drift for transition

ACES Literature review

date
February 2022

authors
Nick Williams
Timo von Wirth
Igno Notermans

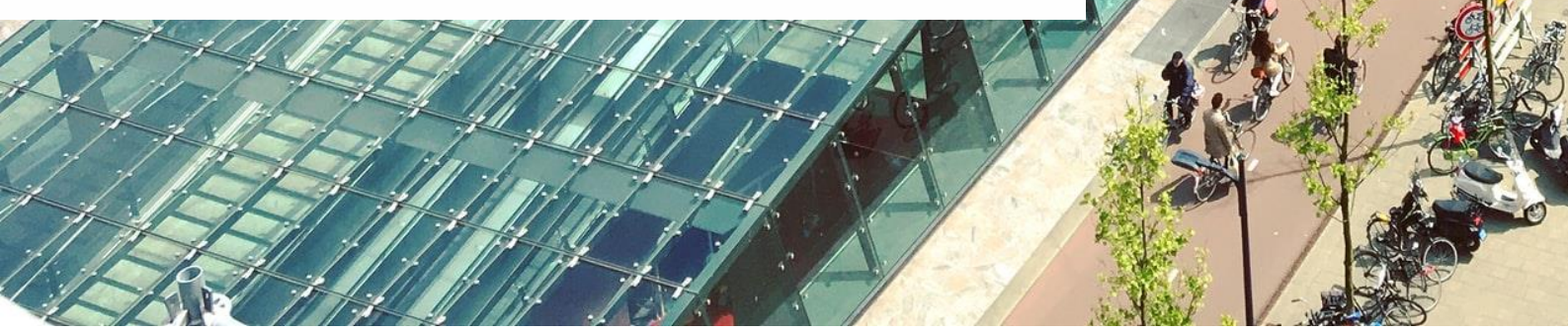


Table of contents

1. Introduction

The Norwegian port sector is in transition: it is facing the challenge of becoming zero-emission in 2030 while the economy is heavily dependent on oil and gas. Where the port's many (regional) functions and actors meet, from freight to electricity and from fishery to ferrying, they face transition pressures and opportunities. The ACES project aims to facilitate and accelerate this transition in Norwegian ports through organizing four transition arenas in three ports (Kristiansande, Borg, Bodø) and one on the national level addressing the port sector as a whole.

In preperation to these arenas, we synthesise the scientific knowledge up to know on the application of transition management specifically to ports industrial clusters and on transition knowledge in the port-maritime sector. This document presents the outcomes of a systematic literature review on these topics that includes an annotated bibliography and more indepth summaries of 21 scientific articles. These articles provide an answer to five main questions, the numbers in each question correspond to the number of the article in the annotated bibliography and summary section:

1. What are the theoretical roots of transition management? (7, 11, 13, 14, 15, 16, 17, 19, 21)
2. What are empirical examples of applying transition management in ports? (2, 4, 6, 7, 16)
3. What are transition perspectives on ports and the maritime sector? (2, 3, 4, 6, 9, 10, 12, 19, 20, 21)
4. What are other relevant studies on change toward sustainability in ports? (1, 2, 3, 4, 6, 8, 13, 17, 18)
5. What are relevant papers on sustainable port-city development? (1, 5, 8, 9, 10, 17

The method of this systematic literature review is presented in chapter 2, the annotated bibliography and summaries follow in chapter 3 and 4. The next page provides an overview of the included articles and on which pages to find them.

Overview of included articles

Article	Annotated Bibliography (page number)	Summary (page number)
1) Bergsma, J. M., Pruyn, J., & van de Kaa, G. (2021). A Literature Evaluation of Systemic Challenges Affecting the European Maritime Energy Transition. *Sustainability*, *13*(2), 715.	6	10
2) Bjerkan, K. Y., Hansen, L., & Steen, M. (2021). Towards sustainability in the port sector: The role of intermediation in transition work. *Environmental Innovation and Societal Transitions*, *40*, 296-314.	6	10
3) Bjerkan, K. Y., & Ryghaug, M. (2021). Diverging pathways to port sustainability: How social processes shape and direct transition work. *Technological Forecasting and Social Change*, *166*, 120595.	6	11
4) Bosman, R., Loorbach, D., Rotmans, J., & Van Raak, R. (2018). Carbon lock-out: Leading the fossil port of Rotterdam into transition. *Sustainability*, *10*(7), 2558.	6	12
5) Carpenter, A., & Lozano, R. (2020). Proposing a framework for anchoring sustainability relationships between ports and cities. In *European port cities in transition* (pp. 37-51). Springer, Cham.	6	13
6) Damman, S., & Steen, M. (2021). A socio-technical perspective on the scope for ports to enable energy transition. *Transportation Research Part D: Transport and Environment*, *91*, 102691.	6	13
7) De Geus, T., Wittmayer, J. M., & Vogelzang, F. (2022). Biting the bullet: Addressing the democratic legitimacy of transition management. *Environmental Innovation and Societal Transitions*, *42*, 201-218.	7	14
8) Englert, D., & Losos, A. (2021). Charting a Course for Decarbonizing Maritime Transport. Summary report for policymakers and industry. The World Bank Group: Washington.	7	15
9) Fenton, Paul. (2020). Port-City Redevelopment and Sustainable Development. In *European port cities in transition* (pp. 19-36). Springer, Cham.	7	16
10) Frantzeskaki, N., Wittmayer, J., & Loorbach, D. (2014). The role of partnerships in 'realising' urban sustainability in Rotterdam's City Ports Area, The Netherlands. *Journal of Cleaner Production*, *65*, 406-417.	7	16
11) Hebinck, A., Diercks, G., von Wirth, T.,Beers, P.J.,Barsties, L., Buchel, S., Greer, R., van Steenbergen, F., Loorbach, D. (2022) An actionable understanding of societal transitions: the X-curve framework. *Sustainability Science*	7	17
12) Kelly, C., Ellis, G., & Flannery, W. (2018). Conceptualising change in marine governance: learning from transition management. *Marine Policy*, *95*, 24-35.	8	18
13) Kemp, R., Loorbach, D., & Rotmans, J. (2007). Transition management as a model for managing processes of co-evolution towards sustainable development. *The International Journal of Sustainable Development & World Ecology*, *14*(1), 78-91.	8	20
14) Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability transitions research: transforming science and practice for societal change. *Annual Review of Environment and Resources*, 42, 599-626.	8	21
15) Loorbach, D., & Geerlings, H. (2017). Ports in transition. In *Ports and Networks* (pp. 364-378). Routledge.	8	22
16) Loorbach, D., & Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, *42*(3), 237-246.	8	23
17) Meadowcroft, J. (2009). What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy sciences*, *42*(4), 323-340.	8	24
18) Mjelde, A., Endresen, Ø., Bjørshol, E., Gierløff, C. W., Husby, E., Solheim, J., ... & Eide, M. S. (2019). Differentiating on port fees to accelerate the green maritime transition. *Marine pollution bulletin*, *149*, 110561.	8	24
19) Rotmans, J., & Kemp, R. (2008). Detour ahead: a response to Shove and Walker about the perilous road of transition management. *Environment and Planning A*, *40*(4), 1006-1012.	9	25
20) Sondeijker, S., Geurts, J., Rotmans, J., & Tukker, A. (2006). Imagining sustainability: the added value of transition scenarios in transition management. *Foresight*.	9	25
21) Voß, J. P., & Bornemann, B. (2011). The politics of reflexive governance: challenges for designing adaptive management and transition management. *Ecology and Society*, *16*(2).	9	26

