Enhancing Liveability Through Community-Centric Approaches To Asset Management And Affordable Digital Tools

Authors

Vivienne Ivory. Technical Principal, Social Science, Resilience and Public Health, WSP Opus Research, Lower Hutt, New Zealand (vivienne.ivory@wsp.com)

Kai O'Donnell. Researcher, WSP Opus Research, Lower Hutt, New Zealand (kai.odonnell@wsp.com)

Philip McFarlane. Sector Leader, Water Asset Management, WSP Opus, Auckland, New Zealand (Philip.mcfarlane@wsp.com)

INTRODUCTION

The 'Smart City' model calls on the increasing availability of data to create feedback loops between decisions and infrastructure (Ivory, O'Donnell, & Schindler, 2018), providing the chance to improve efficiency as well as accountability to stakeholders (Scholl & Scholl, 2014). In order to be 'smart' about our cities, we require both the data infrastructure and people capacity to collate, connect, and communicate across silos and between those who manage assets and those who are stakeholders. Cities can benefit from 'smartness' that increases the ability to know what is going on with infrastructure at any given time (Scholl & Scholl, 2014). Such knowledge helps city managers to anticipate and plan for changes needed to investment and operations. They also need the capacity to analyse, diagnose and communicate *in order to* improve quality of life for citizens – which after all should be the ultimate goal of being smarter (Roche & Rajabifard, 2012).

The management of public assets faces a similar challenge of ensuring that the goal of managing assets is to improve quality of life for the communities they serve. This is reinforced in international standards on asset management with ISO5000:2014 stating that "Asset management does not focus on the asset itself, but on the value that the asset can provide to the organization. The value … will be determined by the organisation *and its stakeholders* [added emphasis]." This focus on value is taken

through to the definition of asset management which is defined as the "coordinated activity of an organization to realize value from assets." 55001:2014 Asset management – Management Systems – Requirements. ISO55000 acknowledges that there are normally many other competing objectives to quality of life, such as cost reduction that could constrain the quality of life objective. Hence there is a need to consult with stakeholders to establish the appropriate balance. Doing so effectively requires better value from data, that then enables better decisions by asset managers and stakeholders (including the community), which then allows the realisation of better value from assets.

Better value from data

Underpinning smarter approaches to our infrastructure, assets, and cities is the data and information that can be mined from them. Geospatially-referenced data is key to smart approaches because it provides city decision-makers with spatially-relevant information upon which to make and evaluate decisions about infrastructure investments. While the volume and content of data about our cities and towns is ever increasing, coverage can be uneven in a number of ways. Robertson et al (2016) referred to information overlays as the 'digital skin' of our urban environments but observed varying levels of coverage by geography and the representativeness of population groups in user-generated content. The type of knowledge captured digitally can also vary.

To date, the smart agenda has primarily focused on large urban centres where the data possibilities, information needs, and built environments, are large and complex (Roche & Rajabifard, 2012). Robertson and Feick (2016) found that urban areas with poorer popolations, fewer technology industries, and less dense urban form had 'digital skin' with less depth and coverage, yet the need for good quality information to manage and govern assets efficiently and effectively is as great in these areas as more digitally advantaged areas. Smaller settlements such as our regional centres have the same needs but lack the economies of scale for collating and managing data and struggle to attract the interest of technology providers with services that are fit for purpose. Smaller budgets means that affordable ways of being smarter are now needed.

Better value from infrastructure: Setting community centric levels of service for assets

Funding infrastructure has always involved a balancing act between not neglecting existing assets while addressing changes in demand on them (DoT, 2013; Neumann et al., 2015; OECD, 2012). Adding to the challenge are the impacts of increasing safety, environmental, and technical standards, the planning requirements for new assets (Bowditch, 2013), and climate change (Larsen et al., 2008).

Setting Levels of Service (LOS) within an infrastructure delivery context is one method of balancing limited resources against a variety of needs. The National Asset Management Steering Group (NAMS, New Zealand) defines LOS as 'the descriptions of the service output for a particular activity or service area against which performance may be measured'. NAMS describes LOS in terms of both the 'customer' (measures of how the customer receives and experiences the service), and 'technical'

(measures technical experts use for longer-term, network-level infrastructure management). Customer oriented LOS are often presented in a way that can be easily understood by non-experts, whereas technical oriented LOS are expressed in a technical language that staff can use to efficiently communicate about managing assets. In theory, customer LOS can be translated into technical LOS so that asset performance meets with customer satisfaction, with checks made to ensure they are not out of kilter with each other. For example, performance metrics designed around acceptable levels of bacteria in drinking water or the number of discharges of untreated waste-water to waterways may instead be stated in terms of a household's accessibility to quality water, or the number of days in a year a river, lake or beach is safe to swim in. The New Zealand Local Government Act 2002 stipulates that a local authority, "in the course of its decision-making process… give consideration to the views and preferences of persons likely to be affected by, or to have an interest in, the matter" (New Zealand Government, 2002; section 78.1).

