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Preparing for disruptions: A diagnostic strategic planning intervention for sustainable development

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ABSTRACT

Despite the emphasis on sustainable development in some of the contemporary planning and policy rhetoric, we face an implementation deficit in practice. The impediments to the widespread adoption and successful implementation of sustainable infrastructure in cities' critical sectors—such as water, energy or transport—are varied and complex. Although the scholarship has made some attempts to understand and categorize those impediments, not much has been said about *how* to identify them in a specific practical context. This study proposes a model for a diagnostic intervention in the ongoing process of strategic infrastructure planning, as a way of revealing context-specific impediments. The diagnostic intervention incorporates an explicit and reflexive consideration of short-term barriers and long-term disruptors into the strategic planning process, and assists with drafting the required coping strategies. The intervention has been tested in water infrastructure planning for one of the world's largest urban renewal areas in Melbourne, Australia. This trial application provided promising outcomes for addressing the implementation deficit of sustainable development: it created a platform for various stakeholder groups to engage in explicit discussions on their confronted problems, which often have trans-organizational causes and impacts; it enabled reflexivity within the ongoing planning process; and, it helped to consider a large portfolio of future uncertainties to provide an enabling condition for more robust decisions to be made. Moreover, the trialed intervention provided empirical evidence in support of the scholarly discourse which contends that sustainable infrastructure delivery is not only about the development of technical solutions, but is also about the development of processes and tools that support the widespread adoption and successful implementation of those solutions in the face of wide-ranging impediments.

1. Introduction

Almost three decades after the rise of sustainable development as a grand vision, we are facing an implementation deficit in practice (Holden, Linnerud, & Banister, 2014; Newton, 2012).Worldwide, in critical sectors such as water, energy and transport, investments in conventional infrastructure predominate, and the adoption of sustainable alternatives often remains too slow (Negro, Alkemade, & Hekkert, 2012; Rijke, Farrelly, Brown, & Zevenbergen, 2013; Walsh, Glendinning, Castán-Broto, Dewberry, & Powell, 2015).

Scholars agree that the shift in infrastructure delivery in today's cities toward sustainable solutions would be a radical change (Pickett et al., 2013; Truffer, Störmer, Maurer, & Ruef, 2010), requiring cumulative capacities built into strategic planning processes. Currently, a range of impediments across different sectoral and geographic contexts tend to delay, divert or stop the desired transformation (Brown & Farrelly, 2009; Negro et al., 2012). Strategic planning literature often refer to those impediments as *barriers* (e.g. Ferguson, Brown, & Deletic, 2013; Hunt & Rogers, 2005). Innovation literature refer to them as *systemic problems* (e.g. Wieczorek & Hekkert, 2012) or *systemic failures* (e.g. Klein Woolthuis, Lankhuizen, & Gilsing, 2005). They include a range of political, economic, social, institutional and technological issues, such as: lack of political will, insufficient capital resources, limited community engagement, fragmented institutional frameworks and technological failures (Brown & Farrelly, 2009; Klein Woolthuis et al., 2005).

While there have been some academic attempts to categorize the impediments to the adoption and successful implementation of sustainable infrastructure solutions, not much has been said about *how* to identify them systematically in a practical context (Wieczorek & Hekkert,

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2012). More importantly, it is not well understood how strategic planning methodologies can incorporate an explicit consideration of those impediments, and assist planners and decision makers in designing the required resolution strategies.

To address the implementation deficit of sustainable development, however, such an understanding is crucial. As Voß and his colleagues argue, in steering for sustainable development universal solutions may not work; instead, we need to be able to identify and deal with particular problems within their concrete empirical contexts (Voß, Newig, Kastens, Monstadt, & Nölting, 2007). Similarly, other scholars warn against generalized solutions or blueprint approaches and emphasize the need for diagnostic analyses in dealing with complex problems (Edquist, 2011; Moser & Ekstrom, 2010; Ostrom, 2007). Malekpour and colleagues highlight this with specific reference to planning, and call for the development of diagnostic approaches that help with the systemic and empirical identification of problems and barriers as part of the strategic planning process (Malekpour, Brown, & de Haan, 2015).

Against this backdrop, this paper puts forward a model for a planning intervention to assist the systemic diagnosis of impediments to sustainable infrastructure delivery within their practical contexts. Broadly speaking, strategic infrastructure planning in the context of sustainable development starts with developing a vision, followed by designing strategic pathways/options to achieve the vision (Ferguson, Frantzeskaki, & Brown, 2013). Our diagnostic intervention targets those strategic planning and decision-making processes that have already envisioned and intended sustainability, to be achieved through innovative infrastructure options. The intervention would then assist planners and decision makers to explicitly and reflexively identify a range of challenges and barriers to realizing the vision and strategic options as part of the strategic planning process. It also helps with drafting coping strategies, in order to remove, circumvent or ameliorate the identified impediments.

The diagnostic intervention we propose may be considered as a member of a broader family of approaches that deal with high uncertainties in long-term planning and aim at increasing the robustness of planning decisions in the face of future challenges. Examples include Assumption-Based Planning (Dewar, Builder, Hix, & Levin, 1993), Robust Decision Making (Lempert, Popper, & Bankes, 2003) and Adaptive Policymaking (Walker, Rahman, & Cave, 2001). However, what we propose is not a grand planning framework or methodology. It is indeed an intervention that aims at capacity building within the ongoing processes of strategic planning for more robust outcomes toward realizing sustainable development.

The paper also reports on the trial application of the proposed intervention in water infrastructure planning for one of the world's largest urban renewal areas (approx. 500 ha) located in Melbourne, Australia. This empirical application provides insights into the details of the implementation challenge, as well as a potential roadmap, for delivering a *Water Sensitive City*—a vision that encapsulates sustainable, liveable and resilient urban water systems. The methodological approach and the insights derived from the trial application are relevant and potentially useful for both academic scholars and practitioners who aim to achieve sustainable development in infrastructure sectors.