2. Method

To understand the applications of transition management in the port sector we conducted a systematic literature review. From there, we defined the search terms for transition management in ports. Then, to identify and select the most relevant sources, we conducted a content analysis. The search procedure, which lasted from the end of November 2021 to the start of December 2021, consisted of scanning the following databases: google scholar, ScienceDirect, Scopus, and the EUR Library. Within each database, keywords were used to understand the growing acceptance of transition toward renewable energy as a necessary step towards decarbonization in ports. The search included all sources including book chapters and scientific papers to do a broad literature review. The following search terms were used either separately or in conjunction, in a variety of combinations: ports, maritime, and sustainability. This yielded 634 total articles. Initially, selecting articles was done based on the key terms, the merit of their title, and the abstract mentioned in the papers. The key terms used included transition management, ports, logistics, industry, mobility, maritime, sustainability, decarbonization, and transformation.

Furthermore, the articles needed to be written in English and be published in the 2000s. we applied the same search terms and procedure to the different databases. The search terms yielded 298 results in the EUR Library, 227 results in google scholar, 6 results in SCOPUS, and 103 results in ScienceDirect. Overall, that produced 634 total papers including duplicates. From these results, a snowballing technique was used to find similar articles that added further dimensions to the research. To move to the next step of analysis and narrow down the number of articles, the following criteria was applied: if transition management was mentioned but weakly applied or published before 2000 it was cut. Furthermore, articles were cut if sustainability was mentioned but was unrelated to cities and/or ports, or if ports were mentioned but transition management was not applied. Then, machine learning from Mendeley provided personalized suggestions based on the existing library. These were used to incorporate eight further references which fit the criteria.

Table 1: Methodology of Literature Review

Steps	**Procedure**	**Results**
1) Initial literature review	Unsystematic search of databases for literature connected to transition management in ports	Determine the relevant keywords to be used in the literature review
2) Gathering data	Systematic search of databases	634 articles which could potentially be used
3) Screening the data	Analyzing the articles title and abstract	71 articles met the criteria for further analysis
4) Investigating the data	Saving the articles which fit	71 articles saved

5) Filtering the articles	Doing further screening to confirm whether the articles are relevant	67 articles for final analysis after a second round of applying the criteria
6) Deep analysis of the articles	Analyze entire paper using the guiding questions: 1. What are the theoretical roots of transition management? 2. What are empirical examples of applying transition management in ports? 3. What are transition perspectives on ports and the maritime sector? 4. What are other relevant studies on change toward sustainability in ports? 5. What are relevant papers on sustainable port-city development?	Internal discussions between the DRIFT Project team determine the five guiding questions all the articles fall under
7) Content Analysis	All the references were analyzed based on whether they could be used to answer one or more of the guiding questions from step 6	Final data set of 21 articles for analysis

After this step, only 71 articles remained for further analysis. Then, in the second round of analysis, an additional four articles were excluded for not meeting the criteria. The most represented authors were Derk Loorbach and other members of DRIFT, in the field of transition management. After DRIFT publications, the most represented journals were the *Journal of Energy Research and Social Science, the Journal of Environmental Innovation and Societal Transitions (EIST),* the Journal of *Policy Sciences,* and *the Journal of Sustainability*.

The content analysis of the 67 articles left was done with a focus on the abstract and conclusion to determine the article's relevance. The analysis was shaped by the guiding questions regarding the application of transition management to ports. This included both conceptual and practical applications, including what transition management looks like and how to apply it. The DRIFT project team had internal discussions and according to a list of criteria related to the project objectives of ACES, an additional four papers that were not part of our search process were added to the final set of n=21 papers.

3. Annotated bibliography

1) Bergsma, J. M., Pruyn, J., & van de Kaa, G. (2021). A Literature Evaluation of Systemic Challenges Affecting the European Maritime Energy Transition. *Sustainability*, *13*(2), 715.
The maritime sector is on track to increase emissions by 2050 but it is important that it innovates to become sustainable while still being economically viable. The maritime sector's systematic challenges (mostly due to inertia) are structured and evaluated. These four activities are categorized into: developing strategy and policy, creating legitimacy, mobilizing resources, and developing and disseminating knowledge. Limiting the direction and legitimacy of actors greatly diminishes the potential for adaptation.

2) Bjerkan, K. Y., Hansen, L., & Steen, M. (2021). Towards sustainability in the port sector: The role of intermediation in transition work. *Environmental Innovation and Societal Transitions*, *40*, 296-314.
This article uses survey data of Norwegian ports to investigate transitions and intermediation. Port authorities occupy a crucial role between systems of energy and transport and intermediaries are important for progressive transition work in ports and with those involved. This study complements previous research by highlighting the value of quantitative transition measurements to test the effect of intermediation.

3) Bjerkan, K. Y., & Ryghaug, M. (2021). Diverging pathways to port sustainability: How social processes shape and direct transition work. *Technological Forecasting and Social Change*, *166*, 120595.
This article builds on the message of the previous one (both study two leading Norwegian ports). There is a huge, underutilized potential for systems thinking and deep transition in ports. This article focuses on the unique social processes of different ports transition pathways. The article explains the determinative dynamics of inter-process and inter-level dynamics, as well as hierarchical structures. Success is when port sustainability expectations are lined up with heterogeneous value chain expectations.

4) Bosman, R., Loorbach, D., Rotmans, J., & Van Raak, R. (2018). Carbon lock-out: Leading the fossil port of Rotterdam into transition. *Sustainability*, *10*(7), 2558.
The old regime of a heavily fuel-dependent Rotterdam began shifting after a mix of internal and external pressures. Rotterdam port has since turned toward a circular and bio-based economy. Transition management can be used to reposition the incumbent actors to facilitate the transition of Rotterdam port but also other large energy-intensive industries.