Identifying the central focus of the LOS process is a useful way of identifying the relationships between asset 'parties'. A LOS that is primarily technical tends to be asset-centric, where the technical expert is the primary driver of the LOS process and user of information. Experts makes decisions, consult other experts, and deliver according to asset-focused key performance indicators (KPI's). Increasingly practice is moving towards metrics that explicitly focus on customer and/or community perspectives (Haider Husnain, Sadiq Rehan, & Tesfamariam Solomon, 2016; Han, Chae, Hwang, & Choung, 2014; Khan et al., 2009). The community is visible in such a customer-centric approach through consultation by experts and by user metrics in the KPI's. However, decisions are still the domain of experts and the emphasis is on responding to customer satisfaction with prescribed options for levels of service. The asset-focused metric is part of the process, but the overarching metric is one that is customer-focused. Nonetheless, it is not uncommon for specific metrics to be reframed with more 'people focused' terminology in a customer-centric approach but which does not engage directly with the community, nor rarely reflects community concerns around domains such as equity or resilience.

The role of the expert in a community-centric approach, by comparison, is to support the community to drive the LOS process and make decisions on what is important, informed by user-focused KPI's. In terms of values, both the customer-centric and community-centric approaches are reflected in both the International Association for Public Participation (IAP2) recommended best-practice (e.g. "public participation is based on the belief that those who are affected by a decision have a right to be involved in the decision-making process" and "…includes the promise that the public's contribution will influence the decision" (IAP2, 2018, p. 2) and the New Zealand Local Government Act (2002). However, a community-centric asset management model represents a move toward decision-making that is driven by the community, rather than solely by experts (a case of empowerment as opposed to simple involvement, in keeping with IAP2 Public Participation Spectrum, PIA, 2011).

Changes over time

Assets change over time in a number of ways. The assets themselves change over their lifecycle and this is a key technical task for experts. The wider context of assets also changes: the values and needs of users, as well as environmental and technological factors. If we are to move the involvement of the community in asset decisions beyond the initial consultation phase, both asset managers and the community as users need to be able to understand how the asset is performing against goals while it is operating. Asset and user KPIs can then be linked to the community generated vision in a way that allows communities to continue to monitor and make decisions about an asset's level of service over time, allowing for change in the asset, community priorities, and other broader factors.

This repositioning of experts and community over the whole life of assets requires a deeper ongoing conversation between those charged with looking after assets and those who ultimately own and invest in the asset – current and future ratepayers (including those who indirectly pay rates such as renters and children). Rather than primarily responding to customer satisfaction and preferences for options, a community-centric approach allows for a future focused LOS that captures the values of the community 'owners' and ensures that asset decisions address these values. For communities to be engaged in asset decisions, they need to be informed about the status of assets (current and future) and to be able to understand the inevitable trade-offs. And both experts and the community need information about the diversity of perspectives and values across the community so that decisions about assets are transparent and fair.

Digital tools for setting community-centric levels of service

The remainder of the paper reports on the findings from a pilot research project undertaken as part of the National Science Challenge, "Building Better Homes, Towns and Cities" Strategic Research Area "Next-Generation Information For Better Outcomes". We investigated how digital tools can help local authorities set community-centric levels of service. The research is targeted to the particular data challenges faced by provincial local authorities where the overall goal is to develop affordable tools so that local authorities can combine existing and new geospatial data sources, and incorporate 'community' knowledge alongside 'technical' knowledge, in a cost-effective way when making decisions about assets. The following sections describe the methods and outcomes from the pilot, and discuss their implications for Smart Cities and asset management.

