a*). Since then, a gradual shift has occurred from access and availability of technology to inclusion and human agency, the ability for all people to make choices and have a say. In the same vein, the EU (2020) stresses the importance of relevance, that technology adapts to varying needs, and that digitalisation is introduced under conditions that are conducive to an open and democratic society, along with start-ups and business growth.

The blend of opportunities and issues at stake plays out particularly strongly, and with high visibility, in urban development. Recent work (URBiNAT, 2021) has reviewed the nature of digital tools and associated elements making up what is defined as digital enablers of participatory activities entailing the co-creation by citizens of NBS and Healthy Corridors. Through their ability to achieve, e.g., Reach, Inclusion, Interactivity, Initialisation, Sustainability, Linking and Trust, these instruments have already demonstrated huge potential. The present report proceeds by outlining the way forward for digital enablers in the present context.

Much of the focus is placed on preparing and initiating specific digital enablers in URBiNAT cities. Part of the purpose here is to frame a process that is conducive to experimentation, instructive sharing of experience and learning how to successfully apply digital enablers under varying circumstances. On this basis, key stages such as consultations, preparations and the implementation of digital enablers, benefit from parallel advancement across the cities involved. Part of the benefits materialise in real time, as synergies can be captured in structuring and calibrating the matching of digital enablers with conditions on the ground, including the needs and actions by user categories with varying attributes.

For this, the exchanges and collaboration within and across the participating cities are of high importance, relating closely to URBiNAT's Community of Practice (CoP).[1] While the degree of engagement across the cities naturally varies[2], the purpose is to help build a holistic understanding of how citizens and stakeholders can be engaged in co-creation of NBS and Healthy Corridors, with digital enablers providing effective, targeted support. A questionnaire suited for broadening the scope, has been developed and tested as part of this effort.

[1] URBiNAT's CoP featuring several layers of interacting parties, within and between cities as well as with other relevant organisations (URBiNAT, 2020).

[2] This includes the degree to which the officials who form part of the project have taken the lead, experts have weighed in, or a broader set of actors been thoroughly involved. Irrespective of such variation, the objective to underpin participation is maintained as the key tenet throughout the learning process.

As a concrete outcome of the present work, two specific digital enablers have been selected and framed for implementation in the URBiNAT project going forward. Both go beyond the realm of existing instruments in striving for a systems approach and promoting innovative solutions while taking ethical issues into account, e.g., by the use of open data and open source. While presented in greater detail later in this report, these two enablers may be briefly introduced as follows:

i) **My Edible Neighbourhood** picks up on, and responds to, the outright demand of citizens in the study areas to initiative innovative means for community building of direct relevance to their daily life, specifically linked to local food. This digital enabler has been framed to combine opportunities for **growing food locally, raising awareness about edible food in the neighbourhood,** and increase the **availability and quality of locally produced food**. A user-friendly app with PGIS run on smart phones, currently in preparation, forms part of the solution.

ii) **ii) Circular Cities Café (C3)** represents an interactive participatory platform launched in support of **exchanges and exploration of collaboration opportunities around NBS**, with students and researchers in the URBiNAT cities shaping the core of the new network. An initial interactive platform has been established, currently linked to URBiNAT's website but aiming for subsequent migration to an independent structure conducive to user innovation in a leveraged Community of Interest (CoI).

Further structuring the lessons of past experience and the ongoing URBiNAT activities, the report presents an initial set of guidelines for such implementation of digital enablers. The report concludes with final recommendations and key take-aways.

2. Key Objective of Digital Enablers in Urban Regeneration

The advance and diffusing of ICT are at the epicentre of an ongoing shift in governance that plays out strongly at the level of regions and cities, away from top-down towards a people-centric approach which pays full attention to human and social factors. Rather than passive bystanders, people's active and constructive engagement is viewed as critically important for working out operational and sustainable solutions to a host of issues and challenges confronting modern societies. These include the presence of forces that propagate polarisation and fragmentation. While some areas and communities slide into states of degradation and a loss of opportunity, others prosper. Even in stages of seemingly positive economic and social development, such areas and the people concerned may keep falling behind due to, e.g., fierce competition for resources, escalating costs and prices, and the gaps in skills and opportunities we associate with the digital divide (OECD, 2001*b*; van Deursen et al, 2011; ITU, 2016). In the end, unbalanced development will undercut the prospects for all to enjoy a sound and safe environment for working and living.

The massively enhanced capacity of digitalisation to propel interactivity and new initiative for the population at large, takes the potential for citizen engagement to an entirely new level. A major distinction has arisen, however, between authorities providing information to largely passive recipients and that of citizens becoming thoroughly engaged and capable of communicating as well as acting on those issues that are of relevance to them (OECD, 2020; Vesnic-Alujevic, 2020;

URBiNAT, 2021). This we may conceive of as interwoven with a wave of “democratic innovation”, referring to the successful rise of citizen-led initiatives (Newton and Geissel, 2012).

Having said that, it remains unclear under what conditions favourable adjustments occur. Distinguishing between various kinds of impacts, Fung et al. (2013) found stronger empirical evidence of technology contributing incrementally to policy reform, compared to truly transformative change. Key questions remain how to recognise and act on fruitful opportunities for evolution, battle inertia, and withstand unproductive and distortive pressures. This has been referred to as the need of building capacity for “transition”, placing actor agency at the centre, avoiding capture by self-interest, and adopting a holistic framework where “reflexivity” and social learning define criteria for the quality of outcomes. In the resulting space, it is envisioned that overarching change can be enacted through collaboration capable of embracing diverse interests and actors (Healey, 1997).

Enabling progress in such respects stands at the heart of URBINAT’s agenda, with much attention paid to the scope for social, inclusive and grassroots innovation, social entrepreneurship, and solidarity economy initiatives (Cozzens and Sutz, 2014). Such activities may take myriad shapes while embedded in local networks and enriched by the engagement of diverse actors and competencies. This has led to more rapid uptake by previously unreachable user categories, along with changing attitudes and impacts on behaviours, reflecting the role of networks, including social networks, in shaping relations (O’Hara et al., 2014). Meanwhile, new approaches to marketing and diffusing information have profound implications for the speed with which digitally propelled goods, services and social innovations become accepted by new user categories (Mailoni et al., 2016). Innovative start-ups utilising digitally enabled means of raising capital, such as crowdfunding, may thereby achieve an expanded client base. Other but related implications arise in the spheres such as education and health (Halpaapt, 2020).

In recent years, NBS have become viewed as important vehicles for generating urban regeneration and supporting sustainability more broadly. In mimicking nature, NBS tend to encompass significant environmental assets and associated functionality. NBS are not only limited to nature, however, but connect with the intricacies of culture and the dynamic for unlocking social progress. Their adoption and development tend to draw upon and propagate ample benefits, impacting not just on those most immediately concerned, but with much greater reach. For these reasons, it is hard to measure and reflect those benefits in terms of organisation and business models, presenting hurdles for the internalisation of the gains along with a tendency for underinvestment in NBS in the first place (McQuaid et al., 2021).

The linking of NBSs through co-creation of Healthy Corridors, opens for new means to capture synergies between NBS, involve more actors, and work out holistic solutions to a range of outstanding issues. Countering fragmentation and polarisation by people themselves shaping inclusive public space, represents a major building block. The means need to be at hand, however, to achieve inclusion. Depending on the context, various actor groups may be crucial, including “unusual suspects”, i.e., those who may not be brought on board by traditional means of engagement. Table 1 provides an overview of actor categories to be borne in mind when devising digital enablers.

Working out formulas for combined deepening and broadening of citizen participation stand at the heart of URBiNAT. Gaining practically useful insight and valid instruments for embracing disadvantaged groups, in deprived areas, belong to the key objectives while also presenting some of the main challenges in this context.

Table 1: Relevant actors and the role of digital enablers

Relevant actors	How to prepare for a successful implementation of digital enablers
Citizens, local communities, NGOs	• Co-diagnostic in identifying priorities for digital applications • The structure and building blocks of digital enablers need to be aligned with co-diagnostic results • Initiation process has to include piloting, fine-tuning so that an understanding for the functionalities of the digital enabler will benefit the target group • Roll-out on a step-by-step basis and in various manners that ensure that all target groups are reached and provided with a comprehensive understanding on how to use the digital enablers
Technology providers, businesses	• Close collaboration with municipality and other actors in order to grasp the full viability of the four building blocks of digital enablers • Actively engage in the co-diagnostic phase so as to design the digital enabler with a user-driven perspective in contrast to a technology-focused one • Test the ideas and pilot the digital enabler among small citizen groups before scaling and roll-out • Be prepared for modifications as the user interface evolves • Open for innovative business models including multiple stakeholder scenarios
Authorities, policy makers, municipalities, public administration	• Mapping of digital tools usage, digital literacy levels, etc., to understand where digital gaps prevail • Engage in efforts to bridge the "digital divide" among city areas and citizens including making digital tools available, ensuring affordable internet connections, providing training in digital literacy • Make open data available which serves as inspiration for technology providers and Nature Based Enterprises

Source: IKED and DTI, 2021

Along these lines, the present report embarks on the preparations and initialisation of digital enablers in support of co-creation, with a view to their ability to:

i) Achieve inspiration, reach, targeting, raiding quality of participation/co-creation
ii) Enhance the development of existing or new NBS, applying through all relevant stages (from preparation and design to implementation to use by implementation of IoT, sensors, etc., facilitating co-monitoring and measuring of impacts)
iii) Create participation platforms, with links to NBS, for relevant target groups
iv) Underpin awareness and changes in behaviour that can cater for sustainability for the long term
v) Promote socio-economic development, job creation, entrepreneurship, and innovation by engaging citizens in the co-creation process.

Bearing such aspects in mind, work on digital enablers in the present context has been framed with a view to continuous improvement through structured experimentation, learning, and diffusion. Linked to the concept of Healthy Corridors, the aim is to underpin systemic effort in support of urban regeneration and a sustainable urban environment.

A fundamental caveat should be underlined, however. Digital enablers are not necessarily preferable to traditional means of participation, nor always well-suited to replace them (Hasler, 2017; IAP, 2017). The two may be complementary, although in some cases one may be strictly

preferable. Clearly, the reach and functionality of digital communication brings specific possibilities. Similar issues may arise whether participation is propelled through non-digital or digital means, however, e.g., in forging compromise or balancing short- and long-term interests (Fenwick and Edwards, 2016; IAP, 2017). Further, as will be returned to, inherent risks and downsides to digitalisation tend to be disproportionately taxing for vulnerable groups.

Summing up regarding the key objectives for digital enablers in the present context, high emphasis is placed on the mechanisms through which meaningful and value-enhancing participation can come about. Their application must critically be framed on terms that go beyond traditional linear modes of urban planning, or the narrow self-interest of policymakers, officials, or experts, favouring a holistic approach for broader participation and co-creation of NBS and Healthy Corridors, where all key actors can play their part. The set-up must be credible and effective in sustaining enduring results. URBINAT aims for framing parallel implementation and learning processes around smaller project cycles, across the participating cities/study areas. Lessons that are context-specific will be distinguished from those that are more generic, opening for an improved understanding what works and what does not work under varying circumstances.

3. Drawing on Key Elements of URBiNAT

Selected elements of URBiNAT's approach, which provide an important underpinning for the preparations and implementation of digital enablers, are outlined in this chapter.

Most fundamentally, the project brings together nine cities which assume different roles, although sharing a high ambition to upgrade and strengthen the role of NBS coupled with citizen engagement. Three of the cities, Nantes, Porto, and Sofia, already have extensive experience of NBS and assume the role as Frontrunners in the project, inferring that they are spearheading new approaches in the various activities, including participatory methods, and preparing for their further linking in Healthy Corridors. The Follower cities of Brussels, Høje-Taastrup, Nova Gorica and Siena take active part in the exchange and are obliged to prepare plans for how to advance NBS and Healthy Corridors. The non-EU cities, Khorramabad and Shenyang, assume observer status, with scope for intensive engagement and own project implementation depending on what level of ambition they opt to apply.

While the nine URBiNAT cities thus fall into the categories of Frontrunners, Followers and Observers, that does not translate into a corresponding hierarchy in terms of experience from applying digital enablers. The cities taking part in the project represent a mixed bag in this respect.

Having said that, all nine clearly display high awareness of the opportunities at hand in participatory processes. Each has identified ways forward to realise Healthy Corridors, established more or less functional Task Forces linking citizens and stakeholders, and adhered to the joint CoP with its associated vehicles for consultation, learning, and diffusion. Meanwhile, throughout the period in which the present report was processed, all found themselves struggling with the specific hurdles brought about by COVID-19, which meant there were few alternatives to

embarking on digital enablers as a means of communicating with and engaging citizens on issues of urban and societal development.[3]

3.1 Local diagnostic

The basic local diagnostic carried out in URBiNAT has been completed for the Frontrunner cities. The corresponding exercise for the Follower cities is presently in the final stage. Based on the information at hand for the study areas of the seven European URBiNAT cities, Table 2 presents an overview of the status of infrastructure for digital enablers, divided into three categories. These feature the conditions for accessing the Internet, digital tools, and the level of digital literacy. Taken together, consideration to these three provide a reasonable point of departure for determining the preconditions for applying most kinds of digital enablers.

Reviewing this material, the contours of two categories appear. For Brussels, Høje-Taastrup, Nantes, Nova Gorica and Siena, Internet and access to digital tools appear rather well catered for. Similarly, digital literacy accounts for limited issues, although gaps between generations and socio-economic groups present various challenges. Porto and Sofia, meanwhile, have invested in bandwidth but access to the Internet remains problematic, and consideration is required as to what tools are available. These cities meet with greater issues in regard to digital literacy as well.

While it is too early to draw definite conclusions, based on actual observations on the ground, Nantes and Brussels appear to pursue largely successful initiatives encompassing the study areas, using digital initiatives, whereas most of the other cities remain focused on more conventional methods for engagement (URBiNAT, 2021). More work is required in each city though, to identify relevant gaps, and devise instruments suitable for reaching out to the diverse categories of citizens residing in the study areas.

For the preparation of digital enablers, however, the inputs of that mainstream local diagnostic cover only part of what is required, resulting in a need to collect complementary information. This includes, for instance, how and why citizens actually engage in digital communication. The lack of sufficient mapping in this regard is particularly stark due to high variation among user categories. Further, digital communication is associated with clear-cut issues and risks, which affect users differently. Examples include the issues that arise from proprietary platforms, risks of data misuse, outright cybercrime, whether the public communication strategies and service provision at hand is relevant to the needs of users, and also concerns with affordability (Marler, 2018). While various methods can be applied, adequate collection of information on the perspectives of citizens should be ensured. In the case of the present work, a special questionnaire has been directed to citizens, see Appendices 1 and 2.

Some relevant contributions to the local diagnostic have been carried out in WP3, notably on the mechanisms influencing co-creation by citizens of NBS and Healthy Corridors. Task 3.2 set out to examine and map the status of “soft infrastructure”, including participatory culture and its implications for attitudes and the scope for collaboration. On this basis, further insights have been gained into, e.g.:

[3] The limited scope for physical interface arising in the context of COVID-19 meant that the CoP itself had to strongly rely on features of a virtual CoP (vCOP), as the only viable means of maintaining continuous orderly exchanges and collaboration (URBiNAT, 2020).

Table 2: Digital Infrastructure in the study areas of URBiNAT cities

	Kinds of Digital Infrastructure		
	Internet connection	Access to digital tools	Level of digital literacy
Porto	Fibre optic network available	Limited to mobile phones and smartphones	Generational Divide, with higher digital literacy among the young
Nantes	Good coverage	Widespread use of smartphones except by older generation Few laptops and tablets	Generational, socio- economic and educational gaps
Sofia	Sufficient bandwidth Lower affordability	Many have smartphones, fewer laptops and tablets	Relatively low digital literacy, significant generational gap
Høje Taastrup	Good WIFI and cable connections as well as 4G mobile connections	Primarily access via smart phones, some PCs/Macs and for others access to PCs at library	Most people are digitally literate Some elderly, immigrants and others in need are offered assistance at city hall, libraries, NGOs and schools
Siena	Civic network accessible wireless Francigena WIFI available for citizens, tourists, and pilgrims	Web pages easy to access and consult. Siena Comunica has a user-friendly interface linked to social media	Good level of digital literacy among citizens, and a willingness to experiment with new solutions
Nova Gorica	Broadband access plus Hot Spots with free WIFI at multiple locations	Smartphones are common and most families have at least one laptop	Digital literacy level is relatively high, but generation gap exists
Brussels	Broadband and Fibre Access throughout the city	Smartphones are common and most households have access to laptop or tablet, incl. free of charge at community centres	Digital literacy is basic and generational gap prevails, but citizens are positive to use of digital tools

Source: IKED, 2021

i) The landscape of municipal facilities and centres influencing community exchanges, identifying "hot zones" where it may appear particularly important to exert an impact.
ii) Community channels for impetus, e.g., "resource persons", ambassadors or project promoters and promotion groups, well placed to back and boost a participatory process at various stages of the project.

Shifting to focus on digital enablers for co-creation, T3.3 reviewed their standing relative traditional approaches, taking stock of more general trends as well as presenting in-depth observations from specific other cities, in Europe and beyond, viewed as interesting reference points. As for the findings for the use of digital enablers across the URBiNAT cities, that report pointed to a rich set of applications already in place, but also concluded on limited use in the study areas. With reference to participation in support of NBS and Healthy Corridors, the situation at hand is largely one of mostly untapped opportunities.

Summing up, local diagnostics need to help gather an understanding of the basic means through which digital enablers can realise inclusion and co-creation, with a view to different kinds of users

as well as the presence of complex structures and high variation within each city. In regard to digital enablers, the URBiNAT cities varied considerably in regard to their preconditions as well as strategies already before the project's start and have continued to do so. Complementary information, beside the mainstream local diagnostic, may be required to realise urban regeneration through a constructive learning process.

3.2 Co-creation

The work undertaken to date in work packages 2 and 3 has served to lay the basis for URBiNAT's approach to co-creation. In the early stages, local diagnostic of relevance for awareness creation, mapping of participatory culture, and the identification of relevant stakeholders, has been greatly important.

Effective participation is supported by educational elements and training that help both bring out the best of urban planners whom, it should be stressed, have a key role to play and with valuable competences which should be utilised in the best way possible, and also to help underpin constructive citizen engagement based on a willingness to appreciate diversity and confront conflicting interest.

A well-executed plan may require:

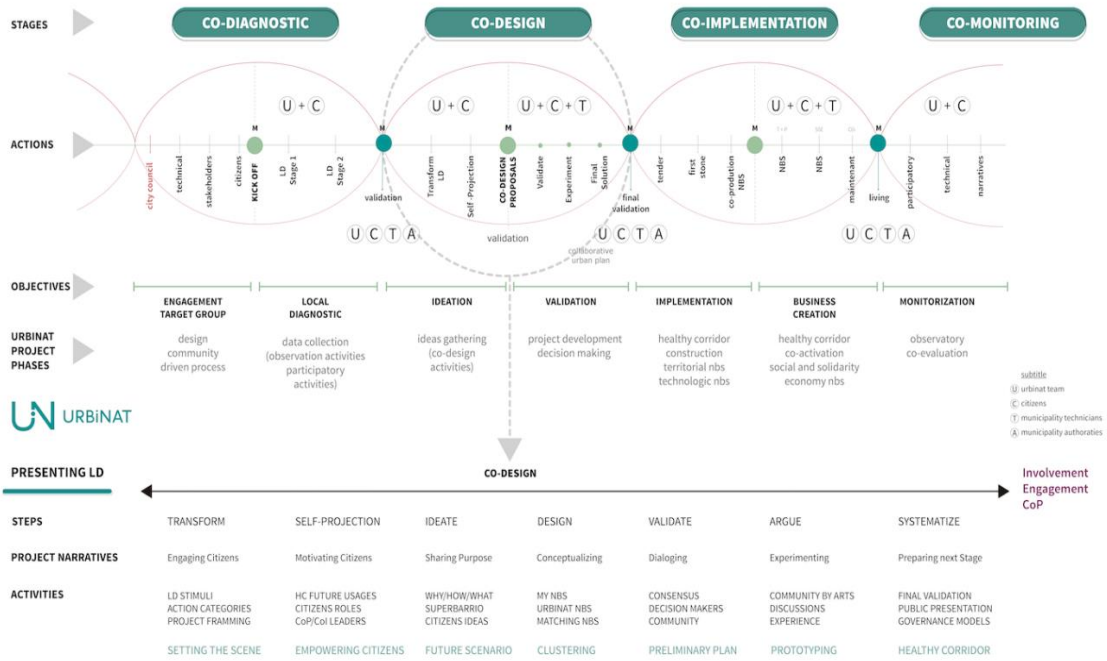
a) Mindset evolution on the part of urban planners, in support of inclusion;
b) The assessment of issues and problems beyond the limited scope of the municipality or vested interests;
c) Room for candid and creative input from the relevant local stakeholders and neighbours;
d) A sense of involvement and belonging, strengthening the identity and building new linkages and a sense of community among all;
e) Genuine value-enhancement from the implementation of executed plans.

The degree to which citizen engagement is sought, and with what results, can be depicted using a framework such as Arnstein's ladder (Arnstein, 1969), outlining a spectrum that stretches from mere input to empowerment. Inputs may be measured by expression of appreciation and buy-in. At higher levels, quality feedback and two-way influences are essential. A genuine sense of control, accountability, connectedness, vision, etc., will be required to verify empowerment.

Digital enablers bring great potential to contribute, in several ways. This includes mechanisms for citizens' needs and aspirations to be articulated and heard, as well as when it comes to the mechanisms for promoting and upgrading citizen engagement, e.g., through enhanced targeting, flexibility and interactivity, advanced through iterative rounds of experimentation that allow for learning from citizen responses in "real time". Multiple combinations may be achieved, ranging from creating awareness and building capacity to citizens shaping their own incentives/motivation for involvement on the ground. Other stakeholders (e.g., organisations, businesses, NGOs, informal groups), may assume differing facilitating or supporting roles, depending on interest, purpose, resistance, tools, methods, content and/or data.

Access to information importantly has a bearing on the degree to which joint interests can be identified and be built upon. The following exemplify ongoing activities in URBiNAT of relevance in this context:

Figure 1: Co-creation process



Source: GUDA, 2020

i) Urban mapping addressing targeted workgroups (such as children, families, or elderly citizens); GIS schemes facilitate navigation for the purpose of identifying, locating, and visiting certain places of specific interest and need for target groups, e.g., playgrounds or suitable terrains for exercising.
ii) Engaging stakeholder groups; Associations, interest groups, sub-communities, etc. Mobile applications often service specific CoIs in a targeted manner. Agendas set out to co-create even more tailored digital applications can help propel new linkages and the engagement of additional actors, including other CoIs with which potential synergies are at hand.
iii) Citizen engagement through social media; A wide array of communication channels can be utilised by neighbours to express their needs in novel ways, so as to be better understood by all relevant parties.

Based on the above elements, URBiNAT fosters a set of co-creation processes related to the stage of NBS development. As illustrated in Figure 1, the cities proceed in parallel through the subsequent stages, each marked with its specific set of co-creation activity. The Frontrunners are moving in the first wave, currently entering the implementation stage, with the Followers and Observers a step behind.

Reflecting the importance of the group level, progress may be greatly enhanced by a vibrant Community of Interest (CoI), which may help build favourable linkages between individuals. Typically, those who form part of the CoI share a common interest on such terms that that it can underpin constructive exchanges and also joint action. A CoI may be informal in nature, and less stable compared to a CoP, coming together for a specific project and possibly dissolving once it has ended. Drawing on less structured and more volatile means for underpinning collective creativity, however, CoIs are potentially more innovative and transformative (Saeid, 2015).

Examples of interest groups or activities that can be seen to establish such linkages include:

- Artists (all levels) and connected events such as exhibitions;
- Musicians of various genres, concerts, etc.;
- Chefs (professionals and those who cook at home) and food festivals and events;
- Green business entrepreneurs and mature local green businesses;
- Local sports activities which are specifically strong in the community;
- Environmentalists - forum for sharing practices for urban farmers and gardeners;
- Youth networks.

In the present context, the focus is on CoIs as operationally useful instruments for defining, linking and furthering common interests. CoIs may already be in place, or new ones may evolve. This may occur through various arrangements, ranging from online webinars to set-ups for outdoor arenas with a screen. Again, however, digital enablers offer particular ways forward.

3.3 NBS and Healthy Corridors

The preparation and structuring of NBS available for deployment in URBiNAT have been progressed in WP4. Consequently, the URBiNAT cities engage in participatory consultations entailing the selection and design of specific solutions. The Frontrunner cities have already advanced to the stage where they draw on the specific offerings made available through URBiNAT's "NBS catalogue". In this, recognising the importance of both natural and the societal aspects, the available NBS have been classified in four categories, spanning territorial, technological, social and solidarity economy, and also participatory NBS. The Follower and Observer cities, while not yet at that stage, have nevertheless in some cases identified particular solutions which stand out as being of high relevance for them.

Digital elements form an integral part of many of the NBS represented in the URBiNAT NBS catalogue. In the technological category, the "Mobile urban garden" is based on an augmented reality app while Superbarrio relies much on a digital game. Territorial NBS show high propensity to make use of digital tools such as sensors, GIS platforms, etc. Social and Solidarity Economy NBS include Solidarity Fairs/Markets, Farmers' Market Network, Bread Houses, and Social Currencies, each of which incorporate digital features. Among participatory NBS, Behavioural Mapping, Women's Footprints Map, Photovoice, Motivational Interviewing, and LearnforLife, gain increased leverage through digital means.

Whether digital enablers are part of a specific NBS or not, they may be applied as part of the participation process. The value of any particular NBS, or how it is put to use, is interwoven with attitudes and behaviours. Meanwhile, the potential benefits are multifaceted and may accrue to multiple actors, including groups of citizens as well as stakeholders. The surrounding context matters greatly, including linkages to other NBS through the construct of Healthy Corridors.

It should be noted that the concept of health is here associated with the combination of physical mental and social wellbeing, distinguished from "absence of disease" (WHO, 1947). While the three are related, they span from "physical" being primarily about the individual to "social" having to do with the group, while "mental" is in between.

Healthy Corridors aim to achieve lasting structures, and impacts. The importance of viability for the long term, in contrast to quick fixes, needs to be underlined. Many influences may appear effective at first but turn out to be of transitory nature. Especially for new members of a

community, their effective commitment may take time, including when interactions occur primarily online (Lehto and Oinas-Kukkonen, 2011).

By linking hubs and complementary sources of public space, Healthy Corridors stand to overcome fragmentation in city functions, breeding new creative meetings, communications, and creations in the urban environment. Digital enablers, again accompanied by hybrid solutions, may add potentially crucial dynamic in fostering genuine co-creation by citizens and stakeholders in realising such outcomes. Envisaged benefits include greater awareness, inclusion, trust, commitment, and appreciation for what is accomplished.

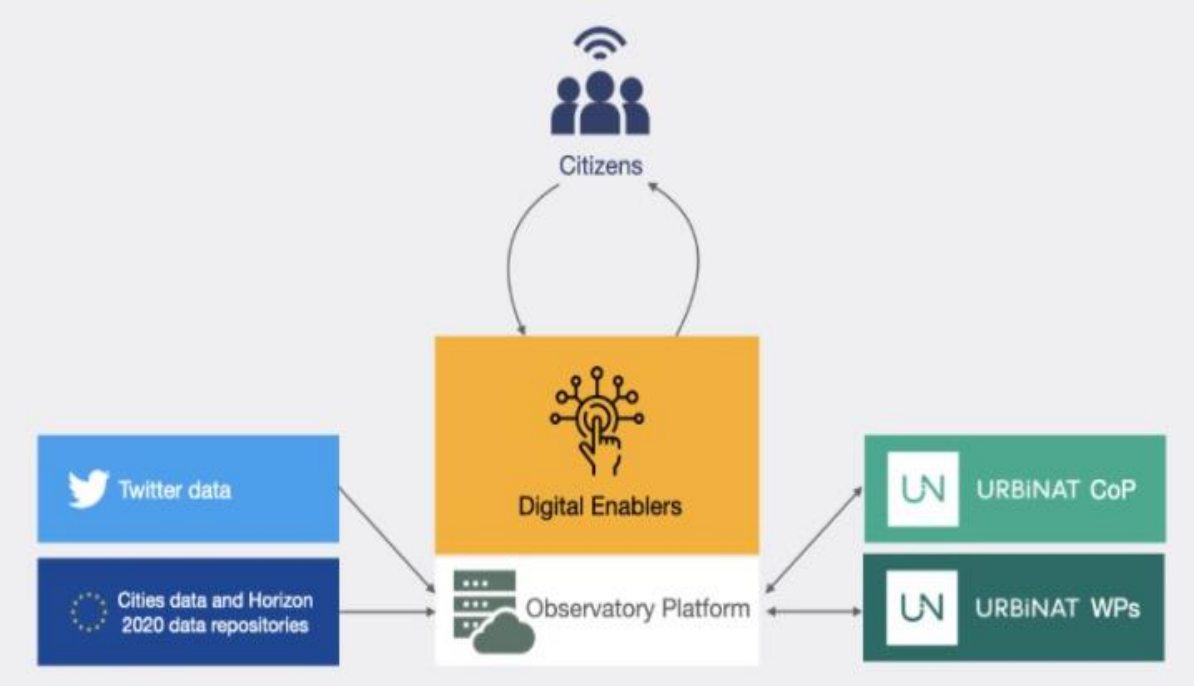
3.4 Data management and the Observatory

The value of inter-actor and inter-city exchange and learning is massively enhanced by the parallel, structured advance of participatory processes around NBS and Healthy Corridors within URBiNAT. Capitalising on these benefits requires a well-developed and user-friendly framework for data collection, processing, and use.