5) Carpenter, A., & Lozano, R. (2020). Proposing a framework for anchoring sustainability relationships between ports and cities. In *European port cities in transition* (pp. 37-51). Springer, Cham.
This book chapter examines how ports and cities can collaborate towards becoming a sustainable port-city. This includes the sustainable integration of economic viability, environmental orientation, and social orientation. The chapter reviews the literature to develop a framework that enables communication and collaboration.

6) Damman, S., & Steen, M. (2021). A socio-technical perspective on the scope for ports to enable energy transition. *Transportation Research Part D: Transport and Environment*, *91*, 102691.
There are currently a limited number of studies using a socio-technical perspective. In this article, three Norwegian ports are analyzed using a multi-level perspective to explain how the

sustainability transition of ports works from a socio-technical perspective. The function of the port is determined by the interrelation of geographical and institutional factors (this means viewing ports as both individual actors and an assembly of actors). When ports play an active role, they can enable transport and energy transitions. Transition in ports is still in its early stages and studying the role of governance to facilitate interactions is an important next step.

7) De Geus, T., Wittmayer, J. M., & Vogelzang, F. (2022). Biting the bullet: Addressing the democratic legitimacy of transition management. *Environmental Innovation and Societal Transitions*, *42*, 201-218.
This article is a response to critiques of transition management for lacking democratic legitimacy- arguing it lacks governance and formal decision-making structures. To understand how it can be legitimised and to address the tensions, transition management is positioned in a framework which positions and applies it to six European cities.

8) Englert, D., & Losos, A. (2021). Charting a Course for Decarbonizing Maritime Transport. Summary report for policymakers and industry. The World Bank Group: Washington.
This article is hopeful about the new possibilities created by decarbonizing the maritime sector, which currently emits roughly 15% of the world's air pollution. Green ammonia and hydrogen would replace traditional fuel, and developing countries with renewable energy resources have a large potential to profit. With the right strategic policy interventions, new export markets would allow them to modernize domestic and industrial infrastructure.

9) Fenton, Paul. (2020). Port-City Redevelopment and Sustainable Development. In *European port cities in transition* (pp. 19-36). Springer, Cham.
This book investigates the conditions under which European ports can move toward sustainability. Some of the major obstacles include fossil fuel dependency, land use of container ports, employment issues, and unequal benefits shared at various stages of the value chain. Chapters mostly use a normative approach to present solutions towards sustainable development although they are often nonspecific and lack technical details. One thing this book does well is address ports in a regional context. Ports and governing bodies require support from state and supra-national bodies to implement policy, sometimes against the wishes of powerful lobbyists.

10) Frantzeskaki, N., Wittmayer, J., & Loorbach, D. (2014). The role of partnerships in 'realising' urban sustainability in Rotterdam's City Ports Area, The Netherlands. *Journal of Cleaner Production*, *65*, 406-417.
This article examines the role of partnerships in Rotterdam's sustainability transition after its port activities were relocated. The impact of the government on this vision was assessed by its role and in terms of synergies created. The success of partnerships as a form of meta-governance came from their role in coordinating self-organized processes without compromising on sustainability or synergy.

11) Hebinck, A., Diercks, G., von Wirth, T.,Beers, P.J.,Barsties, L., Buchel, S., Greer, R., van Steenbergen, F., Loorbach, D. (2022) An actionable understanding of societal transitions: the X-curve framework. *Sustainability Science*
This article addresses the lack of sustainability transition research in addressing the exnovation and break-down, rather than innovation and build-up, of existing frameworks. By using the X-curve to depict the patterns of a transition, people can better understand the dynamics and roles needed in transitions. The use of the X-curve framework is currently limited, but the author believes with further development and take-up, it can be valuable.

12) Kelly, C., Ellis, G., & Flannery, W. (2018). Conceptualising change in marine governance: learning from transition management. *Marine Policy*, *95*, 24-35.
This article explains that existing research is often ineffective because it fails to recognize important institutional challenges of integration. Using transition management to potentially conceptualize and operationalize new long-term strategies may lead to successfully integrated marine governance.

13) Kemp, R., Loorbach, D., & Rotmans, J. (2007). Transition management as a model for managing processes of co-evolution towards sustainable development. *The International Journal of Sustainable Development & World Ecology*, *14*(1), 78-91.
To use transition management to achieve sustainable development, a combination of incrementalism (bottom-up), planning (top-down), and goal-oriented modulations (top-down) are necessary. Affecting the process of transition via managing guided coevolution can be done with prescriptive multi-level governance.

14) Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability transitions research: transforming science and practice for societal change. *Annual Review of Environment and Resources*, 42, 599-626.
This article describes the methodological positions, the models, and the common concepts used to create the basis for sustainability transitions. Furthermore, the fields applicability to solving sustainability problems is explored.

15) Loorbach, D., & Geerlings, H. (2017). Ports in transition. In *Ports and Networks* (pp. 364-378). Routledge.
This book chapter explains that transitioning to sustainable port activities requires a fundamental change. It does so by describing transitions and transition management and providing a structure for governance. Then, to better understand what a sustainable port is and the possible pathways and obstacles to achieving it, an empirical case study is analyzed.

16) Loorbach, D., & Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, *42*(3), 237-246.
This article explores four cases from 1999-2009. It provides empirical examples that portray the advantages and disadvantages of transition management. The two main topics which require further investigation are power and people. In 2009, transition management was shifting from predevelopment to an acceleration phase with regime change. The challenge is using societal pressure and regime actors in the right ways, or else the result may be undesirable.

17) Meadowcroft, J. (2009). What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy sciences*, *42*(4), 323-340.
This article cautions the difficult and inherently political process of governance for sustainable development. As shown in Dutch case studies, lock-in, the influence of regime figures, and a lack of reflexivity all add to the difficulty. However, transition management can contribute to the long-term socio-technical transitions required of advanced industrial economies.

18) Mjelde, A., Endresen, Ø., Bjørshol, E., Gierløff, C. W., Husby, E., Solheim, J., ... & Eide, M. S. (2019). Differentiating on port fees to accelerate the green maritime transition. *Marine pollution bulletin*, *149*, 110561.
This article uses a case study to show the potential of differentiating port fees (based on environmental performance) to increase investment in green technology. If incentives/rebates

are sufficiently large and widespread, this would lead to increased uptake of liquified natural gas (LNG), a cost-benefit of 700,000 euros annually, and several social benefits.

19) Rotmans, J., & Kemp, R. (2008). Detour ahead: a response to Shove and Walker about the perilous road of transition management. *Environment and Planning A*, *40*(4), 1006-1012.
This is a letter in response to an article warning of transition management toward sustainability. Specifically, the article responds to four cautions put forth by the original article. In doing so, it corrects common misperceptions and false assumptions of transition management. The response explains that although transitions are difficult, the potential of transition management as a new governance model is useful/appealing.