2. Conceptual underpinnings of the planning intervention

Infrastructure planning in industrialized countries is often undertaken at multiple scales and levels across national, state and local governments; bureaucratic planning bodies; and water, energy, transport or communication utilities (Furlong, De Silva, Guthrie, & Considine, 2016). Infrastructure planning frameworks are often used to guide the process and provide the required steps for identifying infrastructure solutions. Most existing frameworks vary both within and across nations. However, at the strategic planning level, they often share a number of fundamental steps (Furlong et al., 2016). These include: setting the vision or goal, identifying infrastructure options, evaluating the options, and selecting the options.

There is widespread agreement that conventional approaches to option identification and evaluation are not suited to deliver sustainable infrastructure outcomes (Lienert, Schnetzer, & Ingold, 2013; Malekpour et al., 2015; Truffer et al., 2010; Wright, 1996). Conventional approaches have been underpinned by the rationality paradigm and dominated by a linear optimization thinking (Alexander, 1984; Voß, Smith, & Grin, 2009). The rational model prescribes systematic identification and evaluation of alternative solutions and selection of the one with the best expected/optimal outcomes (Alexander, 1984). The optimal outcomes are typically based on the assumption of the most likely future, or a narrowly defined set of future conditions (Walker, Haasnoot, & Kwakkel, 2013). Such mainstream practices often rigidly and restrictively quantify or objectify strategic infrastructure planning into a set of 'tick boxes' and normative requirements—for the sake of efficiency—thus constraining innovation and exploratory thinking among planners (Leach et al., 2015). Narrowing down on uncertainties and complexities may even be favored by planners and decision makers (Enserink, Kwakkel, & Veenman, 2013; Mulvihill & Kramkowski, 2010), who often lack sufficient time, resources, information and enabling tools to handle the highly dynamic sociotechnical environments surrounding infrastructure decisions (Störmer et al., 2009).

Long-term planning in the context of sustainable development, however, involves redirecting the trajectories of development, introducing new structures and practices and nurturing innovative solutions (Voß et al., 2009). It deals with uncharted pathways that unravel over time as they propagate into the future. Effective outcomes result from the interplay of diverse political, economic, social, institutional and technological factors (Voß et al., 2007). Such a complex planning endeavor cannot proceed with predictive approaches, linear analyses and mechanical steering. Instead, it would require a great deal of exploration, reflexivity, learning and adaptability (Mulvihill & Kramkowski, 2010; Steurer & Martinuzzi, 2005; Walker et al., 2013).

As uncertainties, complexities and interdependencies within urban environments increase, and as the impacts of urban infrastructure extend beyond their immediate temporal and spatial boundaries, the role of planners need to expand (Rogers et al., 2014) to include—among other things—an exploratory analysis of various infrastructure solutions under a range of short-term and long-term circumstances. Multivariability and unpredictability of planning outcomes in the context of sustainable development imply that the search for robust solutions needs to replace the traditional quest for optimal solutions (Rogers, Lombardi, Leach, & Cooper, 2012). Indeed Walker and his colleagues argue that a sustainable plan is not only a plan that fulfills certain economic, environmental and social criteria, but is also a plan that is robust against changing circumstances (Walker et al., 2013).

The journey toward sustainability is a long-term journey, involving high levels of uncertainties (Mulvihill & Kramkowski, 2010). There are examples of infrastructure strategies perceived as sustainable and endorsed by decision makers, which were later derailed due to changing conditions (e.g. change of government or economic downturn) or unintended consequences, ending up with unsustainable investments in practice (see Hurlimann & Dolnicar, 2010; Victorian Auditor-General, 2008). This implies that, not only the present/short-term impediments to the adoption of sustainable infrastructure strategies need to be identified and dealt with, a more proactive orientation toward anticipating future disruptions is also required. This thinking will need to diffuse among a whole range of actors involved in infrastructure planning, including engineers, architects, regulators, developers, and politicians.

To prepare for future disruptions resulting from severe uncertainties, Goodwin and Wright suggest that planning processes need to i): provide conditions to challenge planners' thinking and improve anticipation, ii): assist with designing protection strategies against undesired circumstances (Goodwin & Wright, 2010).

We use this 2-step strategy as a framework to shape our proposed planning intervention model in the next section.

3. A diagnostic planning intervention model

In this section, we present a model for a diagnostic planning intervention which provides a process methodology for planners and decision makers to systematically reveal and prepare for short-term barriers and long-term disruptors to sustainable infrastructure strategies. The planning intervention, as its name suggests, does not aim to comprehensively transform or replace the ongoing strategic planning process. Rather, it is meant to be used as an add-on to the ongoing planning process, in order to build capacity for more robust planning outcomes. Building on the arguments in the previous section, the intervention consists of two main stages: 1): Revealing the vulnerabilities of planning decisions, 2): Identifying coping strategies to enhance robustness.

We first position the planning intervention within the overall strategic planning process, then elaborate on its methodological steps. Fig. 1 provides a schematic overview of the discussions in this section, showing the main components of the planning intervention and its link to the rest of the planning process.

3.1. Position within the strategic planning process

From the strategic planning perspective, the process of steering for sustainability in infrastructure provision entails defining a shared vision of the future of infrastructure systems, and devising pathways to realize the vision (Ferguson, Frantzeskaki et al., 2013). In the context of sustainable development, visions are envisaged desired futures that encompass shared principles for long-term sustainability, and pathways are routes to the vision via a range of strategic options (Loorbach & Rotmans, 2010). In the water sector for instance, examples of strategic infrastructure options may include developing stormwater harvesting or wastewater recycling schemes. Once the strategic options are identified, they are evaluated under relevant context conditions, such as population growth estimations/scenarios or climate change scenarios, using a range of tools (e.g. modelling tools) and techniques (e.g. cost-benefit analyses). Once the viable options have been narrowed down, an official strategy is put together to guide further actions.