Data management entails integrating key aspects of the infrastructure, collection, and analysis of data. Here, the URBiNAT Observatory, advanced in WP5, has been framed to provide continuous support for coordinated experimentation and joint learning. The Observatory heralds the capability to upload all kinds of files and operate via open systems. In particular, the application of open-source software repositories promotes programmes that are modifiable, capable of creating and altering content without the constraints of specific tools and/or proprietary vendors (Ferilli et al., 2020). Figure 2 illustrates how the digital enablers, interlinking with citizens, stack on the observatory. While connected with various sub data sources, including other Horizon 2020 data repositories, the operation draws on URBiNAT's COP, WPs, and local Task Forces for the orderly collection and processing of complementary strands of data. As a particular source of linking to overriding trends in communication, Twitter traffic accessed in real time can be matched with geospatial data to spot patterns of movement, measure trends, and examine geographical variation in well-being.

On this basis, the deployment of digital enablers is staged to process complex information flows, sorting out specific prioritised user categories populating the study areas, as well as other parts of the participating cities. Effective monitoring and evaluation of impacts from the planned activities will require measuring changes in real time, starting out with benchmark/reference values pertaining to the state of affairs at the start, followed by assessment of the impact brought by the interventions and associated engagement of citizens. In the case of eco-food, for instance, indicators measured may include the number of people involved both in production and as consumers, including their awareness, behaviours in terms of food selection, and also well-being. On these points, smart sensors and apps with sharing capabilities for text, voice and images, cater for effective feed of user-specific as well as complementary data from multiple sources. With the help of appropriately devised digital platforms these inputs can be calibrated and matched, feeding quality high-precision analysis of interventions with consideration to relevant confounding variables, including location-data as well user-attributes such as gender, age, and various forms of group-association. The formation of CoIs can be applied to collect and examine additional layers of information related to special interests, social relations, etc.

Figure 2: Digital enablers and associated data flows



Source: IKED and IULM, 2021

Altogether, the data collection and processing will be devised for generating objective measurement and new insights and understanding co-creation can be devised most effectively for citizens with various attributes in support of the most favourable outcomes in terms of NBS uptake and increased wellbeing. This in turn aims to help guide the future preparation and implementation of digital enablers in support of participatory processes around NBS and Healthy Corridors.

Similarly, the data collection and processing made possible by the application of digital enablers, is key to the structured and coordinated advance of experimentation in co-creation of NBS and Healthy Corridors across the URBiNAT cities, pursued on terms that allow for comparability, monitoring and evaluation as a basis for sharing and learning within its CoP.

3.5 Building blocks

Digital enablers are not just about digital tools. In order to achieve basic functionality and specific objectives, other elements need to be put in pace. The elaboration of the building blocks that are key to framing digital enablers has been undertaken in Task 3.3.

In brief, digital enablers may be routed around four main building blocks: i) *purpose*, ii) *methods*, iii) *content*, and iv) *tools*. In Figure 3, purposes feature at the top. Methods appear on the left-hand side, tools on the right and content in between. Alongside experts, citizens - and stakeholders - may importantly engage in shaping digital enablers. When devising and applying digital enablers, all these aspects should be considered in tandem. Figure 3 indicates how the four building blocks may be matched and combined. In a specific case, each category may be subject to adjustment. Entirely new combinations, and enablers, may take shape. Each of the categories is briefly reflected on in the following, while highlighting their interdependency.

3.5.1 Purpose

The purpose of digital enablers relates to their particular strengths and rationale, such as high reach, speed and interactivity, but also flexibility in terms of adjusting communication over time and tailoring to different user categories. As already discussed, these features can be drawn upon for interfaces with citizens and stakeholders so as to support their engagement, notably by way of co-creation of NBS as well as increasing the uptake and impetus of NBS and Healthy Corridors.

A related objective is to generate improved measurement and monitoring in real-time of various indicators, spanning the environmental, social, and economic spheres. Examples include air or water quality, purchasing or consumption of locally produced and nutritious food, physical activity and use of time, mobility, the selection of transport modes, etc.

From a traditionalist governance or macro perspective, digitalisation requires investment for the purpose of cutting operating costs and raising efficiency. Economies of scale and scope may be aimed for through increased speed and expansion of certain activities, or by creating synergy through improved coordination of different activities. The aim may be specified as generate higher financial returns and/or socio-economic benefits. In relation to strategic planning, monitoring and evaluation, digital enablers may be applied to predict citizens' future user patterns as well as to broaden the collection and processing of data, and also for better analysis and feeding of the results back to policymakers, in support of reforms and the design of new programmes.

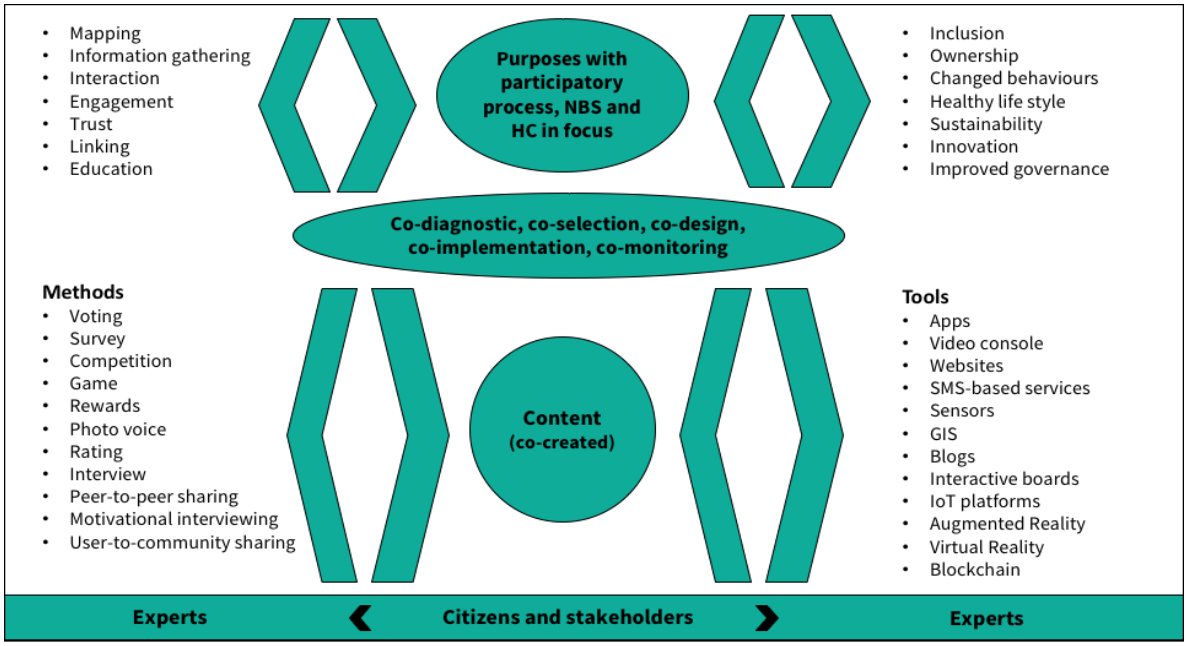
Digital enablers may be enacted for the purpose of making citizens more aware, but also to take initiative and convey their specific needs and requirements, in effect to realise an influence on decisions influencing their own environment. Digital enablers may be framed to inspire citizens in the first place, but also to take part in monitoring and evaluation. At the broader scale, they may be used to effectuate that citizens and/or other actors transition from an apparent camp of passive spectators, or allegedly helpless victims, to becoming active and creative drivers of change (cf. Nambisan and Nambisan, 2013). Such a shift does not occur in isolation though but bears on the organisation and governance of urban planning and implementation. The objective of digital enablers may span propelling and facilitating a transformation in those respects as well.

3.5.2 Methods

The substantive functionality of digital participatory enablers is framed with the help of methods. Examples include voting, surveys, competitions, games, interviewing, motivational interviewing, rewards, photovoice, walk-through, scorecards, idea banks, time banks, peer-to-peer sharing, rating, and peer-to-community sharing. Methods suitable for catalysing bottom-up initiative may take the shape of calls for proposals, the creation of an idea-bank, or launching a competition. Digital enablers provide potential leverage through increased reach, speed, flexibility, cost, room for interactivity, and so forth.

Digital games such as "Urban City Players" may be applied to induce neighbours to co-design new features of their local environment. Another example, Superbarrio, is applied in URBiNAT as a means for citizens to select and design chosen NBS. Evidence shows such games can be effective in creating initial interest and bringing diverse groups together, although not all will be equally attracted. Their role and impact are likely to be temporary rather than permanent, however.

Figure 3: Schematic framework for the building blocks of digital enablers



Source: URBiNAT (2021)

Methodologies to make it possible for digital enablers to realise benefits of personal engagement are in high demand. Introductory "post methodology", for instance, may allow new members of so-called virtual CoPs (vCOPs) to introduce themselves to the group on terms that facilitate rapid acceptance. Various variants may be applied as well for web platforms to facilitate the speedy identification of particularly relevant subjects/messages:

- A system of traffic light colour coding, devised by a "knowledge broker" to fine tune the level of evidence supporting a post (i.e., green for practices proven effective, yellow for those with uncertain effects, red for those proven to be ineffective).
- A "thumbs up" feature similar to the "Like" feature on Facebook, made available to all CoP participants to indicate when a post is of special interest.
- A search function facilitating for users to locate relevant posts.

Rewards represent a key category of methods, which is applicable in support of multiple purposes. The framing is often delicate as rewards must be meaningful from the perspective of those targeted (Thaler, 2015). The impact may vary starkly between various groups, and also at individual level, with the cultural context of great importance. For persuasive systems aimed at changing attitudes or behaviours, Fogg (2009) distinguished between motivation, ability, and triggers. Additional aspects arise as one moves from rewards targeting individuals (what makes *me* tick?) to those addressing communities (what makes *us* tick?). Several studies find rewards to gain strength when taking advantage of social relations (Ladley et al., 2015).

The time span between action and reward delivery represents a particular challenge which plays to the advantage of digital enablers, given their smooth functionality and ability to accommodate whatever method is most effective. Consequently, in the health sector, digital enablers supporting timely response, or effectuating changes in treatment, have come to attain high importance. In health- and lifestyle apps, self-monitoring generally appears as a common method to track and self-discipline behaviours (Bakker et al., 2016). In this case, however, users are often already aware of the issues addressed.

A range of studies have concluded that enacting lasting changes in behaviour in many cases require going beyond marginal adjustment of established habits, but rather achieve a perceived change of context (Marteau et al., 2012; Teyhen et al., 2014). Other methods, e.g., LfL or Urban Acupuncture, devise a sequence of interventions, suited to gradually modify those elements that affect daily life. More gentle interventions of this kind, aiming to stimulate step-by-step adjustment in behaviours, are clearly most effective when taking advantage of social relations, e.g., by making use of peer mechanisms (Andersson and Björner, 2019).

Increasingly, traditional behavioural-change methodologies have been translated into digital space for the purpose of targeting and tailoring to the needs and preferences of individual users (Almutari and Orji, 2019). This has resulted in personalisation and advanced systems for issuing reminders as means to enact lasting changes in attitudes and behaviours (Wood et al., 2005; Price et al., 2016; Alqahtani et al., 2019). The most common usage of behavioural sciences in regard to digital enablers so far has taken place in the area of neuro-marketing which nowadays represents a wide range of sophisticated tools using data mining and machine learning for the purpose of achieving a better understanding how to influence consumer behaviours behaviour (Iancu, 2018).

Based on experience of what works and what does not, many web-based enablers nowadays fine-tune methodology by way of tunnelling (guidance to tasks) and reduction (simplification), which help define and narrow the target behaviours in focus (Kelders et al., 2012) https://www.frontiersin.org/articles/10.3389/frai.2019.00030/full - B15. Meanwhile, community-based participatory research demonstrates the added value of engaging community members as well as academic partners in shared decision making. For various methodologies suitable for engaging youth of various groups, see Jacques et al. (2012).

The usefulness of specific methods often depends on their matching with specific digital tools. Photovoice serves as a participatory method mostly when linked to a smartphone camera, although a web portal with data management functions might to the job for some users. FixMyStreet (www.fixmystreet.com) exemplifies a digital enabler using such methodology for the purpose of encouraging citizens to document and report on neighbourhood issues. The mapping platform MyMaps - fed with data generated through the ArcGis programme – has been applied in URBiNAT diagnostics for the purpose of visualising the results of photovoice and walkthrough performed in elementary schools.

Increasingly important methods for underpinning behavioural change take the shape of persuasive systems that apply group dynamics, peer pressure, or social facilitation more broadly. While not all such methods are inherently digital, use of video, camera or apps have proven to add great value notably by providing the means for discerning how others in a target group perform (Harjumaa and Oinas-Kukkonen, 2009). Connected people can keep track of each other and followers can see the activities of those they are following. A participatory NBS in URBiNAT's NBS catalogue, LearnforLife (LfL), is a methodology that frames rewards as a means for incentivising individuals (Andersson and Björner, 2018), returned to below.

Methodologies based on peer-to-peer sharing and user-to-community functionality carry particularly advantages for scaling, by involving many more members of a community in a structured exchange tailored to coaching and supporting individual users, in effect extending from individual to group benefits. More and more persuasive strategies run via apps place great weight on social interactions as a key vehicle to transmit positive rewards (Orji et al., 2014).

3.5.3 Content

The packaging and structuring of information on terms that induce users to "catch on", is broadly referred to as "content". Content is often subject-specific, i.e., linked to a precise substantive theme which is processed into a format suitable for messaging to a given audience. Although content-development is an ancient practice of high importance through human history, new aspects have arisen with digitalisation. The ability to select and combine vast amounts of data into content fit for diverse audiences has evolved into a major source of value-creation (Schubmehl and Vesset, 2014). Yet, policymaker and researchers only recently started to pay attention (Bonsón et al., 2015). Meanwhile, public e-Participation initiatives mostly achieve modest citizen participation, standing in stark contrast to the enormous uptake of social networks (Toots, 2019).

Content in fact carries enormous capacity to fuel inspiration and ensure user engagement. This is true for basically all sectors, strands of life, and actor categories. It may dwell on details, or help communicate complex phenomena and assets, including the multi-dimensional benefits of NBS. Whichever, its factual contributions are buoyed by the capacity to spice in with streams of subjectivity, while also linking to culture, mindset and aesthetics. It is well-known that the value of content can be much enhanced by design, and also by linking to art, stories, fiction, and so forth. Co-created public space can similarly take advantage of the means to frame a virtual reality, further expanding the opportunities of what can be envisioned, by and for whom.

In the early stages of a co-creation process, local diagnostics and other facts-collection should be framed so as to help guide adapted content development. With co-diagnostics, citizens are in the position to prioritise content of relevance to the issues confronting them. In later stages, content will be devised for more targeted purposes, e.g., in support of specific NBS, their update by various user categories, inspiring new habits, and taking home lessons. The nature and scope of interactions - with citizens as well as among key stakeholders - focusing on continuous improvement, is key (Carroll et al. 2015; Le Dantec et al. 2015). Citizens' fine-tuning content may be critical for generating feedback or engaging specific stakeholders.

Specialised and customizable content in effect takes on properties of "soft architecture". This applies, e.g., on top of behaviour-change methodology - games, rewards, or motivational interviewing techniques - which may have broad applicability but be of little relevance unless properly complemented with tailored, smart content. Finetuning content is often the key to reach and engage specific target audiences and/or achieve particular purposes.

A particular aspect is the creation of data by users themselves. Broadly speaking, processes for developing user-generated content (UGC) are growing in importance (Li et al., 2016). Examples of cities widely viewed as successful in arranging with broad-based citizen engagement, such as Stockholm and Helsinki, have typically introduced digital enablers that are highly user-centric and open for users to create or modify content .[4] For examples of innovative content developed bottom-up by self-organising urban groups, one may consider the local organic-food community of Aarhus, or the evolving ecology of digital tools illustrated by Saad-Sulonen and Horelli (2017).

Having said this, questions and challenges may arise, e.g., who to engage in creating content, and how to arrange the selection (Prpić, 2015). Further, analysis of content creation by different kinds of users point to the strong influence of skills, socio-economic class, etc, on user content. So-called "elites", based on such attributes, tend to dominate content associated with traditional

[4] https://www.nordregio.org/sustainable_cities/maptionnaire-map-based-questionnaire-service/

politics, while “non-elites” are more oriented towards developing social and entertainment content (Blank, 2013). Gender is also a factor, including when it comes to propensity to place various kinds of content online (Hargittai and Walejko, 2008).

Depending on the context, an online environment may foster a particular user system, or distributed environment, with differing dynamics and highly diverse orientation of content as observed not least in open-source software communities (Raymond 2001; Stewart and Gosain 2006). Particular issues appear when digital enablers are framed with a view to stimulate or enable user content. The approach relating to the engagement of different user categories becomes greatly important (Shapiro, 2010; Lukyanenko and Parsons, 2020).

On social media platforms, most data is user generated, including text, photos, videos, etc. Citizens with potent digital skills create campaigns and events, commercial as well as non-commercial. For many such content-generators, popularly referred to as “Influencers or YouTubers”, however, substance is biased, driven for a specific purpose, and seldom available for scrutiny of accuracy or objectivity (Mayrhofer et al., 2019). The gate keepers put in place by social media channels are often unable or unwilling to combat fake news and non-verified information.

When linked to wide-ranging digital networks, tailored content development opens for influencing huge numbers of users, counted in millions, or even billions.[5] Using big data and machine-learning, the enormous amount of personal data collected by Google, Facebook, YouTube, etc., is constantly channelled to specialised marketing campaigns, appearing across a range of sectors and societal spheres. Such practices have also been shown to play a prime role in breeding fake news in support of populist sentiments and autocratic regimes (Applebaum, 2018; European Parliament, 2019).

3.5.4 Digital tools

Digital tools represent the technical aspect or building block. Traditional models for participation require citizens to be physically present at a given time and place, opening for addressing a range of practical issues while also tackling limitations of time and costs. The difficulties tend to be particularly compounded in marginalised and deprived areas, and for disadvantaged and less articulate groups (Nunes and Caitana, 2018; Ertiö, 2015).

By contrast, the combined advance of affordable smartphones, broadband and social networks have made it possible to achieve unprecedented levels of connectivity throughout society, opening new avenues for citizens and communities to engage actively in shaping their environment, including in disadvantaged areas. Computers, phones, tablets, sensors, apps, SMS-based services, social media (Instagram, Snapchat, Facebook, LinkedIn, WeChat, Twitter, Telegram, WhatsApp and Messenger), websites, blogs, GIS, virtual reality, and video consoles, came into play, depending on the context.

In contrast with conventional methods, the widespread use of social media offers planners with a handy tool for engaging with citizens (Williamson and Parolin, 2012; Evans-Cowley, 2010). In fact, many governments tend to use existing social media channels, in particular Facebook, as a prime means to inform citizens. As will be further discussed, such opportunities are at hand in the

[5] As of 2020, more than 4.5 billion people worldwide were connected to the Internet. The number of social media users exceeded 3.8 billion and those with handsets 5.2 billion (Kemp, 2020).

present context as well. In other respects, reliance on social media may be associated with high cost (Vesnic-Alujevic, 2020).[6]

Extending beyond desktop computers with Internet connections, social media are more easily accessible from smartphones than from traditional desktops. Barriers to access dwindle with the "online whenever wherever" principle and allow participation "on the go" (Ertiö, 2015). Mobile participation, i.e., the mobile form of e-participation, is defined as "the use of mobile devices to broaden the participation of citizens and other stakeholders by enabling them to connect with each other, generate and share information). They bring an attraction especially for youths and young adults who are difficult to engage in public affairs or participation schemes (Clark et al., 2013). Other categories, e.g., some older citizens, may lose access, however.

Mobiles, increasingly taking the shape of "smartphones", have diffused rapidly to become far more prevalent than computers on the global scene, applying particularly to poor and minority communities (Castells et al., 2007). Their rise propels plenty of benefits (Höffken and Streich, 2013): escape from dependency on fixed-broadband; flexibility and usability, e.g., easy-to-handle-touchscreens; multi-functional, combining phones, cameras, email, etc.; enabling multi-channel communication through instant messaging or social networks; small and portable (mobility); extension of functionalities with apps, and; users can program new apps to spur wider innovative services (user-driven innovation). The 'rush towards mobile' has been best observed in services, initially built for desktop computers, now in mobile version with accompanying native apps.

It is well-known that mobile applications (apps) offer particular channels for engaging some disadvantaged and vulnerable communities (Goolsby, 2010). In the US, cell phone use, mobile Internet use, and cell phone app use have become greater among African Americans and English-speaking Latinos than among whites (Smith, 2010). Following an array of user-friendly applications, my-participation, i.e., the advance of co-creation using mobile telephony and smartphones, is increasingly capable of catering for the special interests of niche groups. Not only that, but the practice is also evolving of engaging users in the actual co-creation of the digital enablers themselves, with a user-friendly app at centre-stage.

For mobile telephony, Ertiö (2018) categorises "communication strategies" on the basis of: i) representation; ii) networking with the public, and; iii) citizen engagement. Representation implies a static functionality, a way of ensuring that certain perspectives are represented. Networking has to do with exchange by way of dialogue, i.e., two-way (or multi-party) exchanges. Ertiö (2015) classifies mobile instruments according to their degree and qualities of participation, in regard to: i) type of data collected; ii) information flow, and; iii) citizen empowerment.

Creative and multifaceted data collection is enabled by sensors such as cameras, GPS, audio, and voice recognition. Interpretation and measurement of quality in the surroundings are facilitated by auxiliary sensors, creating "the real-time city" (Townsend, 2000 and 2013). Further, various kinds of "participatory planning apps", enable higher levels of participation, empowerment and progression in exerting an impact. Ertiö contends that the impact of planning apps has been modest thus far, but the potential ahead is substantive.

Meanwhile, Geographical Information Systems (GIS) are used to store and manage complex spatial data as a basis for analysis covering social, economic, cultural or governance aspects. Remote Sensing (RS), meanwhile, opens for complementary preparation of landscape projects.

[6] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC115008/futurgov_web_lq_v2.pdf

Together with Live 3D, virtual reality maps, and energy management systems measuring efficiency, such tools offer opportunities for innovative representation of spatial processes and phenomena (Sieber, 2006).

By its nature, however, GIS was expert-centered at the start. Participatory methods gradually became applied, however, in both the production and use of GIS (Ndzabandzaba, 2018). The result, referred to as participatory GIS (PGIS), led on to "Public Participation Geographic Information Systems" (PPGIS), denoting broad-based informed citizen participation in decision-making, using these tools. Imaginative geo-visualisation interfaces such as Google Maps and Open Street Map — underpinned by Web 2.0 technologies — make it possible for almost any citizen with an Internet connection to generate and publicize their own maps and geographic information (Adams, 2013). Smartphones using GPS technologies may apply 'geo-tagging' by way of physical objects or online content, along with location-aware information. Individuals using geo-visualisation interfaces to disseminate data further generate Volunteered Geographic Information (VGI) (Goodchild, 2007; Sui et al., 2013).

Today, communication via digital tools regularly offers advanced functionality on-demand, e.g., including a chosen degree of privacy, anonymity, security, traceability of verifiability. Many web platforms driving a virtual Community of Practice (vCoP), recognised since the early 1990s (Lave and Wanger, 1991), apply such servicing for members on a huge scale.

In the case of monitoring and evaluation, smart sensors linked to IoT-platforms are increasingly deployed for a myriad of functions. Hard data can be collected and conveniently analysed, covering environmental conditions such as air pollution, soil quality, or water flows, as well as citizens behaviour by way of, e.g., mobility, time spent in public space, or social interactions. On this basis, digital enablers can be effectively deployed to set benchmarks for what applies before a particular intervention has taken place, subsequently followed up on for observing changes over time and concluding on impact assessments, AI applications help guide the efficiency of existing systems, as in the case of electricity grids or managing transport systems, as well as improve the design of new ones (EU, 2021). Having said that, the terms on which AI is to be applied remains in flux, reflecting the absence of established orderly governance mechanisms for its advancement (Kaspersen and Wallach, 2021), as will be returned to.

Rather than viewed as "technological in nature", the unique strengths of digital tools centres on the close interface with users that they make possible. When guided by Ambient Intelligence, digitalisation opens for unique means of responding to people's feelings and aspirations. Having said that, it should also be underlined, digital enablers form part of a broader toolkit at hand for supporting participation, including through non-digital means. In practice, the application of digital tools meets with challenges and drawbacks. Their use should be selective and viewed as complementary to traditional support of participation (Hasler, 2017). Where the boundary lines between digital and non-digital run, or what combination is most effective and useful in enabling desired outcomes, depends on circumstances. When selecting digital tools in support of inclusion of disadvantaged groups and deprived areas, again, consideration is required of their specific challenges, e.g., regarding infrastructure, access to, and familiarity with technology among the target audiences.

4. Cross-cutting Dimensions

In the following, we extend the previous chapter with additional observations of selected themes that require in-depth consideration as part of the framing of digital enablers devised for the purpose of underpinning active participation and co-creation.

4.1 Culture

Whether there is active participation, and it extends into constructive co-creation is not a given but varies greatly depending on specific conditions. A particular determinant of great importance emanates from what we refer to as “culture”. While a concept with multiple connotations, consideration to culture in a broad sense is critical for understanding the behaviours of individuals, groups, and institutions. The influence may go different ways, e.g., whether the dominating sentiment leans towards openness and tolerance, or the opposite. Corporate culture matter greatly for whether an organisation is open for recruiting diverse competences and trying new ideas, or rather leans towards defending entrenched positions, and to separate insiders from outsiders. Various aspects of culture and mindset similarly influence the terms under which participation may unfold within a city, or more locally. Mapping of participatory culture coupled with complementary analysis of actors and interests of importance in the special case, may thus be critical for devising and applying digital enablers of relevance in the local context.

The extent to which personal relations matter for loyalty and trust exemplifies the kind of conditions which influence the effectiveness of online communication in extending beyond the mere exchange of factual information to build new relations, overcome disparate perspectives or reach agreement. Some cultures further accept critical reflection and cross-fertilisation of ideas with ease, while others react with tension and defensiveness. Some are prone to flexibility; others insist on formality. The scope for online communication to achieve results obviously varies from one such cultural context to another, while also playing out differently in interfaces between them. Such aspects require consideration when determining why and how to apply digital enablers. In the study areas of URBiNAT cities, high cultural diversity may go together with lack of trust in authorities and suspicion what is aimed for with a scheme inviting participation and co-creation. Digital enablers may be crafted so as to help overcome the associated issues but, in the absence of adaptation to the particular context, they may be rendered ineffective.

Culture is not static though, but susceptible to change. Certain methods help injecting change, e.g., by instigating more favourable attitudes towards cultural bridging and exchange ((Marteau 2018, Hagger et al., 2020). Digital enablers can be made effective in this respect by picking up on strengths, curiosity, and a natural interest by targeted citizens, or as pointers to weaknesses based on a notion that what is presently lacking can be put in place. Digital enablers have been deployed for such purposes since more than a decade, often linked to social innovations. Bridging between members of different ethnical groups may be achieved by opening for their joint participation in activities of joint interest, such as physical activity, cooking, or training (Redecker et al., 2010).

The handling of inter-cultural relations significantly influences to what degree an ethnically diverse environment, e.g., with a strong presence of immigrants, will struggle with discrimination and exclusion, or if countervailing forces supporting bridging will make headway. Related concerns arise when it comes to managing human rights and gender, whose inclusion in a culturally and ethnically diverse set-up tends to meet with challenges. Digital enablers can again

be applied as part of a response, building awareness step-by-step through a gradual process, and strengthen skills selectively to counter digital divides (van Deursen et al., 2011). By establishing non-conventional communication channels, they may run into fewer conflicts with vested interests and resistance from entrenched social relations.

Issues of exclusion, related to culture and behaviours, may be identified with the help of Community mapping (Crampton and Stewart, 2004). In URBiNAT, local participatory culture has been mapped, partly channelled through local Task Forces in each participating city. Their mandate includes staking out supportive functions in preparation of Living Labs, and to help muster focus in crafting common solutions. The means are at hand to instigate maturing processes in support of common identity, collaboration and the ability to strike meaningful compromise, applying to various domains of the portfolio, including Reach, Inclusion, Targeting, Interactivity, Initialisation, Sustainability, Linking and Trust.

4.2 Actors - stakeholders

Besides government and citizens, a range of stakeholders is intrinsically involved in various aspects of digitalisation. The private sector, or "business", naturally takes centre stage in many cases, being the prime source of R&D and investment in developing new or adapting existing digital solutions. Academia, including universities, represent a major other source of research and carry the main responsibilities, as part of the educational system, for training and skills upgrading, although much training and "life-long learning" is ongoing throughout society. Non-government organisations and civil societies, spanning a wealth of diverse, often community-driven organisations active in a realm of societal spheres, such as culture, sports, other leisure activities, environmental protection, and so forth, represent another sub-set.

Inadequate strategies regarding stakeholders may, for several reasons, serve as the source of failure in urban development projects. Most obviously, this may be due to the exclusion of relevant parties, which may therefore be misinformed, adopt a negative stance, or simply ignore a project that would have benefited from their active engagement (Kitchin, 2014). Projects may also fail, however, because the actual involvement of parties with conflicting interests prevent constructive agreement on mutually beneficial outcomes (Fischer, 2014; Elelman and Friedman, 2018). The way purposes and processes are framed is of critical importance for what outcomes are achieved, with strong implications for what difference digital enablers can make. On the other hand, far from all cases are advanced in ways that underpin constructive participation. In many instances, digitalisation is driven by incumbents, with a view to ensuring support for mainstream solutions, from the perspective of businesses, technocrats, or vested interests of various kinds. The result may be steamrolling a supply-push of high-tech applications with user and citizen interests playing second fiddle. Plenty of observers argue that participatory processes keep losing out in mainstream urban planning or end up influencing merely subjects of modest significance.

