Cities 46 (2015) 67–75

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

Strategic planning of urban infrastructure for environmental sustainability: Understanding the past to intervene for the future

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ARTICLE INFO

Article history:
Received 2 November 2014
Received in revised form 15 January 2015
Accepted 7 May 2015
Available online 16 May 2015

Keywords:
Strategic planning
Public infrastructure
Sustainable development
Sustainability transitions
Scoping study
Historical review

ABSTRACT

Urban infrastructure systems have long lifespans and influence the state of the environment for extended periods of time. Processes of strategic planning for urban infrastructure are thus instrumental to materializing environmental sustainability visions. Continued investments in infrastructure with adverse environmental impacts imply that sustainability priorities are not embedded in planning processes, as these processes tend to follow the path-dependent legacy of older planning paradigms. This study identifies the cognitive framings that underpin the evolution of strategic planning over the last century, to reveal the path-dependent attributes of strategic planning thinking that undermine alternative solutions. To do that, a scoping study of the literature on strategic planning of public infrastructure, from 1900 through 2013, was conducted. The findings reveal how the scholarly paradigms for infrastructure planning have transformed over time, from optimization to sustainability. While the planning practice in cities has often taken up the sustainability discourse in line with the scholarship, its actual attributes might lag behind. Knowledge about these attributes is scarce since the contemporary scholarship often contains aspirational proposals for change and little detail on how planning is undertaken in practice. It is likely that the incremental approach to infrastructure planning, which has been the dominant approach for decades, perpetuates a planning culture which contradicts the requirements for sustainability transitions, by limiting the scope of alternatives to optimizing the status quo instead of creating conditions for change. To develop effective planning interventions towards sustainability transitions in urban infrastructure systems, the paper calls for diagnostic tools that examine the realities of planning practice, and, operational frameworks for bridging historically-entrained modes of practice to sustainability aspirations.

1. Introduction

Since the rise of the notion of sustainable development more than 2 decades ago (WCED, 1987), decision makers and planners in cities across industrialized countries have been trying to figure out its practical implications for development of long-term strategies (Malbert, 1998). In this respect, strategic planning of public infrastructure is in a central position to operationalize environmental sustainability visions. Urban infrastructure systems, such as sewerage systems or electricity supply systems, have significant impacts on the environment, and as the scholarship on large technical systems highlights, they attract huge investments and can survive long after they have been proved to be problematic (Walker, 2000).

Despite the internationally agreed vision for sustainable development, the latest assessment report of the United Nations Environment Programme, amongst others, reveals that the world continues to move down an unsustainable path (UNEP, 2012). Wonthaggi seawater desalination plant in Australia, Belo Monte hydroelectric dam in Brazil and extension of the Kaunertal hydropower plant in Austria are just a few examples of contemporary large infrastructure projects that have raised concerns regarding adverse environmental impacts. Truffer, Störmer, Maurer, and Ruef (2010) argue that, despite the call for sustainability transformation of infrastructure sectors to confront global environmental problems, current strategic planning approaches in these sectors tend to perpetuate conventional infrastructure investments (Truffer et al., 2010). Walker (2000) explains this as an 'entrapment' or a 'lock-in' phenomenon (Walker, 2000). Lawrence, Reisinger, Mullan, and Jackson (2013) explain this lock-in with reference to planning and highlight that conventional planning approaches are entrenched within current decision-making frameworks and long-term planning follows the path-dependent legacy

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http://dx.doi.org/10.1016/j.cities.2015.05.003
0264-2751/

of those conventional approaches (Lawrence et al., 2013). Scholars, such as Störmer et al. (2009), attend to addressing the current failure of strategic planning processes, by exploring alternative planning methodologies for sustainable transformation of infrastructure sectors (Störmer et al., 2009).

This study is based on the hypothesis that, to inform the scholarship (and practice) on causes and solutions for environmental issues, it is essential to understand the path-dependencies and the carriers of processes of infrastructure planning, and intervene from there. Indeed Wright (1996) strongly posits that developing interventions in the planning process to promote sustainable development can only be done through understanding the history of how current urban infrastructure systems have been planned and how this shapes today's infrastructure planning. However, analysis of the history of infrastructure planning in the context of sustainable development has often been limited to introductory summaries or brief indications (e.g. Haasnoot, Kwakkel, Walker, & ter Maat, 2013; Truffer et al., 2010). To address this gap, this study aims at identifying the processes and cognitive framings that underpin the evolution of strategic planning for public infrastructure in the urban context over the last century. This is important for revealing the path-dependent attributes of strategic planning thinking, which are likely to undermine alternative public infrastructure investment outcomes that would attend to minimizing environmentally adverse impacts.