We suggest to intervene as part of the evaluation process, i.e. before the development of the strategy, to challenge and 'stress-test' the defined vision and the potential strategic options (see Fig. 1). In a participatory setting involving representatives from various stakeholder groups, participants will engage in interactive discussions among themselves to explore a wide range of short-term barriers and long-term disruptors to the vision and the potential strategic options. They also identify coping strategies that could enhance the robustness of the vision and the strategic options. Participants would then reflect on the exercise to potentially revise the vision and the strategic options in an iterative way, or, incorporate a set of coping strategies in the strategic plan to enhance robustness. The outcomes of this exercise would then feed into more detailed analyses (including quantitative analyses) to shape action plans.

The participants in this planning exercise would be the stakeholders in the infrastructure decisions under consideration, i.e. those who are affected by the decisions, and those who have the power to influence the outcomes (Freeman, 1984). If the boundaries of the case and the roles and responsibilities of different actors involved in the process are clearly defined, stakeholders can be almost easily identified (Reed et al., 2009). For instance, in water infrastructure planning in most Australian cities, main stakeholders include: state government departments, local governments, planning authorities, regulators, water utilities, developers and the public. In less clear cases, identifying stakeholders will be an iterative process using a range of methods such as expert opinion, focus groups, semi-structured interviews, snow-balling, or a combination of these (for more details see Reed et al., 2009).

3.2. Methodological steps of the planning intervention

This section describes the methodological steps of our proposed intervention. A description of the detailed mechanisms through which the intervention could be delivered is presented in Section 4.2.

As discussed earlier, the intervention consists of two main stages: 1): Revealing vulnerabilities, 2): Identifying coping strategies.

We suggest that revealing vulnerabilities could occur in at least three steps:

1-A): Exploring the disruptors to the vision:

Despite the recent surge of interest in visioning as a way of framing decisions in view of a better future (Albrechts, 2012), the exercise is often divorced from practical realities (Myers & Kitsuse, 2000). In many cases, infrastructure investments are short-term responses driven by electoral cycles or immediate requirements (Fuenfschilling & Truffer, 2014) instead of a long-term vision. Without explicit consideration of such drivers and their consequences on planning decisions, visions could turn into 'blue-sky wish lists' and lose their functionality (Myers & Kitsuse, 2000).

While we emphasize the role of visioning in guiding the strategic planning process in the context of sustainable development, we suggest

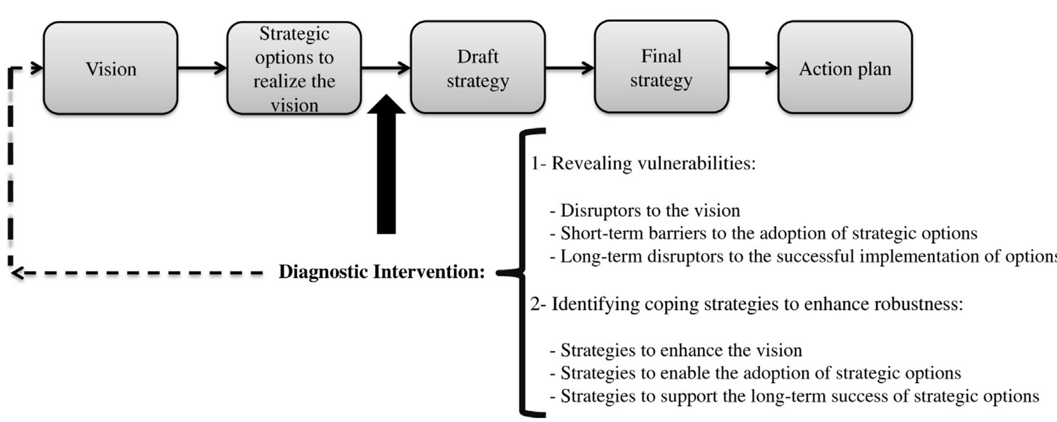

Fig. 1. An overview of the diagnostic intervention and its link to the overall strategic planning process.

that stress-testing of visions could help increase their robustness in the face of changing circumstance or alternative interpretations. To do that, stakeholders need to engage in interactive discussions to explore the factors (across political, economic, social, institutional, technological, legal and environmental domains—commonly known as PESTLE in strategic management, with the addition of 'institutional' in our variation) which may paralyze the vision, or distract short-term actions from aligning with the long-term vision. Those factors/disruptors would then need to be listed for further reflections, and to inform the development of coping strategies.

1-B): Exploring the short-term barriers to the adoption of sustainable options:

The barriers to the adoption of sustainable infrastructure options are often diverse and complex, requiring explicit consideration at the outset of any development. They may range from high investment or operating costs, to matters related to social acceptability of some options. As Hunt and Rogers (2005) indicate, many of those barriers are often evident to planners and decision makers; yet, they are not always made explicit and collectively discussed as part of the planning process.

In our proposed planning intervention, we suggest that planners and decision makers across various stakeholder groups engage in interactive discussions to identify a range of barriers (across political, economic, social, institutional, technological, legal and environmental domains) that hinder or delay the adoption of sustainable solutions. The identified barriers would then need to be listed for further reflections, and to inform the development of potential resolution strategies.

1-C): Exploring the long-term disruptors to the successful implementation of sustainable options:

Long-term disruptors, in this context, are factors that can impede the long-term success of adopted sustainable solutions, or make them fail completely after implementation. An example may be technological failure of a sustainable option after implementation, putting public health or safety at risk. Unlike short-term barriers, which are encountered by planners and practitioners in their routine practices, exploring long-term disrupters requires imagination and creativity. The field of futures studies has put forward tools that may support the anticipation of future issues (Hunt et al., 2012). While forecasting techniques extend past and present trends to predict what is likely to happen, Foresight techniques, such as scenario analysis, assume a higher level of uncertainty and explore multiple possible futures to assess their consequences on planning decisions (Enserink et al., 2013).

Our proposed intervention is based on Foresight thinking and uses exploratory scenarios (see Börjeson, Höjer, Dreborg, Ekvall, & Finnveden, 2006 for scenario typologies), to prepare for the futures that *can* happen, regardless of their probabilities. We suggest that participants engage in interactive discussions among themselves, and creatively brainstorm about 'what can go wrong'. They can explore a portfolio of drivers (across political, economic, social, institutional, technological, legal and environmental domains) that could potentially lead to the failure of each strategic option, either upon or post implementation. The disruptors could then be documented across each of the domains mentioned above, and inform the development of coping strategies to enhance robustness.

