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### Navigating mega projects through complexity and uncertainty: strategic and adaptive capacity in planning and decision-making

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### Chapter 1: Complexity and Uncertainty: Problem or Asset in Decision Making of Mega Infrastructure Projects?

How should one cope with complexity and uncertainty in mega infrastructure projects? While rational planning theories tend to eliminate or to reduce these unruly conditions, the authors of this article are in search of a different approach to deal with the characteristics of complexity and uncertainty proactively. Three theoretical reflections are introduced to explore possible solutions: (1) the change of institutions to address the problem of excessively-simple structures for making decisions on complex projects (2) the shaping of a learning environment in order to deal with uncertainty and emergent properties and (3) balancing the generation and the reduction of a variety of policy options in order to select a limited number of feasible options and to bridge the strategic exploration and the operational processes of decision making. Informed by this conceptual thoughts, concrete pathways are developed and discussed in a case study of the construction of a high-speed railway line in the Netherlands.

### Chapter 2: Planning Infrastructure in the Face of Complexity: Enhancing the Adaptive Capacity of Mega Projects

Mega Projects are riddled with complexity. There is a general tendency in policy to reduce the complexity of planning and decision-making by simplifying both the process and the scope of projects. However, by framing a project's scope or process in a narrow way at an early stage, the possibility to adapt to changes in the context, and thus deal with unexpected challenges is limited. , In addition it reduces the chance to profit from new insights and new possibilities. This paper aims to explore the mechanisms that enhance or limit the adaptive capacity within the process of decision-making and planning of mega projects. We develop the concept of adaptive capacity using organizational learning theory and use empirical data from a mega project in The Netherlands to identify the moments of adaptation and to discern these mechanisms. Adaptations are especially crucial in overcoming deadlock and we expect a strong relation between the adaptive capacity and the mechanisms to overcome different types of deadlock. In this research we find that incremental adaptations such as mitigation measures are the initial response to deadlocks, but that for deadlocks caused by strong opposition, radical adaptations are

needed. A more pro-active approach to enhancing adaptive capacity is desirable and might paradoxically even lead to cheaper and more relevant projects and faster planning and decision-making.

### Chapter 3: Adding Value to Mega Projects: Fostering Strategic Ambiguity, Redundancy, and Resilience in the Decision-Making Process

Current practice in decision-making about mega projects seems to be aimed at limiting outside influences; reducing complexity by simplification; and framing content and process in a narrow manner. We argue that limiting the scope of decision-making, as mentioned above, is detrimental to the added value of the mega project because it often leads to excessively narrow solutions. This article develops a conceptual framework for analyzing the opening and closing of decision-making on mega projects. It aims to show the significance of strategic ambiguity, i.e. the tension between different purposes and goals; redundancy, i.e. organizing alternatives to prevent lock-in and path dependency; and resilience, i.e. balancing between accepting and enacting change in the interaction with the project environment. Our research involves case studies of two typical transport mega projects in the Netherlands, and we use these two case studies to explore the usefulness of our analytical scheme and to gain a deeper understanding of the decision-making and planning of these types of projects. A combination of in depth interviews and secondary sources serve as our main sources of data. Our analysis demonstrates that creative solutions and added value are to be found in a recombination of policy options: recognizing the need of a wider project mission; the usefulness of redundancies; and the organization of critical and knowledgeable actors. Mega project planning has a lot to gain by organizing feedback and strategically opening and closing the decision-making process. Although it is tempting to reduce uncertainty by closing the decision-making process in an early phase, practitioners should be aware that it comes at the cost of losing an integrative approach. Previously discarded or underdeveloped alternatives may also later return. It is therefore important to find a balance between opening and closing the process and organizing enough feedback and redundancy of actors and information.

## Chapter 4: Keeping it Simple? A Case Study into the Advantages and Disadvantages of Reducing Complexity in Mega Project Planning

There are many articles discussing time and cost overruns in mega projects. This paper, however, looks at a case that was successful in managing these aspects: a metro extension in the Rotterdam Region in the Netherlands. The literature identifies several causes for overruns and the question thus becomes what prevented these causes from occurring? The answer in Rotterdam's case seems to be a strict focus on reducing complexity, or in other words to keep it simple. Therefore, the main focus in this article is on the reduction of complexity and its effects on the planning of mega infrastructure projects. Are there only advantages to this approach or do certain facets of this approach have negative consequences? Using a case study method with interviews, this article shows the conditions under which the reduction of complexity is beneficial or detrimental.

## Chapter 5: Adaptive and Strategic Capacity: Navigating Mega Projects through Uncertainty and Complexity

In an effort to combat the complexity and uncertainty that comes with mega infrastructure development, planners often seek to simplify the process and scope of their projects, making plans that consist of rigid sequential steps. The question is how this approach influences planners' responsiveness to uncertainty and complexity in mega project decision-making and planning. To answer this question, the paper introduces and links two concepts: adaptive capacity and strategic capacity. It develops these concepts and applies them to three large infrastructure projects in the Netherlands. The article first looks at the concepts individually and then links them together. It shows that, to be successful, planning needs to navigate a project through uncertainty and complexity and that these concepts are important to take into consideration.