Method

Two small regional local authorities were invited to participate as partners in a research pilot (referred to below as Partner A and Partner B). They were identified through industry networks as councils grappling with asset management challenges, a drive to engage more fully with their communities over asset decisions, and a desire to use data and technology more effectively but with limited resources (funding, technology, and expertise). Introductory discussions with key personnel provided

the opportunity for researchers to hear about the information challenges faced by key council staff around setting infrastructure levels of service, and in particular, how to engage with community for decision-making over the life-cycle of assets. The engagement identified three overarching questions that were common to the cases:

1. How can we tell whether our infrastructure is giving us what we need?

2. What information, processes or tools do we need to tell us whether it is giving us what we need?

3. What can we make that is meaningful, accessible, useful, and affordable to help people making decisions?

The pilot took the form of a series of three workshops. Due to unforeseen events, the second council (Partner B) did not continue following the first workshop. The pilot was designed in keeping with a 'Design Sprint' (https://designsprintkit.withgoogle.com) approach as a series of interactive workshops. The Design Sprint approach was selected for its rapid development approach where participants are encouraged to explore different issues and approaches rather than focus on the detail of a possible solution, and allowing for a more free-flowing conversation within the workshop so that the underlying issues and opportunities could be revealed.

Workshop composition and design

Workshop participants were identified and recruited by the Council partner in collaboration with the research team. Workshop composition aimed to be a mix of perspectives and disciplines involved in infrastructure decision-making. Participants included elected councillors as well as council officials from across the council and council agencies, and included planning, data management, engineering, and communications, and in Partner B, included community representatives. Two researchers attended the workshops, taking turns to lead and facilitate exercises, and to record observations. Information was captured through the use of 'sticky notes' by participants, facilitated writing on large format sheets, and researcher notes taken during sessions. Following each workshop, all material was reviewed by both researchers to ensure coverage was satisfactory prior to extracting content and key themes.

Design Sprints typically take place over five days of intensive workshops which was impractical for the council research partners. Therefore, an adapted process was developed to retain key elements of Design Sprints in the workshop design, notably, creativity and iteration, and bringing together multiple work disciplines and perspectives to generate a hot-house of ideas and discussion. The three workshops were supported by two material development phases undertaken between workshops by the researchers. The following section describes the adapted process.

Workshop process and outcomes

Step 1: Workshop 1 sought to reveal the geospatial information challenges and needs amongst participants. Participants were asked to identify the data, information, and knowledge needed to make infrastructure decisions, describe what currently exists and where there are significant gaps, and the challenges they face using data and addressing gaps for decision-making. Participants were asked to consider the information needs of three different 'groups; council, commerce, and community. Prompts for discussion included the accessibility, usefulness and affordability of data and knowledge to convey meaning and community values and needs.

The breakout session questions were: What knowledge, information and data do we need to make this decision? What do we have already? Where are the gaps? What are the challenges (to using the knowledge, information and data, closing the gaps, and making decisions). Discussion within the workshop led to the identification and agreement about barriers and opportunities for developing practical and affordable digital tools to aid decision-making. These included practical issues of incomplete information (because the right data is not collected, accessible, or interpretable), managing datasets to get better value out of data (e.g., awareness of and being able to link multiple datasets) and higher level issues of using data to communicate about things that matter to people.

In Partner A, participants identified three points of interest as focal points for the Design Sprint: (i) infrastructure development in a target suburb, (ii) three-waters infrastructure in general, and (iii) management and development of park facilities.

The data needs, availability, and gaps across the three sectors were mapped into a matrix, revealing challenges to using the knowledge, closing data gaps, and making decisions. For Partner A, these included:

- *Connecting through data.* Knowing about and connecting disparate datasets (need for data collection and management to be designed for working together) and addressing the limited two-way communicating across silos and separation—for example, between council and councillors

- *Representing* social 'people' data and community views

- *Communicating* consequences through evidence-based decisions and evidence-based narratives.

Two areas for opportunity emerged; tools that give data purpose and tools that link people and data.

- Purposeful data collection and management to foster integration and better value.

- Integrating information for a fuller picture about communities (data *on* people), their environments and their assets (data on 'things'). Working with data for more effective reporting and translation into useable forms so that decisions are based on evidence-based

narratives as opposed to anecdote.

- Portraying trade-offs and uncertainty in decision-making, communicating other values and perspectives (data *from* people)

- Creating community appetite for engagement (data *for* people).