Meanwhile, corporate sector surveys, such as that of Solis and Littleton (2017), find that most businesses struggle with digitalisation and how to accommodate and take advantage when it comes to organisational, technical and skills aspects. Private sector investment tends to be short-term and cost-minimizing, rather than strategic and long-term oriented. Risk-aversion and a lack of strategic leadership commonly mean that digital renewal often is left to be dominated by technical considerations and the scope for apparent marginal efficiency gains, meaning that opportunities to identify and pursue higher-order benefits in organisational motives, and capacity of driving forces to making better decisions are foregone. The potential damage of such

limitations has been reflected in many years' evaluation of ICT-benefits in the corporate sector, that investment in ICT for narrow purposes, without accompanying measures for skills improvement and organisational change, risk to undo the most important benefits and can be outright counterproductive (OECD, 2001*a*; Strassman, 2004; Melville, 2004). With the continued advance of ICT in recent years, businesses clearly are in the process of placing digitalisation much closer to its strategic core (Deloitte, 2020).

Besides the public and private sectors, NGOs and civil society more broadly, increasingly turn to digital enablers as an instrument to attain reach and more targeted communication in support of behavioural change to achieve various results. While this is again partly motivated by the advances of ICT, evolving objectives and organisational change of such bodies matter strongly. Part of the motivation has to do with the shifting mode towards knowledge development and exchange "anywhere, anytime".

Some may set out to impede progress or distort the outcomes, especially if not appropriately involved. For instance, citizens in a neighbouring area that will be affected through the introduction of certain new NBS-facilities, perhaps because their transport routes will be impacted through congestion or just because they will experience a sense of competing ideas, should have the option to raise questions and make suggestions with a chance of being heard and also to contribute. Effective mobilisation of digital enablers in support of participation requires organisational competency capable of differentiating between processes that promote obstruction and derailment, and those that facilitate constructive compromise and mutual buy-in, in support of better outcomes (Hanna, 2000; Shipley and Utz, 2012).

Stakeholder relations matter greatly to societal fabric including decision made. Even in the event particular projects focus squarely on a particular district or user category, "others" not granted opportunities as a perceived consequence thereof, may raise resistance, radiate a dismissive attitude and, in various ways, undo tangible results. Groups not in the driving seat may charge "not invented here" and their alienation regarding a given project deepen rather than diminish. Stakeholder engagement will therefore inevitably matter and must be tackled one way or the other. A strategy to this effect should weigh in the objective and the potential contribution of stakeholders, bearing in mind the following aspects:

1) Which stakeholder categories are key depending on context? Those who actively liaise with citizens in the targeted neighbourhoods, and who may play a role in influencing their participation, are obvious candidates. Social workers, workers in community centres or other public institutions, schoolteachers, vendors but also community leaders, formal or informal, may matter. Which category deserves attention varies, however, depending on the targeted group of citizens, such as the elderly, the unemployed, single mothers, or teenagers. In another context, the focus may be on urban planners, city officials, elected politicians, a category of experts, landscape architects, those responsible for energy, water, or other utilities of relevance to NBS, hospital workers, teachers, parents, or social workers. Yet other categories of importance for furthering the value of NBS are made up of local business, the private sector more broadly, entrepreneurs, financiers, and civil society leaders. In a specific case, green entrepreneurs or social innovators may be key.

2) The purpose may be to collect information that is helpful for local diagnostics or framing the strategy for participation. By surveying stakeholders, digital enablers can be used to identify which ones are most important to engage, and through which mechanisms. In each stage of co-creation, digital enablers carry the potential to facilitate measurement

and analysis. Monitoring using social media may help identify facilitators or champions as well as novel communities of interest. Digital enablers may track and specify what motivations pertain to various stakeholder categories. By tagging stakeholders to their interests, digital enablers may provide direction for each to receive relevant information.

Each situation is unique, and the question is how to effectuate a dynamic that keeps forging stakeholder relations that are favourable and constructive in working with others to identify and resolve the issues that matter. In order to promote such stakeholder engagement, instead of undercutting it, people, and social relations must take centre stage. Technology, irrespective of its form, should add value and ensure that expectations are met, without being allowed to dominate and take on its own life.

Use of digital enablers should be user-friendly and well-anchored with citizens, so as to match their needs and operate in tandem with their actions to open up new opportunities. How to get there is another story though. Addressing a blend of challenges and opportunities, engaging a range of actors whose differences need to be overcome, leaving place for a sense of shared interest, will be required. Consider the following broad actor categories:

Citizens: The application of digital enablers for interface with users should be well-anchored with citizens and be framed so to be relevant in the light of challenges or interests of relevance to users. Further, the building blocks of digital enablers need to be oriented for the purpose of ensuring easy access, inclusion, openness, interactivity, and collaboration (Näkki and Koskela-Huotari, 2012; Schuff et al. 2010).

Based on observations of existing digital enablers, however, the bottom-up initiatives undertaken thus far, emanating from citizens, in many cases rely on mainstream social media channels, such as Facebook and Instagram. The gains in terms of accessibility and convenience in this case, risk being compromised by the reliance on vendors that subject citizens to issues of data ownership, privacy and user manipulation.

A particular aspect is that of crowdsourcing data, i.e., the engagement of citizens in large-scale data collection, which offers significant cost advantages, but meets with challenges in ensuring the quality pf data. According to Salgado and Galanakis (2014), participatory design remains undervalued in traditional urban planning, calling for increased effort to leverage its role and contributions at each stage of the process. As noted already by Clement et al. (2008), services incorporating 'peer-production' can help overcome the issues. Participatory methods may offer solutions, based on design principles leading citizens to provide data from the viewpoint of their perceptions (Lukyanenko and Parsons, 2020; Prpić et al., 2015).

Policymakers: Digitalisation assumes a prominent role in a widening spectrum of policy reforms. The EU (2020) stresses the importance of putting technology at work for people, adapting to varying needs. Conditions conducive to start-ups and business growth go together with an open, democratic and sustainable society.

A favourable relationship has been observed between the competency of policymakers and governance, om the one hand, and the quality of collection, processing and diffusion of information on the other (Johnson and Sieber 2012; Sieber and Johnson, 2015). A particular aspect has to do with the degree to which policymakers champion open data and cherish participation by civic society as a tracker of societal issues and a genuine sounding board (Coleman, 2013).

Decision-making at local and regional level carries distinct features in this regard - reflecting their greater proximity to the actors and interests at hand. Going against privileged groups may be more demanding at that level, as narrow interests may be in the position to inflict greater damage, but digital enablers bring new opportunities to create transparency, putting pubic interests in the open and bridge between conflicting interests.

NGOs/interest groups/non-for-profit organisations: NGOs, closely linked with specific CoIs, can cultivate relationships with target groups using digital enablers; widen the scope for further reach; actively invite citizens to participate in co-creation; improve understanding for the associated benefits; and open up for connecting citizens through CoIs. NGOs usually have a very strong "purpose" to which their most loyal members and target audiences find it easy to relate. As such, members and other stakeholders who share this sense of purpose are easily motivated to engage and contribute through digital enablers that support the fulfilment of this purpose. As NGOs struggle to expand their base of volunteers and donors, constructively devised and deployed digital enablers can facilitate targeting relevant audiences while under-pinning mutual value creation. Digital enablers may also help NGOs achieve a more efficient distribution of support services.

Business/private sector: The private sector leads in the research and development effort that propels technical progress, innovation, associated competence development and user-driven applications. Today, businesses around the world tend to put emphasis on improved data analytics, cloud computing, internet of things, and artificial intelligence are referred to as of high priority (Deloitte, 2020). As digitalisation unleashes powerful network effects, economies of scale and scope may propel rapid growth and marked dominance. Platform economy dynamics connect providers with users, by-passing middlemen, lowering transaction costs and opening for better matched service provision. Meanwhile, small firms may benefit from digitalisation due to greater flexibility and ability to dig out new (narrow) market niches, taking advantage of borderless knowledge networks and low-cost diffusion channels (OECD, 2017). Related to this, the private sector may identify new productive use of digital enablers by citizens in deprived areas, and/or visualise the value of NBS and Healthy Corridors. Innovative examples of the latter include making available abandoned plants, recyclable construction material, reusing batteries or upgrading outdated IT hardware, or offering bicycle, furniture, and electronics repair workshops. On the other hand, business interests attaining a dominating position may cause lock-in, countering diversity and broad-based opportunities.

Digital enablers offer unique means to "shrink the difference between" the main actor categories, with policymakers, citizens, experts and scientists operating side-by-side in support of sustainability. Although each city, and also each district, feature unique properties in some respects, many prime challenges are essentially the same. Learning from practical experience between cities, comparing lessons from parallel experimentation, opens for more structured learning and more precise lessons and conclusions what is truly relevant for success.

4.3 Minorities and vulnerable groups

The impact of digitalisation on specific vulnerable groups gives rise to a host of questions. Disadvantaged groups typically have access to fewer digital tools per household, for instance, calling for the arrangement of accessible and attractive complementary facilities such as community centres, libraries, etc., offering relevant complementary entry points.

Some issues centre on minorities, such as those marginalised by ethnical or religious belonging. Citizens with specificities refer to a broad range of sub-groups, possibly affected by disease or handicap that may account for exceptional vulnerability. Sub-groups such as children, young generations, or the elderly, represent major parts of society, while at the same time finding themselves in a minority position in some respects. For all there is the question whether ICT leads towards "inclusion", and whether they evolve towards a position of enjoying more, rather than less, "equality" on terms relevant to their situation.

On a positive note, digitalisation has been shown to underpin resilience in vulnerable communities, by offering improved prevention, signal detection, and damage containment. Also, it has brought new means and opportunities for community-building by minorities. Digital tools may, for instance, offer unique means for connecting with others within a niche community, on terms relevant to its members (Correa and Jeong, 2010). This exemplifies functionalities appearing online that do not present themselves in the real world, and which may neutralise or diminish the consequences of separate treatment. On a related note, an individual's belonging to a gender, minority, or any other group that is mistreated, may be concealed in digital communication (Sasakawa Foundation, 2017). Multiple manifestations of damaging discrimination and inequality nevertheless remain online (Robinson et al., 2015).

Digital enablers are well suited for tailoring communication to identified target groups. Individuals and groups that are marginalised and vulnerable, possibly due to income, education, or ethnicity, require special attention. Examples are teenage girls, single household men, unemployed, persons with weak health and "unusual suspects" (i.e., individuals who rarely take active part in community activities). Reaching and activating any such group will hinge on communicating matching their specific needs or interests.[7]

For the study areas, m-participation using either existing apps or embarking on novel apps-development, generally offers the most effective entry point for reaching young adults left out of traditional participatory community scheme. For engaging the elderly, on the other hand, other kinds of activities may be developed. Innovative examples include programs or events, possibly at school or in public places, where arrangements are made for members of the older generation to blend with youth for taking part in constructive reverse – or blended - mentorship. Here, the elderly supports the young by sharing from their life experience, while the younger generations serve as mentors and coaches on the means of using new technology.

Factors of high relevance for the applicability and reach of digital enablers further include reading/writing; digital skills and competencies, interest in and readiness to use tools, and experience of participation via digital means. These blend with mainstream socio-economic factors such as education, profession, gender, age, or ethnical belonging in influencing receptiveness to change (Thaler, 2015). The availability of content formulated in the language of targeted ethnical minorities may be a necessity for relevance. For those lacking education or familiarity with books or abstract communication, easily recognisable symbols and emotionally convincing arguments may be devised. Yet, icons and visuals may critically require adaptation, given the presence of variation in connotations and attractors for different user categories.

[7] In relation to such issues, lessons can be drawn from the EU-funded Erasmus+ project COMENSI, focusing on community engagement for social inclusion and the development of methods for the activation of citizens at risk of exclusion, see http://www.tesserae.eu/project/comensi/

Finding ways of motivating a broader spectrum of citizens to express their views and become part of developing solutions instead of being viewed as "the problem", is key to realising an inclusive co-creation process. Countering risks of conflict, meanwhile, calls for fruitful linking, laying the basis for acceptance and compromise, and building trust (Holz, 2018).

4.4 Facing the digital divide

Although digital enablers greatly facilitate diffusion and reach to a myriad of diverse users, in effect, ICT may enhance rather than counter discrepancies in access to information, opportunity, and wealth, with economic as well as political ramifications. As observed for years, for instance, digitalisation risks dismantling social relations and support structures (OECD, 2001*b*).

On the whole, digital disparities related to affordability have been diminishing for years (Castells, 2010). Although digital technologies tend to be priced out of range at their time of introduction, and thus be less accessible for those with lower incomes, the period required for catch-up is diminishing with technical progress. According to ITU (2021), data and voice price baskets have dropped the most in developing countries over the past year. Yet, the same source states that ICT services remain prohibitively expensive for most people in the least developed countries.

A host of other issues merit attention at community level. Low-income and minority teens have been observed to be charged more for Internet access via mobile platforms (Brown et al., 2011). Low-income populations may also experience periodic disconnection or the loss of service due to inability to pay their bills, hardware dysfunction or loss, or device theft. Social support networks, of importance for mitigating such threats, tend to be less prevalent for the most vulnerable (Sampson et al., 1997).

Other aspects have to do with major differences in use (Napoli and Obar, 2014). Past studies have pointed to social stratification. Individuals with higher incomes were found to access the Internet more often for "information-based" and "transaction-based" activities, while those with lower incomes rather engaged in social and entertainment uses (Zillien and Hargittai, 2009). Park (2015) found female and minority teens to be highly capable but also diverse in their mobile engagements. Teens with higher skills in content production and who turn to their phones more often to accomplish particular tasks, were more likely to engage in civic activities, such as volunteering in the community or debating politics with family and friends.

In which way mobile phones and social networks interact is a subject of contention (Campbell, 2015). Confounding factors, such as the nature and strength of social relations, influence the outcome. Parental status, and an urban location, go together with more productive social use of mobiles (Park, 2015). Linking to close confidants promotes health and the ability to cope with adverse events (Cohen, 2004; Dickens et al., 2004). Phone sharing, a means to increase reach to the disadvantaged, has been found to be gendered, with men more often in the position of owning and lending phones than women (Blumenstock and Eagle, 2010; Burrell, 2010). The phenomenon of phone sharing links to the subject of affordability as a factor for global poor (ITU, 2016).

Another salient aspect of the digital divide, prevalent in many locations, leaves the older generations behind, reflecting limited exposure to ICT and the means to keep up with fast-changing technology. As observed in URBiNAT's study areas, generational gaps tend to be particularly pronounced in social housing neighbourhoods.

In brief, social factors, blended with attributes such as skills, age, gender, etc., remain greatly important determinants of habits, motivations, and behaviours impacting online communication (Marler, 2018; Silver et al., 2019). The continued presence of a digital divide, including within the urban environment, typically bears on discrepancies in such respects, rather than technologies.

5. Launching New Digital Enablers

Starting in 2020, representatives from the URBiNAT cities engaged in exchanges on digital enablers with a focus on identifying their most useful contributions in promoting citizen participation related to the NBS and Healthy Corridors in preparation. In this, the URBiNAT cities drew on their set-ups for structured consultation with citizens and stakeholders, associated partly with the Task Forces in each neighbourhood. Additionally, various exchanges were arranged with citizens in the study area. Meanwhile, continuous feedback loops were established with the coordinating URBiNAT team.

As noted, a survey was developed and tested in Siena, for the purpose of extending to each of the participating URBiNAT cities, to collect information of direct relevance to the perceptions and attitudes of citizens influencing such conditions. Complementing the previously pursued local diagnostics, and directed to the citizens in the study areas, the questionnaire is intended to allow for direct comparisons across the cities of citizens' use and perceptions of digital tools. It further aims to explore citizens' priorities, i.e., what issues are viewed as most important to address through the application of digital enablers.

On this basis, the selection process for the first digital enabler narrowed in on demand for linking to food and urban gardening. The reasons included the broad-based interest among citizens in the study areas to increase collaborative activities centring on food (in most of the study areas of the URBiNAT cities, particular places are devoted to community gardening and urban farming). Furthermore, stakeholders and administrators observed that activities related to food already rank among the most prominent bonding activities. At the same time, they shared the assessment with citizens of an untapped potential to do more, with a digital enabler offering the potential to unlock that potential.

Other factors contributed to the focus on food. The situation taking hold early 2020 was heavily influenced by the strains and needs created by the ongoing COVID-19 pandemic. Among its various expressions, as citizens spent little or no time in their offices, most shifted attention to creating a hospitable home environment. Another manifestation was the search for a "home" outside the city, away from the densely populated areas where many people had gravitated in the past. A third shift was towards a generally elevated awareness of what is associated with nutrition and good health. All these three trends related with a heightened community interest in the promotion of locally produced food, on terms that help bond with nature as well as underpin local identity, which is eco-friendly, affordable, and healthy.

While the URBiNAT cities, similar to other cities in Europe and elsewhere, pursued a number of responses to the pandemic situation, a need has become apparent of further adaptation and innovation in the way digital enablers are devised and applied. Examining the evolving sentiments in their cities and their match with the themes of URBiNAT, the participating cities have agreed to engage in the framing of the digital enabler presently named **My Edible Neighbourhood.** The aim

is multifaceted, including community-building related to locally available food, linked to the interest of growing food and awareness about edible items in the neighbourhood. One of the functionalities addresses the potential of donating - or offering at a very low cost - food items which are at risk of being wasted. Food waste represents approximately 20% of all household waste, which indicates that much can be done to reduce that figure.

As a second theme, several cities, and citizens, expressed an interest in identifying more effective mechanisms for creating linkages, at the level of groups and individuals, within as well between the cities, with reference to NBS and Healthy Corridors more broadly. For this purpose, a second digital enabler has been defined and introduced, in this case in the form of a participatory platform, **Circular Cities Café**.

Before turning to these cases for greater detail, next we consider the mechanisms and context for bolstering participation, followed by reflections on the maturing of digital enablers that have led to the present state of affairs, lending support for the approaches adopted here.

5.1 Mechanisms for bolstering participation

Taking advantage of the potential benefits of digitalisation in regard to speed, precision, ease of use, interactivity, and so forth, are all relevant in the present context. Yet, those aspects are of secondary importance. Of key relevance here is their ability to bolster participation. Two basic mechanisms are in play, either building on and leveraging interests, or meeting with outstanding needs in support of community building, of concern to citizens and stakeholders linked to the study areas.

This implies the prevalence of two main mechanisms, in essence taking the shape of approaches for digital enablers to bolster motivation in support of co-creation:

i) Asset-enhancement/Strengths-based CoIs, boosting existing or supporting new NBS, typically broadening or deepening participation.
ii) Responding to Challenges/Creating Solutions, handling socio-economic realities, typically countering low participation among certain citizens groups.

Let us consider a few more aspects of the respective mechanisms:

i) Challenges/solutions-driven approach

The focus here is on challenges that are of high relevance for citizens while also feasible to address in the process of framing NBS and Healthy Corridors. We have engaged with the citizens and relevant stakeholders in digital workshops to identify challenges, and then select one or two to be addressed with the support of digital enablers. In Sofia, for instance, local communities in the study area have identified a particular set of challenges related to harvesting of fruit, where digital enablers offer opportunities for solutions. In this regard, URBiNAT partners are exploring the application of various models using Participatory Geographic Information Systems (PGIS).

ii) Identity/strength-based approach

In this case, co-creation draws on established lessons of pedagogy and practical training (Saint-Jacques, 2009), on the effectiveness of reinforcing positive experiences and driving forces. The approach starts out assessing neighbourhood identity, attitudes, and values. A Community of Interest (CoI) is identified with reference to existing positive connotations in the neighbourhood which citizens share an interest in fortifying and building upon to resolve

particular issues/for a specific purpose. The CoI is thus about mobilising a “glue” which can be used to grow a viable platform. Operational attributes are associated with the CoI. For example, to what extent is there a set of characteristics such as music, art, food, “green”, gardening, sports, or anything else that might generate a particular CoI in a neighbourhood. In Porto, one of the Frontrunner cities of URBiNAT, a specific website is under establishment for the purpose of leveraging viable CoIs in support of citizen participation. At times, this positive identity is latent and requires effort and regeneration for its revival. In such cases digital enablers can support and nurture the process including citizen engagement towards reaching a critical mass of actions in strengthening the existing or latent neighbourhood identity.

In applying either kind of mechanism, or source of motivation, as a basis for co-creation, ways can be worked out to bolster participatory processes around NBS and Healthy Corridors in the participating cities. In Task 3.4, the digital enablers in formation relate to existing assets and interests, with their rationale dependent on ability to frame value-enhancing additions, including by opening up new opportunities for users. Their realisation requires, however, taking account of preferences and actual decisions made by citizens, stakeholders, or other relevant actors.

Additionally, the planning phase has considered both the relevance – and prospective value – of instituting digital enablers in each specific case, and the scope for horizontal, cross-cutting value-generation across cities. For My Edible Neighbourhood, this has critically boiled down to whether conditions have been such that the implementation process across two or more of the URBiNAT cities (Frontrunners and/or Followers) could allow for effective comparisons of the results achieved, thus helping to identify key success factors as well as causes of distress and challenges. For the Circular Cities Café, inter-city linkages have been integrated from the start.

It is of key importance that the framing of digital enablers genuinely reflects conditions on the ground and meets with the demand of citizens. At the same time, in the present context, attention has been paid to the scope for linking specifics with what is of generic interest, particularly among the participating cities, but also eventually for cities and communities widely in Europe and around the world.

As noted, the process of preparing, piloting, and implementing selected digital enablers has been framed for parallel and simultaneous progress in several inter-linked URBiNAT cities. A related consultation process has been aimed for in each of them, involving citizens and stakeholders as far as possible. On this basis, the objective has been to arrive at reasonably related prioritised challenges/interests, suitable for addressing with digital enablers across the URBiNAT neighbourhoods.

The two applications of digital enablers that have been selected, introduced in further detail below, have been shaped in this light, based on the aim to feature elements of sufficiently common interest to allow for mutual engagement learning along the way. Further, through the CoP, the stage is set for wider diffusion as well as the collection and exchange of experiences to feed into broader usage.

5.2 Maturing applications

At the inception of digital enablers, in the late 1990s, the solution at hand was characterised as architecture-initiated personalisation, or tunnelling. In the early apps, detailed profiling aimed for bonding with the user. In 2007, with the release of the first iPhone, interactive apps took off,

advancing hand-in-hand with 3G, then 4G and, more recently, 5G. In parallel, the importance of strengthening social skills was recognised (Jenkins et al., 2009), with group dynamics a powerful instrument for engagement, using peers and community linkages to generate kickbacks.

From there on, digital enablers have arisen as a potent means to mature participatory culture, shifting mindset from preoccupation with individual expression to appreciation for community involvement. This was underlined in URBiNAT (2021), where strengthening of community aspects featured among the top purposes observed for digital enablers.

Specific technologies can similarly be seen to have moved in this direction. GIS, for instance, initially placed the emphasis on spatial location, with the standing of a particular user tied to that place (Corbett and Keller, 2006). This resembles the role played by physical "third places" (neither home nor work but, for instance, private and public space for purposes such as education, entertainment, recreation, shopping, or religious worship) seen to promote knowledge exchange and skills development in physical space. The role of such space remains critical in the digital era, although both physical and virtual elements are evolving.

The introduction of user-centric design has increasingly enabled citizens to gather factual, objective data about their environments "on-the-go", calling attention to the presence of local issues. The quality of sensors in mobile phones has improved rapidly and come to emulate official simulation-based maps (D'Hondt et al., 2013). Mobile phones further stimulate idea generation by way of "situated engagement" (Korn, 2013). Instead of attending a meeting at a particular time and place, citizens may browse or look for development plans about those locations that matter more to them. Geo-fencing using mobile GPS can serve as the basis for further innovation in generating valuable citizen participation in urban planning, at little additional cost (Ertiö, 2018).

A related concept is that of "net localities", where hybrid space is created through a combination of digital and non-digital interactions. An example is the use of public screens serving to display feedback from citizens tweeting with each other in real time (Tomitsch et al., 2015). Open data contests backed by suitable incentives may induce new relations and alliances (Desouza and Bhagwatwar, 2012). The use of QR codes by which data can be made available to citizens via their smartphones is becoming increasingly popular. Several functionalities of QR codes were further developed and widely applied during the onset of COVID-19, in effect having become a salient feature of citizens´ everyday lives around much of the world. The plentiful applications taking hold feature various use-cases, spanning tracking of infected people, patient information, vaccination results, to the shift from physical menus to digital ones, fed by the QR codes adopted by restaurants and cafés (Nakamoto et al., 2020).

Specific niche products, such as digital visioning techniques coupled with gaming strategies, present opportunities for catching the attention and engaging specific groups that would be very difficult to use via mainstream communication channels. With PGIS as a kind of predecessor, computer aided design, virtual environments, and digital games now offer development-oriented user "immersion" in a sensory and imaginative way.

With the rise of participatory sensing apps, immobile devices forming interactive sensor networks, users have grown the capacity to gather and share local knowledge (Burke et al., 2006). Using tools with which citizens are already familiar is obviously the least demanding. Sensors are now commonly built into smartphones, typically connected to GPS-functions, the camera, microphone, accelerometer, 3D scanners, UV index, etc. WideNoise uses the microphone to collect and monitor sound, the accelerometer's sensor helps monitor road conditions while auxiliary

sensors analyse air quality. Yet, engaging users in identifying or advancing new tools may lend important support to the overall objective of co-creation.

A continuous advance of digital platforms has provided the essential capacity to receive, process and distribute the ever-expanding data flows in real time. While proprietary vendors account for mainstream storage, cloud services and other required functionality, alternative platforms using open source are prone to community engagement, UGC and other manifestations of bottom-up initiatives as a replacement for top-down technology-driven "fixes", are gaining ground.[8] These platforms host mainly user-generated data, e.g., text, photos, videos. They tend to be programmed and controlled by users. As noted, the user-generated content is often of a persuasive nature and shielded from public scrutiny in regard to accuracy and objectivity, placing high responsibility on gate keeper functions.

In preparing specific applications of digital enablers, suitable to addressing the two selected fields, various options for their design and functionality have been considered. As a result, PGIS and the associated development of a smart app have attained a key role in the case of My Edible Neighbourhood.

Separately, an interactive platform has been devised to support the Circular Cities Café, with the aim of linking different target groups in the cities for sharing and learning in order to support the development of joint projects and advancement of the CoP. These digital tools are being matched by the application of methodologies helping to underpin motivation for co-creation, rewards, etc., as will be returned to.

5.3 Two applications under way

In this section, we return to the two selected fields and applications of digital enablers under development as part of this activity, for the purpose of examining them in greater detail and outline the way forward. They are here initially presented one by one:

5.3.1 My Edible Neighbourhood

The case for introducing this digital enabler partly draws on the already demonstrated benefits of Community Gardens and Urban Farms, which are highly visible in several of the URBiNAT cities. These existing NBS support recreation, food production and social involvement. Despite their presence and demonstrated usefulness also for many of the URBiNAT neighbourhoods, the demand for locally produced eco-friendly food products offered on trusted terms and at affordable prices (or zero cost) remains mostly latent and yet largely untapped.

Although several of the cities had already previously developed websites for community gardening, the communities in focus meet with technical, linguistic, and also cultural barriers limiting their access. For these groups, mobile Internet access is most strongly associated with the use of social networking sites (SNSs) (ibid), while news and factual information are less often accessed (van Deursen and van Dijk, 2014). Meanwhile, Internet content is often optimized for PC rather than mobile phones (Marler, 2018).

[8] An example is offered by Decidim, visit https://decidim.org/

The present set-up, by contrast, incorporates four sets of engagement practices, underpinning alternative modes of participation for local residents and other relevant parties, reflecting the community setup as well as individual preferences:

- **Grow:** Opening a path for users to actively participate in producing food locally, such as urban farming, community gardening, etc. Here, the user is in the position to seek out information about the location of urban farming facilities, including when and how to engage;
- **Find:** Offering the means to localise natural and edible plants and fruits in public spaces, wildlife parks, etc.;
- **Match**: Interactive information services enabling seasonally calibrated matching of demand for eco-friendly and local products with trusted suppliers offering locally produced food from suitable farmers, markets, etc., at affordable prices - the functionality will also include information on food donations from shops and restaurants;
- **Share**: The means for structured sharing of user-generated ideas and content-development centring on food production and recipes using local food and their innovative furthering and applications.

By combining these functions, My Edible Neighbourhood aims for synergy to ensure benefits from previously disparate actions and services. Actions that previously were spread thin on many actors, thus attracting little attention in conventional governance, can here attain considerable weight when combined with the help of a digital enabler that induces awareness by inviting joint actions. Citizens, partners, and experts thus discern the opportunity to instil co-creation of food production to match increased demand for ecologically and locally produced products.[9]

The digital enabler initiated for the purpose of addressing these issues incorporates a smartphone application (MyEN). As illustrated in Figure 4, MyEN features functionality that opens pathways for the user to proceed in accordance with optional preferences, as just outlined in terms of grow, match, find and share. While the basic functionality will be universally embodied, the activation of MyEN in a particular environment, applying GIS, specific action paths will be at hand, having been workd out locally.

With this set-up, MyEN goes beyond what has been previously developed. In Nantes, a special website, www.dialoguecitoyen.metropole.nantes.fr, offers a pathway for citizens to engage in urban gardening or other activities processing or accessing locally produced food. Neither that website, or any mobile application presently available, is in the position to provide generic information relating to geographic location and edible locally available.[10]

Users are awarded the means to select among alternative functionalities offered by MyEN. Adding to that, knowledge of other relevant actors as well as the means to connect with them, provide a meaningful context and open for collaboration. Further, functionality inspiring an adjustment in behaviour towards healthier lifestyle (e.g., engaging in farming or gardening activities, walking to the market, and consuming healthier food), enhances demand for relevant locally produced food, thereby supporting local production of eco-food. Taken together, these elements provide momentum for community building, related to Locally produced food, while also linked to increased availability and quality.

