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The exploratory analysis of trade-offs in strategic planning: Lessons from Regional Infrastructure Foresight

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ABSTRACT

The sustainable transformation of infrastructure sectors represents a challenge of prime importance worldwide. Due to long life times of infrastructures, strategic decision making has to explicitly consider uncertainties in context conditions, value considerations and available technological alternatives. However currently, strategic infrastructure planning is often carried out in a very narrow perspective. The present paper argues that foresight informed strategic planning, allows addressing trade-offs related to context uncertainties, value conflicts and sustainability deficits in a structured way. The paper introduces a specific procedural proposal, the Regional Infrastructure Foresight method (RIF) and illustrates its potential virtues through an application to urban water management planning in a Swiss region (Kiesental).

1. Infrastructure planning and foresight

In OECD countries, most infrastructure sectors such as electricity supply, water supply and sanitation were constructed over the 20th century by implementing a narrow socio-technical paradigm of central generation plants with wide area distribution networks. The presumed superiority of this paradigm relied on a series of assumptions, like the predictability of the socio-economic development of the supplied region [1], the predetermination of the technical option, and the politically set criteria of effective, homogenous and affordable infrastructure services [2].

It is fair to say that this socio-technical constellation has been highly successful over the past decades. Nowadays, infrastructure organizations are confronted with an increasing amount of future uncertainty [3] that calls for a fundamental reconsideration of the former success model, at least in three respects: (i) the context conditions are less stable and predictable due to increasing changes on the demand side and changing regulations, (ii) the available technical solutions offer new options to provide infrastructure services in a radically different form; and (iii) the criteria by which the optimality of the infrastructure is assessed have become more diverse and disputed.

Over the past decades, strategic planning in these sectors was mostly focused on narrowing down context uncertainties, value considerations and system configurations to reduce complexity and ease implementation [1,4]. Given the increased range of uncertainties, the recent literature has provided a number of new approaches and tools like modeling tools, real option approaches and decision analysis. However, these approaches are often deficient with regard to addressing the broad range of uncertainties associated with the long planning horizon (more extensively treated in [5]).

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Foresight has its strengths in addressing broad ranges of future conditions by adopting participatory and discursive approaches. Yet, in particular Technology Foresight has often been restricted to identifying future context conditions in order to scrutinize the robustness of specific strategies or as a means to identifying more sustainable futures. More specifically, it has focused on fostering cooperation and networking in science, technology and innovation policy [6]. Foresight is however much less well developed in strategic planning contexts as it often misses the link between analyzing uncertainties to assessing options and suggesting implementation strategies [7].

In the present paper, we want to build on foresight methods for improving strategic decision making in infrastructures through the method of Regional Infrastructure Foresight — RIF. Relative to Technology Foresight, we emphasize the implementation side of socio-technical systems, i.e. we want to analyze under which conditions the receptiveness for innovative solutions could be increased, especially in contexts that are otherwise rather averse with regard to innovation [8]. Foresight methodologies should therefore not only inform the identification of future context conditions but may also be applied to future system options and preference structures. Such a methodological framework is likely to depart — in style and content — from the currently dominant forms of strategic decision making in infrastructure sectors [5]. While in conventional approaches, reduction of uncertainties was the guiding principle for structuring the decision problem, we will propose a foresight based approach that allows for considering a maximum range of uncertainties. This enables the identification of the major trade-offs associated with context uncertainties, newly emerging technological solutions and potential future interest conflicts associated with the implementation of specific system configurations. Finally, we will also address the issue of sustainability deficits of decisions: how to anticipate and integrate them into the formulation of a long term management strategy for infrastructure development.

We will present empirical evidence to support our claims from the experiences of implementing the RIF method in the Swiss sanitation sector. As the sustainability of the established technical system has raised some criticism [9,10], new solutions to urban water management are discussed more widely today. Sanitation services are mostly provided by public organizations and strategic planning is mostly carried out in a very narrow perspective: tending to blind out alternative solutions, context uncertainties and broad goals. We therefore consider strategic planning in sanitation as an appropriate test domain for the methodology. A similar approach has been presented by Dominguez et al. [2]. They utilize infrastructure foresight to identify technological and organizational capability deficits. In the present paper, we aim at explicating the contribution of the foresight approach to the identification of trade-offs.

The argument of the paper develops as follows: In the next section, we lay the ground for combining strategic planning in infrastructures with foresight methodologies. Section 3 presents the procedural outlay of the Regional Infrastructure method and introduces concepts for addressing the trade-offs relative to context uncertainties, conflicts and sustainability deficits. Section 4 presents the results from the application of RIF in the Kiesental region in Switzerland. The final section gives an outlook on further application domains for foresight and strategic planning in infrastructure sectors.

2. Breaking up path dependencies in strategic infrastructure planning

2.1. Characteristics of infrastructure sectors

Infrastructures represent a specific challenge to strategic planning methods. Due to the long life time of their key technical components and the strong coupling between technological and institutional structures they exhibit strong path dependencies [11]. They are particularly strong in OECD countries where infrastructure networks have been established since decades. In the social science literature, the couplings have been described as socio-technical regimes. They consist of rules, standards, scientific knowledge, engineering practices, technologies and skills that determine a stable context in which highly complex system configurations can develop [12]. Socio-technical regimes create advantages for system development as they tend to reduce the costs of knowledge generation and the political costs of decision making [13]. However, the structure of the socio-technical regime also tends to blind out more radical socio-technical alternatives and favors incremental improvements [1,4,5]. For instance, a historical analysis of the emergence of the currently dominant socio-technical regime in wastewater treatment is elaborated by Geels [14].

As infrastructures are often public services, their operation and maintenance are strongly dependent from policy and mostly delegated to the local or regional level. Particularly in public organizations there is often a wide lack of capabilities for running strategic planning processes [2]. Additionally, network infrastructures have a clearly defined spatial extension and are of key relevance for economic development, human wellbeing and locational advantage for industry and citizens of a specific region. Therefore, infrastructure planning has to incorporate an explicit political dimension as well as a wide range of actors with diverging interest positions. Given the long life times of most infrastructures, strategic investment decisions will only take place every couple of decades. As a consequence, these decision making processes are often non-routine, badly structured and complex [15].

Due to the long term horizon of infrastructure decisions, the planning process has to deal with lately increasing uncertainties in different fields. Firstly, uncertainty in context conditions has been increasing substantially due to changing regulations, rapid urbanization and shrinking rural regions as well as market liberalization [3]. Secondly, the range of possible technological system alternatives has been substantially expanding. Due to ICT, miniaturization of components, new technological solutions like membrane technology or new measuring and control devices, radically different system configurations might become available with grossly enhanced performance characteristics. And thirdly, the criteria by which the optimality of system configurations is assessed have been becoming more diverse and disputed. For almost one hundred years in industrialized countries, infrastructure