20) Sondeijker, S., Geurts, J., Rotmans, J., & Tukker, A. (2006). Imagining sustainability: the added value of transition scenarios in transition management. *Foresight*.
This article is a comparative literature review that aims to position transition management in current sustainable development. The application of TM is currently limited so scenarios are analyzed to better understand how complex long-term steering by transition management can fit with specific development processes.

21) Voß, J. P., & Bornemann, B. (2011). The politics of reflexive governance: challenges for designing adaptive management and transition management. *Ecology and Society*, *16*(2).
This article examines how adaptive management and transition management consider politics. Currently, both forms of reflexive governance lack integration with politics, so the author suggests two paths for more robust governance. First, recognizing the politics of learning and preventing domination by powerful actors. Second, considering the dynamics of systematic entrenchment of governance designs in political contexts.

4. Summaries

1) Bergsma, J. M., Pruyn, J., & van de Kaa, G. (2021). A Literature Evaluation of Systemic Challenges Affecting the European Maritime Energy Transition. *Sustainability*, *13*(2), 715.

In the maritime sector, the energy transition lacks innovation, instead exhibiting inactivity and passivity. This study does a literature review to better understand the challenges of the industry. The European maritime sector includes the "actors, institutions, infrastructure, and interactions required for shipping," including all commercial types of ship within the European Economic Area (EEA) (p. 2). Efforts to transition energy are based on the IMO 2018 Climate agreement.
The systematic challenges were broken down into four activities: strategy and policy development, legitimacy, resource mobilization, and spreading information. To improve strategy and policy development, the results presented several potential improvements. First, better organization and a reduced number of unaligned actors. Second, the need to regulate and willingness to adapt. Third, more lobbying and strategic research. Fourth, making shipping more visible/prominent. Legitimacy could be improved by aligning business with energy transition goals, determining regulatory drivers, sustainable ship financing, and reducing financial uncertainty. Mobilizing resources can be helped by reducing the reliance of actors on resource vicinity, using goal-based regulation, replacing/upgrading infrastructure, and increasing research and resource availability. Challenges of knowledge dissemination can be reduced with increased innovation and knowledgeable actors, aligning institutions with energy goals, and better R&D.
In summation, the shipping industry is typified by regulatory compliance. Competitive margins, inertia, and the difficulty of changing structures mean actors need to be reorganized to reduce complexity, a more well-educated workforce is necessary, and governing bodies should increase focus on the sector to create policies that reduce financial/innovative risk. Furthermore, SME's have the potential to be impactful. To reduce challenges the following is required: long-term directives, reducing uncertainty, managing over-regulation and infrastructure dependency, and a major overhaul with new financial and technical R&D. This calls for increased trust to share information and more standardization.

2) Bjerkan, K. Y., Hansen, L., & Steen, M. (2021). Towards sustainability in the port sector: The role of intermediation in transition work. *Environmental Innovation and Societal Transitions*, *40*, 296-314.

Intermediary actors are instrumental for transitions/transformations. Ports can act as an intermediary in the socio-technical systems between the sea, surrounding land, and systems of transport. This article surveys this role using a sample of 96 Norwegian Ports to understand the changing function of port authorities.
Transition work can be defined as "the targeted goals, strategies, and actions that promote sustainability transitions" (p. 297). Furthermore, transitions are processes as well as outcomes. To understand ports as intermediaries, they can be described as actors for regime-based transitions. The different functions of ports include that of being a landlord (owner of an area), regulator, operator, and even community manager. Additionally, the role of ports is changing towards an increased focus on pollution, energy, and climate change.
To study Norway's ports, a quantitative approach involved using a quantitative survey to get information about the following four topics: the port, strategies, implementation, and expectations. The results showed 99% of ports conducted at least one intermediation activity, and 55% conducted all activities measured for. Furthermore, a positive link was found between complex port activity and intermediation. Public ports and ports with sustainability pressure from

owners also practised more intermediation. Overall, ports in surroundings of pressure/ambition for sustainability showed more coordination and intermediation but followed different transition pathways. From this, it is clear that ports are a case of what degree intermediation precedes successful transitions, rather than answering whether transitions and intermediation are in fact related.

> 3) Bjerkan, K. Y., & Ryghaug, M. (2021). Diverging pathways to port sustainability: How social processes shape and direct transition work. *Technological Forecasting and Social Change*, *166*, 120595.

Ports can employ systems thinking to facilitate transitions according to their unique context. By researching two diverging Norwegian ports and their social transition processes, this paper contributes to the understanding of ports as transition sites for sustainability. Using two emerging ports allows the study to research 'uncomplete transitions', which would increase the understanding of the acceleration phase of transitions.
Prudent to understanding transitions is the promise of socio-technical systems. Networks within these systems can use the existing resources to advance the process. One example is collective action to pool resources and create 'protective spaces' for niches. Expectations also play an important role in balancing stability and flexibility. They can align actors, build legitimacy, apply resources in innovative ways, and reduce uncertainty/risk. Another vital aspect is social learning. This process allows for the adjustment of innovation, expectation, and social awareness/beliefs. The different learning types are broad learning and deep learning (more radical change).

Table 2: *Summary of functions and reinforcive characteristics of social processes in transitions. Authors' composition.*

Summary of functions and reinforcive characteristics of social processes in transitions. Authors' composition.

	Social networks	Expectations	Learning
Dimensions	Create collective action Build protective spaces Diffuse knowledge and technology	Coordinate/align Build legitimacy/ protective space Mobilize resources Reduce risk perception	Modify innovation Modify expectations Modify sociocultural perceptions
Reinforcive characteristics	Diversity Integration Stability	Shared Specific Confirmed	Broad Deep

The data was collected from 25 different interviews with Norwegian port representatives and analyzed with coded content analysis. Social processes in the Port of Oslo indicated that its transition was "strategic, coordinated, and scalable" (p. 8) whereas the Port of Kristiansand showed an "incremental and niche-oriented" (p. 8) transition path. Both ports had clear expectations for electrification and a green/sustainable future but couldn't visualize this future and were directed by their markets and value chains. Overall, social processes are not just important strategies for frontrunner ports. Better understanding of how these processes can benefit or harm transitions is important to sustainable ports and has the potential to enhance our understanding of transitions in other domains.

4) Bosman, R., Loorbach, D., Rotmans, J., & Van Raak, R. (2018). Carbon lock-out: Leading the fossil port of Rotterdam into transition. *Sustainability*, *10*(7), 2558.