[9] Transaction costs, information asymmetry, externalities, and hurdles to capture synergies between the benefits of NBS, combine in stifling functioning markets (McQuaid et al., 2021).

[10] Germany offers examples of locally engineered apps in the “find” category, resulting from public sector initiative, see www.mundraub.org. Add-on value-enhancing functions are largely lacking, however.

Figure 4: MyEN

Source: IKED, 2021

The purpose of My Edible Neighbourhood is squarely directed towards enacting participation and co-creation with citizens, including extensive provision of user-generated content. Examples here include useful and attractive tips what kind of products are available in the neighbourhood for free (FIND) and at the market (MATCH) at a particular juncture - along with cooking ideas, recipes, etc. Applying the methodology of LearnforLife, a participatory NBS available in the URBiNAT catalogue, citizens can sign into the app and earn points on their purchases, or by sharing recipes, making regular visits, or by engaging in urban farming and community gardening activities. The resulting points can be used in exchange for discounts on future purchases. On this basis, producers will upload information on a regular basis, such as what products are available and what they can recommend according to price and availability. Citizens, on the other hand, can express demands, make use of the marketplace to prepare for and service festivals and other events, and generally offer their food products on this market.

The outlined portfolio of functions under development aims to enable internalising a wide range of benefits. This includes platform economy efficiency gains associated with lower costs for search and matching by bringing together a diverse community of local citizens as well as other stakeholders with a common interest in value-creation associated with local food. Moreover, due to the parallel process and interlinkages between such CoIs across the participating URBiNAT cities, additional external cross-fertilisation will be staged.

The following envisaged benefits represent complementary elements to be advanced as part of the Healthy Corridor concept:

- Support of local farmers including urban farming;
- Strengthened opportunities for organically produced food;
- Increased physical activity as citizens will be engaged in farming and gardening activities as well as walking in the neighbourhood to locate edible fruits and herbs;
- Home cooking activities favour more healthy food and increased well-being;
- Meeting place for citizens - other activities and CoIs can benefit from having a regular public space for meetings;

- Reduction of food waste as shops and restaurants will be given an outlet food that otherwise would be wasted;
- Specialised themes can be arranged to help sharpen a local edge and make adjustments according to season, the interest of particular communities or in other respects.

The app may be framed to realize any of these features which primarily depend on the abstract architecture and list of functionalities, to be defined and designed by the project team. It can be further built upon to reflect the specific context pertaining to different cities.

On this basis, the MyEN app is developed in a way to be replicated in different contexts and cities, and later, will be maintained and updated by citizen participation. A particularly challenging aspect has to do with the social dimension in a way that citizens, end-users of the app, would both use and provide content of the app.

A scalable approach will be adapted by outsourcing the framing of specialized add-ons: functionalities regarding each city's needs and requirements through co-creation by citizens. In order to prepare for these steps, consolidated design and development work are required. The envisaged way forward will feature a combination of hackathons, workshops, and competitions that in present times will represent a common approach by, several companies and institutes in order to design and solve their coding issues. A well-known and successful case worth mentioning is Walmart, which turned to crowdsourced data science competitions on several occasions (Marr, 2016). Such approaches assist in opening for and highlighting possibilities to address clear-cut needs and realise solutions originating from citizens' participation in user-centric designed workshops and competitions.

The MyEN app will be served over a private server and its data will be stored and managed securely on a private cloud server as well which will be interlinked with the URBiNAT Observatory, to consolidate the CoP. Accordingly, researchers and the observatory users will be able to access and analyse the MyEN app data among other URBiNAT datasets.

5.3.2 Circular Cities Café (C3)

Connecting Communities of Interests (CoIs) online for sharing and learning, is the second digital enabler developed as part of the current activity, in conjunction with the preparation of the present report. All URBiNAT cities have been invited to take part. C3 partly draws on the experience already attained by several of them through the Task Forces and URBiNAT CoP, while extending to the wider sphere of communication made possible by digital enablers.

The core element is a group of students and researchers whose engagement has been catalysed through the interface of the project team leading the current task, and the network of actors engaged in URBiNAT within each city. Each member of C3 will display their profile and their ongoing projects. The members will be linked to the cities in which they have activities as well as to the NBS in the URBiNAT NBS catalogue that they are connected to. The opportunity for participation and becoming a member of C3 has been communicated in this extended network, particularly to students and researchers that had already earlier engaged with NBS, through URBiNAT or other city activities.

In light of the disruptions caused by the pandemic starting in 2020, and the fact that many people would like to connect with other cultures and locations without necessarily embarking on physical travel (associated with negative environmental impacts, as well as ongoing pandemic-related

health concerns), online meetings and sharing in the virtual world serve as means for linking the different nodes, in and between URBiNAT cities. Meanwhile, within each city, C3 is in the process of identifying a potential physical meeting place and connections as well. Over the course of the project, the plan is for inter-city relations to start featuring selective real-world meeting space as well, for instance in the context of joint events and missions.

The initial digital fabric and functionality which form the essence of C3, has been well established at the time that work on the present report has been concluded. Thus far, this has been organised as a platform linked to URBiNAT's website (https://urbinat.eu/circular-cities-cafe). Here, C3 features the profiles of participants, while linking them to specific NBS from the URBiNAT NBS Catalogue as well as to their geographical location. It is currently in the process of evaluating various avenues for deepened networking and substantive co-creation.

In subsequent stages, the intention is for C3 to breed additional innovative means for exchange, growing a more developed online forum for leveraging Communities of Interest while, at the same time, creating connections between the specific groups involved across the various cities. At its core is an appreciation of NBS and sustainable growth, along with related experience, ideas and the development plans. Depending on the precise orientation and directions provided by those taking part, each C3 may place particular emphasis on circular economy, climate change, storm water management, biodiversity, or aspects of health and lifestyle.

The students and researchers that have already entered and started to build the C3 network, incorporate familiarity with URBiNAT from the start, in some cases with direct experience of co-creating NBS and also envisaging Healthy Corridors. Some of them have, for instance, been engaged in the co-diagnostic phase and worked on the methodology for preparing measurement of the impacts in their respective city. As the circle widens, it is already reaching out to other students, notably at PhD and Master level, who have not previously been involved but whose interest in this particular mode of linking to the issues is in a stage of awakening. An advantage of starting out with students and researchers has to do with commonalities in attitudes to learning and developing, and also a virtual absence of any limiting language barriers, making it straightforward to share experience between the different nodes and working together on determining best practices.

Among the URBiNAT cities, Nantes, Porto, Sofia and Siena are presently the most advanced when it comes to growing the initial student community of C3, along with the process of widening the circle. An important ingredient in the parallel efforts across the cities has been the creation of a sufficiently compatible set of templates for shaping Student Profiles (undergraduate, MA/MSc, PhD, special interests, special experience, ambitions, and objectives) as well as Researcher Profiles for those who become actively engaged.

More specifically, member profiles have been arranged so as to be searchable according to certain criteria, such as substantive NBS theme, research focus, institutional links, geography, or plans. Mediated through the URBiNAT web page, joint activities will be prepared, started, and disseminated as suitable, for instance to a certain category of students across all the participating cities. The mechanisms are in preparation to allow for bottom-up initiatives started by individual students or groups (within cities, or horizontally between them) to be taken up and diffused as a basis for new learning processes or actions.

With such functionality, the conditions are in place for interlinkages to emerge and flourish between the different nodes under formation. Along the way, impetus is envisaged for the various

themes and institutions related to specific NBS and associated development mechanisms, while at the same time being picked and shaped by the members (Name + University/Organisation + profile photo + research project/activities + links to relevant resources). Part of the set-up is also for the students to exploit and disseminate relevant research being carried out by the wider ecosystem of which these students and researchers could thereby form a more integrated part, across the spectrum of universities and institutes - in Europe and beyond. which thereby will link up more effectively.

The creation of student and researcher profiles (and, eventually, of other categories of stakeholders), accessible via the URBiNAT website, is being planned in such a way that will facilitate the formation of several interlinked CoI connected to various NBS. The wider C3 community is envisaged to attract and motivate municipality workers, social workers, citizens, NBS enterprises, etc. The establishment of the initial student and researcher network further aims to contribute towards the formation of a gradually deepened and matured inter-city dimension to the Community of Practice[11], working on issues linked to the project.

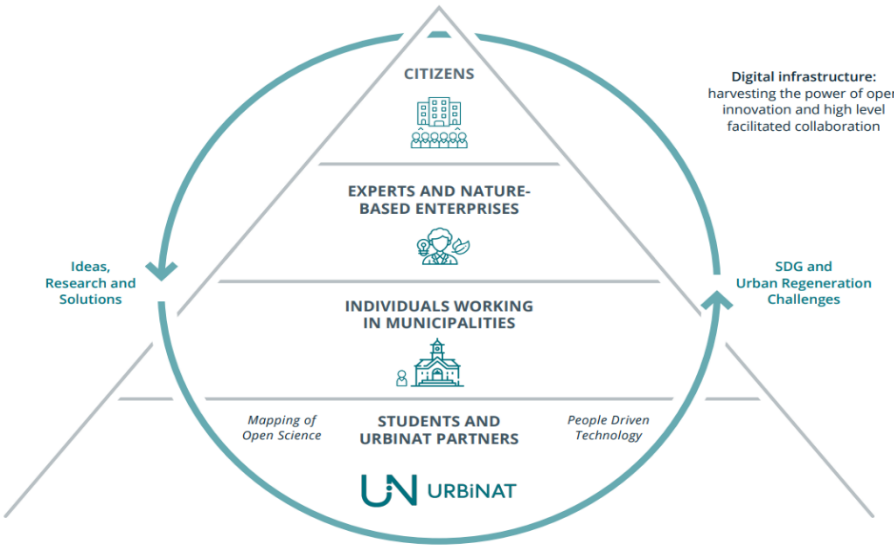
As mentioned above, each student and researcher profile introduced will be tagged to specific NBS being implemented as part of the project. This enables visitors to the website with an interest in specific NBS to search out, instantly, which researchers and students are involved in what. Additionally, a short-cut will be available to get in touch with them. Consequently, the platform features will encourage connections to be made and collaborations to take shape. Each profile page will contain links to relevant material, including articles, videos, and tutorials capable of fuelling a better understanding of specific NBS and the opportunities associated with them. This way, additionally, URBiNAT's public listing of researchers working on NBS will be integrated with larger CoIs being developed as part of sister H2020-funded projects with a related orientation.

Beyond the initial student and researcher community, again, C3 is set to gradually open up for effective engagement by other user categories. Such expansion will evolve in sync with further enhanced functionality offered by the platform. Plans are, in due time, for the online facilities under development on URBiNAT's website to be replaced by a more developed, highly interactive and dedicated, value-enhancing platform. That more mature next version of the platform is envisaged to shape a joint "collaboration space" tailor-made for relevant knowledge-sharing, forming a vehicle for shaping a wide, interconnected network. University students and researchers may remain at its core, but other categories will gradually enter and assume growing importance.

Figure 5 depicts the Community of Practice approach within the Circular Cities Café concept. Initially, students and other URBiNAT partners will be connected through the digital infrastructure, which is run on the concept of people-driven technology. It means that the digital collaboration space will be used primarily for the purpose of improving citizen-centric urban regeneration processes through open innovation. All data shared among platform users will be open-source and used to map already existing science on SDG related topics and urban regeneration challenges. There will be a constant exchange of ideas, research, and solutions between all levels of stakeholder engagement; between students & researchers, the public sector (municipalities), NBS experts, nature-based enterprises and citizens. The set-up will be initiated, however, working with students and other scholars on the ground in the intervention areas.

[11] This corresponds to what is referred to as Level 3 of the CoP: see further URBiNAT (2020).

Figure 5: Community of Practice in the Circular Cities Café



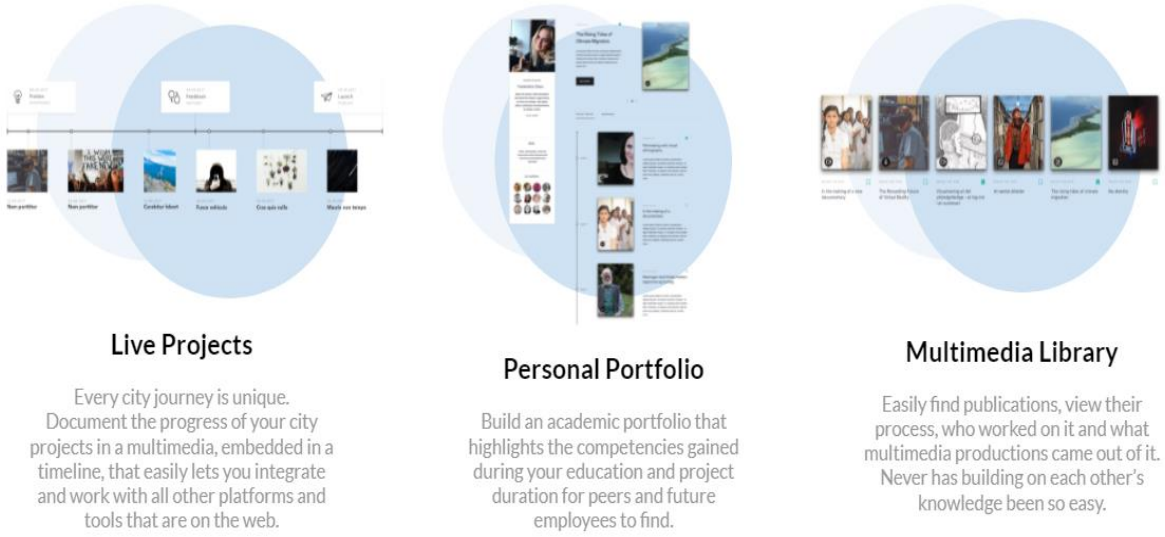
Source: IKED, 2021

The main functionalities offered by the platform are depicted in Figure 6. Platform members will be able to showcase their work on their personal feed (MyFeed), within their digital CV, and in a common News/Media feed section. Student groups will be able to follow their work progress utilising the "Timeline" feature. Behind the scenes, they may communicate in the "Backstage" function. Here, they assign tasks to each other, upload relevant podcasts, photos, documents, and videos. Supervisors will have access to the information uploaded by student groups and be in the position to provide guidance and feedback directly through service functions that form part of the platform. Related research publications will be visible in the "Living Library". Under the tab "community news", users can get information on upcoming events, ongoing university activities, and the latest research findings. All these features will be enhanced by AI functionalities, for example through the "suggested publications", or "matchmaking and mapping" function.

The envisaged process ahead aims for enhanced learning through collaboration, as illustrated in Figure 7. Machine learning functionalities provide for smooth interconnections, responding to the needs and interests evolving over time. On this basis, members may connect directly with other users who are conducting research or engaging in activities which are presenting a match. For example, platform users will be able to expand their network and discover relevant openings for collaborative activities, navigated through applications showcasing the **knowledge matrix landscape**.

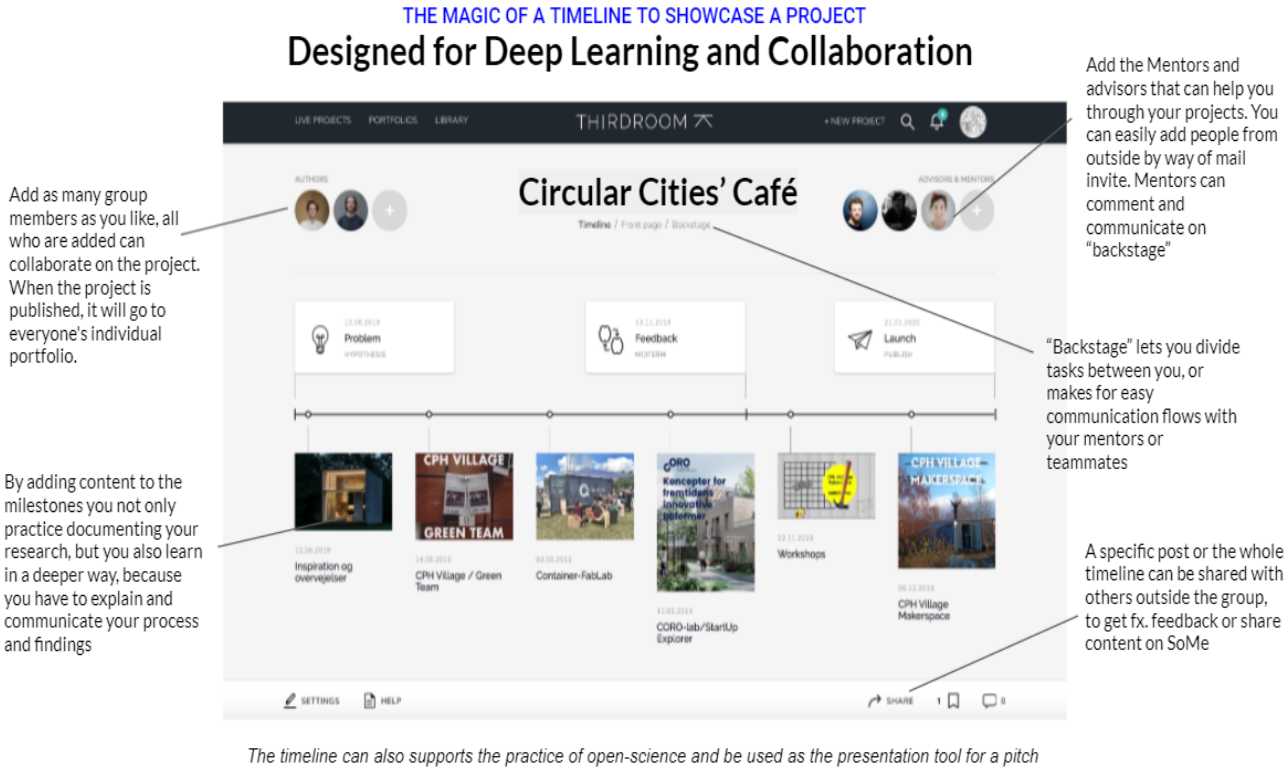
In Figure 8, the prospect is exemplified by resulting potential clusters and categories for knowledge exchange. On the right-hand side, there is the option to specify the required information by applying various kinds of filters, including the entity type, e.g., specific activity, a person, a project, or a publication. Once a selection has been made, it is then possible to conceptualise and visualise particular connections, for instance, between people, projects, or departments. A user-friendly functionality is envisaged, where a search can be specified by filling in open columns denoted "description search", "refine description" and "name search".

Figure 6: C3 Digital platform features



Source: Adapted by IKED from Thirdroom, 2021

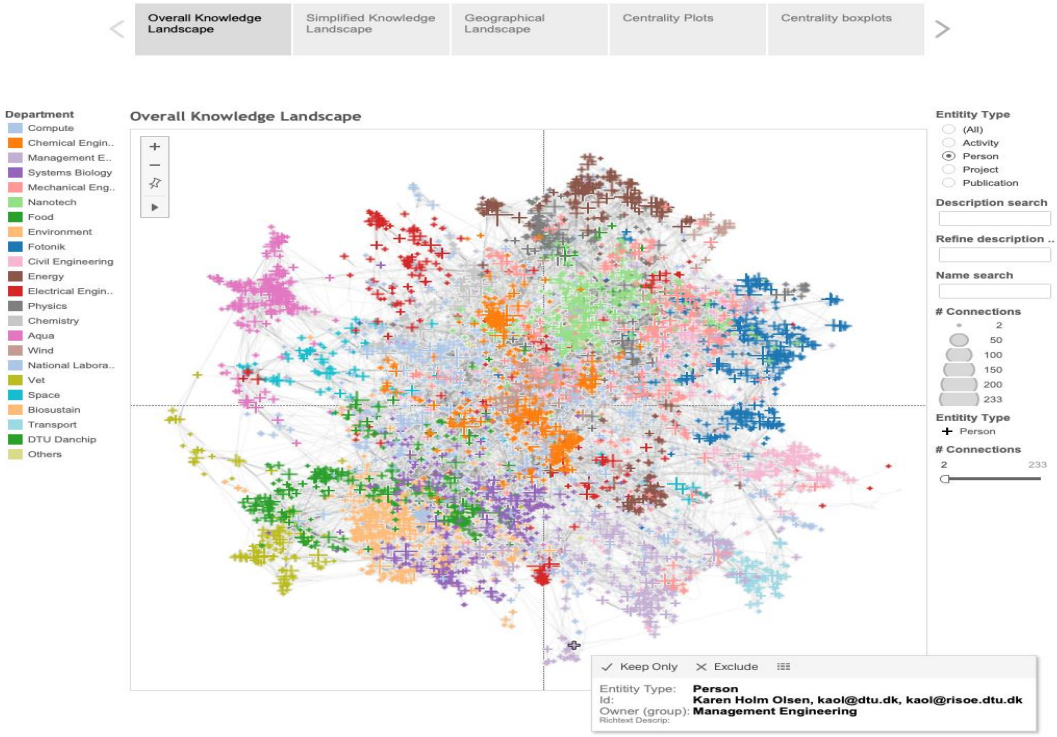
Figure 7: Project timeline Circular Cities Café



The timeline can also supports the practice of open-science and be used as the presentation tool for a pitch

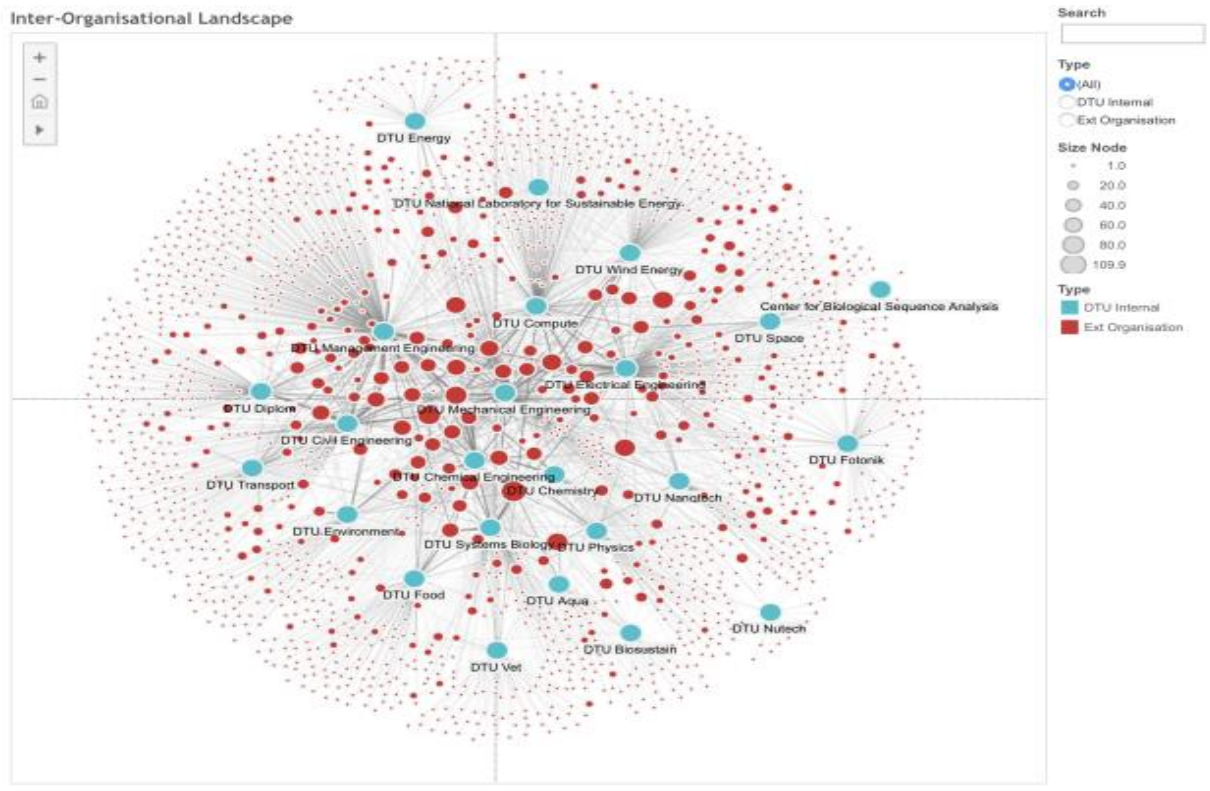
Source: Adapted by IKED from Thirdroom, 2021

Figure 8: Knowledge matrix landscape



Source: Adapted by IKED from Thirdroom, 2021

Figure 9: Inter-organisational landscape



Source: Adapted by IKED from Thirdroom, 2021

Figure 9 depicts a stylised inter-organisational landscape featuring particular interlinkages, which can be created for the purpose of enabling platform users to locate collaborators and knowledge experts.

Governance of the C3 forum is planned to be shared between the municipalities and the CoI networks, while bottom-up initiatives and citizen ownership will be encouraged. Benefits of this digital enabler are expected to include strengthening of neighbourhood identity and citizen well-being through recognition and meaningful activities; intensified knowledge exchanges and new creative collaboration projects around NBS, and; reduced costs including less negative environmental effects from organising events.

6. Digital Landscape and Preparations of Digital Enablers in URBiNAT Cities

Both cases selected for implementation, My Edible Neighbourhood and C3, carry the potential for fruitful parallel implementation in several URBiNAT cities, in support of enhanced and broadened exchange of experience and joint learning within an expanded CoP. Consultations with the URBiNAT cities have outlined their relevance for all. In this, the cities have drawn upon their respective frameworks for consultations with citizens, which have deepened through the activities of the Task Forces and the CoP put in place through URBiNAT.

To further take into account the actual behaviours and perceptions of citizens in regard to digital tools and their potential use, however, the previously pursued local diagnostic has been complemented with a questionnaire directed to citizens in the study area of Siena. The aim is to arrive at concrete and comparable information on citizens actual use of digital tools and their priorities when considering options for initiative ahead. Although only preliminary results are available to date, the aim is further to help identify group-interests across the study areas, and how they may be built on. See Appendix 1 for the questionnaire and Appendix 2 for initial results.[12]

While the questionnaire was developed drawing on consultations with several cities, the precise approach and content was eventually concluded and fine-tuned in close consultation with the municipality of Siena. This was partly motivated by the responsiveness and interest of that city in testing the questionnaire. In particular, Siena was able to effectively apply a hybrid model for its distribution as well as for collecting responses, using both digital and physical channels, based on the aim of reaching diverse citizens in the age groups 15-85 yrs. Thus, the first round of results, drawn upon in this report, relies on that initial pilot in Siena. This will be followed with more extensive collection of responses in Siena itself, as well as the other cities, followed by a comprehensive comparative analysis.

In the following, we briefly outline the relevant background to the application of digital enablers pertaining to each of the URBiNAT cities, based on the information presently available, along with the status of their respective plans for implementing the two digital enablers in preparation. We start out with each of the three lead cities, after which we present the Followers.

[12] https://urbinat.eu/cities/nantes/

6.1 Porto

Porto is served by well-developed networks for both fixed and mobile communications. While a Frontrunner city of URBiNAT, marked by rich experience in NBS, Porto's use of digital enablers is nevertheless relatively undeveloped, especially in deprived areas. Limited access to digital tools in those areas, coupled with demographic and socio-economic factors conditions, provide partial explanations. Additionally, however, general preferences among many citizens favour the use of face-to-face contact. The municipality assumes a related stance, although opportunities are sought to take advantage of digitalisation as well, where most useful. Having said that, step-by-step introduction of digital enablers, co-existing with traditional participatory processes, is viewed as important to avoid a backlash.

An initiative for speeding the application of digital tools while also supporting associated learning, introduced with a view to improving conditions for vulnerable groups, is the so-called Reboot programme. Here, underprivileged students are targeted for a combination of recycling and sharing of computers. Meanwhile, a start-up community, Porto Digital, engages in developing smartphone applications, while linking to NBS. One of the most successful examples aims at reduced electricity consumption.

During COVID-19, the authorities faced stern challenges to keep reaching and involving citizens in participatory activities. Digital enablers thus met with stronger demand to help overcome the impediments for arranging physical meetings. Results were not as expected, though, but commonly met with resistance, including in deprived areas. Considering alternative avenues, representatives of Porto promoted personal phone calls as a means to reach out and inspire people to participate in common activities, although some of them online. The plan was partly to locate "ambassadors" who can act locally by being in direct contact with citizens.

In search of other means to make citizens more responsive to using digital enabler, 3D videos have been identified as an entry point for raising their interest. A particular method has been tested, with a 3D presentation made available online, after which citizens are divided into suitable groups where they meet with targeted incentives for participation in different Zoom meetings. In subsequent rounds, citizens divide themselves into groups for this purpose. Through URBiNAT, this experiment has been shared with the other participating cities, inspiring further search to work out engaging means, typically combining traditional face-to-face communication with communication online. This is partly to overcome the common resistance to digital enablers and, partly, to avoid alienating those who are the least familiar with them though in high need.

In order to boost co-creation through bottom-up initiatives, a process has been initiated to frame a multifunctional platform, Campanh'up, according to the time plan illustrated in Figure 10.

Drawing on Cultural Mapping and introduced as a participatory NBS, Campanh'up is in effect incubated by URBiNAT. It is envisaged to propel diverse mechanisms for combined collection and dissemination of information, training and entertainment, applying various mechanisms including a website, workshops, links to radio stations, etc.