Once the vulnerabilities have been revealed and made explicit, the second stage of the planning intervention would involve the development of a potential road map to remove, circumvent or ameliorate the vulnerabilities. While the identified barriers and disruptors in the first stage would inform the development of coping strategies in the second stage, they should not be directly (i.e. one-to-one) linked to each other. There are two reasons for this: first, as Derbyshire and Wright (2014) argue, linking coping strategies to identified problems implies that the way to prepare for undesirable outcomes is solely through the identification of what might cause them. This thinking is grounded in determinism, which assumes that outcomes or events can be predicted once their causes have been identified and predicted. Given the deep uncertainty associated with long-term planning in the context of sustainable development, we need a non-deterministic approach, in order to prepare for a complex and highly uncertain future without direct recourse to causation. Second, the list of identified barriers and disruptors, no matter how extensive, cannot be complete and would only contain 'examples' or typologies of what can happen. The list is certainly useful as it stimulates—what Malekpour and her colleagues call—*exploratory thinking* (Malekpour, de Haan, & Brown, 2016) among decision makers, and reveals a range of problems that need to be dealt with. However, direct linking of coping strategies to identified problems, without recognizing that there are many more unidentified issues, could be misleading as it could create an illusion of preparedness.

Our proposed non-deterministic approach to identifying coping strategies is rooted in Robust Decision Making thinking (Lempert et al., 2003): good coping strategies are strategies that enhance the robustness of planning decisions, regardless of how the future will unfold. General examples may include: no-regret strategies, flexible or reversible strategies, and strategies that enable small scale experimentations (Derbyshire & Wright, 2014; Hallegatte, 2009). Identifying such coping strategies could occur in three steps:

2-A): Exploring strategies to enhance the vision:

In this step, strategies that enhance the desired vision in the face of potential disrupters are identified through interactive discussions among stakeholders.

2-B): Exploring strategies to enable the adoption of sustainable options:

In this step, participants across different stakeholder groups join interactive discussions to explore strategies that enable the adoption of sustainable options in the face of existing barriers.

2-C): Exploring strategies to support the long-term success of sustainable options:

In this step, participants interactively explore strategies that could improve the prospect of success for sustainable options in the face of future disruptors.

The suite of potential strategies identified through this exercise would then need to be analyzed in more detail before they could shape action plans.

4. Trial application of the diagnostic planning intervention

A fundamental challenge faced by the planning research is the evaluation of new planning concepts, approaches or methods (Haasnoot, Kwakkel, Walker, & ter Maat, 2013). The suitability and effectiveness of a planning approach can neither be determined in the short term, nor from a single instance of a plan generated by that approach, unless there is a competing parallel plan (Dewar et al., 1993). In this regard, planning research often tends to provide controlled real-world applications of new planning approaches to offer evidence on their potential effectiveness through critical reflections on the trialed process (Haasnoot et al., 2013; Hansman, Magee, Neufville, Robins, & Roos, 2006).

In this study, we empirically trialed our proposed diagnostic intervention in strategic planning for water servicing in Fishermans Bend—one of the world's largest urban renewal areas located in Melbourne, Australia. This section reports on the trialed process. The next two sections present the results and discuss the implications of this trial for addressing the implementation deficit of sustainable development.

4.1. Context: Fishermans Bend urban renewal project

Fishermans Bend is an approximately 500 hectare urban renewal area in inner Melbourne. The site is currently industrial and is in multiple private ownerships (Places Victoria, 2013). The renewal project will transform the area into a modern mix of high density residential, retail and commercial developments over the next 40 years, through public and private investments (MPA, 2014). The site will effectively become an extension of Melbourne's city center, playing a key role in the city's future growth, productivity and economic investments (MPA, 2014).

The population of Fishermans Bend is expected to increase from 200 people to at least 80,000 and up to 240,000 people by 2055 (CRCWSC, 2015). This highlights the need for new infrastructure planning and delivery in the area. However, several physical constraints directly affect the development of Fishermans Bend: the site is flat, close to the bay and almost at the sea level. It also sits at the end of the floodplain of Melbourne's Yarra River. As such, the area is highly prone to flooding (CRCWSC, 2015). In addition, the soil in some parts of Fishermans Bend has been contaminated as a result of industrial activities over the past century (Places Victoria, 2013). Soil contamination issues and a shallow groundwater table prioritize raised podium developments over buried assets and services (CRCWSC, 2015).

Regeneration of brownfield areas at the scale of Fishermans Bend provides unique opportunities for implementation of leading edge innovations in infrastructure delivery toward sustainable development of future precincts and cities. Indeed the government's draft vision for Fishermans Bend calls for the use of “best practice environmental sustainability to create a liveable community” that reinforces Melbourne's international position as a liveable, sustainable and creative city (Places Victoria, 2013). In the water sector, a conceptual representation of that vision is the *Water Sensitive City* (Wong & Brown, 2009), which builds on sustainable urban water management practices and incorporates liveability, sustainability and resilience into the design and delivery of urban water services. In a Water Sensitive City, the import of potable water into the city and the export of wastewater out of the city are minimized through diversification of water sources, flood hazards are mitigated in a sustainable way, stormwater pollution of urban waterways is avoided, and water infrastructure are multi-functional, providing ecosystem services and/or contributing to the liveability of the built environment.

Since the vision and key strategic directions for the development of Fishermans Bend have been announced, several shadow strategic planning exercises have been undertaken by experts across various disciplines to develop innovative ideas that realize stakeholders' vision for the area. In this regard, the *Cooperative Research Centre for Water Sensitive Cities,* comprising about 100 Australian university and industry partners, and some non-Australian partners active in the water sector, convened a strategic planning process to identify opportunities for a water sensitive development in Fishermans Bend. This initial planning process was undertaken over a period of five months toward the end of 2014 and early 2015, and was attended by researchers, representatives from state government agencies, local governments, water utility companies and private consultancies. The outputs of that process were a range of innovative and sustainable water servicing options, such as a central green spine for urban drainage, potable reuse of greywater, stormwater harvesting, etc. (see CRCWSC, 2015 for details).