The only way to reduce our reliance on fossil fuels is for a complete overhaul of the existing economy. We need a complete societal change, or in other words, a sustainable transition. Transitions are defined as fundamental regime changes, which includes changing the existing structure, culture, and practices at the intersection of economic, financial, and environmental sustainability. These decade-long transitions are highly complex and often situated within sustainability and energy goals. Using transition management as a new form of governance is currently untested in the broader economy but it is important to understand the role of participating incumbents in facilitating transition management. One such case happened in the port of Rotterdam, from 2015 to 2017.
Transition requires both the breakdown of an existing system (regime destabilization) and the build-up of alternative sustainable practices. Core to this idea is the regime. Regimes are "the dominant culture, structure, and practices within a societal system" (p. 2). The three forces which contribute include building economic and socio-political pressure, lessening resources and legitimacy which diminish performance, and a loss of commitment from actors. Components that are most important to regimes can be used by policymakers for destabilization. These include control policies, regime rule changes, diminishing support for regime tech, and the replacement of key actors.
Incumbent actors are shown to begin with a stable status quo before perhaps later stimulating a transition, which can be guided by transition management under four principles: long-term planning, niches to foster frontrunner innovation, social learning, and participatory stakeholder interaction. To put transition management into practice, action (rather than analytical) research is necessary, as was done with the Port Authority of Rotterdam.

Figure 1. The timeline of the Port of Rotterdam transition arena.

Rotterdam's port regime is characterized by its fuel dependency, its massive scale and volume, and the synergies from carbon path-dependency. Landscape pressures and niche pressures led the Rotterdam Port Authority to seek alternatives. The Port of Rotterdam Transition Arena set up five workshops to introduce transition thinking and provide insights to guide Rotterdam's transition. Furthermore, a shadow track with reflexive short-term acts was added to the existing strategy to support the transition.
Over the course of this process, actors within the Port Authority changed from believing they could only play a minimal role in the transition towards becoming ambitiously proactive. The Port Authority was able to think of disruptive alternatives and a diversified strategy. The previous existing unwavering system in the Port was altered through system analysis to recognize transformative challenges, exploiting uncertainty/potential disruptions, rethinking underlying assumptions of scale/volume, viewing niche-developments as alternatives, diversifying actors, and allowing for open discussion.
The insights developed in this research show: repositioning incumbent actors is an important force, actors can change their positions in response to landscape/niche pressures, changing

discourse is the first step to practising change, focusing on both build-up and break-down is most effective, and repositioning incumbents creates tension which furthers regime destabilization.

> 5) Carpenter, A., & Lozano, R. (2020). Proposing a framework for anchoring sustainability relationships between ports and cities. In *European port cities in transition* (pp. 37-51). Springer, Cham.

While ports can create economic well-being, they are often unsustainable and create a multitude of environmental problems. Furthermore, ports are increasingly disconnected from cities and ports sometimes harm the city. When cities are not actively pursuing long-term environmental, social, and economic sustainable development, and not communicating/collaborating with ports, the cities suffer. Therefore, in order to attain a form of 'symbiotic sustainability,' collaborating is essential. However, collaboration faces several challenges including coordination costs, vulnerability, sharing of information (or the lack thereof), bargaining, and free riding.

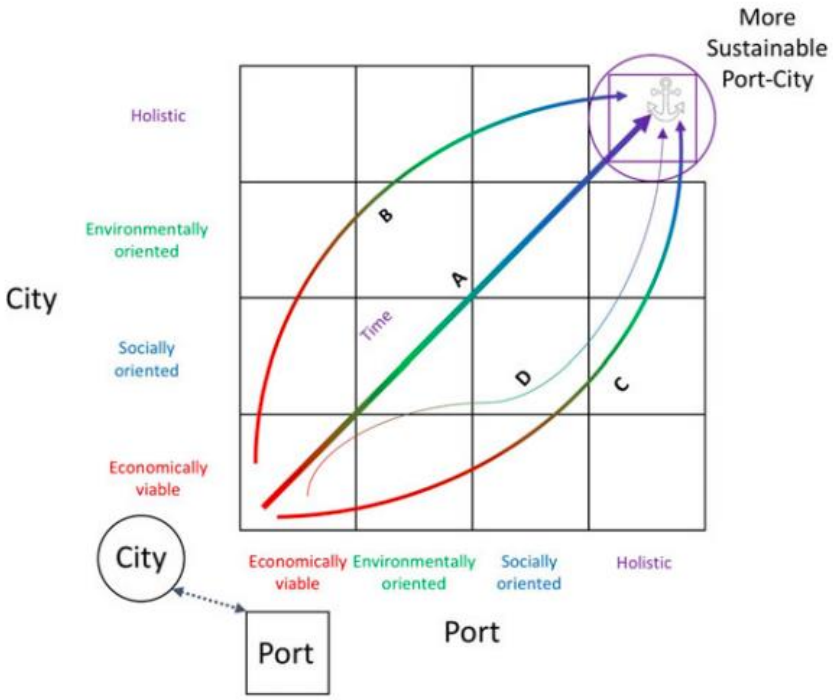


Figure 2: A pathway to a more sustainable port-city

The best way for port-cities to be sustainable is to work holistically and systematically, including all actors/stakeholders (as shown in Path A). Working together to be sustainable means improving economic security, incorporating technology and communication innovations, reducing negative elements/externalities, and creating local jobs.

> 6) Damman, S., & Steen, M. (2021). A socio-technical perspective on the scope for ports to enable energy transition. *Transportation Research Part D: Transport and Environment, 91*, 102691.

This paper applies the multi-level perspective (MLP) to sustainable transitions to understand the role of ports as incumbent actors. The study focuses on how exogenous pressure interacts with geography and institutional work within wider socio-technical systems. Ports are increasingly

seen as part of global value chains that facilitate sustainable development and transitions. Ports may also act as 'energy hubs' where they act as a juncture for energy infrastructure and loads. Unlike Rotterdam, Norwegian ports are smaller, locally owned, autonomous, and have a clearer role as zero-emission sustainable ports. Specifically, this paper looks at Oslo, Narvik, and Kristiansand.
Ports face increasing exogenous pressure to reduce emissions. The International Maritime Organization (2018) aims to rescue CO2 emissions 50% by 2050. Norway itself is targeting an 80-95% reduction by 2050 and a 50-55% reduction by 2030, mainly through electrification. NTP strategies are specialized for different geographical settings, and consider traffic, pre-existing infrastructure, industry, and renewable energy availability. These factors characterize various port network management. Besides networks, institutions and capabilities of ports shape their role alongside engagement with local niche innovations.