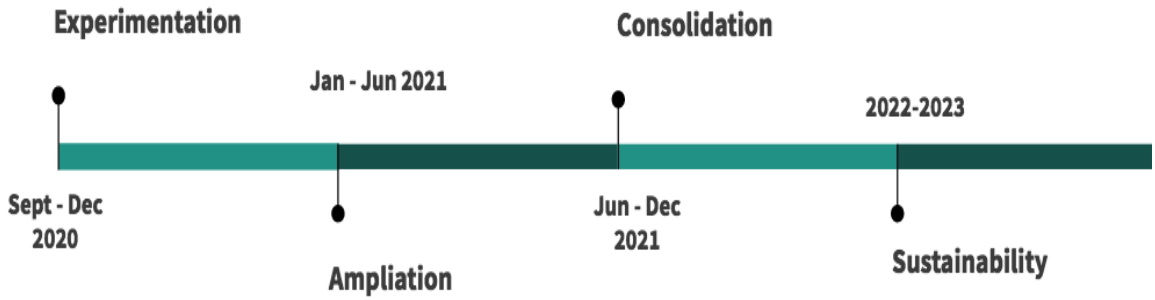
A range of other specific initiatives have been taken to reach out to and engage citizens in the study area, several of which relate to food. These have aimed to, e.g., reduce waste or encourage economical cooking by citizens of their own food while also promoting quality. A particular activity brings people together for consuming their own fruit while promoting awareness of the virtues of eco-food. Along a separate track, urban farming and community gardening have been promoted

through various means, including by featuring in the curriculum at primary school level. Several activities on the ground - at the local school in the study area - have been orchestrated for this purpose.

My Edible Neighbourhood thus resonates with needs and opportunities that have existed in Porto since some time. By introducing the digital enabler under preparation by URBiNAT, Porto will be in the position to further boost its agenda on community gardening. As a particular element, plans are under consideration to link the activity to already existing, or partly new, urban farming initiatives as well as local farmers' markets in the study area.

The CoI is staged to achieve a parallel strengthening of conditions for locally produced food coupled with increased social and customer awareness and trust among consumers in what is on offer. MyEN is further envisaged to connect with planned school activities to grow fruits and vegetables in a sustainable manner for increased wellbeing.

Figure 10: Time plan Campanh'up



Source: CES, 2021

6.2 Nantes

Nantes Métropole has used digital enablers in support of citizen participation since 2014. Through the platform "Dialogue Citoyen", citizens are invited to initiate project ideas that are subsequently assessed and advanced to workshops. A swift and well-structured process leads from ideation to verification, i.e., project approval or rejection, providing an impressive contrast with regular bureaucratic procedures. Specific digital tools have further been introduced by the municipality to support the participation of citizens from the whole territory in addressing major societal topics. Examples include energy transition, reconnecting the city to the river Loire, and how to adapt the city to the increasing longevity of its inhabitants, with projects selected through online voting contests.

The development of apps and other tools has been supported by CityLab, one of the first schemes of its kind to be set up in France, that offers concrete means to foster innovation at the service of residents. Examples of successful applications include the instalment of equipment to inform citizens about air quality and pollution levels. The aim is for this to serve as the starting point of a global experiment on air quality measurement, to be deployed until 2021. Another example is Farmbot, designed for an autonomous vegetable garden.

In the era of COVID-19, Nantes has accelerated the development of an open-data platform (data.nantesmetropole.fr), which offers access to data collected by sensors, such as traffic camera data. For instance, this information can then be used to optimize energy supply within cities by centralising data in one server updated frequently and automatically, inducing a real time response to sudden changes, e.g., such as those due to natural disasters, outbreaks of pandemics, or traffic accidents. On this basis, resource use can be made more efficient, time and lives saved with earlier warning of and more effective responses to various calamities.

Faced with worsening social issues caused by lock-down during the pandemic, reaching out to and supporting citizens presented Nantes with increasingly urgent challenges. A concrete immediate task was that of making the most of a daily 1-hour break in the 24-hour curfew to allow for essential errands. Walkthrough, here using a video broadcast in a bus, was applied to reach people not able to walk long distances, or with limited time. The video was arranged to match with the walking loop, connecting the green spaces of the Healthy Corridor[13].

Plans developed for discussions aimed at determining the best way for citizens to co-design the green areas in Nantes-Nord, naturally shifted attention to what could be achieved using digital enablers. Photovoice, or apps that can be readily applied to take pictures and share them online, were considered. Other applications envisaged could have provided citizens with stickers displaying various NBS, such as herbal gardening, family exercise equipment, compost boxes, etc., for posting on a 3-D map made available in the citizens' bus. [14]

Linked to the current preparations of digital enablers, consultations in Nantes have called for promotion of the green loop, using a municipally managed platform, Patrimonia[15]. Offering a permanent space for discovery and exchange around heritage, Nantes Patrimonia places heavy emphasis on diversity and allowing each inhabitant to take an active part in shaping life in their city, and their city district, while linking to subjects of shared interest.

This project is co-financed by the European Union through the European Regional Development Fund, and by the regional authorities - the Pays de la Loire Regional Department of Cultural Affairs under the agreement between the City and Pays d'Art et d'Histoire - and the national programme for the digitisation and promotion of cultural content.

Nantes has further developed a specific governance model directed to the engagement of citizens in the preparation and implementation of projects, with ambitious goals and setting strict rules for providing citizens with feedback on ideas they have brought forward. Issues arise with inclusion, however, which is a common challenge with traditional methods, as discussed previously in the report. Thus far, digital support has not been activated in this model. An electronic survey distributed during the pandemic, however, collected information from citizens and engaging them in producing ideas for how the municipality should respond. The Nantes approach puts strong emphasis on working out the means for realising effective citizen participation, providing the breeding ground for co-created digital enablers (Hilding-Hamann et al., 2019). Meanwhile, Impact Track is a digital platform located in Nantes, that allows entrepreneurs, foundations, and investors to measure, manage and communicate their social and environmental impact[16].

[13] Video of the walking loop https://vimeo.com/461432240/9845b804e4
[14] The bus is part of the so-called la Mobil´O Project, see https://urbinat.eu/cities/nantes/
[15] https://patrimonia.nantes.fr
[16] https://impacttrack.org/fr/

The above forms a conducive context for Nantes to proceed with My Edible Neighbourhood. This is under way, initially by using QR codes placed on information boards, notably along the routes of the Green Loops. QR Codes may be displayed on notice boards so that citizens who carry a smartphone will be able to connect and thereby receive content displaying additional information on the edible fruits, vegetables, herbs, etc., which may be found in the area.

In regard to the Circular Cities Café, Nantes has already pursued elements of the agenda, as a digital enabler devised to initially connect students and researchers engaged in NBS. In preparing for the URBiNAT initiative, a novel template for members´ profiles is under development and a process for upgrading and expanding the existing C3 core community, already engaged, is well under way.

6.3 Sofia

In Sofia, the general status of digital infrastructure is satisfactory, with sufficient bandwidth, affordable access and the penetration of smartphones and other digital tools at a level that is comparable to many other major European cities. In disadvantaged neighbourhoods, however, digital literacy is fairly weak, and laptops and tablets have a low penetration rate. Low-income levels account for low affordability as the costs of connectivity attain a significant share of household expenses. In the specific case of the Nadezhda urban district, Internet connection and bandwidth capacity are provided by about 10 operators. Costs related to Internet services as well as for digital tools are nevertheless viewed as an impediment by citizens in the neighbourhood, which contrasts with other parts of the city.

Sofia is at an early stage when it comes to application of digital enablers as a means of engaging citizens. The Municipality has a web-platform where citizens can submit comments on ongoing projects or suggest new projects. The platform demonstrates the potential for direct citizen involvement, though there is still room for improvement. Interviews among start-ups applying smart and green solutions display disappointment with and criticism of the Municipality for lack of support and counterproductive policies. Aside from its own website and social media channels, the district branch of the Municipality uses a particular platform to engage with the local citizens (https://grajdanite.bg/home). In the Nadezhda district several of the NGOs are using existing social media channels, such as Facebook and Instagram, for the initial engagement of community members.

The process of engaging citizens is ongoing and has resulted in a number of clear-cut connections and potential entry points for carrying out the activities. Issues, stakeholders, and inputs for devising the digital enablers and the building blocks to be applied, including the platforms, are under consideration. Citizens dialogue workshops will be important for calibrating the best arrangements, in support of comparability and local tailoring, as framed in the CoP.

In the Nadezhda district, using Walkthrough along with workshops, citizens have identified an area with many fruit trees, to be revived using digital enablers. Thus far, most of the fruit is lost due to lack of organisation/knowledge, with most reportedly picked prematurely by youngsters for throwing and playing, or, when the fruit is over-ripe, it falls to the ground and becomes a nuisance for pedestrians and cyclists.

Citizens are looking for a solution to build awareness and create shared interests in the usefulness of the trees and their fruits. Under this context the proposed digital enabler, My Edible

Neighbourhood, has a strong potential to address the challenges and provide a solution. The idea is to set up a PGIS including a digital map of the trees, run via GPS and supported by sensors, with a functionality framed to signal when fruits mature, and help launch joint harvesting drives along with the production of juices, marmalades, compotes, etc. Citizens of the target area emphasise that digital enablers should be easy-to-use, including via simple smartphones. If successful, the plan is for the application to be scaled for Sofia as a whole. In addition to the above, the application, My Edible Neighbourhood will connect citizens with an interest to engage in community gardening as well as display information on local farmers' markets. Recently, a Bulgarian platform that aims to create a digital map of the tree network in Sofia was launched (https://ednodarvo.io/). The URBiNAT Task Force in Sofia has been in contact with the team behind the platform, in order to learn from their experience and explore the potential for collaboration with regards to the citizen-led mapping of Nadezhda.

The idea of engaging in the digital enabler, Circular Cities Café, has been favourably received and preparations are under way to identify students and researchers who would be profiled on the platform.

6.4 Brussels

Among the Follower cities, Brussels assumes a special position when it comes to well-developed strategies for supporting and implementing digital elements, with strong attention to disadvantaged groups. A special service platform has been put in place to call attention among citizens to key outstanding challenges, such as limited mobility, congestion, air pollution, water scarcity, etc. This agenda is presently not user driven but aims at building awareness and activating citizens.

Brussels City has also actively worked on bridging the digital divide by providing tools (computers) and free internet access in all the local community centres in the various parts of the city. This means that in general citizens are familiar with the usage of digital applications and website.

My Edible Neighbourhood is of special interest, partly due to the presence of already existing relevant initiatives. A website (https://www.velt.nu/verger-partage/quest-ce-quun-verger-partage) enables private home owners and also private and public owners of fruit trees to post information about trees that bear edible fruit, if they already have fruits and berries that they cannot consume themselves, allowing them to invite others to come and pick fruit for free.

As citizens in the study area already engage in community gardening, especially of herbs, there is a vibrant basis for extending into new areas such as vegetables. At the same time, there is distinct room for increased value creation, going beyond the usual suspects and working out the means to involve other groups.

An annual local event, a neighbourhood festival, offers a particular opportunity when information about developments of the application My Edible Neighbourhood and developments about urban farming could be displayed.

As for Circular Cities Café, Brussels meets with specific organisational issues. This is because the university involved is the University of Antwerp, and further discussions with both city representatives and the University will be required to work out a locally adapted process to realise the most constructive set-up and engagement in the C3 platform.

6.5 Nova Gorica

Most citizens are positively inclined to using digital tools and especially the younger generations are in possession of smartphones and laptops. The city has established WIFI hotspots, placed strategically around the city, to support easy access and facilitate connectivity. In prioritised locations, WIFI is thereby available for free and without an access code.

Meanwhile, the city website (https://www.nova-gorica.si/) offers full communication in Slovene with short summaries in English and Italian. Prioritised information is packaged for reaching the whole range of citizens and visitors. The website is not interactive, however, so does not offer feedback from citizens. Instead, this can be effectuated using a Facebook account. Some neighbourhoods have set up local Facebook pages enabling citizens to comment, feedback and ideas, particularly linked to specific events and activities.

The readiness of citizens to embrace digital enablers provides a potential for Nova Gorica to engage them in co-creating user-centric solutions, including apps in support of public transport, health services, entertainment, and more. Separately, Nova Gorica is undergoing the evaluation process to become Culture Capital 2025 for Slovenia and is including numerous art and culture activities based on digital solutions that will probably enhance the city's user experience in various forms.

There is an interest in both applications presented by the ongoing exploratory co-creation phase. Thus far, Nova Gorica has no organised harvest festival or other activities building on CoI related to local food production, distribution, and consumption. However, Nova Gorica has in place a digital enabler in support of the distribution of local food, see https://trznicanaborjacu.si/. Green Destinations has recognised the sustainable project "Tržnica na borjaču" as one of the 100 most important examples of responsible tourism development in the world. Meanwhile, citizens have confirmed a clear interest in community gardening. The expectation is that citizens will become active when given the chance and the conditions for growing and finding edible items in the neighbourhood are highly favourable. Discussions on engagements of schools in this context, which has been exemplified by activities in the lead cities, are underway.

Engagement in C3 is confirmed, with the university and the city already having natural links to be developed for the implementation, and there is a strong interest among students to be linked to a platform providing new means of collaboration.

6.6 Siena

Several digital enablers for citizen engagement have already been developed in Siena. In most cases citizens find it easy to access and consult web pages. In particular, citizens are free to access https://www.comune.siena.it/, which offers a user-friendly interface connected to social media platforms. In general, citizens in the study area are very active and community engagement is very strong due to the long historical set up of the *contradas*, i.e., geographical city communities which collaborate with the aim of sustainable engagement including participation in the traditional annual horse-racing festivals.

An "URBiNAPP" has been devised to share information about events, tours and experiences in Siena, including digital vouchers of various sorts. Meanwhile, in the context of COVID-19, the city launched the project "Siena restart together", to inspire looking ahead (see further below). In

February 2020, focus groups were formed to target engagement of key stakeholders from the selected neighbourhoods (associations, priest, doctors, and schoolteachers) to spread the word to other people. According to the local team, teenagers are viewed as the most difficult group to reach with city-specific information on COVID-19.

Further, Siena is reaching out to citizens to offer alternative contact points and communication channels that may be used freely according to preference. Several online forums and groups are developing on this basis. Initiatives by citizens, e.g., to provide community support and speed access to help for those in need. During the taxing period of "lockdown", structured two-way interaction was initiated drawing on the URBiNAT project, for awareness-creation and to inspire creative and innovative communication flows. URBAN TREKKING 2020 has been devised as a digital enabler applied to increase knowledge and inspire citizens to engage remotely in city planning.

Food represents a strong CoI and many citizens in the study area embrace community gardening and urban farming activities. The city has several areas outside the city centre where individuals engage in producing food. My Edible Neighbourhood could serve as a platform to leverage the interest in locally produced and organic food. Local farmers' markets already exist and are expected to be linked to this initiative.

Siena Municipality expresses a firm interest in the Circular Cities Café collaborative platform. Exchange between the municipality and Siena University has already been established under the URBiNAT activities and this exchange has a potential to evolve further in regard to joint action research agendas and start-up projects. As an example of the above, several students were engaged to pursue some of the local diagnostics and there is a confirmed interest for them to push ahead with further engagement in a wider network of student linking.

6.7 Høje Taastrup

In Høje Taastrup, the application of digital enablers has become strongly associated with social media. In particular, the municipality piggybacks on the existing Facebook pages in order to spread information and communicate with residents. Meanwhile, many local communities have their own Facebook pages.

Related to this, an online platform called Innosite serves to allow residents to provide feedback on the development of a park and urban space in a neighbouring district. Innosite has been developed by Realdania, a large Danish philanthropist investment fund. Young people represent an important target group for this and other initiatives. The municipality tries to attract young people to events in the neighbourhood, such as an annual festival, by bringing in elements of interest to a younger crowd, including music and entertainment. So far, digital enablers and social media form only the top layer, as the focus in the study area is largely on creating infrastructure, getting people involved and encouraging them to take ownership.

Meetings were mostly shifted online during the pandemic starting in 2020, leading to a far greater number of citizens interacting online, compared to when meetings were primarily physical. Having said that, where possible, physical workshops have been arranged as a supplement to online meetings. Personal calls have also been made in large numbers to individuals enrolled in social activities. The city further spent increased resources on communicating about COVID-19 in multiple languages, including those spoken by immigrant minorities.

As Danish schools closed and teaching went from face-to-face to online, students from disadvantaged groups faced severe challenges, both when it came to following classes, and the submission of assignments, online. In Høje-Taastrup, the local government deemed the risk of long-time consequences, with the weakest students slipping further behind while suffering other, related psychological damage, as unacceptable. Those experiencing evident difficulties were therefore allowed to return to the classic school environment, thus, to be re-engaged by traditional education methodologies in a controlled environment.

Based on a longstanding tradition with community engagement, in the shape of urban farming, Høje-Taastrup has expressed interest in the MyEN application. Also, in the study area, a number of activities have been pursued directly or indirectly concerned with community gardening, where citizens are able to grow edible items for local consumption. The study area further displays various opportunities for linking with local farmers' markets and engage youth in expanding the interest for organic food.

Connecting to nature in general, many smartphone applications offer interactivity functionalities whereby the user can report the presence of birds, insects, plants, trees, etc. In registering certain sightings, the user also adds to knowledge of biodiversity in specific areas. During COVID-19 times, they have been applied for underpinning renewed exploration of nature by citizens. Some can be applied in nature clubs, in schools for projects and by scouts and other organisations, or simply by people who like to walk around and explore nature in their neighbourhood.

The Circular Cities Café will be explored and discussed with the scientific partner linked to the study area, i.e., the Danish Technological Institute (DTI). DTI is hosting several action research projects and is connected with local incubators where NBS-focused start-ups will be given the opportunity to join the C3 platform.

7. Incorporating Key Lessons

In this chapter we take into account relevant experiences of digital enablers with a view to highlighting key aspects requiring attention in their continued progressing, in URBiNAT cities and beyond. Initially, we consider the experience of a few selected case studies, offering valuable lessons regarding best practices. We then revert to URBiNAT's own experience of digital enablers thus far. This is followed by consideration to incentives, and the associated importance of professional assistance useful for the next stage of framing and adjustment of the various building blocks. Finally, the significance of competences and governance is highlighted.

7.1 Lessons from case studies

Experience of past digital enablers has generated various lessons which, to the extent possible, will be incorporated in the implementation ahead. Following the review presented in URBiNAT (2021), as part of the preparations and advancement of digital enablers set out in the present report, several specific successful examples have been considered for further detailed examination. Among these, two specific cases were selected for a more detailed review to feed into the present work. A summary of main findings of this review is provided in this section.

In the selection of these two cases, attention was paid, first, to the presence of a context marked by the presence of significant NBS, where the purpose of enacting digital enablers was directly related to underpin citizens' engagement. Second, the selected cases displayed clear-cut relevance for citizens, as verifiable by observable behaviours and developments, including hard evidence of co-creation by citizens. Additionally, the cases were selected with a view to their ability to clearly illustrate the role of social relations and how they play out in determining outcomes at the community level.

Part of the purpose has been to help distil elements of high importance for digital enablers to achieve success. This review aims to highlight, examine, and look out for best practice by:

- Describing the process of co-implementation
- Examining strengths and weaknesses in business model development
- Exploring linkages between commercial success with vibrant social innovation and manifestations of solidarity economy
- Reviewing the importance of time frames, piloting, roll-out
- Realising the key to successful adaptation to digitalisation of interactive communication to and among citizens for the purpose of co-creation
- Understanding what changes have been achieved through the introduction of digital enablers - better measurement, wider reach, greater precision in whom to involve, more powerful incentives - in short, which were the true benefits?

The two selected cases, summed up in the following, are: i) Treetalk/Greentalk, a UK application centring on the appreciation of trees and green areas in London, and; ii) The Finnish Biodiversity Information Facility, i.e., a biodiversity platform.

Adding to the above, the review of each has been structured to highlight lessons of use for further idea generation and piloting, and so to provide inputs for Guidelines (see further Chapter 8).

7.1.1 Treetalk and Greentalk[17]

Introduction

Treetalk is centred on an IT application devised for helping people to enjoy trees in their neighbourhood, forming part of greater London. The term Treetalk signifies its mission to promote communication, affinity between trees and people – closeness to nature – as well as to encourage people to talk with one another and specifically share routes around publicly accessible trees in the city of London.

By now, Treetalk has existed for some 3,5-4 years. Its journey during that period has been much influenced by the pandemic. In stages, it has had to move activities indoors or run primarily on-line as people have had to stay at home. Yet, the pandemic meant that people staying in London rapidly acquired an increased appreciation of green areas and associated services. This contributed to enhanced attention to what Treetalk had to offer, attracting a radically different level of public engagement in 2020.

At the core of Treetalk stands its detailed mapping of more than 700'000 trees in London. During the COVID-19 lock-down, it experienced a more than fifty-fold increase in visitors to the site. Obviously, this was driven by the fact that people were seeking opportunities to enjoy in new ways the few outdoor activities accessible to them. It resulted in huge traffic spikes and the media

[17] https://www.treetalk.co.uk/

became interested, which led to additional peaks in traffic. The IT application will create a personalised walk to explore trees in a London location and will provide details and pictures (where possible) of the trees on the route. It allows users to also explore routes in parts of the city outside their neighbourhoods. Already, other cities in the UK and internationally have expressed an interest or are in the process of setting up similar applications for tree or green talks in their cities or local districts. At peaks during the COVID-19 lockdown, 30'000 walks were registered in a single day. Today, Treetalk hosts an average of 2'000 walks per day.

Examples of other products based on the same platform base include:

- GoParks - https://www.goparks.london/about/; The GoParks service highlights parks with features and allows for separately curated routes around these parks. GoParks London – also a free app – funding from social sector bodies (see below)
- Greentalk - https://www.greentalklabs.com/greentalk-plans/; Greentalk is an online, consumer-facing map-based tool enabling users to discover and interact with green infrastructure in a pre-defined area of any size from a city park to a whole country.

Actors

The Treetalk, Greentalk and GoParks apps have all been created by Greentalk Lab. The organisation employs three persons with a mix of programming, data and environmental/nature skills and interests. In order to develop the apps Greentalk Lab have collaborated with

- municipal departments providing the data
- municipal departments having plans to plant and maintain additional trees in their municipality as well as
- departments perhaps wanting to offer ways to explore and create routes around certain cultural points of interest like parks, gardens, trees, artwork or buildings.

For the Greentalk and GoPark apps Greentalk Lab, and especially the concerned municipal departments, have also worked with community actors and citizens' groups at local level to understand their interests, motivation, and likely roles in relation to the general purpose of the municipality. In this way, the municipality found synergies to explore in these two apps.

Financing

Greentalk Lab have partly financed the initial app developments themselves and partly through separate projects like the GoParks project which was financed through different funding programmes that the participating organisations applied for. The participating organisations in the Big Green London map consortium comprise: CPRE London, London Friends of Green Spaces Network, Greenspace Information for Greater London, Revolution Consultancy and Design; and the National Park City Foundation. Today, most of Greentalk Lab services are offered on a commercial basis.

Source of data

The application uses data released from the Greater London Authority (GLA) https://data.london.gov.uk/dataset/local-authority-maintained-trees. The application will have a long way to go before every tree is mapped as there are more than 8 million trees in London, but already more than 600 species of trees are registered in the Treetalk application.

The Greentalk app service established in Hounslow Borough required data provision from three different partners to the Hounslow authorities. Hounslow has outsourced management of trees to three different plant service companies. One partner for trees in streets, one for trees and plants in parks and the third one for trees and plants in social housing estates. Through these sources

Greentalk Lab has registered trees in urban woodlands and parks also. In Hounslow, this has meant that a further 90'000 trees over and above the Treetalk count have been identified, now totalling 123'000 trees. For woodlands, trees are often registered as groups of the same species of tree.

Greentalk Lab uses the tree data released as open data to present and display the data in an interesting way and encouraging users to conduct walks visiting trees or other points of interest.

At the start, some 700'000 trees were registered in the streets of London, although not every borough were able to provide reliable data on tree population. The data quality issues faced included, e.g., lack of detail on correct species, spelling mistakes and incomplete information. Greentalk Lab has been in touch with the boroughs to understand how data have been collected and used.

Success factors

As a result of the pandemic, local authorities have come to realise that they need to provide people opportunities to experience their local nature and take an interest in their environment and trees. It is the aim of the city councils to expose the fascinating information in an attractive way to citizens in their communities. It is about communicating the very interesting information about trees, including about rare trees and blossom experience opportunities, but also what these trees do to add value to the community in terms of improving climate, temperature, air quality, etc. Obviously, to focus on the communication, dissemination and benefits, different departments and other external stakeholders need to get involved in order to mobilise these activities.

With the Hounslow implementation, citizens are offered these services:

- Ability to "Like" trees on the app
- Tagging individual trees with comments
- "Gathering" modules – embellish trees and provide further description
- Curating routes – you devise a route to share with others – look at the map by selecting trees, where you can also describe the route in a narrative.

Diversity/inclusion

The Hounslow local authorities, clients of Greentalk lab, want to develop social cohesion and attract diversity through the involvement and engagement of all citizen groups. In doing that, they are encouraging community groups in socially deprived neighbourhoods to help maintain trees and plants by offering them a presence on Greentalk and a voice in terms of liking, tagging and commenting on trees and routes around their favourite trees.

Business model of Greentalk Lab

The initial Treetalk app was offered as a free app to citizens. It allowed Greentalk Lab to develop the platform and test data quality and functionality with users. With users starting to apply routes using the app, further learnings were gathered, and ideas started to emerge for the further development of the platform. The Greentalk app service is offered as a licensed platform to cities. In addition to Hounslow, cities like Bradford and Manchester are already clients of Greentalk Lab.

This means that Treetalk is now available as Greentalk in any city with the functionality that this particular city would like implemented. The Greentalk app may be branded however the city likes.

In terms of the Treetalk app, this will remain free for the city of London Apart from introducing the regular GLA updates from open data, the functionality is not expected to change.

Greentalk offers something beyond what Treetalk is and can do. Basically, it can act as a shop window for local authorities.

Greentalk Lab currently has multiple dialogues with cities in the UK and outside the UK. It is also working with the health insurer BUPA to develop a product BUPA provides to business clients to offer their employees an attractive city walk around their work premises including looking up trees and/or artwork. There is evidence that such city walks will improve general mental and physical health amongst employees and as such, the app would quickly be worth the investment.

Pricing structure for the Greentalk app service:

- Starting cost is offered in three tiers – a) small city up to 10'000 points of interest, b) Standard Unlimited and c) Standard Pro, which also offers social media integration. The costs are 1) initial setup cost and 2) monthly subscription.
- The cost range spans 5'000-15'000 pounds sterling with monthly subscriptions between 350 and 900 pounds, depending on size and functionality.
- Greentalk Lab requires the provision of high-quality data, which may raise a challenge for many cities.

Indicators of achievement

Key indicators for the Treetalk app include: i) number of users; ii) number of routes registered, and; during the lock-down, a real increase in app downloads, registrations and routes used.

For city authorities, the key indicators are the numbers of trees adopted by citizens or local communities. Also, many city authorities are planting new trees as part of the climate adaptation and de-carbonisation strategies. According to Greentalk Lab, up to 30% of trees planted will fail due to inadequate maintenance and water provision. With the Greentalk app, and tree adoption by citizens' groups, watering and maintenance of trees can be optimised and failure rates reduced. Obviously, the replacement cost of failed trees is high and a reduction to 5-10% will benefit the local authorities significantly.

Cities need to show what they are doing environmentally, and it can be difficult to promote and engage communities in tree and woodland projects. With the Greentalk app, city authorities can encourage and incentivise communities to adopt and maintain trees, groups of trees, or entire parks.

The trees planted and their subsequent growth contribute to carbon storage, air improvement and strengthening of the local environment.

Transferability to other cities

The Greentalk platform allows for adaptation to individual city requirements and has also been adapted to "park talk", as shown through the GoParks app service developed in London.

Apart from the case of trees, this kind of platform can be adapted to support other activities of interest to many members of a particular community.

7.1.2 The Finnish Biodiversity Information Facility (FinBIF) [18]

Introduction
With the biodiversity crisis accelerating all around the world, hindering data gaps need to be addressed urgently. Efforts to source and mobilise more biodiversity data is vital. Apart from observational data platforms receiving their input from private citizens, the business model of the international biodiversity data infrastructures (BDDIs) places heavy reliance on networks of participating national nodes or institutions for data inflow. One such national node is the Finnish Biodiversity Information Facility (FinBIF) which was established in 2014.

The FinBIF combines processes and services generating digital data with sourcing, collating, integrating, and distributing existing digital data. FinBIF has developed data systems for natural history collections and observations and has constructed a national DNA barcode reference library. Data flows are managed under a single IT architecture, services are delivered through the same on-line portal, collaboration takes place under a single umbrella concept, and development visions are presented to funders under the FinBIF brand.

FinBIF's financing is currently based on the core budget of its host institution, the Finnish Museum of Natural History (Luomus) at the University of Helsinki (UH), in effect channelling resources from the Ministry of Education and Culture. In addition, FinBIF receives significant external funding from national sources as well as EU research infrastructure funding. The growing importance of its service for national decision-making on the sustainable use of natural resources and nature conservation is expected to soon widen the financial scheme to include additional funding from other relevant ministries.

Co-creation
The host institution, the Finnish Museum of Natural History coordinates the national and international cooperation. A wide national collaborative network has been an integral part of FinBIF from the start, and many organisations from all sectors of society have participated in the development of FinBIF's services and in the mobilisation of data. Seven advisory and co-creation groups was set up in which approx. 140 specialists have shared their expertise on a voluntary basis to advise on service development. The wide collaborative network and the all-inclusive business model of FinBIF has helped attract funding from a range of the different sources (see above).

Moving forward, the FinBIF Research Infrastructure is included to the final draft of the national Nature Conservation Act It indicates that FinBIF will be fully recognised by government and society and will lead to nationally fixed mandate and more secure position of the FinBIF services to local and national authorities. FinBIF is also included to the national Research Infrastructure roadmap, which in turn opens wide range of avenues for more collaboration and funding opportunities.