For Partner B, the workshop focus was agreed as the ongoing management and monitoring of wastewater infrastructure and the associated community engagement. Mapping the range of data that was available to, and needed by decision-makers revealed a number of areas where knowledge, information, and data was needed, but relatively few known sources were identified. There were clear gaps in available data and information to inform future-focused decisions and to be able to engage with the community about ongoing infrastructure problems and decisions. For example, there were no data sources identified by participants that could be used to understand future infrastructure needs and demand. Challenges included:

- *Being able to monitor, report and engage over time*, including about how to show variability. Practical issues such as staff turnover, varied digital access and capacity, and costly data collection restricted information use. It was not clear how much information is wanted, and how to make information relevant to people.

- *Understanding system performance, historical performance and future trends* was difficult as buried assets are difficult to measure and historical data is less accurate from a predictive standpoint due to climate change. There was concern about the potential to overload stakeholders with too much information or too detailed information. Communication about system performance required interpreting complex data, but also provide the tools and information for interested parties to go deeper. For example, informing stakeholders around complex interactions (e.g. pollution spikes associated with rain/ weather events and how these do not necessarily indicate a 'bad' system).

- *Developing trust, trusted data and trusted narratives* meant a need for trust to be built in information that is 'acceptable' as well as trust in the relationships (in expertise, in each other, and knowing and trusting each others agenda). This was seen as vital in order to speak into the 'knowledge vacuum' so that when conversation occurs it is based on good data.

Emerging opportunities for *tools that link people and data and that 'show' infrastructure included:*

- Using data and digital tools for two-way interaction between council and community about infrastructure over the life of the assets.

- Better understanding about the ongoing state of and need for infrastructure, both within council and for the community.

- Make long term infrastructure choices meaningful to people so they can help prioritise.

- Interpret, synthesise, and visualise complex information so it is meaningful, based on evidence, not just anecdote, shows change over time, and is easily available.

Step 2: Data Lookbook involved developing material for the second workshop. Researchers collated examples to illustrate the range of data sources, presentation, processes, and issues identified by Workshop 1 participants across community, commerce and council domains. Examples came from participants who manage and use different types of data (for example, water infrastructure engineers, GIS managers, and communications staff). Examples were also sourced from the public domain to illustrate ways of sourcing and presenting information for decision-makers and alternative sources, (comparing property values across the country and over time). The Data Lookbook visually represented these datasets and their use in a single document.

Step 3: Workshop 2 challenged participants to design a tool that a) linked 'people' data with existing data on 'things' (physical infrastructure, natural environment, buildings, etc); and b) can both gather and share 'people' data such as infrastructure usage, attachment of people to place and assets, perceptions. and aspirations.

The Data Lookbook was used to demonstrate the range of data sources and types available as well as ways of visualising information in more or less digestible ways. The lookbook prompted to discuss about what data could be better used and how it could convey information effectively. Participants were invited to design tools using two physical formats, a book and a map. Materials were supplied to make a book (loose sheets of paper, scissors, pens, staplers, etc), and multiple copies of large-format suburb maps were provided so that participants could trial elements. Physical formats were chosen for the ease with which participants could rapidly mock-up design features and critical elements. Working together on a physical format prompted joint attention to the challenge, discussing, revising, and clarifying with each other.

Using the two formats, participants were asked to address two design challenges using a suburban catchment as a case to focus attention:

1. How to communicate needs, vulnerability, possibilities, potential change, impacts of infrastructure development,

2. How to show the interaction between people and things e.g. use of assets, status of assets, attachment of people to assets, perceptions, aspirations, full value of asset to individuals, community, and the city.

Following each exercise, features of the design mock-ups were reflected back to participants to identify common points and key differences. Comparisons across the two tasks and formats explored priorities for action – what would be most effective and needed? A number of recommended approaches emerged from the exercises to address priorities:

- Normalise people engaging with Council through tools that are part of everyday interaction between council, commerce and community – a 'one stop shop'.

- Use story-telling and visualisation methods to show effect of potential infrastructure choices, impacts, including making costing meaningful (e.g. 'cup of coffee' units), including steping through choices and options (showing positives, negatives and costings). Use Personas to engage and demonstrate issues, show comparisons, helping the community relate to other, and represent different community needs and perspectives.

