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Panarchy within a port setting

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ABSTRACT

All facets of present day society are subjected to an ever increasing rise in uncertainty. Seaports are no exception. As complex clusters of industrial activity and gateways for distribution networks, they are vulnerable to external and internal shocks disrupting supply chains. This evolution forces stakeholders to ponder on "sustainable development," and to foster adaptive capabilities and create opportunities. The development and further substantiation of the notion of 'resilience' underlined the need to study how clusters and networks (should) respond to major disturbances. In this paper, we scrutinize the concept of port resilience by revisiting the Panarchy and adaptive cycle theorem of Holling (2001). The objective is to determine if this framework can be applied to a port development context. The paper outlines the literature on Panarchy and adaptive cycles and links it to ports. It also provides an overview of the general theorem and explains the value for maritime research. The framework is linked to a set of cases on port infrastructure and development.

1. Introduction

Risk management can no longer be considered as being at the margin of strategic management. Most policies and management tactics try to apply fixed rules to keep the 'business as usual' mindset going as long as possible. This tendency to keep current norms in place often leads to an overall loss of resilience for the underlying structures. This gradual loss of resilience continues in most systems until shocks can no longer be absorbed (Holling, 1986). Unpredictable conditions demand a resilient, flexible and adaptive strategy that can adjust to uncertainty and change, which affects all levels of industries, including the maritime sector.

The theory of Panarchy, as developed by Holling (1986), provides a framework for understanding change in economic, ecological and institutional systems. It is a cross-scale interdisciplinary theory named after the Greek god Pan, the creator of chaos. The purpose of systems like Panarchy is not to explain what is, but rather in building narratives allowing to give sense to what was and what might be (Holling, 2001). Its value lies in the power to suggest questions that are relevant when trying to understand transformations both in natural and socio-economic settings.

We introduce the Panarchy theorem in an exploratory way as a theory relevant to seaports. We believe that this framework is suitable for ports due to the variety of stakeholders involved in its processes. The Panarchy model can help to create a narrative on how the complex dynamics between all stakeholders involved in the system can progress. We argue that this research contributes to the extant literature on port geography, since this academic field is continuously challenged to analyse changing market environments. As stated by Ng and Pallis (2010), "evolving circumstances affect (often unexpectedly) market demand and stakeholders relations. The original setting has difficulties in executing stated functions, and, therefore, the sector adjusts to the new conditions." (page 4) Most port reforms share key objectives: efficiency, economic benefits through competition, the minimization of bureaucracy, a reduced demand for public investments, the enhancement of management skills, efficient labour organization, and organizational re-scaling so as to facilitate economic coordination between different social and spatial levels (Brooks, 2004; Cullinane and Song, 2007). It is not the goal of this paper to prove that the Panarchy theorem can be fully fitted to port systems. We rather attempt to introduce a new framework, which can in turn be tested and used to better our understanding of seaports.

Just as port reforms have been rather chaotic and unpredictable, the accompanying trajectory of the theoretical discourse on the modern seaport has not been a linear one (Olivier & Slack, 2006). From the seminal works by Bird (1963) and Taaffe et al. (1963) spawned a substantial body of research on the spatial development of ports (Hilling and Hoyle, 1984; Rimmer, 1967). Ng et al. (2014) analyse the extant literature in port geography. They argue that, in past decades, the focus on the study of the relationship between ports and their surrounding landscapes diminished. Also, along the same lines, they refer to the fact that "port geography research has become distanced from traditional geographical approaches, moving towards a more practical industrial focus" (page 88). The consideration of applying the Panarchy theory to

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ports fits nicely in this more business-oriented approach in port geography and the search for other frameworks than the ones linked to theoretical and conceptual discussions within human geography. The Panarchy framework is not intended to expand and renew existing theorems but rather to offer a possibility of clarifying the past transgressions and evolutions. It is well-suited for addressing city–port interactions, as described in the Anyport model and further expanded by Hoyle (1989) to account for the growing separation between port and city. An alternative model has been presented by Charlier (1992) outlining a diachronic model of urban port spaces by suggesting the concept of the port life cycle, a notion befitting Panarchy.

In this paper, we address the following research question: "Can certain aspects of port evolution be explained using the Panarchy theorem?". We provide an answer by identifying and presenting examples in ports of the specific properties on which the Panarchy framework hinges. Various aspects linked to the Panarchy framework will be examined such as rigidity traps, poverty traps, hierarchical levels and multiple stability states. We also look at the implications for management purposes. The paper attempts to contribute to the emerging research on flexibility and vulnerability within the maritime industry, by focusing on the underlying mechanics that are causing stresses and actions that lead to threshold changes within ports. The limitations of this work are defined by the constraints of the Panarchy theorem and research conducted in the port geography field. At present, the research on Panarchy in ports is rather concise. Therefore, the notions proposed in this paper are more explorative and open avenues for further research and substantiation. New research questions could, for example, include: the further investigation of the links between Panarchy and the broader maritime sector. We believe that more scrutiny and inquiry towards the possible matches and scale investigations could benefit port geography research in general.