FinBIF's service portal is available at https://laji.fi or https://species.fi (in Finnish, Swedish and English). Currently, 41'000 species are included (85% of the estimated total Finnish multicellular biota). The taxon specialists (currently approx. 60 specialists) maintain the taxon database (national taxonomic backbone) using a web application.

[18] Based on interview with Kari Lahti, Mikko Heikinen and representatives of FinBIF
https://www.nature.com/articles/s41597-021-00919-6

Volume of users
In its first full operational year (2017), FinBIF attracted almost 175'000 new users and more than 300'000 use sessions. Meanwhile, the number of users has increased to 615'000 in 2021. These users are not registered but have typically accessed data or entered observations. For downloads and uploads on the portal, it is possible to register yourself and to date 13,000 users have registered. According to FinBIF more than 80% of the registered users are normal citizens with a keen interest in biodiversity and often also a more specific interest (perhaps as a bird watcher).

Citizens' engagement
Citizens participate in FinBIF typically through projects or Citizen science campaigns (e.g., Atlas of Finnish Fungi funded by a private foundation) and nature societies may collaborate with FinBIF and be provided with custom-made data entry forms that are then distributed to citizens. Additionally, FinBIF is a member of the iNaturalist Network, and supports a localised national portal, iNaturalist Finland. Finnish data sourced through it are copied to FinBIF's data warehouse and integrated into the total data mass.

The FinBIF supports citizens who wants to collect data for reasons of wanting to promote biodiversity typically via project partners. The FinBIF administration does not have staff that work specifically with communications to people and influencing of users. Instead, they work with for instance Nature conservation associations or specific nature interest groups. These groups and associations are much better at engaging their members and it is through these partners that FinBIF reaches the interested citizens.

Some of these partners have engaged citizens through website surveys for instance on invasive species. They are typically led by organisations and are project based (specific project funding). These organisations also help with training of users to collect the best possible data. Other projects include continuous monitoring schemes like monitoring of flying squirrels and invasive alien species (IAS) surveys (EU Life+ projects) and Zero Carbon Dairy Farm biodiversity monitoring (Valio Ltd.).

Organisations and working groups include association of bird watchers, insect collectors, expert groups on different organisms. Species information working groups etc.

Citizens' motivation
Typical citizens that become regular users of the portal and services are those who have a keen hobby in biodiversity or specific animal or plant species. For example, insect collectors who generate a lot of insect data. FinBIF has evidence that these users are motivated by being able to record data that can also be used for science. Others have stated in surveys that they are motivated by being able to make the world a better place. They expect to have a real impact on how nature is being protected and maintained. Another important motivation is that they can record species and share information with their friends, incl. tracking when they have seen something rare.

Furthermore, with the emergence of iNaturalist as an app that is tailored to different national biodiversity taxa, this has increased the number of observers dramatically. With the advanced artificial intelligence tool incorporated into iNaturalist it can help identify what has been photographed. Using iNaturalist, whole families and amateur nature enthusiasts have started providing data and taking an interest in nature. The COVID-19 lock down further increased the number of users. The iNaturalist app introduces an educational and learning element to a nature

hike. All kinds of species come alive and allow for in-depth study. Consequently, more people develop new hobbies through the joy of learning about nature.

Finally, the biodiversity interest leads to a sense of community with other likeminded people, be it around squirrels, mushrooms, insects, or birds. Experts can be approached, and discussions take place online and at meetings. Training sessions are organized where experts can help by showing and teaching participating citizens or pupils.

Educational applications

FinBIF is integrated with the e-learning environment for species identification 'Pinkka' of the University of Helsinki (http://pinkka.helsinki.fi/pinkat). The services use the same taxonomy and feed content (textual information, images) into each other reciprocally. Additionally, primary schools have been encouraged to create digital herbaria and other species collections through a tailored service at FinBIF. This has engaged schools in samples collecting as a long-standing educational tradition. The set-up from FinBIF allows the pupils and teachers to use their mobile phones to collect data but as a matter of fact it has not been that successful for unknown, properly unanalysed, reasons. Scientist working with schools are now trying a different route to improve the uptake of the tools in schools.

Collaboration with municipalities and local authorities

Biodiversity in Finnish nature in general is relevant for FinBIF. This includes the Urban spaces with interesting developments taking place also in Finland. FinBIF works with municipalities and have created tools for them to allow them to engage their green spaces in the biodiversity data gathering and communication.

Municipalities, among other public authorities, require trustworthy data upon which they can make decisions about the future developments of nature and biodiversity in their cities and remaining natural habitats. With reliable data, FinBIF are helping municipalities to do the best possible planning allowing for biodiversity needs.

FinBIF provides city administrators with tools to assess the state of biodiversity and supports their efforts to establish projects. A specific platform is offered to the cities/municipalities to store and share data on biodiversity. While drawing on a range of different sources, the so-called public authority portal (https://laji.fi/en/about/5633) aggregates and organises the data in ways that are relevant for administrators dealing with nature and biodiversity at city level. Some 60 Finnish municipalities are using the portal directly today. As mentioned before, FinBIF has set up several advisory and working groups and one of these groups is the public authorities group.

Especially among public authorities and extractive industries (e.g., forestry) there are concerns and doubts about the quality of the citizen science data, but gradually through continuous communication they are learning that citizen science data is reliable if only it is managed, curated, and validated appropriately.

International interest in good practice

FinBIF's approach has already rendered extensive international interest along with awards for its contribution to open data and science. Discussion of hands-on collaboration as well as sharing best practices has taken place with many relevant parties in the field of biodiversity informatics. With Nordic partners, especially Artdatabanken in Sweden and Artsdatabanken in Norway, FinBIF has continuous collaboration to further improve the services provided by these biodiversity data infrastructures. New collaboration is on the way with Australia and the Netherlands to learn from

each other's successes. FinBIF is also a national node of GBIF (Global Biodiversity Information Facility) and Luomus[19] is voting national member in its Governing Board.

Achievements

Among its chief outputs, FinBIF has served to co-create advanced infrastructure, one unit for all, one agreement for all, with all relevant institutes working together. Further, a main objective has been to exert a direct impact on the speed of biodiversity loss around the world. Its adherence to producing open data has greatly benefited many scientists at the Finnish facility. When the mosquito-borne disease Zika fever emerged, for instance, the GBIF successfully provided the data required for understanding its spread (see e.g., https://iphylo.blogspot.com/2016/04/the-zika-virus-gbif-and-missing.html).

According to the representatives interviewed, the greatest achievements of FinBIF include:

- involving all relevant public institutions – data support from ministries, data providers, local authorities, and research institutions;
- establishing and maintaining a national checklist of species – a taxonomy backbone, and;
- although FinBIF combines observations from many relevant sources (ca. 41 million. records in 450 datasets), producing integrated data that is widely recognised as highly reliable.

Key challenges

The biggest challenge during the establishment phase had to do with change of culture, mindset, and way of thinking. The persistent ideology of believing in the high monetary value and societal power of owning data has been gradually diluted with more understanding of the immerse value of open data and science. Now more and more data providers are willing to contribute to the common good by providing their biodiversity data with open access licensing (e.g., Creative Commons 4.0 BY). That has been the goal of FinBIF from the very beginning.

The second challenge is that FinBIF must prioritize. Even though funding has been obtained resources are still scarce. FinBIF therefore cannot fulfil the needs of every possible end user.

Relevance for URBiNAT cities

URBiNAT cities are all developing Urban Greening plans where they need to consider their stance on biodiversity. There is pressure on cities from nature conservation associations and citizen groups to do more for biodiversity in the city. To support the best possible discussions and decisions and development of greening plans to optimize biodiversity with the resources at hand, cities and stakeholders alike need good quality data.

FinBIF equivalents exist in all countries incl. France, Portugal, Denmark, Italy, Belgium. Bulgaria and Slovenia. They may not all be as well designed and all-encompassing as FinBIF, but with constructive input from cities they can improve and deliver the data needed over time to improve biodiversity in European cities.

With city specific projects that engage citizens in collecting biodiversity data, city administrators and communities of interest can improve data collected and provide the basis for the development of very targeted urban greening strategies.

[19] The Finnish Museum of Natural History is an independent research institution functioning under the University of Helsinki (https://www.luomus.fi/en).

7.2 Stimulating responses

In previous work, URBiNAT applied Superbarrio, a tablet-based game, in the co-design of NBS, resulting in valuable observations and insights. While, from the outset, Superbarrio included both digital and non-digital elements, due to the onset of the pandemic and its associated limitations on social gatherings, the approach was adjusted to allow operating with almost total reliance on digital execution. With digital enablers still applicable where physical meetings face severe constraints, their importance for realising quality processing and outcomes of co-selection has gained traction.

In the game application of Superbarrio, 3D objects serve as focal points for content development. Users can think about, for instance, how many trees may be planted in a given space, pedestrian passages be arranged, parks be devised. or what can be achieved by the installation of lights when adding benches in a particular location. Superbarrio goes beyond the mere application of a digital tool to present citizens with user-friendly methods as well as inspiring content.

In effect, Superbarrio facilitates the integration of communication, motivation, selection, and design functions. Thus far tested and explored in Nantes, we have learned that Superbarrio provides citizens with a potent instrument to observe, measure and compare (score) the anticipated benefits of each NBS, as well as contemplate how they may be leveraged through specific design. This helps structure citizens' perceptions and suggestions from early on, in support of effective monitoring and evaluation later on.

In short, Superbarrio demonstrates that specific methods can be applied and leveraged in the co-design phase with the help of digital enablers for the purpose of communicating with and collecting inputs from diverse sets of citizens. This offers support for better framing of NBS and Healthy Corridors in sync with local needs. Other examples to this effect include Delphi method (Linstone and Turoff, 2002) and Triz method (Altshuller, 1984), focusing on co-identifying proposals, arguments and solutions consensus through open peer validation, prioritizing and feedback. Depending on the local situation, their integration and use can be managed through, for instance, apps, websites, SMS-based services, blogs, interactive boards, or polls.

Beyond the lessons of previous studies and past work, our next consideration in this chapter has to do with the mechanisms for stimulating user responses, i.e., how to devise effective incentives. In the applications under way, we partly draw on the methodology of LearnforLife (LfL), a participatory NBS in URBiNAT's NBS catalogue. LfL is a methodology that frames rewards to incentivise individuals, weighing in the features of target audiences in relation to desired outcomes (Andersson and Björner, 2018). Efficient reward design resonates with local culture, e.g., when it comes to the desirability of visibility and recognition.[20] The following exemplify elements with high potential for underpinning strong impacts:

1. Rewards - individuals are motivated by specific incentives that are tailored for each target audience to personalise the experience. Digitally, this can be translated into points collection, digital currency, visual recognition and praise, time bank or other types of visual elements.
2. Step-by-step approach - devised for each target audience in order to neither "overwhelm" nor "starve" the user on content; instead, content is fed in a gradual step-by-step manner that

[20] In this, we partly build on the methodology inherent in the participatory NBS- LearnforLife (LfL), devised specifically to propel digital enablers. LfL offers a systematic approach to inspiring progressive learning as a basis for behavioural change, utilising five distinct key functions (Andersson, 2018).

enables learning/behavioural change at an individually adjusted pace. In a digital enabler, this could be mirrored by visualising every change/progress accomplished, enabling speedy feedback loops and countering fatigue.

3. Timely managed content and rewards to achieve effective incentive schemes. AI and machine learning can be deployed effectively to ensure highly receptive systems, establishing a strong link between actions followed by optimized reward structures.
4. Social interaction with peers and community - a debriefing function increases the manifestation of the learning and the behavioural change. This can be applied effectively in online communication, whereby one or several individuals can share results and private information with ease in a safe space.
5. Co-opetition – blending competition and collaboration can help strengthening community engagement by creating a sensation of group identity and group dynamics, which may fuel inspiration also among those that might appear the least receptive at the start.
6. Peer-to-peer review can be devised in support of social bonding and community values, performed by real-time participatory sensing using not just smartphones, but also simpler mobile phones equipped with appropriate apps which increasingly are attainable for most people at low cost.
7. Co-creation of digital enablers, although carrying costs, offers specific opportunities, especially in regard to target groups such as youth in deprived areas. Novel digital applications, e.g., in the shape of 3D visualisations, Augmented and Virtual Reality, present attractive means for differing individuals (including the most tech-savvy) to work with others while immersing themselves in envisaged states of their neighbourhoods, offering a feel for what they could be and look like in the future.

In devising digital enablers suited for achieving desired results through the engagement of citizens, all the building blocks of digital enablers need to be synchronised and adapted to the task at hand. Local diagnostic, e.g., of digital infrastructure and citizens´ access, as well as prioritised issues, expectations, and behaviours, can help stalk out the way forward. The analysis of URBiNAT's experience in this respect, as well as of pursuing digital enables thus far, is still ongoing. Box 1 provides a snapshot of main points that apply for the three digital enablers pursued by URBiNAT, structured in terms of their building blocks, along with a few clarifying observations. Linking also to the two examples of digital enablers reviewed in some depth in the preceding section, the following observations summarises factors that appear to support success:

- In regard to the building blocks of digital enablers, all five cases are clearly framed in support of an overriding purpose directly connected with citizens' participation and NBS.
- All five cases feature methods apply distinct rewards. These are generally staged for structured, gradual progression, e.g., using step-by-step visualisation. In four of the five cases, all except Superbarrio, social interaction is applied as a key method, devised in support of continuous engagement. In Superbarrio, the elements of gaming and competition shape the core engagement process. At the same time, the gaming part feeds demand for continuous maintenance and a constant search for novel features that can be added as a way of maintaining the interest of users.
- In all cases, users contribute importantly to the shaping of content. However, at the same time, content is influenced as well by various organisations, interest groups and experts. In some cases, arrangements are made for the purpose of keeping substance relevant and up to date, while in others the purpose may be more subtle. The combination and balance between the two - user-driven content and stakeholder/expert involvement – plays an important role.

Box 1: Brief on Building Blocks, three applications of Digital Enablers

i) My Edible Neighbourhood:

Brief on Building Blocks preparation:

- Purpose: Make use of existing and future food reserves such as fruits, berries, herbs, vegetables in public spaces which can be harvested by citizens (FIND) , engage in community gardening and participate in urban farming initiatives (GROW), Locate markets/farmers selling affordable and locally produced food (MATCH), User Interactivity by posting of related content (SHARE)

- Methods: Engagement by physical awareness sessions, incentives to share content

- Tools: PGIS, mobile application, website, QR codes

- Content: Information about edible products, community gardens and related markets, benefits of how to use, recipes, shared content

- Target groups: Neighbourhood citizens, networks of community gardening and urban farming, local farmers´ markets

- Key words: Reach, edible, urban farming, nutrition & wellbeing, community activity, zero waste

Inspirational examples: https://mundraub.org/

ii) Circular Cities Café (C3)

Brief on Building Blocks preparation:

- Purpose: Leverage the CoP in the URBiNAT context in a user-friendly and intuitive setting, share best practices, exchange of research, initiate joint projects, inform about events

- Methods: Engagement in a stage-by-stage process – starting from students engaged in the URBiNAT project, and then expanding the community to professionals working in relevant NBS city projects, Nature Based Enterprises (NBEs), NGOs, volunteers and individual citizens who are engaged in NBS project or who would like to become engaged

- Tools: Website, mobile application

- Content: Action research projects with NBS focus, Nature Based Enterprise start-up activities, NBS city projects, NGO activities in the cities linked to NBS, citizen generated NBS projects

- Target groups: Students engaged in URBiNAT projects, researchers, experts, NBEs, NGOs, volunteers, citizens – all with a strong interest in NBS projects including the implementation and results of such projects

- Key words: Co-creation, NBS, research, pilot, scaling, impacts

Inspirational examples: https://www.thirdroom.org/

iii) Superbarrio

Brief on Building Blocks preparation:

- Purpose: Engage citizens in the urban planning process by co-designing their neighbourhood, allowing the citizens take ownership so as to make full use of new NBS implementations

- Methods: Engagement by physical awareness sessions, explaining the digital enabler to the citizens and allow them to try out different features and visually exploring how selections of various NBS changes the neighbourhood features

- Tools: Tablet and 3D visualisation

- Content: Maps of neighbourhood, NBS and other urban design features

- Target Groups: Neighbourhood citizens, urban planners and other potential stakeholders directly involved in the spatial planning process

- Key words: NBS, co-selection, urban regeneration, gaming

Inspirational example: https://www.minecraft.net/

- The prime tools applied centre on managing GIS data, which plays a central role in all the examples under consideration her, except the Circular Cities Café. In that case, strong focus on its substantive themes serves as the point of departure for creating linkages irrespective of the specific location of the communicating subjects.

Again, a rich array of sources may be exploited for accessing complementary data, as a basis for interpreting and understanding user patterns. One such source is mapping the communication of microblogging online using Twitter. Such data offers the means to differentiate between user categories based on, e.g., their location, mobility, user history and habits, patterns of interest, etc. Although Twitter has fewer active users in the study, compared to some other social networks, and may offer less complete user information, Twitter has been successfully applied in previous evaluations of user demand, e.g., of transit services (Collins et al., 2013; Schweitzer, 2014). In the present context, patterns of user sentiment in the study areas, and their links to NBS, are mapped on a continuous basis. This will be attended to in search of evidence for influences on the perceptions and attitudes of various user categories subsequent to various interventions and also the co-creation by citizens of NBS and Healthy Corridors.

7.3 Risks and downsides

While considering the progress under way and opportunities at hand, the presence of caveats, although already flagged in previous chapters, requires further reflection.

Based on observations of existing digital enablers, many self-organised groups and other bottom-up initiatives emanating from citizens rely on mainstream social media channels, such as Facebook, Google or Instagram (Saad-Sulonen and Horelli, 2017). National and local authorities may often explicitly or implicitly support the practice, and also rely on these networks for their own services. This has clearly arisen as mainstream practice in many cities around the world, including several of the URBiNAT cities. Benefits clearly arise from ease of use, accessibility, connectivity, and convenience, given the apparent quality of service and powerful network effects. On the other hand, the gains are compromised by the reliance on vendors that subject citizens to covert misuse of their personal data.

Facebook offers a particularly accessible platform for citizens to interact smoothly with one another. Not always understood, or conveniently forgotten, however, these services are accompanied by hidden costs. Coordinated with numerous other sources of data, all information exchanged through Facebook feeds a continuous, ever-present collection and processing of in-depth information which is subsequently traded for marketing or purposes. The resulting gains are, in effect, let up by the users unknowingly.

The benefits for network providers of such activity keep increasing disproportionately with the number of users. This is as every new user adds to the value that can be extracted from all those already onboard, a classic example of network externalities (Shapiro and Varian, 1999; Schmalensee and Evans, 2007). Among the social networks, Facebook is the main beneficiary of such externalities, reflecting its close association with the innate drive of people to project their actions and qualities to others. Consequently, as shown by Øverby (2018), Facebook's valuation over the past decade grew in direct relation to the number of users, with a stark mark-up. The increase in value emanates from several sources, including enhanced bargaining power vis-à-vis its various clients and counterparts.

Weighing the pros and cons of different strategies is not straightforward. Saad-Sulonen and Horelli (2017) point to "digital artefact ecologies" of self-organised communities that rely on the use of freely available, familiar, mundane technologies like Facebook, Google Drive, Dropbox, and Doodle. By contrast, use of platforms that run on open systems, thereby avoiding dependency on proprietary vendors, require substantive effort, investment, and development work, possibly including support by experts in ICT, at least in the short term. On the other hand, the latter put users in control of their own data and development, leaving them less vulnerable to commercial exploitation and with greater development potential. At the same time, the individual's engagement with social media cannot be separated from society's position (O'Hara et al., 2014). This brings into focus the need of balance, e.g., between surveillance vs. privacy, control vs. empowerment, or big data and open data, in search of an equilibrium capable of striking a balance between the competing interests and values at stake.

Some responses occur naturally, as a result of policy, market forces, or a combination of the two. The expanded reliance on cloud computing that occurred over the past decade was not without security issues. As a result, management of sensitive data has seen a partial return to storage in secure servers. Exchanges over the Internet are increasingly encrypted. PKI provides non-repudiation through digital signatures that, especially when combined with Certificated Authorities and trusted Certificates, support of trusted transmissions. Finally, the general Data Protection Regulation of the EU has brought major advances in the protection of private data.[21] Having said that, much remains when it comes to achieving viable user protection nationally as well as internationally. Technical advances and the rise of new applications need to be accompanied by stronger collaboration on the development of legal and privacy safeguards for users, as well as initiatives on the social economic front, e.g., for apps and text-messaging to be associated with basic requirements for safety and security (Figueroa and Aguilera, 2020).

The importance of these aspects has been clearly demonstrated in application areas of high relevance to the present report. This includes GPS-based tracking data (Weber, 2010; Abosaq, 2019; Elmaghraby and Lovisa, 2014), heath applications (Shao et al., 2015) and social networks

[21] https://gdpr-info.eu/.

(Moustaka et al., 2018). Breaches and documented misuse have increasingly plagued mobile telephony as well. The Pegasus scandal[22], for instance, has recently shattered the common perception that mobile telephony would be safe and free from surveillance or risks of exploitation. Fundamentally, inadequate security and data protection engender malicious activities (Nemitz, 2018), calling for safeguards and countermeasures.

Meanwhile, coordinating communication protocols and standardisation while managing heterogeneity is key for achieving basic interoperability between smart cities (Allam and Jones, 2020). Central data-processing entities are typically required for big data emanating from multiple sources, such as smart sensors, mobile phones or watches. Popularly referred to as "smart brains" orchestrating the ecosystem, with the help of AI, machine-learning enables automated smooth user-interface and service provision. Further, so-called human experience platforms build increased capacity, linked to growing user competencies, convenience, and declining costs (Deloitte, 2020). Fundamental issues pertain to AI governance, however, the resolution of which requires consideration of both efficiency and ethics. The concept of human capability may be pointed to, as a guiding framework. This implies adopting an approach to AI governance that is rooted in human rights, as well as distributed in that it aims for resolution of issues at the level where they can be practically dealt with, while also coordinated in ensuring protection against critical risks such as data misuse and violation of privacy.

Finally, the presence of economic, social, and political issues are partly interrelated. The unfettered ability of a few powerful players to direct and influence the dataspace has resulted in a string of corruption and infotech scandals, which by today have become all but commonplace. Ranging from business-government scandals such as the Cambridge Analytica–Facebook Scandal (Cadwalladr, 2018) to Facebook's Russian along with others (Debatin et al., 2009), the 5-billion fine handed to Alphabet by the EU for monopolistic practices (Cassidy, 2018; Finley, 2017), government mishandling of data indicated by whistle-blowers such as Snowden (Greenwald, 2015) WikiLeaks (Benkler, 2011; Domscheit-Berg, 2011; Roberts, 2012), are powerful signals of the breach of trust well under way between government, business, and citizens (Hawken et al., 2020).

Meanwhile, geographical and social mapping undertaken over the years in the US, UK and European countries, illustrate how populist movements apply big data analytics with skill and precision to thrive on social polarisation (Autor, 2016; Becker et al., 2017; Ginsburgh, 2020). Excluded individuals and communities are particularly prone to falling prey to "fake news" propelled digitally for political purposes, as they are more vulnerable to cybercrime and commercially motivated misuse of data and identity theft (ICO, 2018). The situation is related to the generally growing need of safeguards for protecting privacy, enabling adequate authentication and authorisation of IT systems, the rule of law, and civic rights. Innovations have brought some remedial action, including new forms of "digital counselling", some by the private sector and others by local communities building competencies and promoting measures supporting safety online (Andersson, 2008; Kitchin and Dodge, 2019; Ismagilova, 2020). There is a need of encouraging and rewarding such capacity-building along with digital enablers and market-driven responses in response to the threats of data exploitation for various purposes.

[22] On the Pegasus scandal, see https://www.npr.org/2021/08/25/1027397544/nso-group-pegasus-spyware-mobile-israel

7.4 Competences and governance for urban development

Urban planning and development, along with city governance more generally, inevitably need to meet with a myriad of objectives, the handling of which requires a wide range of competencies. Officials and technocrats encounter vested interests in search of pervasive influence. Considerations of societal and behavioural aspects, on the other hand, may be fuzzy, and lack influential champions. Often, citizens are claimed to be “in the driving seat”, although their opportunities for being heard are relegated to filling in a questionnaire or sitting in as bystanders at irrelevant meetings (Thomas et al., 2016).

Based on interviews in several cities, Filion et al., (2015), observed the presence of struggles between institutionalism, political economy, and path dependency. Proper tools for assessing outcomes in terms of distributional impacts, and whether those most in need are particularly scarce, are mostly lacking (Shipley and Utz, 2012). According to Forester (2006), mediated participation techniques can help redirect conflict into joint inquiry and search of solutions rather than escalate conflicting demands, and thus achieve practical ends aiding diverse interests.

In order to meet with a particular purpose in the urban context, a critical aspect often has to do with the challenge of overcoming conflicts, including by promoting a process capable of leading to some sort of “acceptance”, or “compromise”. The task of linking differing target audiences may require inclusion of groups historically neglected, or left on the side-lines (Holz, 2018). Making this possible is likely to require multi-stakeholder engagement through a process that entails the identification of mutual interests. Achieving a sense of joint ownership, transparency and sharing of information and ideas will be important from early on.

Achieving both upward and downward accountability, while related concepts, carries deep-rooted implications for civic engagement and associated governance reform (URBiNAT, 2020). Successful strategies to build capacity for “transformative change” (Wolfram, 2016) require basing insight on multiple sources, including different scientific disciplines, practitioners and citizens. To overcome the issues, it is of high importance to engage and provide room for diverse competences which, taken together, are capable of mediation. Such aspects cannot feature as an afterthought, or correction of glitches in overriding technical or social frameworks. An adequate effort is warranted from early on, allowing for timely and open-ended consideration of social and behavioural aspects.

Cities and other public sector institutions are mostly reliant on “importing” required competencies without the ability to judge and enact proper balance in perspectives with a view to matching societal issues. For serious processes of public consultation and participation to be set in motion, reliance on imported expertise is insufficient. The organisational culture including broad-based attitudes is crucial. Planners, and not just those immediately involved, need to be involved and integrated in constructive exchanges, while also receiving adequate training.

Healy (1999) argued for the critical importance of creating extended peer communities as a basis for establishing the trust required for coming to grips with, and addressing, complex societal problems. Online communication vastly expands the speed and efficiency with which this can be done although, at the same time, success is likely to hinge on shared leadership arrangements structured for that purpose (Johnson et al., 2015). Adding to that, the functionality needs to be carefully framed, with the objectives to be achieved reflected in how the building blocks of digital enablers are constructed and combined.

Related to the above, we observe that social or mediating support typically helps speed common understanding by conflicting parties, facilitating for them to overcome discrepancies and negotiate balanced outcomes. In Motivational Interviewing (MI), an NBS incorporated in URBiNAT's catalogue, trained professionals essentially assume a role as peers inducing insight and mindset that can help bring about long-term adjustment in behaviours. In part, success emanates from the ability to instil self-confidence, a sense of "can-do", supported by a process entailing continuity and personal contact. Traditional approaches exert limited reach, however, and do not operate when parties are geographically dispersed. In the health field, however a plethora of digital enablers have arisen to transfer the logic of real-world counselling into virtual space, thereby maintaining the functionality while achieving much greater reach. The results have realised many life-saving changes in behaviours among those suffering from life-threatening illness and yet caught in risky behaviours (Kelders et al., 2012; Stephens and Allen, 2013).

The point is, with the help of digitalised peer support coupled with appropriate incentives, a myopic and destructive mindset may be shifted among large numbers of people to caring for well-being in the long term accompanied by commitment environmental protection and sustainability. The Bella Mossa programme in Bologna, for instance, is a digital enabler pioneering awareness creation and rewards as a means to incentivise changes in behaviour in support of fewer cars with single occupancy and reduced CO_2 emissions (URBiNAT, 2021). Effective reward design needs to reflect culturally imprinted sensitivities, however, influencing what carries most weight in instilling recognition and motivation. Exactly what achieves desired results must therefore be tested. Based on experimentation, however, fine-tuning of rewards in relation to particular goals can be adjusted along the way. An example of such practice is the LearnforLife methodology, which aims to maximize impact using minimal intervention as optimised through a reiterative process of experimentation and fine-tuning in real time (Andersson and Björner, 2018).

The advance of digital enablers in support of participatory processes linked to NBS and Healthy Corridors represents, in a sense, a relatively uncontroversial playground for bringing about horizontally coordinated competence development and capacity building to back up meaningful public consultation. In effect, it serves as well as a countermeasure and mitigation against the remaining bias in the smart city agenda. This is particularly as it is shaping up as a focused effort of bringing digitalisation to bear on where it matters most, in support of people, and reformed governance.

Yet, a conscientious effort is needed to operationalise this agenda. URBiNAT's strong focus on deprived areas and disadvantaged groups means that priority is placed on building the capacity to make a difference where it matters the most.

Active experimentation is required, along with the ability to incorporate lessons of past best practice. This should include lessons for the framing of the various building blocks that need to be devised in sync with one another, to underpin the functionality and impacts that are in demand. Presenting and taking into account of selected case studies from elsewhere, as well as URBiNAT's own experience, this chapter has confirmed the common focus on a clearly-crafted purpose of promoting participation in the processes surrounding NBS. The methods applied make extensive use of rewards, while trying to advance participation through a process of step-by-step advancement. For content, co-creation by citizens has clearly created distinct value, although experts play a significant role too - and the appropriate balance between the two cannot be determined in any general sense. Regarding the tools, finally, much attention focuses on GIS. The suitable role of tools for online communication may be that of a complement, rather than replacement, of traditional physical approaches for supporting participation.