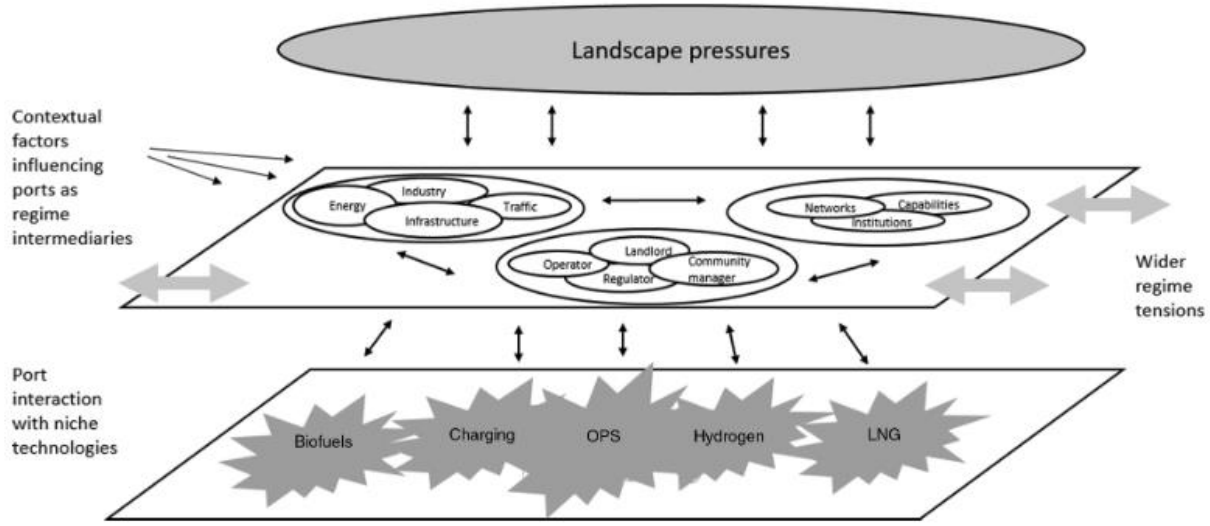


Fig. 6. Schematic illustration of contextual factors shaping ports' role as regime intermediaries.

Figure 3: Schematic illustration of contextual factors shaping ports' role as regime intermediaries.

Overall, ports can function as regulators, landlords, operators, and community managers to guide transitions. Given the lock-in associated with transport infrasystems, timing and reorientation is crucial to begin wider systemic change.

> 7) De Geus, T., Wittmayer, J. M., & Vogelzang, F. (2022). Biting the bullet: Addressing the democratic legitimacy of transition management. *Environmental Innovation and Societal Transitions*, *42*, 201-218.

As reflexive governance approaches become attached to institutional change, the democratic legitimacy of formal governance and existing decision-making institutions is challenged. However, it is possible to employ a legitimacy framework within democratic structures that protects the innovative potential of transition management (TM). The critiques of TM include carelessly involving key actors, depoliticizing societal issues, and not integrating opposition/defiance. There are two main reactions to address this. First, the TM approach can be adapted to improve forms of participation, transparency, and the role of power. Second, TM disagrees with the critiques because they are based on a regime of 'established' democracy,

which is a norm disputed by TM. However, to capture innovation and be a radical niche practice which to some degree replaces institutions, it needs to be legitimized within the dominant structures/institutions it fights against. To structure the process, the dimensions of input, throughput, and output need to assess TM's legitimacy based on collective liberal democratic values and normative aspects of transitions (see Table 3).

Table 3: Framework combining legitimacy dimensions based on liberal democratic norms and based on a transitions perspective (in bold)

Framework combining legitimacy dimensions based on liberal democratic norms and based on a transitions perspective (in bold).

Type of legitimacy	Definition Bekkers and Edwards (2007)	Dimensions (norms)	Definition	Source(s)
Input legitimacy	"*refers to a number of norms that can be related to the values of political equality, active citizenship and popular sovereignty*"	Opportunities for participation	Citizens and other societal actors are (equally) enabled to take part in political decision-making, public debate and policy-making.	Bekkers and Edwards (2007)
		Eliciting alternative perspectives	Alternative perspectives (i.e. different from dominant discourses) are actively enlisted, e.g. by involving front runners.	Loorbach (2010)
Throughput legitimacy	"*certain qualities of the rules and procedures by which binding decisions are made*"	Quality of citizen participation	Transparency, accountability, openness and inclusiveness are enhanced.	March and Olsen (1995) in Bekkers and Edwards (2007); Schmidt and Wood (2019); Schmidt (2013)
		Checks and balances	Processes to check the power of the process, e.g. political mandate, ratification local council.	Bekkers and Edwards (2007)
		Cultural imaginaries	A broad range of possible long-term directions (incl. fundamental changes in norms, values and ethics) are discussed during the process.	Loorbach (2010); Pel et al. (2020b)
		Institutional work	Institutions, i.e. rules, regulations, and routines are challenged.	Loorbach (2010); Loorbach et al. (2017); Pel et al. (2020a)
		Reflexivity	Ideas and actions are continuously questioned and adapted to new insights.	Beers and Van Mierlo (2017); Voß et al. (2009)
Output legitimacy	"*concerns the capacity of government to produce certain output or outcomes that actually contribute toward remedying collective problems*"	Responsiveness	Outcomes are effective and responsive to the people's wishes.	Bekkers and Edwards (2007)
		Guided action	Short-term actions are linked to (long-term) cultural imaginaries and institutional change.	Grin et al. (2010); Loorbach (2010)
		Collective empowerment	New sets of social roles and relations are set in place.	Loorbach (2010); Roorda et al. (2014); Wittmayer and Loorbach (2016)
		Reflexive governance mechanisms	Governance mechanisms open to a diversity of actors are set up to evaluate the performance and adapt outcomes to new insights and possible pathways in the face of uncertainty.	Scoones et al. (2020); Stirling (2011)

Six European cities produced roadmaps which included a 'radical core' that involved descriptions of the process's legitimacy. Radical referred to supporting increased intersectoral collaboration and delegating ownership of the pathway outside of city government. This was intended to increase participation of other actors like citizens and providing them more decision-making power (input legitimacy). The process of increasing legitimacy also included increasing quality of participation (throughput legitimacy) via checks and balances and accountability (output legitimacy).

8) Englert, D., & Losos, A. (2021). Charting a Course for Decarbonizing Maritime Transport. Summary report for policymakers and industry. The World Bank Group: Washington

Maritime transport is almost completely powered by fossil fuels, but the initial International Maritime Organization (IMO) GHG strategy set a target of cutting GHG emissions by 50% by 2050. The most likely replacements for zero-carbon fuel include biofuels, hydrogen, ammonia (most preferred), and synthetic carbon-based fuels. Liquified natural gasses (LNG) are being considered but the extent of their role is debated because of the risk of methane escaping into the atmosphere. Therefore, it is likely to play a limited role in the short-term but not serve as a long-term alternative.
IMO's emission target would require more than $1 trillion dollars in investment. Assessing the opportunity for countries is based on criteria of access to energy resources, large shipping volumes, location, a supportive regulatory framework, and pre-existing infrastructure. This presents an opportunity for economic, energy, and industrial development worldwide, but

especially in developing countries. Public as well as industry stakeholder support and government policies like carbon pricing are crucial to the transition.