Step 4: Build demonstrator. In preparation for workshop 3, a demonstrator was built to show the key features and functions identified from Workshop 2 outcomes. The goal was to create a cohesive, single portal interface capable of intuitively delivering the council and community information needs. The research team used as a base an off-the-shelf software tool called Maptionnaire, an interactive geospatial survey tool which allows users to build functionality, branches and questions from modular 'building blocks'. The tool provided the ability to build reasonable likenesses of a range of functions identified through the workshop process, including various existing functions available through the Council website (e.g., paying property rates, finding property information, local news). A mix of existing Council data and mock-ups were used to create the demonstrator. Some functions were active, showing how live user data could be accessed without major processing, whereas others were 'dummy' functions, using non-interactive visual elements to demonstrate information that could be used - notably information that is largely available through existing sources, but may require further processing and technical work to link with such a portal.

The key functionality, language, and content from the Council website provided a bridge between the current design and a new, hypothetical method that incorporated existing functions and needs identified over the previous workshops. A mock-up showed how the current Council homepage could be modified to incorporate geospatial mapping front and centre, then the demonstration walked through how key functions could be accomplished. For the purposes of demonstration, four functions were adapted from the Council website to be in keeping with the Council language as well as capture the issues discussed in workshops. The functions were 'See it' (geospatially located local news), 'Say it' (interaction with management plans, future development, water infrastructure), 'Use it' (use, information and booking council parks and facilities) and 'Pay it' (property rates, consents, dog registration and parking infringements).

Step 5: Workshop 3 'tested' the demonstrator showing the four key functions. Each function was explored with participants using examples, scenarios, and images. The implications of each functionality were explored by discussion of the technical and organisational limitations and possibilities, and the difference it could make to asset decision making.

A second goal was to explore the technical and organisational requirements to support the story-telling

and surveying functions necessary to guide users through potentially complex or data rich asset decisions, both existing and what would be needed. Participants were then asked to identify the changes needed to implement functions (and associated barriers) in terms of desirability and difficulty using a matrix, and prioritise them in terms of 'low hanging fruit' and biggest impact.

The digital tool was seen as offering considerable value as a 'one stop shop' for facilitating better communication between the council and the community about assets. Potential uses and enhancements of such a tool were discussed throughout the demonstration. The tool was seen as being coherent with the council values of innovation and transparency, and the current digital strategy. Topics discussed over the workshop revealed underlying concerns and priorities for a digital tool; accuracy of information, transparency about council decisions, efficiency, better communication, ease of use, and normalising two way interaction between council and community through digital tools. A new "Do it" function could be used to normalise interaction with council functions via the website (e.g, consenting, booking facilities.

The discussion identified multiple current capacities that could be used to develop a digital tool with the desired functionality, as well as needs yet to be met. Locating needs on the desirability / difficulty axes helped identify changes that needed to be made at an organisational level as well as in technical capacity. Results from the assessment are shown in Figure 2: gaining organisational buy-in was seen as both vital and the most difficult.
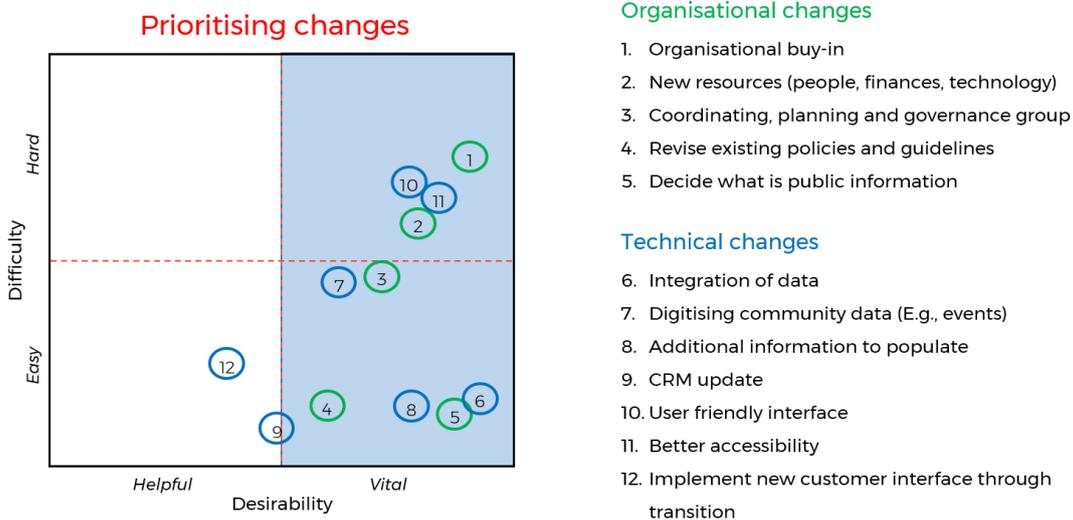
Figure 2: Assessment priorities for making changes for better digital tools

Step 6: Lessons and recommendations were summarised into a short form report shared with research partners establishing the value story for digital tools to support community-centric approaches to levels of service.