8. Guidelines for Digital Enablers of Co-creation

The present report has considered different ways in which digital enablers can be used to strengthen participatory practices aimed at unlocking the potential of Nature-Based Solutions and, in the particular case of URBiNAT, to co-creating fully integrated and viable Healthy Corridors. In this chapter we lay out a set of guidelines regarding the co-creation of digital enablers for this purpose.

These Guidelines are intended for use by diverse actors, including city administrators, urban planners, NBS-related business developers, civil society organisations, researchers, citizens and other stakeholders. They are intended to be practical and actionable, and to continue to evolve over the course of the project. They have been developed in line with with URBiNAT's Communication and Dissemination Plan (V2, Nov. 2020)[23] notably with regards to monitoring, data management, and the production of materials in a language, style and format that is suitable for any targeted audience profile.

A complementary objective is to provide stakeholders involved in the co-creation of Healthy Corridors with greater awareness of the potential benefits of appropriate digital technologies and services (while recognising and learning to avoid risks). In this, the Guidelines are based on the experience and lessons of the activities laid out in the present report. These partly draw on the selection, deployment, and monitoring of digital "enablers" pursued by URBiNAT Frontrunner and Follower cities to date, in search of social, environmental and economic benefits. Where possible they also take into account the wider European and global experience of what works and what does not work in these realms of activity.

Part of the guidelines address the building blocks of digital enablers, i.e., how to combine purpose, methodology, content and technology, for supporting the co-creation of NBS and Healthy Corridors in a particular context. They also consist of a set of actions that can be taken at local, city or regional levels to compensate for, or address, weaknesses of existing institutions, infrastructure, and service. In order to enact the potential benefits, governance frameworks must build and entail the capacity to encompass participatory processes, including where beneficial through the support of digital enablers.

For the actors involved in the co-creation of Healthy Corridors for their city, the guidelines call for attention to the following questions:

- Which digital technologies suitable for protecting, realising or achieving the benefits of local environmental assets or ecological services are **already** available and/or in use in your neighbourhood, city or broader administrative region?
- Does your city provide a proper enabling environment, including investment and training, for the development and deployment of digital enablers in support of co-creating NBS?
- Is the private sector fully mobilised, through fiscal, regulatory, or other incentives, to support research and innovation for new digital technologies?
- What role can civil society play to promote the uptake of digital technologies that are consistent with local sustainable development plans?

[23] URBiNAT Communication and Dissemination Plan (Nov. 2020): https://public.3.basecamp.com/p/Yzf8VaQV2hpzgZRvkBWEdnMC

In the following, we present categories of guidelines with a view to their varying roles, across the different stages of co-creation of Healthy Corridors, as well as with regard to different actors and functions.

8.1 Guidelines for co-creation with all involved

The Guidelines are applicable across the key stages of co-creation, from that of co-assessment to co-implementation, and co-monitoring. Each phase corresponds to specific stakeholder groups or target audiences:

Baseline assessment. To determine the readiness of a city to promote the widespread development and use of digital enablers to bolster the impact of NBS.

Co-development and co-selection guidelines. To build required capacity in governance, identify key local actors, including digital hubs, developers, open data experts, urban planners, environmentalists, citizens' groups etc., and the opportunities for coordination and co-creation.

I**mplementation and monitoring guidelines.** Practical recommendations regarding the deployment and ethical use of digital enablers linked to the implementation of NBS.

8.1.1 Local Diagnostic (baseline assessment)

The selection and use of Digital enablers in conjunction with NBS must be based on a broad understanding of the main features, as well as the user-profiles of residents in intervention areas. A key tenet for the successful implementation of digital enablers has to do with existing digital infrastructures in the area, encompassing availability of affordable networks, access to specific tools, and the readiness by citizens to use those tools (digital culture).

Local Diagnostic, or baseline assessment, is an essential starting point for any process aimed at evaluating the viability of co-creation, and also digital enablers, throughout the NBS cycle. Decisionmakers and stakeholders should be informed and exposed from the start of relevant aspects to the local context – including actor roles, cultural factors, infrastructure, and aspects of the social fabric and inclusion which are likely to influence the desirability and effectiveness of digital enablers. Particular aspects pertain to the sustainable use of local environmental resources and services. Such assessments should not be carried out solely from inside, capable contributions by independent experts or research institutes are highly recommendable.

A local diagnostic of intervention areas should cover the following:

- The status of digital infrastructure, broadly referring to Internet access, including speed and affordability, typically the availability of broadband (fixed or wireless), 4G and/or 5G networks;
- The rate of penetration by digital tools along with the usage of various networks. Examples of the former include smartphones/mobiles/laptops/tablets, etc. The latter may feature social media channels serviced by vendors such as Facebook and Twitter. Measurement may apply per household/per capita, or to particular kinds of users;
- Digital literacy level of specific groups of citizens, measured indirectly through digital tools penetration or as user patterns. Local diagnostics collecting socio-economic data and also mapping attitudes and behaviours are also important for establishing appropriate benchmarks and ensuring relevance;

- Relations between communities in URBiNAT neighbourhoods and other parts of the cities, including actual relations and communications, as well as perceptions and attitudes with implications for actual behaviours, such as openings for enjoying common public space or responding to joint projects.

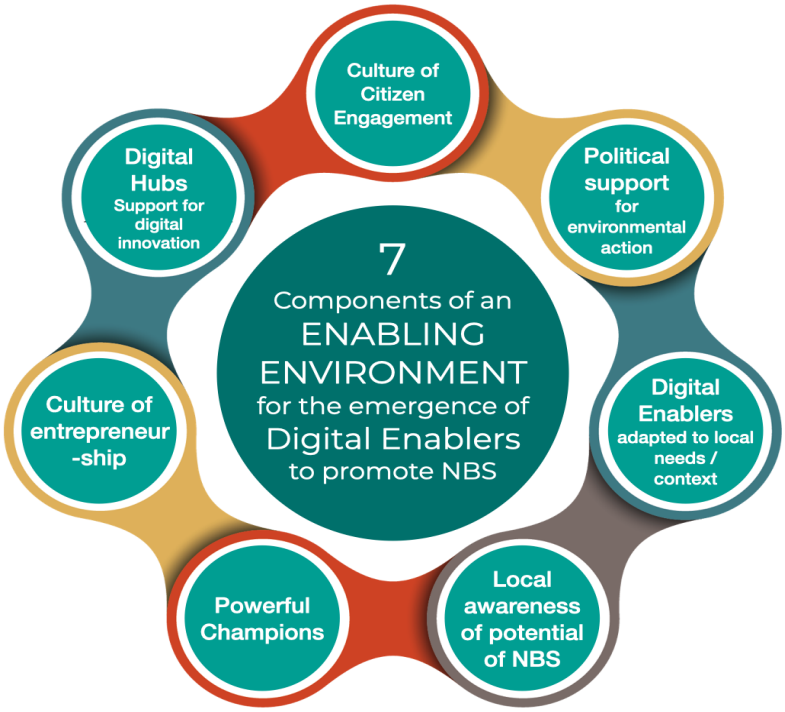
Local Diagnostics need not necessarily aim at an exhaustive review of the local ecosystem, or of the full range of digital economy actors. However, awareness of key actors, and their actual roles, is essential. A listing of the actors and description of main roles may comprise information along the following lines:

- Educational and research institutions, dedicated to training and R&D of relevance for digitalisation;
- The pattern of linkages between education, training and research, on the one hand, and industry and society on the other hand, taking note of sectoral variations;
- Digital hubs and start-up accelerators dedicated to digital innovations, coupled with their degree of access to competency and diverse sources of capital;
- Status of intellectual property rights and management of intangible assets relevant to digitalisation;
- Events, conferences, etc. examining the development and use of digital solutions;
- Local digital/Internet service providers;
- Private sector investors and business angels;
- Public sector facilitators and regulators;
- Open Data service providers;
- Role and effectiveness of public procurement;
- Nature of public-private partnership, or at least dialogue and ability to pull together in addressing main issues;
- Citizens groups and community organisers using social media and other locally relevant digital services to communicate with citizens;
- The status of local environmental and ecological services supply and demand;
- Measurement of health status including its distribution in the population and geographically, and finally
- Soft measures and indications of user perceptions and attitudes on terms that can subsequently be followed up on to arrive at soft indications of impacts on well-being.

A mapping may be framed of the local ecosystem for digital enablers. The example offered by Figure 11 goes beyond what can normally be achieved in the local diagnostic carried out in a specific case, since data with the required level of detail will hardly be achievable within a reasonable budget envelope. In the case of multi-city collaboration, as in URBiNAT, favourable synergies expand the limits for what can be achieved. Some dimensions, such as mechanisms that enable citizens to transmit their perceptions and preferences, can be effectively managed by applying appropriate methods, including joint questionnaires as worked out and tested during the course of this work. Parallel mapping and comparable analysis can thus help characterise relative strengths and weaknesses, resulting in an improved understanding of needs and opportunities. It can also help guide the extent to which experience from other cities is transferable, and/or what adaptation is required.

Another important consideration has to do with the distribution of costs and benefits. How they associate with various scenarios, their profile over time and also likely distribution between interests/actors. This is of essential for informing about feasibility as well as the need for investments and on what terms. Such aspects go beyond the local diagnostic in a narrow sense but features as an essential part of Urban Planning. This underlines the importance of the broader

Figure 11: Components framing conditions for digital enablers



Source: ITEMS, 2021

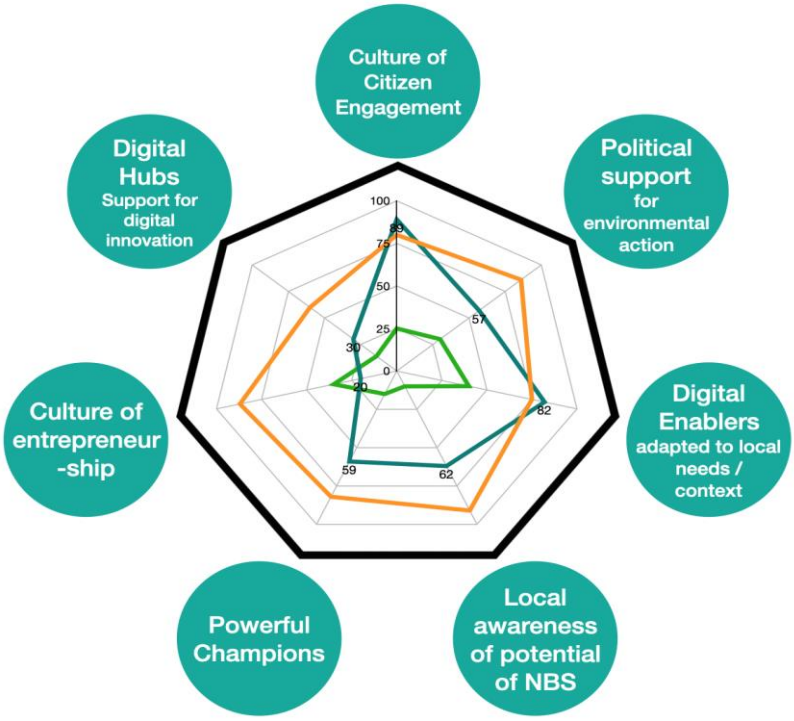
adequately integrated information package and decision basis to guide the application of digital enablers as an integral part of the urban development plan.

As a common feature, digital economy actors and environmental or ecological service providers are typically weakly related, with few vibrant and value-enhancing links between them. Yet the creation of regular and sustained links, and the sharing of objectives between these two spheres, is important for achieving sustainability, i.e., the leveraging of combined, economic, environmental, and social as well as entrepreneurial aspirations and processes.

With digital enablers underpinning co-creation, responding to and achieving relevance for citizens is a prime factor. A traditional local diagnostic will only touch lightly on what is relevant here. In the present report, we have detailed the use of a questionnaire earmarked for mapping and relating to what is key for citizens themselves (see Appendix 1 and 2). Gaining an understanding of how factual conditions, e.g., regarding infrastructure and tools, interact with attitudes, perceptions, and behaviours, go further, however.

Figure 12 shows a stylised radar chart with results regarding the enabling environment for digital enablers from 3 cities (orange, blue, green). In this representation the Orange city has the highest potential, followed by the blue followed by the green. In each case priority investment or training areas are easily visualised, making it easier for decision makers to balance decisions about the allocation of resources.

Figure 12: Stylised map of local ecosystem of digital enablers



Source: ITEMS, 2021

The results of local diagnostic coupled with information and material forming an integrated decision basis may be presented in the form of a radar chart, as shown above, offering a potentially provocative visual representation of cities' strengths and weaknesses when it comes to activating digital enablers for co-creation, and areas where investment, training, actions, or reforms are needed.

Again, it may be over-ambitious to aim for a complete analysis and illustration in this regard. On the other hand, weaknesses, strengths, and priority tasks need to be framed based on a systemic, holistic view. For larger project agendas, including several cities and laid out for implementation and a series of initiatives and investments lasing over several - perhaps many – years, proceeding with such framing if of high importance for the purpose of enabling real results, succeed with participation, and achieve sustainability.

8.1.2 Guidelines for co-selection and co-development of digital enablers

Co-development and co-selection guidelines focus on how to enhance existing opportunities for the emergence of financially self-sustaining digital enablers in connection with NBS, and the creation of new ones.

The URBiNAT experience has shown that many European cities, even those with less developed digital economy sectors, have the conditions in place for the creation of new digital services linked to NBS. However, they may not be recognised as such. The possibilities for seizing investment opportunities and developing new digital services through closer interaction between citizens and digital service entrepreneurs, e.g., through the organisation of events and co-planning exercises,

are not known. Or they are not created. Or else there are missed opportunities to leverage local resources and entrepreneurial spirit.

URBiNAT guidelines highlight how to create new opportunities, notably through:

- The organisation of hackathons involving developers, NBS providers, community organisers, and local citizens.
- The setting up of NBS training modules within the context of implementing digital enablers.

8.1.3 Guidelines regarding digital enablers in NBS design processes

As part of URBiNAT implementations in Frontrunner and Follower cities different types of digital enabler have been used as part of co-design processes. In such cases the question put to participants is: how can digital enablers be used in NBS design processes to enhance functional aspects and increase the number and quality of ecosystem services provided? Examples demonstrate several possibilities, for instance to simulate the system performances of NBS. Simulation tools and parametric design software, for instance, open for the possibility to develop passive environments optimised to support living organisms, simulating the system performances during the design phase, while digital fabrication allows for the production of non-standardised design systems specifically tailored for local needs.

The shift from analogue towards digital does not only happen in the design stage, but also in the manufacturing and fabrication stages. Milling, cutting, bending, and drilling are now processes that are directly driven by a computer code.

8.1.4 Guidelines for monitoring and evaluation

Finally, digital enablers offer huge potential for monitoring and evaluation, notably through the application of smart sensors and IoT to create benchmarks prior to policy and programme interventions that can subsequently be built upon to assess impacts over time. Examples are the number of persons passing (through) a particular place (at a particular time), using a particular service, adjusting various kinds of behaviours, or shifts in attitudes and sentiments signalling states of mindset and well-being.

8.2 Principles and practical measures

These guidelines represent an effort to formulate a set of sound principles and practical measures for preparing for and implementing digital enablers in the context of the co-creation of a Healthy Corridor. They span several dimensions, including:

- Consideration of governance frameworks and their transformation.
- Special actor categories that should be taken into consideration.
- Ethics, such as respecting citizens' integrity, privacy, security, counter exclusion based on, e.g., gender, age, or skin colour.
- Collecting data that is relevant, including from citizens directly, seriousness about local diagnostics.
- Attention to "communication and interactivity".
- Relating to complexity and covering synergies.

In the following, we note additional elements under the key categories, set to form part of the guidelines:

8.2.1 Actor roles

Where applicable, the following actors/roles need to be specified:

- **Reformers** play an essential role for governance frameworks to evolve in support of enhanced competencies and organisational frameworks to encompass co-creation and effective citizen participation. Linked to this, the ability to work across traditionally impeding turf lines is of high importance for building the capacity to apply digital enablers, based on a holistic approach as well as with the operational capacity to, prepare and frame the building blocks for most favourable results.
- **Gatekeepers** are needed for ensuring coverage, along with monitoring and validation, of those challenges that are deemed most demanding in the particular case. They may be responsible for ensuring that content is continuously updated and relevant and flag the content that may have become obsolete. The latter is not least important in the case of user-generated content. Although Artificial Intelligence (AI) can do part of the job better than any human, people still play their distinct part, including when it comes to explaining and harnessing respect for the gatekeeping role that needs to be put in place.
- **Technicians and professionals** specialised in digitalisation remain of high importance. Cities and other public sector institutions are mostly reliant on "importing" required competencies without the ability to judge and enact a proper balance in perspectives with a view to matching societal issues.
- **Stakeholder groups** tend to be diverse and play varying roles. Yet, their actual involvement may be key to bringing hidden conflicts into the open and garnering broad-based and long-lasting support for a particular set of NBS and their manifestation in Healthy Corridors and changed city functions.

8.2.2 Ethical Considerations

Ethical principles, in line with URBiNAT's prerequisites, go back to human agency, i.e., human rights and the ability for all people to make choices and have a say. They span from the stages of research, framing preparations, and enacting co-creation to implementation. Legal requirements, as enacted by the European Union and/or individual countries, naturally help shape the foundations. Ethical principles go further, however, venturing into the codes of conduct permeated by culture and social relations. The threats of data misuse, violation of privacy and the integrity of users, with particularly dire consequences for vulnerable groups, need to be fully taken into account in any initiative on the ground. Beyond this, the emerging risks of big data, IoT, and AI, for which orderly governance frameworks are currently lacking, must be foreboded and taken into account in forward-looking analysis and programme plans.

Two URBiNAT documents will be used to guide the development and activities involved of digital enablers in URBiNAT:

1) URBiNAT's *Code of Ethics and Conduct*, which consists of a set of general ethical principles and procedures to be adopted and endorsed by all those involved in the project's activities, and also under perview of the Ethics Commission.
2) URBiNAT's *Code of Ethics for Communication and Dissemination*, included in its Communication and Dissemination Plan (D6.1), to which all partners in the URBiNAT project are requested to adhere.

8.2.3 Data management

Large amounts of Data are generated through digital enablers. Irrespective of the precise nature of the data, open data and open source are preferable, partly in order to steer away from the issues associated with proprietary vendors. Preserving the integrity of users, privacy and protection against data misuse attain highest priority.

8.2.4 Study areas and targeting

In deprived urban areas, digital app use cases may differ dramatically from what is observed at the level of the city as a whole. This includes, for example, the status of digital infrastructure, the penetration rate of digital tools, and the level of digital literacy among targeted groups. Issues on the ground will be different, e.g., with regard to jobs, incomes, interests, security, social relations. Culture and mindset matter greatly, for example when it comes to shaping attitudes and behaviours, affecting individuals, groups and organisations. Traits within targeted categories of citizens influence the means for communication and trust-building, while concurrently bearing on professions, gender, age, civil status, ethnicity, interests, digital skills, competencies, and so forth.

8.2.5 Relevance - interactivity flow?

Another basic element for shaping digital enablers with the potential to be taken up by citizens has to do with the co-creation process, i.e., to what extent do citizens and relevant stakeholders collaborate and engage constructively? This includes characterising and framing the issue at hand; identifying needs, challenges, strengths, shared interests and/or dreams; and how to make a difference using digital enablers through effective targeting, outreach, training etc.

Take account of genuine interests by citizens, where they have commonalities, or deviate. Additionally, there is the question how their interests reflect on actual conditions on the ground, such as cars getting parked all over a green area, excessive waste, lack of citizens taking responsibility, and so forth. Attitudes of such sort in effect represent “soft” influences with hugely important implications for what will eventually represent success in urban plans.

8.2.6 Framing the building blocks

The framing of digital enablers requires a broad spectrum of competences. This includes taking full advantage of the building blocks (purpose, methods, content, tools), and the synergies between them.

A successful approach much hinges on involving citizens and stakeholders from the start, in consideration of and in order to identify the underlying purpose, or objective, to be achieved. Methods, such as competitions, games, rewards, and surveys, may be applied to initiate active participation and supporting sustainable engagement.

Content critically helps to fine-tune mechanisms of targeting and accomplishing relevance for diverse groups, including in marginalised and underserved communities. This may be fixed by addressing and making arrangements for differences in language, working with symbols, visuals, and bringing to the forefront mechanisms for social bonding that reside in culture.

Digital tools applied should offer ease-of-use and benefit from the familiarity of special target groups.

8.2.7 For use of mobiles specifically

For reaching citizens, given the dominance of smartphones rather than PCs for Internet access among vulnerable groups, m-participation is typically most effective (Pearce and Rice, 2013). Strategies for inclusion and empowerment may include:

i) Expanding usage – encouraging users to learn how to use mobile phones for "serious" participation, going beyond "entertainment".
ii) Situated engagement – making use of the ubiquity and portability of phones to reflect "on-site".
iii) Utilising sensor data – collecting and analysing geo-referenced data captured by the phone's sensors.
iv) Prioritising means for UGC, including for niche groups.
v) For non-tech savvy groups, such as the elderly, promote hybrid approaches including inter-generational learning with reverse mentoring.

8.2.8 Plan for complete programme cycles

We outline the way forward in the application of digital enablers. Moving to the next step, the ability & foresight should be put in place from the outset, to enable planning for all stages, including:

i) Initial awareness campaigns
ii) Selection and design
iii) Roll out & Communication strategy
iv) Debugging & Fine-tuning
v) Sustaining the impact - Users´ uptake and feedback

Similar to the importance of considering and embracing the potential contributions of co-creation throughout the NBS cycle, the competencies and organisational requirements for taking account of and executing value-enhancing digital enablers need to be established and built upon from the start.

8.2.9 Addressing complexity and capturing synergies

In practice, central issues and obstacles are likely to combine in ways that are unique to each set-up, making it critical how to match/leverage plans with a combination of needs, from enhancing mobility, to increasing the quality of public spaces, to creating new channels of communication, or galvanizing citizens to take their own initiatives to address issues themselves. Context, culture, the diversity of attributes, and stakeholder relations, matters greatly for how to approach such complexity and leverage synergies.

Consideration should be given to the scope for complementarity while countering contradictions and potential conflicts. Some impacts are mutually strengthening, as in the case of building interactivity and linking, or in the way of creating trust. Exerting sustainable impacts and achieving transitional governance, for instance, are mutually reinforcing, while inclusion for all and targeting may be accomplished along separate tracks. What works by way of initial inspiration is typically different from enacting long-term behavioural change.

8.2.10 Incentivising – social fabric

Using a methodology that can be tailored to fostering incentive-effects in the light of user attributes, and the particular objectives to be achieved. Individual and group levels need to be viewed as complementary. Group level to take account of the wider social context, high priority on inclusion, overcoming fragmentation.

8.2.11 Risk assessment and countermeasures

Finally, where downsides and risks are present, for example, services which run the risk of reinforcing the stigmatisation of a specific area (e.g., App mapping unsafe or risky areas), data misuse, or of over-use and fatigue, "risk assessment and mitigation measures" attain high importance.

9. Conclusions and Key Take-Aways

Digitalisation is one of those manifestations of modern society that attract the most interest and attention from many sides. Despite the promise of great benefits for multiple actors, the literature and recording of empirical findings appear full of paradoxes. Here is a phenomenon that is seen to drive the economy, transform business, upend people's work and private lives, carrying vast implications for virtually all societal domains. Yet, the potential benefits and actual outcomes of all this appear obscure, ambiguous, and leaving many unfulfilled promises behind.

The first part of the present report outlined the context of digitalisation more broadly, as well as the issues addressed in URBiNAT. In focus have been the potential benefits of digital enablers in support of urban regeneration, notably in the shape of co-creation of NBS and Healthy Corridors. Beyond that, however, the objective has been to uncover ways to realise these benefits, while steering free of the potential risks and downsides.

Previously pursued work in URBiNAT has fed into and been further built on in the present report. Revising the local diagnostics undertaken for the study areas of the Frontrunner and Follower cities and its relevance for the present work, the report has underlined the importance of complementary examination of user perceptions and priorities. A questionnaire, launched to help fill the gap, was tested in Siena and generated a set of tentative yet interesting observations. Among them, the results confirmed the strong reliance on mobile telephony, the dominance of use for social purposes although blended use applied as well, a positive attitude to furthering the use of digital enablers, and concerns with mobility among those given highest priority.

Again, at this point, those results can only be viewed as indications and pointers for what requires further examination. How responses differ between user categories will be studied when a larger number of responses are at hand, as will indications of group dynamics.

The report has further reviewed and reflected on a number of potential contributions by digital enablers. Through massively enhanced reach and speed of communication, interactivity and

means of inspiration, digital enablers can be used to achieve radically enhanced levels of targeting, inclusion, flexibility, adaptability and so forth. They can be adapted and fine-tuned in accordance with specific circumstances, local context, and passing through consecutive stages of co-creation. Advantages may emerge through innovation coupled with entrepreneurship and the rise of special business models, and/or social innovation and solidarity economy initiatives.

Another aspect is their ability to establish reference points for benchmarking which can be followed up and measured against effectively. The appropriate application of smart sensors and IoT, for instance, opens for monitoring and evaluation of policy and programme interventions through the NBS cycle, taking account of environmental conditions, social indicators, well-being, and sustainability.

Here, again, the focus is placed on digital enablers in support of participation, with reference to NBS and Healthy Corridors. This is an essential context for coming to grips with fundamental challenges confronting the urban environment and how it is governed. As pointed out by various observers, however, participation is not always constructive and may come with a cost, requiring time and effort. Digital enablers are also not necessarily preferable to traditional approaches to participation, and their use may be complementary rather than serve as a substitute. At the end of the day, the proper application hinges on governance and capacity as well as process and methods.

Strong emphasis is placed on careful calibration of the way digital enablers are structured and adapted to match conditions on the ground. This calls for taking account of variation in the attributes of citizens, of the issues they are confronted with, as well as of the role played by confounding factors. Particular attention is paid to disadvantaged groups, the issues and challenges invoked by the digital divide, and also the downsides and risks which are more or less inherent to the application of digital tools.

While the direct costs associated with smart platforms, technologies, and network charges have typically become less salient. Indirect, hidden costs are inflicted by misuse and exploitation of personal data. The progression of IoT, data-driven diagnostics, and AI is inevitably associated with doubts regarding security, privacy, ethics, and accountability.

Digitalisation and the evolution of governance frameworks are importantly interlinked. Some refer to digitalisation as framing a “watchdog” role for citizens. The report has reflected on reform processes leading towards reflexive governance, capable of putting in place the capacity to encompass participatory processes, including - where beneficial - through the support of digital enablers. The building blocks of digital enablers - characterised as purposes, methods, content, and tools - their various contributions and openings for how they can be combined, offer a range of possibilities. Particular digital tools, such as social media, and interactive smartphones have been discussed in some detail, notably linked to inclusion. Overcoming the limitations of fixed broadband, for instance, the expansion of cellular technology has brought dramatically improved access in areas with previously weak connectivity (URBiNAT, 2021). Further, novel approaches open up for bottom-up initiatives by otherwise marginalised citizens. Innovative apps or strands of content may be co-created by citizens, with the potential to instil value-enhancing social innovation as well as provide support to start-ups and sustainable business development.

Following the portfolio approach to digital enablers (URBiNAT, 2021), the report has ventured into the process for identifying specific applications. In this, strong consideration has been taken to the interests of citizens in the study areas of the URBiNAT cities, how to link the cities in enhanced

sharing of experience and joint learning, and the scope for demonstrating mechanisms of wider relevance. Meanwhile, nascent CoIs can be leveraged by digital enablers, either through the strengthening of existing assets, or by addressing outstanding needs.

Against this backdrop, two fields have been selected for the application of digital enablers as part of this work, each of which with a specific digital enabler defined and worked out: i) community building on locally produced food linked to increased availability and quality, with “My Edible Neighbourhood”, and; ii) a participatory platform for exchange of experience, ideas and proposals related to NBS, with Circular Cities Café (C3). In advancing the preparations and initialisation, suitable to addressing the issues in each field, various options for design and functionality were considered along the way. In the end, For My Edible Neighbourhood, PGIS and the associated development of a smartphone application (MyEN) attain a key role. For C3, the set-up is currently hosted on URBiNAT’s webpage, in due time to be migrated to a separate platform using software more specialised to growing a vibrant online forum around the leveraged CoI.

Going forward, the subject of digital enablers will continue to be advanced through a gradually upgraded interface and collaboration with the URBiNAT cities around their parallel implementation backing co-creation related to NBS. In addition to the Frontrunner cities of Nantes, Sofia, and Porto, substantive progress has been achieved in several of the Follower cities, notably Brussels and Siena.

Drawing on these various tracks, the report has further set out to present initial guidelines for the advance of digital enablers. Intended as practical and operational, these guidelines invite actions at local, city or regional levels which in part aim to compensate for, or address, the weaknesses of existing institutions, infrastructure, and service. To enact the potential benefits at hand, governance frameworks nevertheless need to respond and evolve in tandem.

Some of the key take-aways of the report may be summed up as follows:

- Governance frameworks are challenged to grow the capacity to embrace co-creation, manage a holistic approach, undo territorial silos, and put in place operational capacity for digital enablers, spanning from preparations to framing their building blocks, executing and evaluating impacts.
- The application of digital enablers should be informed by solid local diagnostic, involving key parties and citizens engaged from early on.
- Adequate representation of citizens’ perspectives should be ensured, by the adoption of techniques capable of reflecting their relevant interests, perceptions, and attitudes.
- Strengths-based and/or needs-based CoIs can be leveraged by digital enablers, and more effectively linked.
- The adoption of digital enablers requires competency, ability to judge options at hand, identify cases in which the benefits are particularly likely to dominate, and the skills to devise and apply them.
- Co-creation importantly needs to be considered with a view to its contribution throughout the NBS cycle.
- Digital enablers can be targeted and tailored effectively, including for generating awareness along with behavioural responses, entailing a spectrum of diverse citizens and stakeholders.
- Digital enablers are uniquely placed to support urban regeneration through Inclusion, by engaging target groups in deprived areas, and overcoming fragmentation and polarisation in cities through NBS and Healthy Corridors.