However, it was widely agreed that, given the long-term horizon in the Fishermans Bend project, practical realization of the vision and the water sensitive options could be susceptible to various barriers and disruptors impacting on the planning and implementation process along the way. The water sensitive ideas had to be implementable in the short-term, i.e. when early developments would start, and also relevant till the end of the development in 2055, when new conditions would most likely prevail. Against this backdrop, an intervention appeared necessary: the diagnostic planning process was subsequently launched by the Cooperative Research Centre for Water Sensitive Cities, in order to reveal the vulnerabilities of the ideas developed in their initial planning process, and to identify the required coping strategies.

4.2. Research design: The diagnostic planning process for Fishermans Bend

The diagnostic planning process for a water sensitive Fishermans Bend involved the use of the diagnostic approach proposed in this paper in a participatory setting. Two half-day workshops were held in October 2015, each attended by 13–15 representatives from major stakeholder organizations including: state government agencies responsible for water policy, urban planning policy and environmental regulations; local governments/municipalities; and water utility companies. With the exception of two people who couldn't attend the second workshop, the participants were the same across both workshops. The two workshops were a week apart and each was followed by an evaluation session, in which the participants reflected on the trialed process and the outcomes.

The research team conducted context analyses prior to the first workshop. This involved collection and analysis of secondary data, i.e. background documentation on the Fishermans Bend project, such as policy materials, media releases and organizational reports from major stakeholders. Primary data was also collected through informal interviews with some of the key individuals within major stakeholder organizations, who were closely involved in the Fishermans Bend project.

The research team also designed workshop activities and one of the researchers acted as the facilitator and observer/analyst during the workshops, without contributing content to group discussions. Workshop discussions were conducted in groups of 4–6 people to generate diverse results, and then all groups exchanged and discussed their generated ideas.

Among the water sensitive options identified in the initial planning, four were selected for further scrutiny in the diagnostic process. They were selected so as to cover different implementation scales (i.e. whole development vs. individual buildings), and to include a range of water services (i.e. water supply, wastewater collection, drainage). They included:

- Central green spine: a drainage strategy that incorporates natural filtration of stormwater into the urban landscape. The suggested green spine in Fishermans Bend has a transport function as well: it is also used as a tramway passing through the middle of the development.
- Greywater to potable reuse: a water supply strategy to minimize the reliance on central water supplies, and to decrease the load on the sewerage system by recycling the water from taps, showers and washing machines.
- Pressure sewer: a sewerage collection strategy that allows the use of smaller and shallower pipes in a contaminated site like Fishermans Bend, and reduces peak flows to the treatment plant through scheduling of flows.
- Stormwater harvesting through podium building design: the podium design of buildings, as instructed by the Metropolitan Planning Authority (MPA, 2014), is harnessed to increase the efficiency of drainage and to provide an alternative water source. Due to site contamination, the design of buildings will incorporate elevated public realms (i.e. podiums) at the base of multi-story buildings, with minimum sub-terrain structures. The podium areas could incorporate green infrastructure, capturing and treating stormwater, while enhancing the amenity of the built environment.

The first diagnostic planning workshop focused on revealing the vulnerabilities, i.e. what can go wrong in the realization of a water sensitive Fishermans Bend. At the outset, the research team presented on scenario planning methods and the concept of exploratory scenarios which underpinned this exercise. In three major activities, the participants interactively and creatively explored A): the disruptors to the water sensitive vision, B): the short-term barriers to the adoption of the four water sensitive options mentioned above, and C): the long-term disruptors to the successful implementation of those options. For each activity, the participants documented the results of their discussions on flip charts in groups of 4–6, and then all groups reconvened to exchange and discuss their generated results.

The second workshop focused on identifying coping strategies. In the beginning of the second workshop, one of the researchers presented consolidated outputs from the first workshop for validation by the participants, and also to inform the development of coping strategies. Afterwards, three major activities were undertaken by the participants: A): exploring strategies to enhance the vision of a water sensitive Fishermans Bend, B): exploring strategies to enable the adoption of water sensitive options, and C): exploring strategies to support the long-term success of water sensitive options.

Table 1
Potential disruptors to the vision of a water sensitive Fishermans Bend.

Political disruptors	
Overarching theme	***Example disruptors***
Uncertainty in the political landscape; Inaction or loss of momentum	Change of government or government priority Change of leadership or direction at the relevant authorities Change of the broader development vision Inertia and losing opportunities
Economic disruptors	
Overarching theme	***Example disruptors***
Lack of a strong business case for a water sensitive development	Economic downturn Emergence of competing investment priorities Delayed benefits of water sensitivity, exacerbated by the difficulty in quantifying the benefits
Social disruptors	
Overarching theme	***Example disruptors***
Inadequate public understanding about the implications of water sensitivity	Change of societal preferences Risk perceptions toward some of the water sensitive options (e.g. recycled water) Societal demand for quick fixes in times of crises (e.g. droughts and floods), dictating large and conventional infrastructure
Institutional disruptors	
Overarching theme	***Example disruptors***
Inadequate institutional arrangements to enforce water sensitivity	Lack of enforcement of the vision through governance structures, policy and regulatory instruments Economic valuation frameworks not in favor of water sensitivity Lack of monitoring and evaluation frameworks to benchmark progress toward the vision
Technological disruptors	
Overarching theme	***Example disruptors***
Technological infancy of water sensitive solutions	Failure in a high profile water sensitive project Technological developments in non-water sensitive options
Legal disruptors	
Overarching theme	***Example disruptors***
Inadequate regulatory/legislative instruments to support water sensitivity	Lack of enforcement of the vision through planning mechanisms or regulatory instruments Potential legal challenges against water sensitive investments
Environmental disruptors	
Overarching theme	***Example disruptors***
Extreme climatic events	Sea level rise endangering the development Extreme droughts and floods urging immediate implementation of large and conventional infrastructure

5. Results

5.1. Impediments to the practical realization of a water sensitive Fishermans Bend

The impediments to the practical realization of a water sensitive development, as consolidated from the diagnostic planning intervention for Fishermans Bend, are presented in Tables 1 to 3.