This study attempts to develop a tentative typology that characterizes the evolution of strategic planning processes. This is particularly relevant since many scholars have indicated some shifts in direction and content of strategic planning scholarship over time (e.g. Beierle & Konisky, 2000; Haasnoot et al., 2013; Störmer et al., 2009; Truffer et al., 2010), and yet no study has systematically conceptualized those shifts. To do that, against a backdrop of a distinct lack of evidence that specifically highlights the attributes of strategic planning practice, a critical review of the literature on long-range planning and strategic planning was conducted, focusing on the public infrastructure sector. The review covered the literature of the whole 20th century, including prior to the rise of the environmental movement, up to the present time. The reason for covering such a long period of time was to profoundly understand the strategic planning thinking and culture that have shaped current urban infrastructure systems, whose establishment, in many cases, dates back to several decades ago.

2. Methodology

Among the methodological techniques for critical review of literature, the scoping study methodology was chosen for this study. Scoping studies map the key concepts underpinning a research field and the main sources of evidence by incorporating a broad range of studies into the review process (Arksey & O'Malley, 2005). The methodology was particularly suitable for this study since it could provide a comprehensive coverage of the relevant literature regardless of the study types (Davis, Drey, & Gould, 2009).

This study used the comprehensive and the most utilized methodological framework for conducting scoping studies developed by Arksey and O'Malley (2005). The framework consists of 5 stages:

Stage 1: Identifying the research question
Stage 2: Identifying (potentially) relevant studies
Stage 3: Study selection
Stage 4: Charting the data
Stage 5: Collating, summarizing and reporting the outcomes

Expert consultation was also used to inform and validate the findings of the study. This would not only add to the methodological rigor, but also would help acquire additional insights beyond those directly found in the reviewed literature (Levac, Colquhoun, & O'Brien, 2010).

2.1. Information gathering

The operational question to guide the scoping review was: *How has the scholarship on strategic planning for urban public infrastructure evolved, and what have been the qualitative shifts in that knowledge over time?*

To identify potentially relevant studies, decisions were made regarding the time span, the language and the sources of the literature to cover. The time span from 1900 through 2013 was covered. This period was chosen since the explicit discourse around long-range planning of public works emerged and developed in the early decades of the 20th century. During the same period, many of today's public infrastructure systems in industrialized cities were constructed. However, it would be worthwhile to acknowledge that some of the existing urban infrastructure systems were shaped prior to 1900. Modern water supply and sanitation systems, for instance, were developed in England in the 19th century, with developments soon spreading to other parts of the Europe and the US (Juuti & Katko, 2005). In Australian cities, development of urban infrastructure, including water supply and sanitation systems, succeeded the European settlements in the 19th century (Brown, Keath, & Wong, 2009).

As for the language, it was only feasible to consider literature written in English, and though this limits the generalization of findings, it mainly affects those from the first half of the 20th century, as English became the lingua franca of most scholarships in subsequent years.

Searching for literature took place using electronic databases. The databases utilized were Google Scholar and Scopus. Scopus was chosen, since it includes a wider range of journals than most other databases such as Web of Science (Falagas, Pitsouni, Malietzis, & Pappas, 2008). However, Scopus only covers publications from the end of the 1960s onward (Falagas et al., 2008). Therefore, Google Scholar was used to search for publications from 1900 to 1970, since it theoretically covers all online-available publications (Falagas et al., 2008).

The search terms, according to the scoping study framework, were defined loosely at the beginning of the study and then refined in a reflexive way once some sense of the scope of the field was gained. The search keywords included: *long-range planning*, *strategic planning*, *public*, *infrastructure* and *city* or *cities* or *urban*. It was known that the choices made about the keywords might have had excluded potentially relevant publications that use different terminologies, such as 'master planning'. Therefore, the expert consultation exercise at the last stage was used to ensure all the key issues and concepts were included.

The total number of returned search results at this stage was about 750. A mechanism was then developed for excluding irrelevant studies. Studies were included if they addressed at least one of the followings:

- Explicit justification for the need for long-range/strategic planning of public infrastructure: this would provide insights into the drivers for development of strategic planning knowledge.
- Purposes of long-range/strategic planning processes: this would provide insights into the objectives that planning processes tended to fulfill.
- Methodological approaches for long-range/strategic planning: this would provide insights into practical application of planning processes.
- Challenges for application of long-range/strategic planning: this would provide insights into implementation barriers and the

drivers for research in other fields that would support or complement strategic planning.