- Realising the value-added of granting inclusion of otherwise marginalised voices, and/or those stuck on the defensive will benefit from innovative approaches. The same applies to balancing - or overcoming - the influence of “insiders” or vested interests.
- Cities that rely solely on proprietary vendors and commercial social media channels as the vehicle for interactive community engagement risk losing the opportunity to craft solutions for and by citizens in regard to sound and effective participation.
- The potential advantages of open source and open data, coupled with short term costs and barriers, motivate initiatives to support the co-creation of such platforms by citizens.
- Geographical Information Systems (GIS), which enable analysis and mapping of spatial and geographical data using digital tools (Craig et al., 2002), can be effectively mobilised for participatory approaches. Experience demonstrates the potential for such PGIS to strengthen communities, build capacity, and unite stakeholders around common goals.
- Where suitable, applications should be extended to offer support for citizen participation in decision-making (PPGIS).

Beyond the above, further work and experimentation are required to nail down the best way for digital enablers to make use of their superior reach and functionality to underpin social interactions and synergy between diverse knowledge exchanges, occurring “anywhere, anytime”. In this, the scope for realising constructive collaboration, moving beyond a narrow “what is in it for me” perspective to include “what is in it for us”, is anticipated to be of high relevance ahead. This and other key aspects will be followed up on in the continued work on guidelines, initiated in this report. That strand of activity is set to progress in parallel with the continued implementation of the two selected digital enablers - My Edible Neighbourhood and Circular Cities Café - in URBiNAT cities. Updates and results of the implementation processes will feed into the final conclusions and recommendations of the project.

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Appendix 1: Questionnaire for Complementary Local Diagnostic

Questionnaire for Citizens in preparation for Implementation of Digital Enablers supporting NBS, participation and the Healthy Corridor concept

⊕ PAGE TITLE

Kindly answer the questions by selection the relevant response or provide your answer in writing where applicable

1. What type of digital tool(s) (i.e., devices which are connected to the internet) are you using on a daily basis? 0

- ◯ a) Mobile phone
- ◯ b) Laptop
- ◯ c) Tablet
- ◯ Other (please specify)
- ◯ None of the above

2. If you have responded any of a) to d) above, kindly respond to this question:. Which device are you using most frequently? 0

3. How do you access internet? 0

- ◯ a) By mobile internet subscription
- ◯ b) By home internet subscription
- ◯ c) By my workplace/school internet subscription
- ◯ Other (please specify)
- ◯ None of the above

4. If you answered any of the alternatives a)- c), please answer this question: In regard to internet connectivity – the following statement is applicable for my use of digital tools (you may mark more than one alternative) 0

- ☐ Internet subscription is too expensive
- ☐ Speed of internet connection is often problematic
- ☐ There is no problem for me caused by low internet speed or high cost

5. When I use a digital device, I mostly do it for the following purpose: 0

- ◯ Private
- ◯ Work or studies related
- ◯ Other (please specify)

6. When I use my mobile phone for private purpose, please rank for which of the activities below it is used most frequently (rank the most frequent with nr. 1, the second most frequent with nr 2., and so on (rank as many or as few as you like)

If you do not use mobile phone, please mark alternative i) with x ○

a) Calling and receiving calls	
b) Texting and receiving texts	
c) Sending and receiving emails	
d) Taking photos	
e) Downloading and using Apps	
f) Social Media activities	
g) Games	
h) Searching for various topics	
i) Search for specific locations	
j) Other activity. Please specify and rank	
k) I do not use mobile phones	

7. If the City of Siena would offer more digital applications for citizens' participation, would you be interested? 0

- ◯ a) Yes
- ◯ b) Maybe
- ◯ c) No

8. If you answered alternative a) or b) on question 7. Kindly respond to this question. In which of the following areas would you like to see more offerings from Siena Municipality in regard to digital applications. Please rank your answers with 1 for the highest, then 2, and so on (rank those you view as useful to address - as many or as few as you like). 0

a) Transport	
b) Car Parking	
c) Food	
d) Waste management/ recycling etc	
e) Public space	
f) Urban Gardening	
g) Nature	
h) Sports activities	
i) Public events/meetings	

9. About me - Please mark as appropriate: 0

- ☐ Male
- ☐ Female
- ☐ I live outside the city
- ☐ I live in other parts of the city
- ☐ I live in the xxx neighbourhood

10. About me - Please Mark as appropriate: 0

- ☐ 15-20 yrs
- ☐ 21-29yrs
- ☐ 30-49yrs
- ☐ 50-65yrs
- ☐ 66-74yrs
- ☐ 75-84yrs
- ☐ 85yrs and above

Appendix 2: Questionnaire Pilot Results

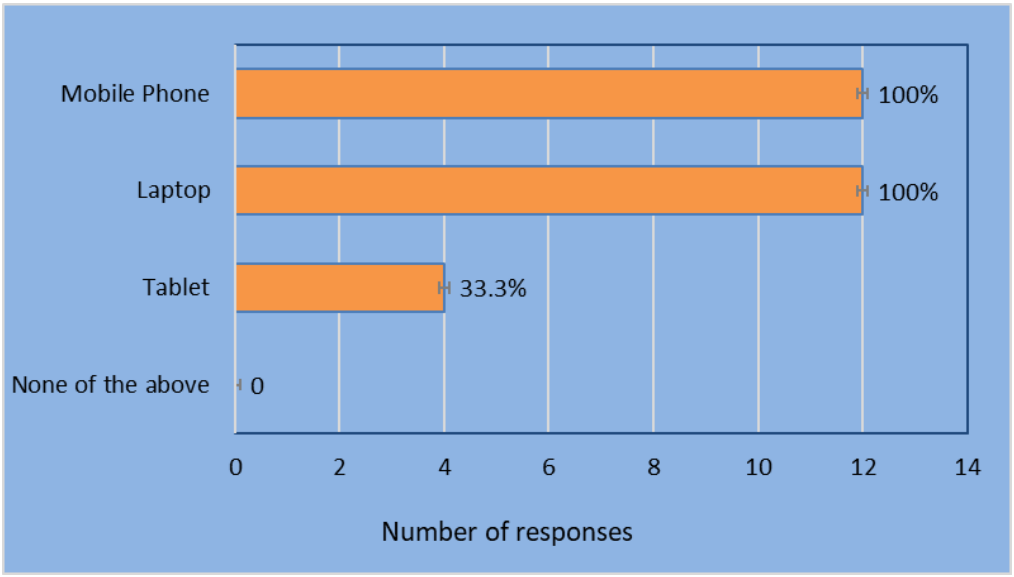
In the following, each question is spelled out, followed by figures that visualise the main results of the pilot collection, pertaining to that question.

Question 1:

What type of digital tool(s) (i.e., devices which are connected to the internet) are you using on a daily basis?

a) Mobile phone
b) Laptop
c) Tablet
d) Other. Please specify
e) None of the above

Figure A2.1: Types of tools used daily for Internet access, share of responses

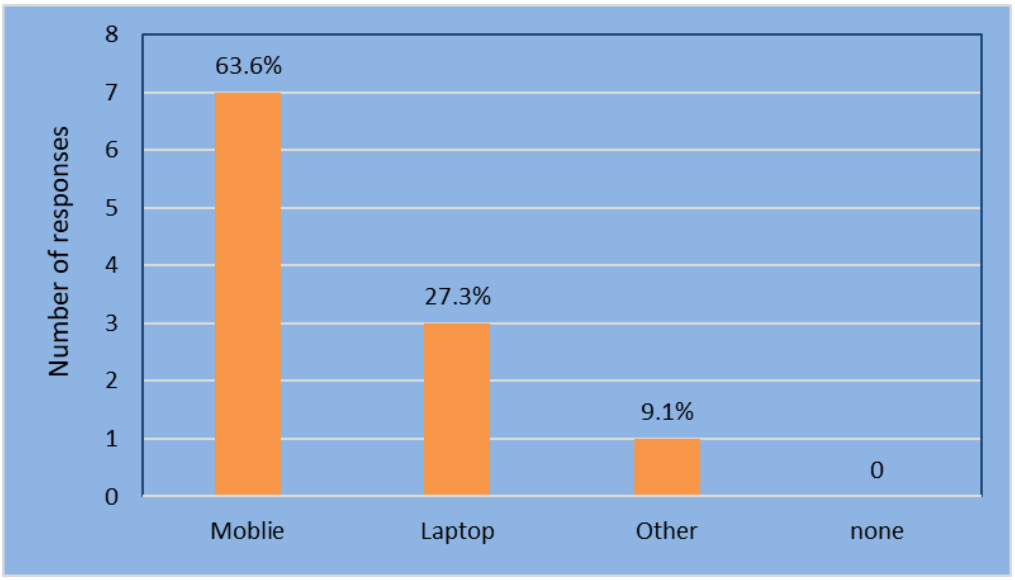


Question 2:

If you have responded any of a) to d) above (not e)), kindly respond to this question: Which device are you using most frequently?

Kindly mention which one.

Figure A2.2: Which tool is used most frequently, share of responses

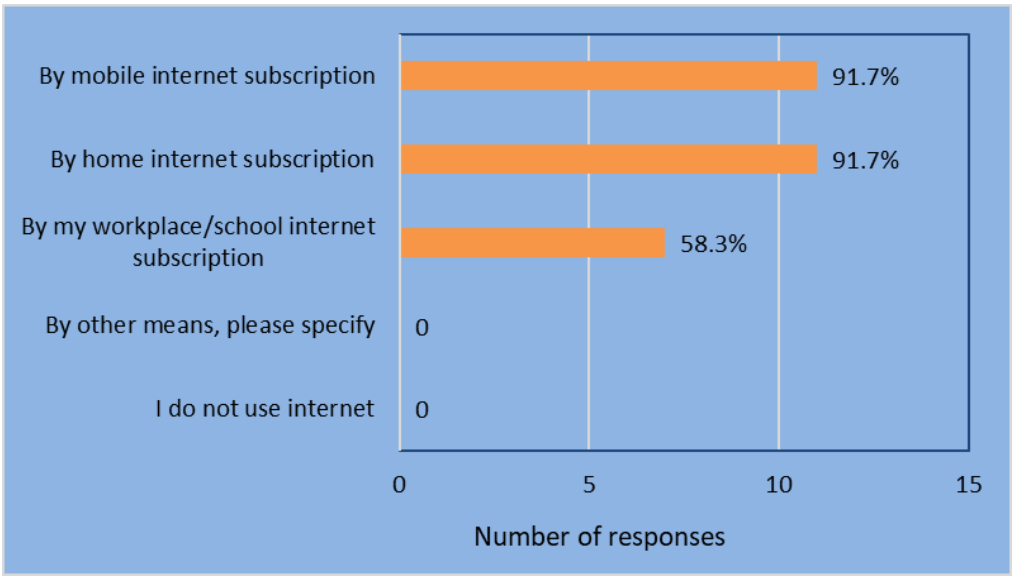


Question 3:

How do you access the Internet?

a) By mobile internet subscription
b) By home internet subscription
c) By my workplace/school internet subscription
d) By other means, please specify
e) I do not use internet

Figure A2.3: Means of connecting to the Internet, share of responses

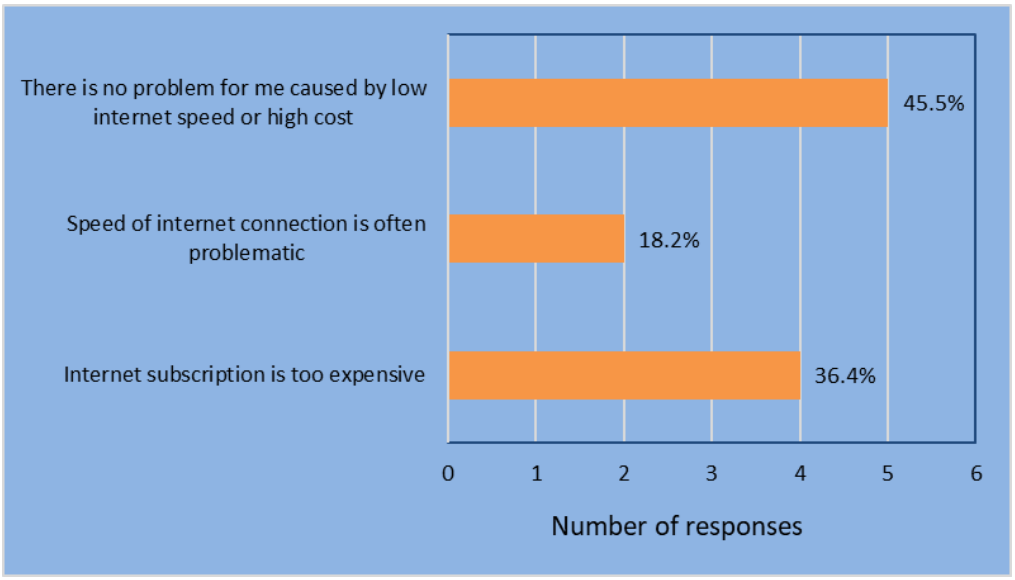


Question 4:

If you answered any of the alternatives a)- d), please answer this question: In regard to internet connectivity – the following statement is applicable for my use of digital tools (you may mark more than one alternative)

a) Internet subscription is too expensive.
b) Speed of internet connection is often problematic
c) There is no problem for me caused by low internet speed or high cost

Figure A2.4: Perceptions applying to connectivity, share of responses

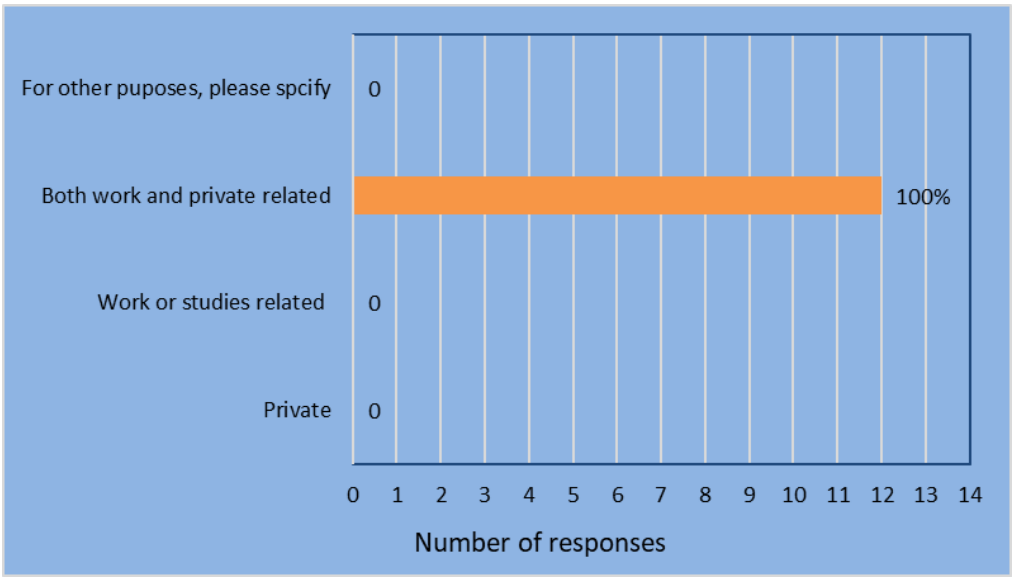


Question 5:

When I use a digital device, I mostly do it for the following purpose:

a) Private
b) Work or studies related
c) Both work and private related
d) For other purpose. Please specify

Figure A2.5: Purpose for use of digital tools, share of responses



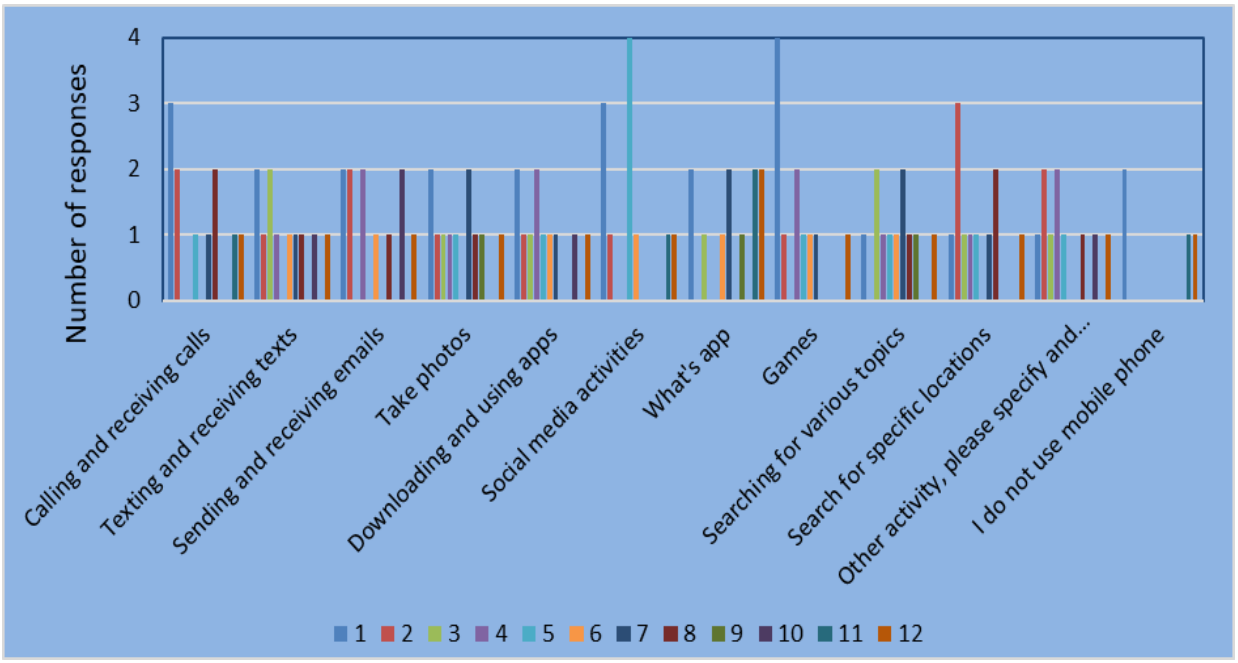
Question 6:

When I use my mobile phone for private purpose, please rank for which of the activities below it is used most frequently (rank the most frequent with nr. 1, the second most frequent with nr 2., and so on (rank as many or as few as you like)

If you do not use mobile phone, please mark alternative i) with x

a) Calling and receiving calls.
b) Texting and receiving texts
c) Sending and receiving emails
d) Taking photos
e) Downloading and using Apps
f) Social Media activities
g) WhatsAapp
h) Games
i) Searching for various topics
j) Search for specific locations
k) Other activity. Please specify and rank
l) I do not use mobile phone

Figure A2.6: Purpose for private use of digital tools, share of responses

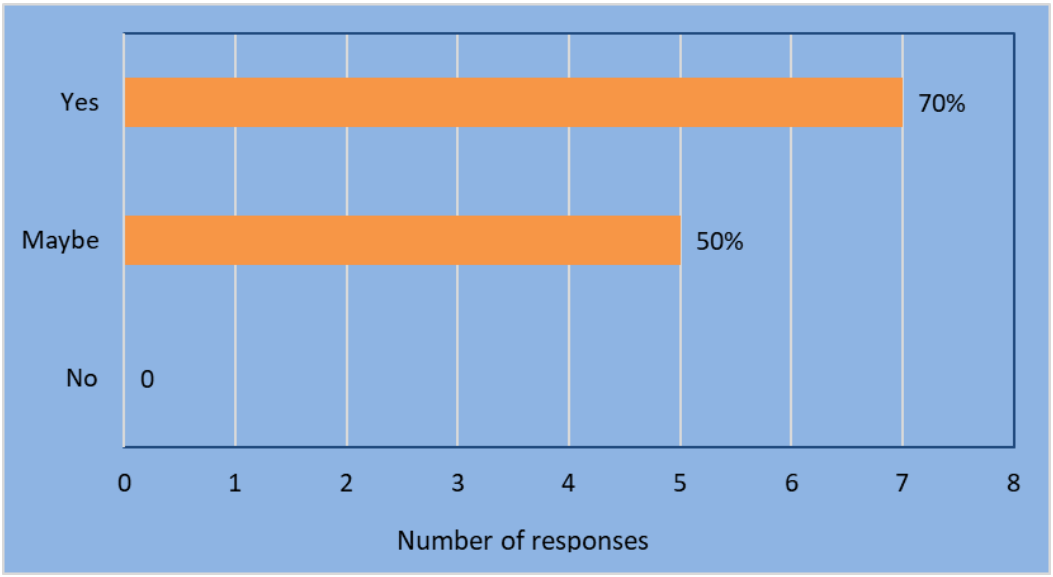


Question 7:

If the City of Siena would offer more digital applications for citizens' participation, would you be interested?

a) Yes
b) Maybe
c) No

Figure A2.7: Interest in expanded digital applications, share of responses

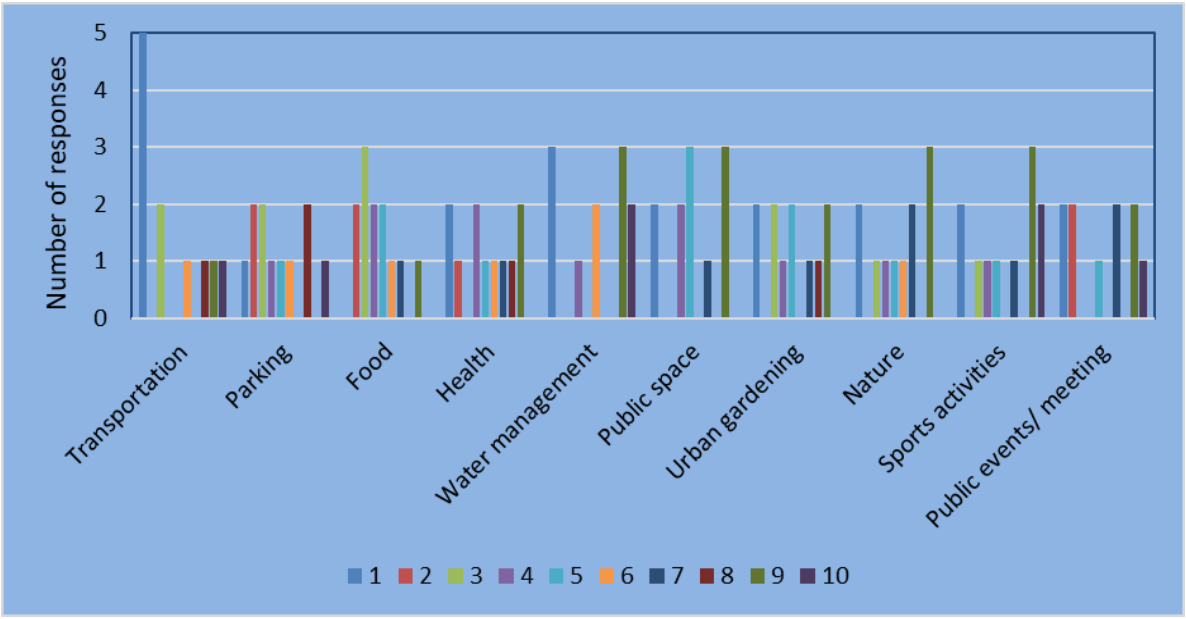


Question 8:

If you answered alternative a) or b) on question 7. Kindly respond to this question. In which of the following areas would you like to see more offerings from Siena Municipality in regard to digital applications. Please rank your answers with 1 for the highest, then 2, and so on (rank those you view as useful to address - as many or as few as you like).

a) Transport
b) Car Parking
c) Food
d) Health
e) Waste management/ recycling etc.
f) Public space
g) Urban Gardening
h) Nature
i) Sports activities
j) Public events/meetings

Figure A2.8: Priority purposes for added digital applications, share of responses

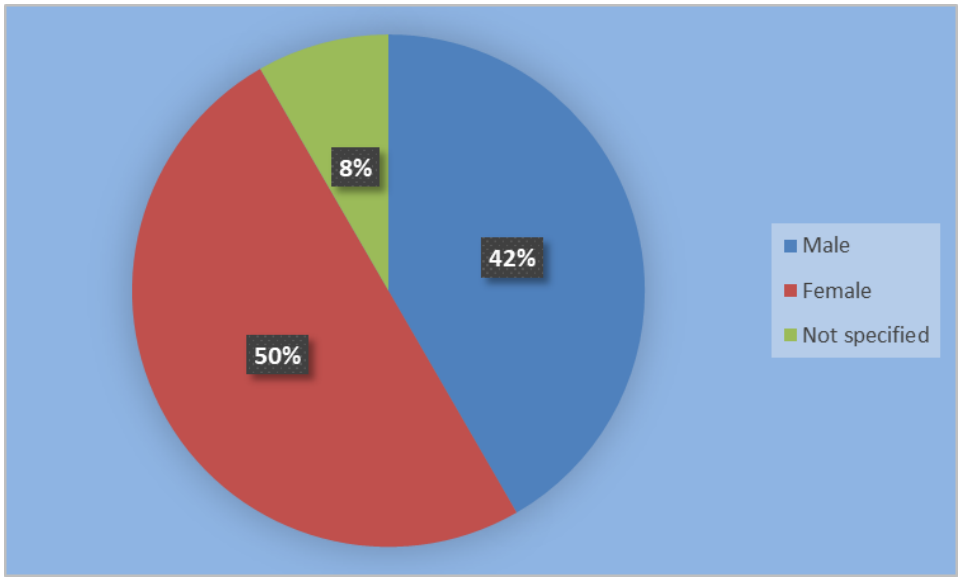


Question 9:

About me - Please mark as appropriate:

Male/Female

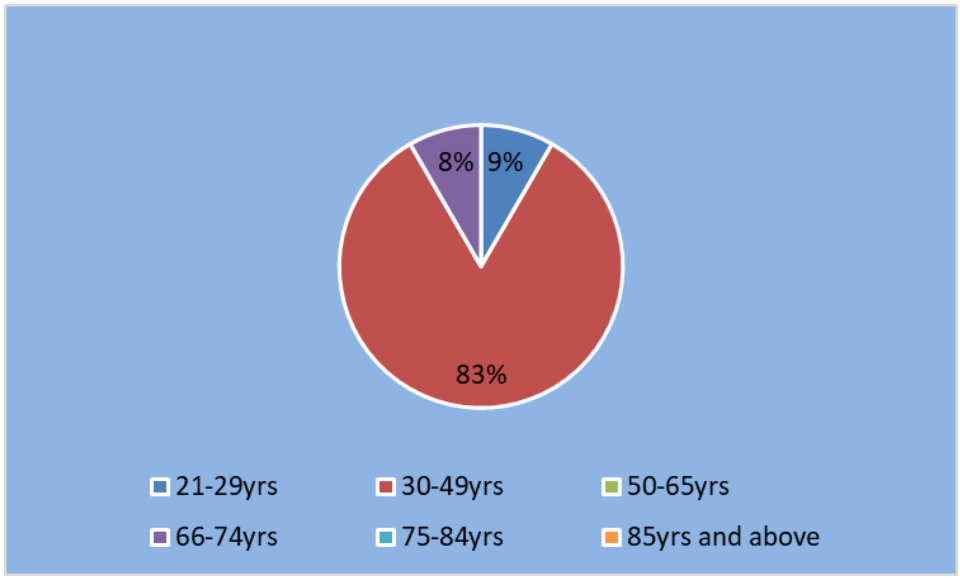
Figure A2.9: Profile of respondents, age group



Question 10:

Age groups: 15-20 yrs / 21-29yrs / 30-49yrs / 50-65yrs / 66-74yrs / 75-84yrs / 85yrs and above

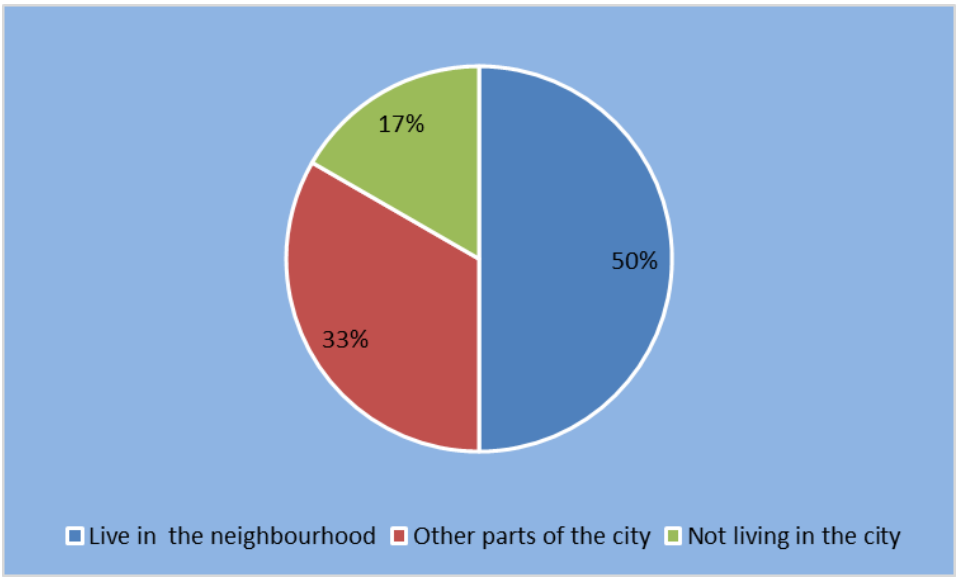
Figure A2.10: Profile of respondents, age group



Question 11:

I live in – xxxx - the neighbourhood / other parts of the city / not living in the city

Figure A2.11: Profile of respondents, age group



Question 12:

On privacy policy

Figure A2.12: Attitude to privacy