The first section of the paper will outline the literature on existing port management theories and models. Here, we attempt at identifying existing gaps that can be remedied by the Panarchy model. The second section introduces the model, including essential properties like adaptive cycles. The third section presents port-related examples of the theory's cornerstones. More in particular, we apply the framework to a set of cases on waterfront redevelopment and port sustainability challenges. Finally, we use a combination of the product life cycle model and Panarchy model to analyse management capabilities through the adaptive port cycle.

2. Existing literature on port management theories and models

The literature is abundant with port management and development models. Some of these models already acknowledge the existence of endogenous and exogenous cycles that affect port evolution. As stated by Wilmsmeier et al. (2014) economic and shipping systems together generate pressure on the port system in the form of ever-evolving specific requirements with respect to infrastructure, superstructure, equipment, efficiency and organization. To fully understand the use and added value of the Panarchy theorem in port-related research, a fundamental understanding of the existing models and their shortcomings is required.

The earliest spatial development models on ports already dealt with interactions between different entities within a larger system. However, it has been suggested that early spatial port development models such as Bird (1963) or the more hybrid port generation model (UNCTAD, 1992) are unable to capture the complexity of port infrastructure, operations and services (Bichou & Gray, 2005). The UNCTAD model stated that the development of ports from first to second and then third generation was historically dependent primarily on size, but it was also driven by the one who exercises strategic control. A wide range of other factors, e.g. port size, geographical location, working culture and extent of public/private involvement, have exhibited significant changes. These should be added to better describe the situation that exists in ports and which cannot realistically be categorized into discrete 'generations' (Bichou and Gray, 2005). The WORKPORT model provides a clearer reflection of the developments that have taken place in ports since the 1960s by defining the key dimensions and milestones in this evolutionary process.

From a port authority perspective, the institution itself is limited in its set of actions stemming from its specific nature (Notteboom and Rodrigue, 2009; Ng and Pallis, 2010). Notteboom et al. (2013), based on Strambach (2010), argue that via the concept of institutional plasticity a port authority can achieve governance reform by a process of adding layers to existing arrangements within a path dependent environment. The inclusion of critical moments and shifts that require institutional adaptations are introduced in this particular strand of research.

Wilmsmeier et al. (2014) build further upon these existing models and frameworks by insisting that the entity normally considered a unified port is not only created by numerous actors but is endlessly being recreated with each new relationship or network in which the port is embedded. The authors introduce a concept similar to resilience as noted in the Panarchy theorem, when they state that 'Transport systems exhibit a self-organizing structure; however, transport autopoiesis is likely to have a particularly high inertia when it comes to changing system variables, due to its "lumpy" or time-lagged investments.' This temporal analysis resulted in a port life cycle theorem that stated that since ports develop in a discrete manner, their adjustment to global import and export flows will always lead to a scarcity or surplus (i.e. a mismatch between supply and demand) on infrastructural levels. In addition to such natural cycles, there is the long-term lifecycle of the port, through development, introduction, growth, maturity and decline (Cullinane & Wilmsmeier, 2011).

To fully understand the full plethora of dynamics present in previous frameworks, specific attention has to be given to the effect of different interacting hierarchical scales. As the Panarchy theorem is already quite extensively documented and applied in other branches of research like ecological and social sciences (Garmestani et al., 2009), it possesses a solid accepted structure and set of definitions. With the introduction of Panarchy in port research, a narrative can be obtained to frame most of the historical development patterns described by previous theorems.

3. Panarchy explained

The Panarchy theory is a systems-thinking adaptation of ecological and complexity theorems that is used to explain the evolving nature of complex adaptive systems. It acknowledges the complexity of dynamic states in constant evolution and subject to a particular hierarchy. Also, it allows for the incorporation of lower, smaller and faster-changing scale levels, as well as the larger and slower supra-regional and global levels in one general theorem.

The core framework of this paper is based on the seminal work of Holling and Gunderson (2002) who first used the term Panarchy to describe changing complex environments. The Panarchy theorem recites the interaction between three dimensions, i.e. resilience, connectedness, and potential. Connectedness is the internal capacity of the system for reorientation. The term potential refers to the external possibilities of the system. The term resilience captures the amount of shocks the system can endure before either collapsing or shifting towards a new stability system. Fig. 1 visualizes the interaction between scales using port-related examples.

There are four phases that should be present in any complex adaptive system. They have been observed and described across multiple fields albeit often labelled in different terms. Holling and Gunderson (2002) term these phases as exploitation (r); conservation (K); release (Ω); and reorganization (α). They can be grouped into a front loop, or a maturing phase of a system, and a back loop, also described as the collapse or renewal.