As a result, copies of, in total 115, full publications were obtained that fulfilled the inclusion criteria.

2.2. Synthesis of obtained information

The information obtained from the primary research publications were analyzed through charting, i.e. sifting and sorting material according to key issues and themes. Descriptive-Analytic method was used as the charting method, which entails applying a common analytical framework to all the primary research items and extracting standard information from them (Pawson, 2002).

The following information was extracted from the primary research publications:

- Key research focus of the scholarship on long- range/strategic planning of public infrastructure, to indicate the drivers for knowledge development and research on strategic planning
- Objectives and the implicit and explicit agendas of long-range/strategic planning
- Approaches, methodologies and techniques developed for long-range/strategic planning
- Challenges for practical application of long-range/strategic planning
- Authors' affiliations as academic scholars versus practitioners, to potentially indicate the orientation of strategic planning studies towards practical relevance or research excellence

Once the information was extracted, qualitative shifts that had occurred throughout time were identified. Based on those shifts, information was categorized chronologically, representing distinct periods, and summarized in an information matrix.

2.3. Validation of findings

The study and its findings were presented to a few experts in long-term planning and long-range policy design disciplines for validation and critique. The exercise was also used to identify if there had been any missing concepts essential for the study. The experts were chosen for their relevant expertise, making sure there would be diversity in their geographic locations. Six experts took part in the consultation exercise, consisting of three regarded professors and three senior practitioners with leading roles in infrastructure planning, all from different countries, namely Australia, the Netherlands, the UK and the USA.

3. Findings and discussion

The information matrix resulting from the scoping study is presented in Table 1. In this matrix, the periods between which qualitative changes in direction and content of the literature could be observed are identified, though such boundaries cannot generally be sharply drawn.

Fig. 1 presents a tentative typology of distinct phases of strategic planning thinking over time. The key findings are summarized in four layers:

1. Dominant perspectives in the literature on strategic planning for public infrastructure
2. Qualitative phases in the strategic planning scholarship
3. Paradigms that have governed the strategic planning research
4. Historical context of the period from 1900 to 2013, and the major events likely to have been influential on strategic planning knowledge and research

The information matrix served as the basis for above analysis. To identify the paradigms, the work of Thomas Kuhn (1970) was used, according to whom, "close historical investigation of a given specialty at a given time discloses a set of recurrent and quasi-standard illustrations of various theories in their conceptual, observational and instrumental applications" (Kuhn, 1970). These are the community's paradigms as disclosed by their publications and they can be derived with relative ease, despite occasional ambiguities.

An additional layer, the 'intellectual landscape', was added to Fig. 1 following the expert consultation exercise. According to one expert's feedback, strategic planning is a discipline that has built extensively on existing ideas within a bigger intellectual ecosystem, and has interacted intensely with other disciplines. Searching within the discipline alone may overlook these other relevant intellectual influences. The guidance of the experts and their knowledge and expertise led to a map of this landscape. Fig. 1 shows this map and the sets of ideas that were influential on the development of the scholarship.

3.1. Qualitative phases within the historic context

1900–1921 and 1922–1930

As the information matrix indicates, no literature from 1900 to 1921 could be found online in which long-range planning of public infrastructure was explicitly referred to. The term started to appear in the literature following World War I and the economic crises that occurred in the U.S. in 1920–1921 (Anderson, 1945) and in some parts of Europe such as the UK (Mallery, 1923). Long-range planning of public works was introduced as a way to stabilize the economy and to combat unemployment. It mainly consisted of adapting the timing of public works execution to economic cycles, to make them coincide with times of low business activity to provide unemployment relief (e.g. Andrews, 1930; Mallery, 1928; Mitchell, 1922). Amongst the authors in this period were practitioners as well as academic scholars.

1931–1945

In the 1930s, along with the Great Depression that hit the world, a consensus was formed in industrialized countries around the necessity of long-range planning of public works for stabilizing the economy, underpinned by the ideas of the British economist, John Maynard Keynes, who was advocating for the public sector to actively spend on public works during recession periods ("economics," 2014). Planning for the long term also started to diffuse into cities' planning (e.g. Hall, Kirkpatrick, Schermerhorn, & Shurcliff, 1936) and natural resources development and conservation (e.g. Hyatt, 1938; Joerg, 1935), to deal with the growing demands of urban populations. The research focus in this period was on enacting long-range plans through legislative bodies and enforcing them through administrative and executive bodies in the public sector (e.g. Mallery, 1931). Establishment of planning boards and planning departments to carry out the long-range plans became a priority within Western governments (e.g. Merriam, 1944). Although planning was a top-down practice, gaining public support for long-range plans was highly advocated (e.g. Roper, 1934). This may be attributed to the extent of the problems of the depression and the long time it took to regain equilibrium, which could easily result in revolutions and riots by the nervous masses (Roper, 1934). The scholarship on long-range planning in this period was dominated by practitioners. This might be indicative of a priority of relevance over excellence in strategic planning knowledge during those years.