Table 1 includes a range of disruptors to the water sensitive vision, as made explicit by workshop participants. The disruptors did not refer to any specific water sensitive technology or solution, but were rather about the vision as a whole. The overarching disruptors across political, economic, social, institutional, technological, legal and environmental spheres mainly related to:

- Uncertainty in the political landscape; political inaction or loss of momentum
- Lack of a strong business case for a water sensitive development
- Inadequate public understanding about the implications of water sensitivity
- Inadequate institutional arrangements to enforce water sensitivity
- Technological infancy of water sensitive solutions
- Inadequate regulatory/legislative instruments to support water sensitivity
- Extreme climatic events (e.g. floods and droughts) urging immediate solutions.

The participants commented that they perceived political and economic disruptors (the first two points above) as the biggest threats to the vision, since they appeared to be the hardest ones to tackle from within the water sector.

Table 2 presents a range of barriers to the adoption of the four water sensitive options, as made explicit by the participants. Economic barriers related to potentially higher capital or operating/maintenance costs compared to conventional systems were brought up in discussions around all the four options. Other barriers, however, varied across the four options:

For *central green spine*, the barriers mainly related to the complexities arising from multiple uses, i.e. drainage and transport (e.g. conflicting design standards across multiple uses; inadequate mechanisms for cross-sectoral infrastructure planning, cost sharing and operation).

For *greywater to potable reuse*, the main barriers to adoption were negative perceptions toward potable use of recycled water.

For *pressure sewer*, no major social and political barriers were identified, but a few technical difficulties were indicated, including the lack of design standards for application of pressure sewers in high rise buildings.

For *stormwater harvesting through podium building design*, which needs to be implemented at the building scale, the barriers mainly related to the lack of a strong value proposition to developers/investors.

In the end, the participants concluded that, while *central green spine* had the largest number of identified barriers to adoption (see Table 2),

Table 2
Barriers to the adoption of water sensitive options.

	Political barriers	Economic barriers	Social barriers	Institutional barriers	Technological barriers	Legal barriers	Environmental barriers
Central Green Spine		• Competition for space (wider roads) • Potential maintenance costs • Potential timing mismatch between funding and sequential infrastructure delivery	• Low societal tolerance toward ponded water in public spaces	• Inadequate mechanisms for cross-sectoral infrastructure planning, cost sharing, use and operation	• Conflicting technical standards across multiple uses (transport vs. drainage) • Low design flexibility • Lack of full life cycle proof of concept	• Litigation for flood accidents in public space • Planning control for land acquisition	• Competition for space (wider roads) • Potential maintenance costs • Potential timing mismatch between funding and sequential infrastructure delivery
Greywater to Potable Reuse	• Government's policy against potable use of recycled water	• Cost of the separate greywater collection system	• Risk perceptions toward recycled water	• Authorities' resistance toward potable use of recycled water • Lack of mechanisms for cost and risk sharing among stakeholders		• Existing plumbing regulations	• Emissions resulting from energy use
Pressure Sewer		• Potential higher operating costs compared to gravity sewers			• Storage requirements • Lack of technical design standards for application in high rise developments	• Inadequate regulations for operating public (utility) assets on private properties	• Odor concerns • Emissions resulting from energy use
Stormwater Harvesting through Podium Building Design		• Potential increased costs to developers • Potential maintenance costs		• Lack of mechanisms for cost and responsibility sharing among stakeholders	• Inadequate design guidelines to optimize podium building design for water-related outcomes	• Lack of clarity about the ownership of stormwater	

Table 3
Disruptors to the long-term success of water sensitive options.

	Political Disruptors	Economic Disruptors	Social Disruptors	Institutional Disruptors	Technological Disruptors	Legal Disruptors	Environmental Disruptors
Central green spine		• Higher than expected O&M costs	• Increase in car use and demand for more road space	• Failure of cross-sectoral ongoing support (e.g. due to maintenance difficulties)	• Water damage to trams		• Groundwater level rise • Extended droughts increasing O&M costs • Major floods undermining confidence in the green spine
Failure Scenario: *Green spine losing its drainage function, revert to conventional big pipe drainage*							
Greywater to potable reuse	• Loss of political support (e.g. resulting from a contamination incident)	• Higher than expected O&M costs	• Loss of community support (e.g. due to a contamination incident) • Health scare campaigns	• Loss of support from key players	• Technological advances in other technologies (e.g. cheaper desalination) • Technological failure leading to water contamination	• Legal issues arising from a contamination incident	
Failure Scenario: *Loss of greywater as an alternative source, revert to non-water sensitive supply and sewerage systems*							
Pressure sewer	• Loss of political support resulting from a failure • Political backlash resulting from a failure in pressure sewers elsewhere	• Higher than expected O&M costs	• Loss of community support (e.g. due to potential odor problems)		• Technological failure leading to an incident (e.g. explosion) • Poor design or maintenance causing overflows • Manipulation with the control system (e.g. hacking)	• Legal action on water utility arising from an incident	
Failure Scenario: *Revert to conventional sewerage system in the middle of development, and/or, backlash on pressure sewers for future developments*							
Stormwater harvesting through podium building design	• Loss of political support (e.g. resulting from a contamination incident)	• Structural damage to properties	• Loss of community support (e.g. demand to retrofit podiums to other amenity spaces)	• Planning system open to variability	• Poor design or maintenance leading to the loss of function	• Legal issues arising from a contamination incident or storm damage from overflow	• More intense floods urging conventional big pipe drainage • Continuous heat waves and loss of vegetation
Failure Scenario: *Loss of stormwater as an alternative water source, loss of the amenity function, revert to non-water sensitive supply and drainage*							

Table 4
Strategies to enhance the vision of a water sensitive development.