Findings

The pilot identified multiple benefits to the community and council from digital tools that support better use of geospatial information for asset management, and gaining efficiency benefits from enhanced smartness (Scholl & Scholl, 2014). Tools that facilitate the integration of information were valued for their ability to reduce, minimise or avoid siloes within council, and between council and the wider community. They could also reduce inter-regional silos by enabling multi-council cooperation where data themes cross regional boundaries, such as water quality and traffic volumes. Integrating tools were seen as a means of gaining greater efficiencies in data handling and labour, reducing overall costs. In particular, digital tools were seen as offering the opportunity to simplify and improve the accuracy of location data capture and provide a unified method and interface.

As well as providing organisational benefits, integrating digital tools were valued as a common public interface for better public engagement that meaningfull engages stakeholders with decisions (New Zealand Government, 2002). They were seen as acting as a 'single point of truth', but could also allow better user customisation. For example, accessibility and data layers could be tailored to user needs to allow for public, developer, and council 'layers' with varying degrees of access and complexity. Participants valued the ability to visually represent important topics through integrated geospatial data, such as hot topics of community interest, council priorities, and spatial and temporal contexts (e.g. historical context, future trends), giving greater richness to the information used in engagement. Facilitating richer, two-way communication through digital tools, particularly on complex topics, was seen as providing for greater engagement and transparency in Council decision-making.

Gaining better value from geospatial data for asset management and engagement has both implications and opportunities for local authorities and asset managers. The research pilot case identified that resourcing is needed to both build the tools and to supply expertise, which requires political and financial investment within local authorities themselves and within the sector. In the case of Partner A, buy-in for resourcing and coordination would be required from IT, social media, and engineering leadership across council departments. Part of gaining buy-in was the assurance that the needs and interests of diverse stakeholders can be met through technical steps to integrate the multiple datasets and technologies, including sensitivities interpreting data and information in a shared portal. Importantly, it seems that for Partner A, much of the technical skills and tools were available within the council. Rather than large investment in new technological tools, they identified the need for processes that facilitated integration and communication both within council and across the community.

Figure 3 below summarises the opportunities identified in the pilot for creating value through digital tools. The cycle shows the multiple, connected ways in which better use of integrated geospatial data (both generally and specifically for asset management) can provide a value cycle for community and