Table 1
Information matrix of the key concepts presented in the scholarship on strategic planning for public infrastructure.

Papers published in	Key research focus	Main objectives of strategic/long-range planning	Approaches, methodologies & techniques for strategic/ long-range planning	Challenges of strategic/ long-range planning	Authors' affiliations
1900–1921	NA	NA	NA	NA	NA
1922–1930	• How to stabilize the economy and combat unemployment during economic depression	• Stabilizing the economy • Countering unemployment	• Adapting the timing of public projects to economic cycles • Planning processes not addressed	• Predicting the future • Legislations lagging behind knowledge • Administrative obstacles	Both practitioners and academic scholars
1931–1945	• Enacting long-range plans through legislations • Enforcing long-range plans in practice	• Stabilizing the economy • Countering unemployment • Dealing with growing demands of cities • Natural resources conservation	• Top-down but with public support • Establishment of planning boards/ departments • Anticipating the future based on historical data • Incrementally changing plans	• Regulatory apparatus lagging behind knowledge • Gaining public support for long range plans	Practitioners in majority
1946–1950	NA	NA	NA	NA	NA
1951–1974	• Determining the content of the planning process • Developing tools and techniques for long-range planning	• Maximizing the effectiveness of public services in the face of uncertainty and rapid changes	• Defining an organized planning procedure; focusing on internal capacities, with a glance at the external economic environment • Using conditional forecasts and what-if analysis instead of single forecasts • Using computer models, mainly for financial analysis • Applying incremental changes	• Inherent problems of planning for long-term, i.e. uncertainty of the future and rapid changes • Contradicting priorities of strategic versus operational plans	Both practitioners and academic scholars
1975–1989	• If corporate style strategic planning could be applied in the public sector • Defining a strategic planning process for public organizations • Providing conceptual tools and techniques for strategic planning	• Helping public organizations in responding effectively to their changing environment through a coherent planning structure	• Defining the steps in the planning process; taking into account both external and internal environments • Assessing the external environment entails using forecasting techniques, such as construction of a few future scenarios • Involving stakeholders in the planning process • Strategic actions oriented towards change	• Differences of the private and public sector that hinder the applicability of corporate style strategic planning to the public sector • Lack of strategy autonomy in public organizations • Subjective judgments • Orientation towards operational stability in organizations	Academic scholars in majority
1990–2003	• Involving the communities in the planning process • Differentiating traditional planning and strategic planning	• Dealing purposefully and proactively with decisions concerning future issues	• An established model of strategic planning (from the 80s), including identifying missions, external environmental scan, internal resource audit, strategy formulation, action and evaluation • Participatory planning involving communities • Scenario planning to obtain flexibility in the face of uncertainty	• Traditional top-down planning approaches • Citizens' involvement in planning	Academic scholars in majority
2004–2013	• Functions of the planning process per se, rather than the produced plans • Involving the public in the planning process • Improving coordination among stakeholders	Objectives either relate to strategic plans or the planning process per se. Objective of a strategic plan mainly is: • To provide robustness in the face of uncertainty Objective of the planning process is to be a mediator for achieving: • Shared vision and understanding of the future • Relational qualities among actors • Integrated strategies • Trust and legitimacy	• No adherence to a particular formulaic process but rather a discursive practice • Planning through social learning • Participatory planning • Scenario planning and exploratory foresight approaches • Computer modeling, mainly focused on technical performance, in order to inform planning • Participatory modeling • Using sustainability as a criterion in evaluation of plans	• Dealing with conflict • Citizens' involvement in planning • Dealing with multiple objectives, multiple valuation criteria, multiple alternatives and uncertainty	Academic scholars in majority, but also joint academics-practitioners collaborations