> 9) Fenton, Paul. (2020). Port-City Redevelopment and Sustainable Development. In *European port cities in transition* (pp. 19-36). Springer, Cham.

Ports have a strong cultural influence on both their cities and the hinterland. As global trade increases, so does the socio-economic and environmental impact of ports. To a large extent, 'offshore' activities like shipping are self-regulated and it wasn't until the 2015 Paris Agreement that greenhouse gasses from maritime transportation were first regulated.
However, sustainable development is a multidimensional problem that requires coordinated interconnected port-city governance. Together with stakeholders, port-cities need to create renewable fuel infrastructure and services and share information about new renewable innovation and technology with stakeholders and other port cities.
Port cities differ contextually but generally face similar challenges. The ports of Stockholm, which are important to the city's sustainable transition, are a good example of how to overcome these problems. By using differentiated port fees, developing alternative fuels, experimenting, collaboration between municipalities, and joining international climate agreements, the city has become a leader in port-city transition. Overall, port cities have the difficulty of influencing environmental problems outside of their command, staying competitive, addressing local and regional impacts, freight transportation, competition for space, and producing new sustainable development. The port city of Stockholm was able to use multiple tactics that can be applied generally, like multi-stakeholder collaboration, a fossil fuel free climate strategy, and long-term planning. It is urgent that like in Stockholm, ports are given a clear mandate for sustainable development and the city monitors their progress to ensure a two-way commitment towards sustainable shipping and port operations.

> 10) Frantzeskaki, N., Wittmayer, J., & Loorbach, D. (2014). The role of partnerships in 'realising' urban sustainability in Rotterdam's City Ports Area, The Netherlands. *Journal of Cleaner Production*, *65*, 406-417.

Urban regeneration of waterfronts like ports is a complex wicked problem requiring collaboration, and holistic planning and governance. The regeneration of Rotterdam ports was successful in producing and acting on a novel sustainable vision for the transition. Partnerships, which can be between a local administration and its programmes, or community-based, proved to be prudent. In the service delivery industry, partnerships strengths include social synergy, governance and institutional synergy, and resource synergy. Importantly, they allow for flexibility because they can play a versatile role and allow for experimentation. However, partnerships can be hindered by delivery uncertainty, accountability issues, policy fragmentation, and the creation of ineffective practices.
In Rotterdam ports, several partnerships formed. The transition-arena network is a participatory process that brings actors together to determine a long-term sustainability pathway. The Stadshaven Project Office has a process-orientated role to guide rather than manage the vision and created both institutional and resource synergies. The Floating Pavillion has an action-oriented operational role to focus on design and implementation, leading to knowledge synergies by working in an interactive nonhierarchical way. The Clean Tech Delta Partnership also has an action-oriented operation role to bring about more understanding of the bio-based economy and sustainable energy sources, among other things to revolutionize delta-technology. Through interdisciplinary innovation, the partnership created knowledge synergies. Finally, the Rotterdam

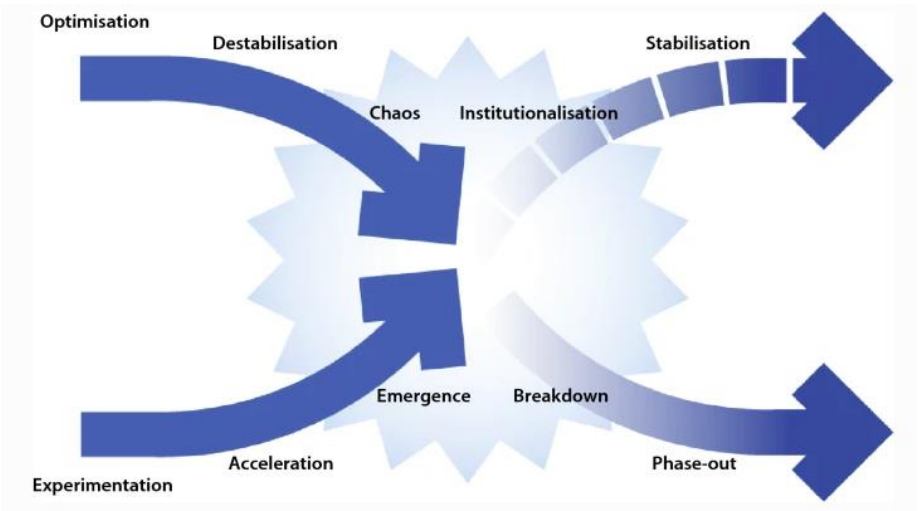
Climate Initiative has a process-orientated tactical role to create knowledge symmetries sharing/producing knowledge in a smooth integrated way.
Of these partnerships, the Stadshaven Office and Climate Initiative stand out as meta-governance centers. The former being a center on vision realization and the latter being a center on learning for climate resilience. However, Rotterdam's ports lacked a reflexive governance level of undertaking which can result in lost tracking of progress and knowledge in the pursuit of a sustainable vision. Additionally, the success of this case is partly due to local government for playing an important enabling role through meta-governance, allowing for collaboration and self-organization.

Overall, the case of Rotterdam revealed several factors of success:

- The sustainability vision and agenda provided momentum for relevant action that was supported by political actors and produced a symbol for leadership
- Early failures were overcome through experimentation that combined novel and old arrangements
- The government proved it could foster collaboration while maintaining a governance role
- Immediate action and diverse partnerships created great synergies

11) Hebinck, G. Diercks, T. von Wirth, P.J. Beers, L. Barsties, S. Buchel, R. Greer, F. van Steenbergen, D. Loorbach (2022) An actionable understanding of societal transitions: the X-curve framework. *Sustainability Science*

The existing framework for transition research is key to understanding societal transitions and while they explain the dynamics of build-up, they are not adequate in describing the process of breakdown and phase-out. In response to these limitations and the increased demand for such knowledge, the X-curve framework was developed. Expertise from the literature was incorporated into the model. This includes insights into niche-regime interactions, the institutional theory of institutional and policy failure, innovation theory, and socio-ecological system studies which includes the 'panarchy cycle'.