council. From the council perspective, more effective use of data through affordable, integrating digital tools can increase the 'smartness' of managing assets through enhanced capacity to analyse, diagnose, and communicate about assets (Roche & Rajabifard, 2012). The pilot identified the opportunity existing within the multiple but siloed datasets about assets and communities held by council. This can include information on asset usage as well facilitating the generation of new data capturing the values and needs of communities. While user generated data from social media has been identified as one source of 'community' data, it is not necessarily representative (Robertson & Feick, 2016). Specific surveys on community values around infrastructure can be valuable sources of information but are costly to implement robustly and repeatedly (Ivory et al., 2018). Platforms such as that discussed above which specifically elicit feedback on assets (through 'Say it' and 'Fix it' functions) and capture everyday behaviours, may be more effective at representing communities when added to survey and general social media methods. Better use through integrating data using spatial platforms on both assets themselves and community needs can enhance the 'digital skin' of regional towns (Robertson & Feick, 2016), and show where critical information gaps occur. Through better information overlays, investment and operational decisions can focus on delivering levels of service that ultimately contribute to better quality of life and reflect local priorities.
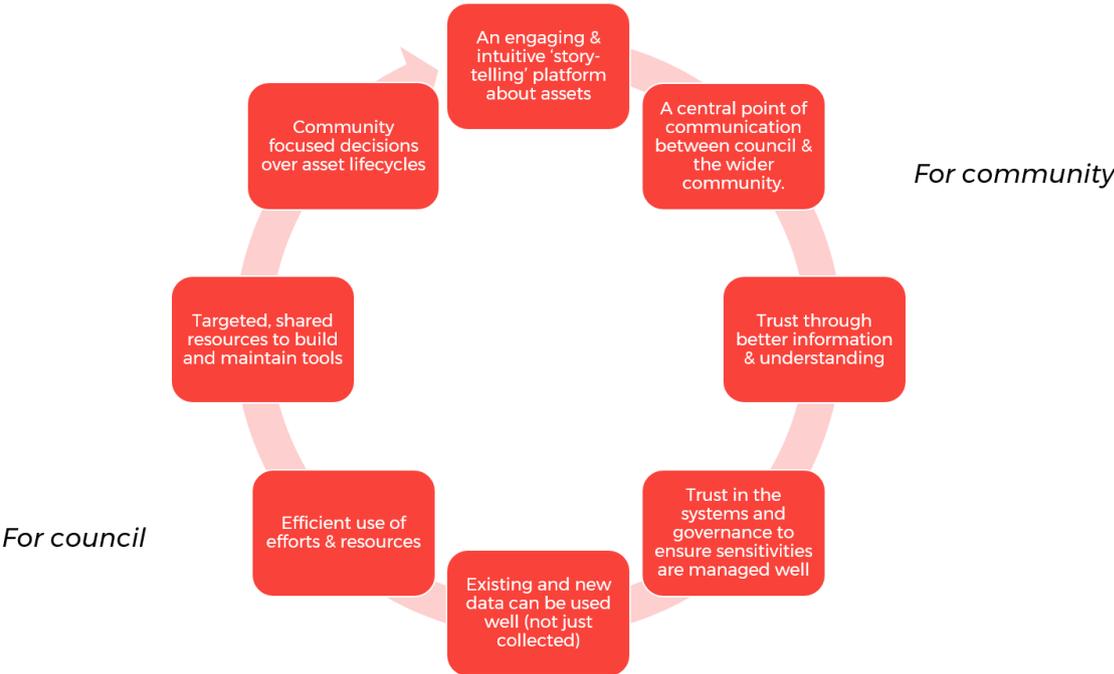
Figure 3: The Value cycle for digital tools to aid asset level of service

As discussed above, a key challenge faced by asset managers to setting levels of service is balancing limited resources with ever expanding demand and changing technological and environmental contexts. For example, the pilot identified that accounting for anticipated future climate change through planning for enhanced use of green space in a suburban water catchment needs to account for limited resources to build and operate pipes with changing expectations for recreational space,

flooding, and new developments. Being able to share that challenging balancing act with the community through digital tools was regarded by the research partners as both a significant goal and benefit in the pilot. The desire to share the challenge represents an evolving shift away from technically-led decision-making measuring asset performance towards a focus on customer satisfaction with existing levels of service (Haider Husnain et al., 2016; Han et al., 2014). However, in the case reported here, there is an strong appetite within the council for the community to be partners in the setting of levels of service, as well as whether they are satisfied with the status quo.

Digital tools were a key means of achieving such a partnership. Continuing the conversation about assets over the whole of their lifecycle was identified as a vital need for both research partners. Digital platforms that foster data generation and story telling about assets on an ongoing basis were seen as a means to develop a deeper conversation about what levels of service mean, including how they may need to change over time. Information was seen as a key means of fostering greater trust between council and the community, both through enhanced understanding by community members of how assets work and by council experts in what is really important to the wider community.

Conclusion

Telling stories about infrastructure and environments through digital tools can engage the community in meaningful decisions with the council about the ongoing management of assets. Through the Design Sprint process, Partner A identified considerable willingness and existing capacity that can be harnessed to gain better value from geospatial information about assets and the wider built environment. Affordable digital tools that harness the power of integrated geospatial data were recognised as critical to facilitating a community-centric approach to asset management over the whole lifecycle of infrastructure.

Digital tools were seen as an achievable and affordable means of generating rich information and asset stories through data integration. Through the Design Sprint process, practical gains in efficiency and knowledge were identified as well as intangible benefits such greater trust and transparency, and richer conversations between council and community. The pilot exercise allowed council to identify the technical and organisational requirements to developing and using fit for purpose digital tools to support community-centric asset decision-making. Changes to technical (e.g., integration, software, interfaces) and organisational (e.g., investment, expertise, coordination, and agreement) aspects would need to be integrated through cross-sector teams. Gaining organisational buy-in across the council was seen as both the most challenging and vital requirement.

Digital tools for integrating data can link people with meaningful data about the things (assets and environments) that matter to them. They were valued as a way of turning data into useful information that is easy to engage with, and to foster an appetite within both the council and the community for a community-centric approach to managing assets into the future. The findings from the pilot show that

doing so offers value to both council and community. If we are to move from the rhetoric of people-focused consultation, we need information tools to collate, connect, and communicate between asset managers and the communities they serve.