1946–1950 and 1951–1974

During the years immediately following World War II, the scholarship on long-range planning of public infrastructure seems to have been inactive (see Table 1), possibly because of more immediate needs of reconstructing and expanding infrastructures. However, in the 1950s, long-range planning of public infrastructure started to appear again in the literature. The literature grew rapidly in the 1960s, around the same time when the 'Great Society' programs were being carried out in the US. In this period, long-range planning of public infrastructure transformed from a means of stabilizing the economy, to a means of maximizing the effectiveness of public services in face of future uncertainty and rapid changes (e.g. Wagle, 1971). The perspective on uncertainty and the ways to deal with it also shifted, from using historical data for forecasting the probable future, to performing conditional forecasts in which the assumptions for forecasts had to be explicitly addressed (e.g. Cantley, 1969; Mason, 1969; Tombach, 1963). This realization of the fragility of future forecasts may have resulted from the experience of World War II, which drastically transformed the lives of millions of people beyond any earlier expectations. Unlike the previous periods, in which the planning process and the methodologies for long-range planning were not clearly addressed, the focus of the scholarship in this period was on determining the content, and tools and techniques of the planning process (e.g. Berteaux, 1969; Weidenbaum, 1964). Although the internal strengths and weaknesses within the organizations were still the key focus of the planning process, the external economic environment started to be considered more seriously (e.g. Muther, 1969). One of the expressed challenges for long-term planning in this period was balancing contradicting priorities of long-range plans versus operational/short-term plans (e.g. Litschert, 1968). Moreover, the questions of opting for change and novelty versus controlling the status quo through optimization began to prevail (e.g. Drucker, 1959). The literature in this period was authored by practitioners as well as academic scholars.

1975–1989

The debate that had started between change and innovation on one side and control and optimizing the status quo on the other, led to emergence of strategic planning from long-range planning in the 1970s, oriented towards novelty and action. The historical context from the mid-1960s onwards, such as the rise of various counterculture movements, might have encouraged the emergence of such a change-oriented approach. The energy crisis of the 1970s also highlighted the necessity of responding effectively to the changing context and a different treatment of future uncertainty. As a result, scenario planning was developed as a tool in planning (Schoemaker, 1993). Strategic planning first spread in the private sector planning literature and diffused into the public sector planning literature in the 1980s (e.g. Kaufman & Jacobs, 1987; Olsen & Eadie, 1982). It was defined as a disciplined attempt to produce fundamental decisions that shape the nature and the direction of an organization or a sector's activities (Bryson, 1988). The attention was on specifying different steps in the strategic planning process, taking into account both the internal strengths and weaknesses and the external opportunities and threats, abbreviated as SWOT (e.g. Bryson & Roering, 1987). Unlike preceding planning approaches, strategic planning included stakeholders in the planning process (e.g. Abonyi, 1982). Most publications were authored by academic scholars during this period.

1990–2003

In the 1990s and at the outset of the 21st century, strategic planning in the public sector aimed at dealing purposefully and proactively with decisions concerning the future (e.g. Kemp, 1990). The highlight of this period, following the end of the Cold War, has been the rise of participatory planning approaches and involving communities (e.g. Malbert, 1998). This might have been a response to an increased demand for civil societies' involvement in public sector planning (United Nations, 2004) and a means to bring legitimacy to the planning process (Beierle & Konisky, 2000). Scenario planning was also promoted as a way of obtaining flexibility to accommodate change in the face of future uncertainty (e.g. Swanson, 1990). The dominance of academic scholars in strategic planning knowledge development may be indicative of prioritizing excellence of science over relevance in this period.

2004–2013

During the past 10 years, the strategic planning scholarship has, within the discourse of its scholarly community, expanded from a formulaic process following a sequence of steps, to a way of thinking, acting and learning (e.g. Bryson, Crosby, & Bryson, 2009; Pahl-Wostl & Hare, 2004). From this point of view, the process of planning is as important as the artifact that it produces, i.e. the strategic plan, and the objectives of strategic planning extend beyond producing strategies. The planning process per se follows its own diverse objectives such as achieving shared vision and understanding of the future (e.g. Albrechts, 2012), building relational qualities among the actors (e.g. Pahl-Wostl & Hare, 2004), facilitating uniform translation of strategies (e.g. Czarniawska, 2012) and building trust and legitimacy in the planning process (e.g. Velotti, Botti, & Vesci, 2012). Environmental, social and economic sustainability is a major criterion in assessment of strategic plans for public infrastructure (e.g. Dominguez, Truffer, & Gujer, 2011). Scenario planning has further developed to exploratory foresight approaches that aim at exploration of a wide range of future uncertainties, rather than forecasting the most probable future (e.g. Störmer et al., 2009). Robust decision making (Lempert, Popper, & Bankes, 2003), adaptive strategic planning (e.g. Kwakkel, Walker, & Marchau, 2010), dynamic adaptive pathways (Haasnoot et al., 2013) and other adaptive approaches to planning (see Walker, Haasnoot, & Kwakkel, 2013) have emerged, having roots in Assumption-Based Planning (Dewar, Builder, Hix, & Levin, 1993). They aim at building robust plans that cope under a broad range of future conditions. Considering the long lifetime of urban infrastructure, such approaches to planning have also been suggested in the literature as means of assessing the sustainability of infrastructure solutions beyond the present and the near future, under extreme-yet-possible long-term conditions (e.g. Rogers, Lombardi, Leach, & Cooper, 2012). The use of computer models to inform decisions has become widespread, but mainly focused on the technological aspects (e.g. Azevedo, Gates, Fontane, Labadie, & Porto, 2000). Participatory approaches are advocated everywhere in the literature, from the overall planning process to sub-processes such as modeling (e.g. Pahl-Wostl & Hare, 2004). The geographic associations of the authors on strategic planning are more diverse than ever and a lot of studies are carried out in joint collaborations between academic scholars and practitioners (e.g. Lundie, Peters, & Beavis, 2005).