Strategic pathway	Example strategies
Develop a broad ownership of the vision	Make the vision appealing to all sides of politics Turn the narrative into a long-term thinking that goes beyond electoral cycles Embed the vision in the broader development agenda (water is not the only puzzle piece in a development such as Fishermans Bend) Create a shared narrative for the vision across different stakeholders Communicate the vision in such a way so as to create broad community consent
Develop a market/business-case for the vision	Making the implications of water sensitivity and its benefits explicit Work on quantifying the benefits Communicate the societal benefits of water sensitivity to the public Establish demonstration sites to showcase outcomes and achievements
Ensure delivering on the vision over the long term	Base the vision on performance outcomes, be flexible with implementation measures Promote the legislation of water sensitivity outcomes Map key decision points and actions Set high standards for early initiatives: "get the first domino in place" Develop strong collaboration mechanisms among various stakeholders Develop a network of champions across various stakeholders Set interim milestones for delivering on the vision Create monitoring and evaluation frameworks to assess progress

the showstoppers were for *greywater to potable reuse* and its adoption in the short-term was nearly impossible, especially given the existing policy bans on potable use of recycled water in most Australian states. The participants also commented that *pressure sewer* was perhaps the easiest option to adopt, as it faced no major hurdles in the social and political arenas.

Table 5
Strategies to enable the adoption of water sensitive options.

Strategic pathway	Example strategies
Address negative perceptions	Provide technical evidence and develop local demonstrations projects Work with champions to address the resistance to unpopular options Influence the broader community to overturn policy bans
Enhance the economics of water sensitive options	Develop evaluation frameworks that encompass societal benefits of water sensitive options Develop financial incentives for implementation of innovative options Develop financing mechanisms that facilitate multi-functional infrastructure investments Enable third party supply and maintenance of water sensitive infrastructure
Facilitate multi-agency infrastructure delivery	Develop common understanding and clear objectives across different organizations with regard to water sensitive ideas Develop template agreements for operation and maintenance, cost and risk sharing Explicitly address any conflicting priorities among stakeholders
Proactively address risk aversions	Utilize demonstration projects to provide proof of concept Develop design guidelines and address the existing standards Plan for sequencing/staging the development to cater for change and improvements along the way Actively communicate that innovation requires risk taking and accept potential failure

Table 6
Strategies to support the long-term success of water sensitive options.

Strategic pathway	Example strategies
Strengthen the design and delivery of water sensitive options	Use the best available design guidelines and processes Plan upfront for operation and maintenance Clarify the relevant planning requirements and regulations Plan for timing and sequencing of the development to have flexibility Ensure ongoing inter-organizational commitment (e.g. through centralized coordination)
Anticipate and prepare for disruptions	Proactively explore what might go wrong Educate the public about the implications of water sensitivity to manage expectations Prepare the right messages in advance and engage with influencers for effective communication with politicians and the public in case something goes wrong

Table 3 presents a range of disruptors to the successful implementation of the four water sensitive options, as envisaged by the participants. They are factors that can potentially impede the long-term success of those options, or fail them completely after implementation, identified through exploratory scenarios. The overarching disruptors across political, economic, social, institutional, technological, legal and environmental spheres mainly related to:

- Loss of political support (e.g. as a result of a detrimental technological failure)
- Higher than expected operating and maintenance costs
- Loss of community support (e.g. as a result of a detrimental technological failure)
- Failure in collaborative processes among key stakeholders
- Technical uncertainties of water sensitive options
- Legal actions (e.g. resulting from detrimental technological failures)
- Extreme climatic events undermining confidence in innovative solutions

Most of the above disruptors appeared to stem from uncertainties associated with the novelty of water sensitive options. For instance, unexpected technical failures, possibly leading to contamination incidents, were discussed several times as the main drivers for losing social and political support, or even a backlash on water sensitive options. However, the participants concluded that the disruption of a water sensitive option as a viable solution would not be determined by a technical failure, but rather by how the failure is approached by the community and within the political arena.

5.2. Potential strategic pathways to success

The coping strategies toward the practical realization of a water sensitive development, as consolidated from the diagnostic planning intervention for Fishermans Bend, are presented in Tables 4 to 6.

Table 4 presents a range of strategies, explored by the participants, which could potentially enhance the vision of a water sensitive development. Across all the identified strategies, the overarching strategic pathways were to:

- Develop a broad ownership of the vision among stakeholders and all sides of politics
- Develop a market/business-case for the vision
- Ensure delivering on the vision over the long term

Table 5 presents a range of strategies to enable the adoption of water sensitive options. Across those strategies, the overarching strategic pathways were to:

- Address negative perceptions (e.g. toward recycled water)
- Enhance the economics of water sensitive options
- Facilitate multi-agency infrastructure delivery
- Proactively address risk aversions

The participants commented that to enable adoption, we need to understand why the present barriers exist. We then need to focus on intended outcomes of water sensitive options and work toward enabling those outcomes by addressing the existing barriers from their roots.

Table 6 presents the identified strategies to support the long-term success of water sensitive options. Across all those strategies, the overarching strategic pathways were to:

- Strengthen the design and delivery of water sensitive options
- Anticipate and prepare for potential disruptions

In the end, the participants commented that the identified coping strategies are not action plans and their implementation details need to be worked out before they can be enacted. However, they emphasized that those strategies set the direction for further endeavors to develop action plans toward the realization of water sensitive cities.

6. Discussion

In this section, we discuss the implications of the trialed diagnostic process, as well as the produced results/contents, for sustainable infrastructure delivery. We then conclude by discussing broader implications of this research for policy and planning research in the context of sustainable development.

6.1. Implications of the trialed process

Although we cannot determine the ultimate effectiveness of our proposed intervention approach for sustainable infrastructure delivery based on a single trial and in the shot-term, we can provide critical reflections on the trialed application to indicate its potential for supporting sustainable development.

