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

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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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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