3.2. Paradigm shifts within the intellectual environment and the planning perspectives

The qualitative changes in the strategic planning knowledge domain can be attributed to the paradigm shifts that occurred over time. As indicated by the recurrent theories, concepts and approaches, expressed in the long-range planning literature, 'Control and Optimization' of the status-quo was the paradigm that governed the long-range planning scholarship until the mid-1970s. In policy analysis and master planning literature, this is called a 'predict-and-act' paradigm (Taneja, Walker, Ligteringen, Van Schuylenburg, & Van Der Plas, 2010), in which long term public

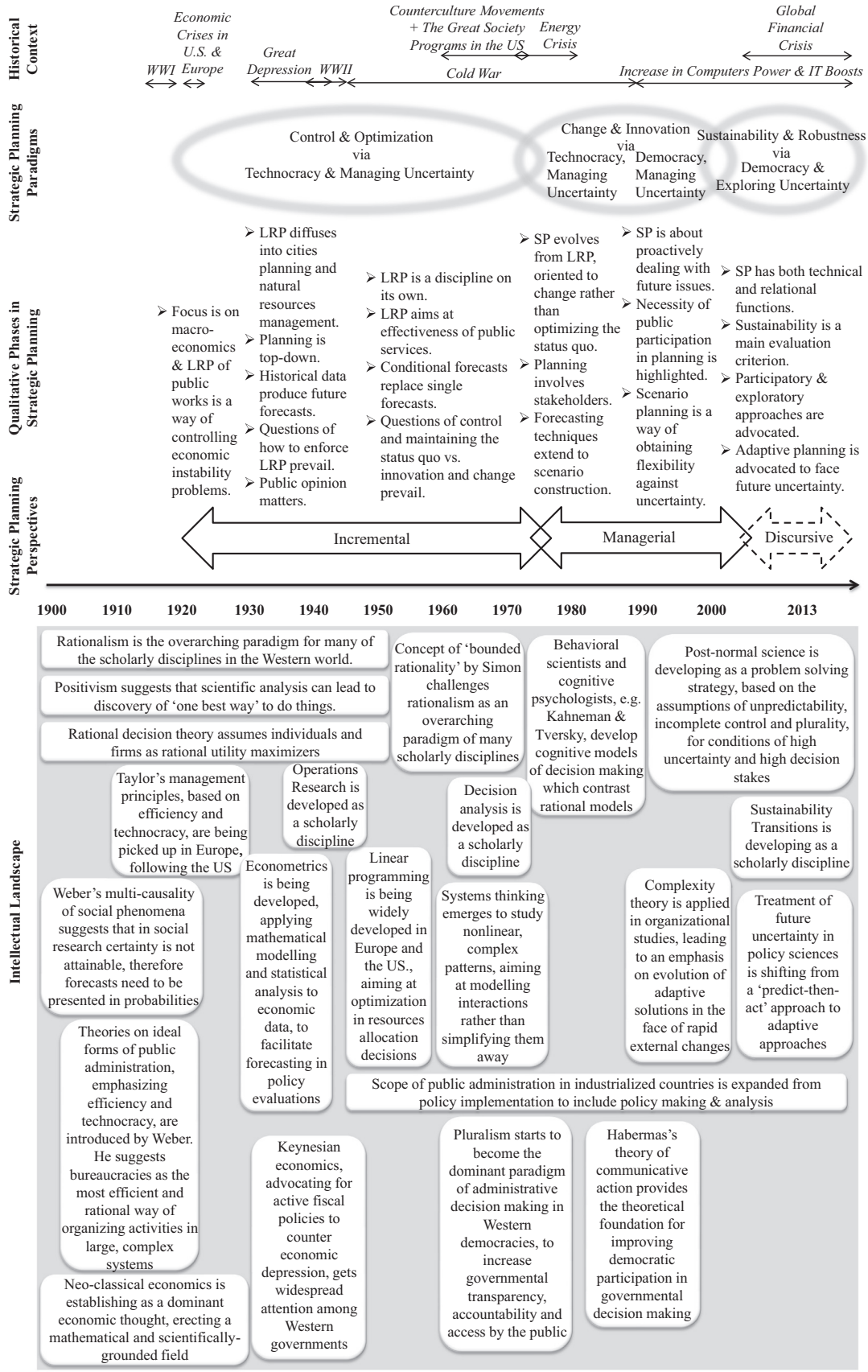

Fig. 1. The typology of distinct phases of evolution of strategic planning thinking for public infrastructure over time. In this figure, SP stands for strategic planning and LRP stands for long-range planning.

infrastructure plans are produced based on the best forecasts of future demands. Such a worldview on planning has been underpinned by 'rationalism' and 'positivism', as the overarching paradigms of many scholarly disciplines in the Western world in the first half of the 20th century (Alexander, 1984; Mintzberg, 1994).

In that same period, 'technocracy' and 'managing uncertainty' governed long-range planning approaches for the public infrastructure. The dominance of the technocratic view has been underpinned by the vast pickup of Taylorism as a theory of scientific management in the US and Europe in the first decades of the 20th century, emphasizing technocracy and efficiency as management principles (Maier, 1970). The desire for managing uncertainty is demonstrated in the discussions on forecasting the most probable future conditions (e.g. Sawyer, 1932).

Emergence of strategic planning from long-range planning in the 1970s occurred alongside the paradigm shift that opted for 'Change and Innovation' instead of 'Control and Optimization' of the status-quo. The shift from control and optimization might have been a consequence of the challenges imposed to the belief in rationality through the concept of 'bounded rationality' (Simon, 1955, 1956), and the development of cognitive models of decision making that contrasted the rational model (e.g. Kahneman & Tversky, 1979).

In the years following the 1970s, the technocratic view on planning started to change as well. Observers of how planning decisions were made started to emphasize their political context (Alexander, 1984). Despite the leading role of planners in earlier rational models, the subsequent literature acknowledged the full force of political processes in planning (Brooks, 1993).