Using the case of water services planning for an urban renewal area in Australia, the trialed process brought various stakeholder groups into a participatory and interactive conversation through which they systematically revealed a range of impediments to sustainable infrastructure delivery and explored potential coping strategies. The participants stated that although some of those impediments were not entirely unknown, they were hardly ever made explicit and systematically discussed in a participatory environment involving various stakeholders. In contrast, the diagnostic process provided a platform for representatives across different organizations and specializations to engage in clear-cut discussions around their confronted problems, which often have trans-organizational causes and impacts. This outcome is particularly important for addressing the implementation deficit of sustainable development, since shared understanding and concerted efforts of all parties are required to tackle impediments, drive change strategies and avoid detrimental failures (Voß et al., 2007).

The trialed process also enabled reflexivity as part of the planning process. After the trial, those participants who were advocates for sustainable infrastructure in their organizations expressed that they realized they were often emphasizing benefits in their advocacy, but were less proactive in addressing the complexities and vulnerabilities of transition agendas. They mentioned that the deliberate attempt to reveal vulnerabilities and risks associated with sustainable infrastructure planning helped them to better anticipate and engage with the concerns of those who are ultimately responsible for signing off on multi-billion dollar investments, and highlighted the necessary competencies for addressing those concerns.

We also contend that the diagnostic process potentially improved the prospects of developing robust decisions toward practical realization of sustainable infrastructure delivery. Admittedly, we cannot foresee the ultimate planning outcomes of the trialed process, nor can we trace back the outcomes to the single trial of the planning intervention retrospectively. However, we can build on Futures studies and robust planning literature to argue that the process provided an *enabling condition* for more robust decisions to be made. The scholarship has characterized such an enabling condition as a condition in which a wide range of uncertainties have been represented (Haasnoot & Middelkoop, 2012; Hulme & Dessai, 2008). In our proposed and trialed diagnostic planning intervention, a wide range of uncertainties were indeed considered through short-term and long-term scenarios which were explored across political, economic, social, institutional, technological, legal and environmental spheres. This opened up an extensive portfolio of challenges and possibilities before the participants; a portfolio that wouldn't have been so thoroughly disclosed otherwise.

Based on our experience throughout the trial process, the success of this planning intervention relies on a number of factors. This intervention is particularly suitable at early stages of planning, when no commitment to any solution alternatives has yet been made. Stakeholders' engagement and their commitment to undertaking the intervention are also essential for success. In our case, the Cooperative Research Centre for Water Sensitive Cities played a leadership role in bringing together various stakeholder groups. In other contexts, project coordination bodies, such as project steering committees, could potentially play a key role in this regard. Another enabler of success, which we did not utilize in our case study, would be running participatory processes with the community, not only for co-creation of the vision and infrastructure solutions, but also for addressing the barriers and disruptors and identifying coping strategies to make the solutions work.

With regard to time and resources, carrying out the intervention as suggested in this study does not require extensive time and massive resources. Nevertheless, taking the strategic outcomes from this intervention into more detailed analyses to specify *how* to proceed and *who* is responsible would indeed require time investments and dedicated efforts across all stakeholders.

6.2. Implications of the produced contents

While the initial planning process for a water sensitive Fishermans Bend had produced a set of innovative water servicing options, the diagnostic process revealed a wide range of challenges associated with the practical realization of those options. Some of the identified barriers and disruptors are context-specific (e.g. the ones related to *greywater to potable reuse*, which mainly result from a policy ban in Melbourne and the existing negative perceptions on potable reuse of recycled water), while others are more generic and have been reported elsewhere as well (e.g. Dean, Lindsay, Fielding, & Smith, 2016; Dobbie, Brown, & Farrelly, 2016; Negro et al., 2012). These generic challenges call attention to: legacy approaches, practices and cultures; systemic dependencies among different components of urban environments; uncertainties associated with technological novelties; impacts of political and economic volatilities; inadequate governance structures, institutional, legal and economic valuation frameworks and regulatory instruments as contributors to the implementation deficit of sustainable development. They reiterate, through empirical evidence, the ongoing discourse in the scholarly and practice communities that a shift toward sustainable infrastructure delivery is not only about technological advances, but is also about the development of processes and tools that can effectively support the widespread adoption and successful implementation of those technologies in the face of impediments. Without such a holistic approach all that we might get would be what Hunt and Rogers (2005) refer to as piecemeal improvements, consisting of ‘trophy projects’ and ‘bolt-on extras’ that pay trivial contributions to sustainable development.

7. Conclusions

A great deal of sustainability scholars has warned against blueprint approaches or panaceas in dealing with systemic problems, and has instead called for diagnostic approaches (e.g. Edquist, 2011; Malekpour et al., 2015; Moser & Ekstrom, 2010). In this paper we put forward a diagnostic intervention, to be used as part of the evaluation of infrastructure options—or candidate strategies—in strategic planning processes. The proposed intervention assists planners, engineers, architects, regulators, and decision makers more broadly, to explicitly and reflexively explore short-term and long-term impediments to sustainable infrastructure delivery, and to develop the required coping strategies.

In our proposed approach, we focus on understanding the vulnerabilities of candidate strategies to enhance robustness. This thinking has been previously adopted in some planning initiatives internationally. Examples include: Adaptive Delta Management in the Netherlands (to ensure flood protection and freshwater supply into the future), Urban Futures project in the UK (to assess the resilience of urban regeneration solutions in the face of future conditions), PlaNYC in the United States (to develop climate change adaptation strategies in the New York City infrastructure-shed). The main difference between our approach and the above approaches may be in our explicit and deliberate search for failure scenarios, rather than assessing the robustness of candidate strategies under future scenarios. Our approach also opens up an explicit discussion across different stakeholders with regard to the enablers for infrastructure strategies to be realized. Those enablers involve processes and tools (e.g. governance processes, regulatory instruments) that support the adoption and successful implementation of innovative infrastructure strategies.

The diagnostic intervention proposed in this study targeted early stages of the strategic planning process and was tested in one case study; yet, it revealed a wide range of barriers and disruptors to sustainable infrastructure delivery. This indicates that, to effectively address the implementation deficit of sustainable development, we need various interventions at various stages of planning in order to maintain reflexivity, critically appraise our planning activities and identify the blind-spots. The development of such interventions could constitute an important element of the contemporary research agendas that aspire to the practical realization of sustainable development.

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