Reference List

Bowditch, G. (2013). Australia's infrastructure cost conundrum. *Faculty of Engineering and Information Sciences - Papers: Part A*. Retrieved from http://ro.uow.edu.au/eispapers/2763

DoT. (2013). *Action for Roads: A network for the 21st century*. UK: Department of Transport.

Haider Husnain, Sadiq Rehan, & Tesfamariam Solomon. (2016). Risk-Based Framework for Improving Customer Satisfaction through System Reliability in Small-Sized to Medium-Sized Water Utilities. *Journal of Management in Engineering*, *32*(5), 04016008. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000435

Han, S., Chae, M. J., Hwang, H., & Choung, Y. (2014). Evaluation of customer-driven level of service for water infrastructure asset management. *Journal of Management in Engineering*, *31*(4), 04014067.

IAP2. (2018). *IAP2 Core Values*. International Association for Public Participation.

Ivory, V. C., O'Donnell, K., & Schindler, M. (2018). Potentials, problems and possibilities for developing New Zealand's built environment through high-value geospatial information. *Kōtuitui: New Zealand Journal of Social Sciences Online*, 1–17.

Khan, Z., Moselhi, O., & Zayed, T. (2009). Level of service based methodology for municipal infrastructure management. *World Academy of Science, Engineering and Technology*, *52*, 96–105.

Larsen, P. H., Goldsmith, S., Smith, O., Wilson, M. L., Strzepek, K., Chinowsky, P., & Saylor, B. (2008). Estimating future costs for Alaska public infrastructure at risk from climate change. *Global Environmental Change*, *18*(3), 442–457.

Neumann, J. E., Price, J., Chinowsky, P., Wright, L., Ludwig, L., Streeter, R., … Jantarasami, L. (2015). Climate change risks to US infrastructure: impacts on roads, bridges, coastal development, and urban drainage. *Climatic Change*, *131*(1), 97–109.

New Zealand Government. (2002). *Local Government Act 2002: Public Act 84*.

OECD. (2012). *Strategic transport infrastructure needs to 2030: International Futures Programme*. UK: Department of Transport.

Robertson, C., & Feick, R. (2016). Bumps and bruises in the digital skins of cities: unevenly distributed user-generated content across US urban areas. *Cartography and Geographic Information Science*, *43*(4), 283–300. https://doi.org/10.1080/15230406.2015.1088801

Roche, S., & Rajabifard, A. (2012). Sensing places' life to make city smarter. *Proceedings of the ACM SIGKDD International Workshop on Urban Computing*, 41–46. ACM.

Scholl, H. J., & Scholl, M. C. (2014). Smart governance: A roadmap for research and practice. *IConference 2014 Proceedings*, 163–176.

BIOGRAPHY

Dr Vivienne Ivory is a Technical Principal at WSP Opus Research specialising in place, mobility and infrastructure. Her research interests include resilience, longitudinal studies, and transport and neighbourhood mobility, and the role played by digital information infrastructure in New Zealand's resilience and wellbeing. She leads the Resilience Governance research programme within the Resilience to Nature's Challenges (RNC), and is a lead researcher on other programmes, including Resilience Trajectories (RNC), Natural Hazard Research Platform and Building Better Homes, Towns, & Cities, National Science Challenge in the Next Generation Information research programme.

Kai O'Donnell is a social scientist at WSP Opus Research with qualifications in psychology and economics, combined with a background in software and hardware information technology. He has previoulsy worked for the UNHCR (the Refugee Agency) and at Canterbury University developed a passion for organisational psychology—incorporating systems thinking, and quantitative and qualitative methods to understand complex, population level issues while retaining individual level insight. Kai is particularly interested in how we can speed up infrastructure adaption in the face of changing community needs due to climate change, migration and generational changes.

Philip McFarlane is Water Sector lead - Asset Management at WSP Opus. He is an expert in the planning, condition assessment, design and rehabilitation of wastewater, stormwater and potable water systems and is a leader in trenchless technology. He helps utility authorities develop maintenance, operation and asset management practices so they gain the best possible performance from their assets. Philip has over 25 years experience working on the design and project management of civil engineering projects in New Zealand, Asia and the United Kingdom and in 2010 was elected as a Fellow of the Institute of Professional Engineers of New Zealand.