The paradigmatic shift from 'technocracy' to 'democracy' in strategic planning scholarship can be found in the literature of the 1990s (e.g. Malbert, 1998), accentuating participatory planning. Collaborative/participatory planning has its theoretical foundation in Habermas's theory of communicative action, developed in the 1980s (Muller, 1998). Nevertheless, two decades before that, pluralism had already started to diffuse into administrative decision making in the Western democracies (Beierle & Cayford, 2002), intending to increase governmental transparency, accountability and access by the public (Woods, 2013).

In recent years, aspirations for environmental, social and economic 'Sustainability and Robustness' have dominated the strategic planning literature and the notion of resilience has come on to the scene (e.g. Makropoulos, Memon, Shirley-Smith, & Butler, 2008). Resilience in planning infrastructure systems has been distinguished from the older resistance approach by scholars such as Rogers et al. (2012). Whereas in the resistance approach infrastructure systems would be designed to withstand events of high intensity based on statistical analysis of past trends, the resilience approach accepts that future uncertainties may bring about events that will overwhelm the most conservative (and feasible) designs, and that infrastructure systems will need to have the capacity to recover from them. The search for the optimal solution has given place to building robust strategies that perform well across a wide range of plausible future conditions. Future uncertainties are no longer meant to be reduced to allow predictions; rather, they need to be explored, to allow testing the performance of strategies against them.

All these shifts also brought about different strategic planning perspectives within the scholarly commentary. The findings from this study show that the 'incremental' perspective was dominant in the long-range planning literature until the mid-1970s. A good deal of research also confirms the domination of incremental model in administrative decision making before the 1980s (Alexander, 1984). The incremental perspective, as defined by Dominguez et al. (2011), focuses on an incremental adaptation of existing systems as a reaction to developments (Dominguez et al., 2011). It deals with future uncertainty by betting on the most probable forecast of context conditions. Within this perspective, the degree of characterization of future uncertainty is low, as is the degree of freedom of the system in responding to change. Narrowing down future uncertainties and system configurations allows for reducing complexity and ease of implementation (Störmer et al., 2009).

Along with the emergence of strategic planning from long-range planning in the 1970s, the literature starts to acquire a 'managerial' perspective to strategic planning in the public sector, which, as defined by Dominguez et al. (2011), focuses on increasing the flexibility of the system to improve its capacity to accommodate change (Dominguez et al., 2011). An example is the shift in public infrastructure investments, from large scale and centralized, to small scale and diversified capacities. However, the degree of characterization of future uncertainty within this perspective is still low.

In recent years, the scholarship has been advocating a 'discursive' perspective (Dominguez et al., 2011). Within this perspective, both the degree of characterization of future uncertainty and the degree of freedom of the system are high. It builds upon informed discourses amongst experts and stakeholders concerning available alternatives, targeted objectives and possible future conditions, whilst explicitly addressing trade-offs in the planning process (Dominguez et al., 2011). Methods have also been developed to explicate tensions and trade-offs involved in fulfillment of multiple, sometimes contradicting, sustainability objectives, to assist in bringing about sustainable development through infrastructure planning and decision making (Lombardi et al., 2011). There is greater integration among different disciplines in the strategic planning process and multi-faceted input and engagement among social, natural and engineering skills is being emphasized (Pahl-Wostl, 2007). The discursive approach aims at a more explicit and reflexive treatment of future uncertainty, using exploratory approaches, and a broadening of the available alternatives, which is therefore expected to lead to more robust strategies.

4. Implications of findings for policy making and strategic planning research towards environmental sustainability

The findings from this scoping study indicate how the scholarly thinking in urban infrastructure planning has changed over time, in tandem with the historic context and the development of concepts and ideas in the bigger intellectual landscape. Infrastructure planning scholarship has obviously moved with its language in line with the emergence of sustainability thinking. However, there has been little apparent reaction to, or engagement with, the changes in the planning practice itself. The contemporary strategic planning literature that works towards environmental sustainability often contains aspirational proposals and little detail on how planning is being undertaken in practice. Bryson, Berry, and Yang (2010) had also indicated lack of sufficient attention to the nature of practice in public strategic management research. Observations of the senior planning practitioners, who took part in the consultation exercise for this study, also suggest that the realities of public infrastructure planning are not completely captured in strategic planning scholarship.

In absence of rigorous documented knowledge about strategic planning practice, and considering the science-practice lag, one might hypothesize that today's planning in public infrastructure sectors across industrialized countries is likely to resemble the managerial or the incremental approach (Fig. 1), while the scholarly thinking has moved to the discursive phase. It might also be the case that different elements of the planning practice are dispersed over the continuum in Fig. 1. The position of planning elements on the continuum might even vary depending on the

geographic and the sectoral contexts. In any case, while the language of policy documents and strategic plans has embraced sustainable development, legacy of the incremental approach to infrastructure planning, which has been the dominant planning approach for decades, is likely to be embedded in the current planning cultures. The incremental approach, which is characterized by confining the scope of alternatives to optimizing the status quo, is clearly at odds with the aspirations for sustainability transitions. The incremental approach establishes a reactive planning culture, where adaptation of the system is only undertaken when developments in context conditions dictate action. In contrast, as Pickett et al. had indicated, a shift in urban infrastructure and dynamics toward sustainability would be a radical one (Pickett et al., 2013). Consequently, strategic planning for sustainable development requires a proactive planning culture which creates conditions for change to deal purposefully with future issues. Even the managerial approach, which expands system boundaries to include various solutions, fails to characterize the breadth of future uncertainty, which may impede favoring radically different options in analysis of costs and benefits.

To develop effective planning interventions towards environmental sustainability, in-depth knowledge of *how things are actually done* needs to accompany the proposals on *how things should be done*. Policy making and planning research that promotes transitions to environmental sustainability need to connect to planning systems that have worked in incremental mode for so long and intervene from there. They need diagnostic tools to identify norms and cultures, opportunities and challenges in planning practice in different contexts, as well as operational frameworks that provide pathways for shifting the historically-entrained modes of practice to radically different aspirations. The typology presented in this study can serve to position the elements of current planning practice in different settings, to potentially reveal gaps between what is suggested in the literature and the planning reality, and to indicate priorities for policy making and planning research towards environmental sustainability.

Acknowledgements

This research was funded under the Australian Research Council's Linkage Projects Scheme (project number LP120100683), for which Dr de Haan was the recipient of an Australian Research Council Post-doctoral Fellowship Industry (APDI). The authors would like to express their sincere gratitude to the following experts who took part in the consultation exercise and provided invaluable feedback on the findings: Professor Robert Lempert, Professor Warren Walker, Professor Richard Ashley, Professor Robert Skinner, Chris Chesterfield and an expert who wishes to remain anonymous.

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