The X-curve portraying the interaction of patterns of build-up and breakdown (based on Loorbach et al. 2017)

Figure 4: The X-curve portraying the interaction of patterns of build-up and breakdown

The X-curve identifies 10 different transition build-up and break-down dynamics common to transitions. It argues that two dynamics are central to transitions: creation of alternative

practices and structures, and the destruction of the exisiting ones. The starting point for the curve is destabilization, which happens when continued investment and lock-in lead to a sudden collapse and subsequent chaos which leads to breakdown. Then, through build-up via experimentation and accelerating diffusions, niche-regimes emerge and that leads to institutionalization. Importantly, the X-curve views transitions as subjective, so dominant/alternative regimes are not universal.
Through the application of cases, the X-curve showed strengthening of systems knowledge, normative knowledge, and transformation knowledge, each of which enable sustainable transitions. The main challenges which arose in the cases outlined above were getting participants to understand chaos, destabilisation, and breakdown, facilitating the idea of transition dynamics rather than policy implications, and remaining a comprehensive framework that portrays all dynamics. However, these same characteristics make the curve simple, versatile, and allow it to portray chaos as inherent to the process of transitions. These strengths make actors reflect individually and collectively about their role, influence, and how to achieve desired transitions.

> 12) Kelly, C., Ellis, G., & Flannery, W. (2018). Conceptualising change in marine governance: learning from transition management. *Marine Policy*, *95*, 24-35.

There is a gap between the way alternative marine management is conceptualized and the way change is practised. Many institutional issues make governance transformation challenging. These include policy layering, path dependency, institutional drift, and actor resistance. In order to create radical transformation, a new type of governance is necessary- one which implements transition management and practical research.
The first step is integrated management approaches, but an understanding is lacking in current literature. In the Coral Triangle Initiative, a grassroots/niche approach proved to be effective in determining occasions for change. However, without political support, institutional change is greatly hampered. Transition management is considered because it includes systematic change, incorporating feedback in a gradual but continuous process that lasts a generation or more. This holistic system is better suited to modern society. The three important elements of TM to marine governance are the multi-level perspective (MLP), the multiple transition stages, and the participatory process.

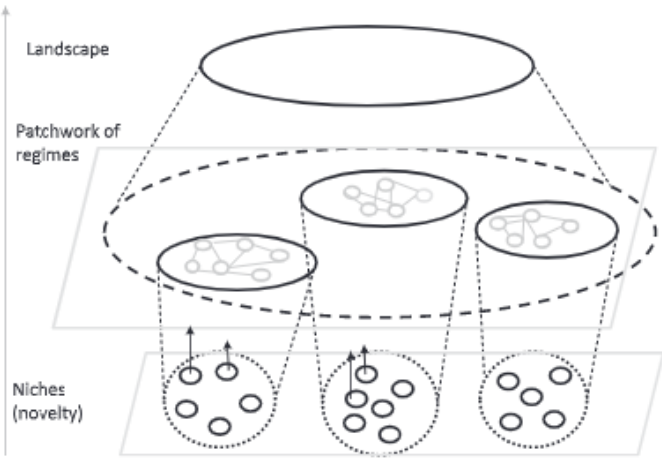


Fig. 1. Diagrammatic representation of the multi-level concept in transition studies. Source: Geels, 2002©.

Figure 5: Diagrammatic representation of the multi-level concept in transition studies.

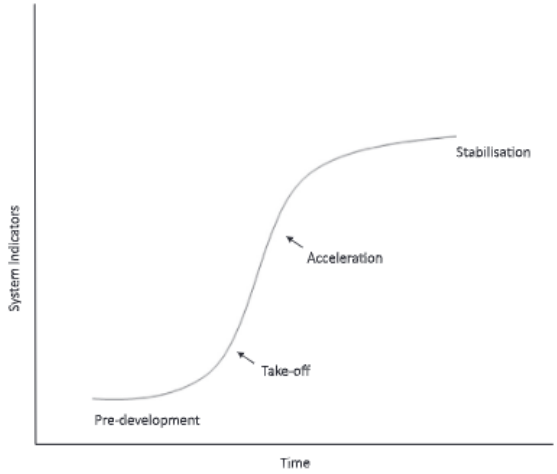


Fig. 2. Multi-stage concept within transition theory.
Source: [74] ©.

Figure 6: Multi-stage concept within transition theory.

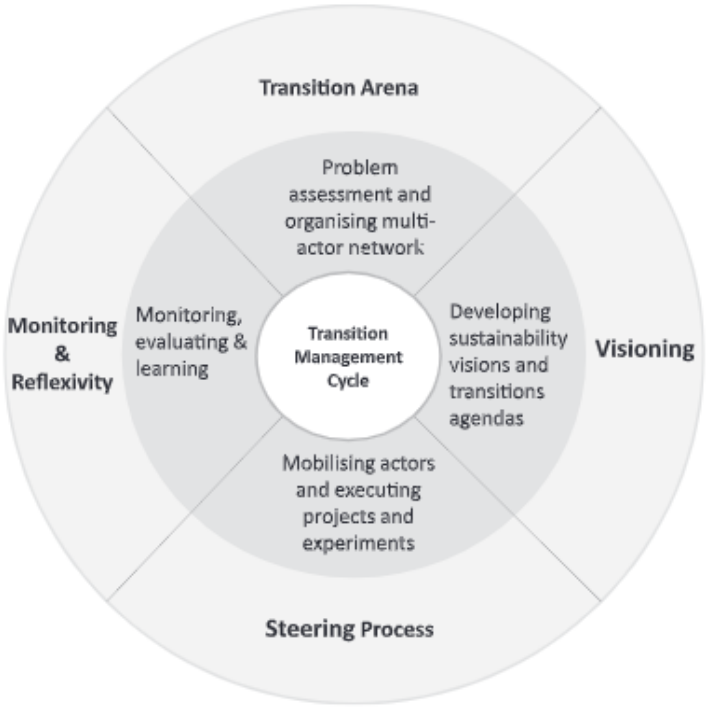


Fig. 3. Transition Management Cycle. Source: [74,43] ©.

Figure 7: Transition Management Cycle.

Processes like ecosystem-based management (EBM) and Maritime spatial planning (MSP) can address the need for better integration by better dealing with the complex institutional context of marine management. TM can address some of these issues by conceptualizing a framework of factors that drive/slow systematic change and provide concrete steps to operationalize change with a transition team, transition arena, as well as experimenting and developing networks.

Further marine governance research on barriers to change would be valuable to better understand whether/how TM could meet its potential.

> 13) Kemp, R., Loorbach, D., & Rotmans, J. (2007). Transition management as a model for managing processes of co-evolution towards sustainable development. *The International Journal of Sustainable Development & World Ecology*, *14*(1), 78-91.

Transition management can be used to guide sustainable development through changes in functional systems and governance. It is necessary to prioritize co-evolution, where the interlinked technological and institutional change evolve in response to each other. However, key problems make managing social change difficult. These include dissent on goals and solutions, the distribution of control/influence, linking short-term action to long-term change, lock-in, and political near-sightedness and turnover. To remedy these problems, transition management in the form of multi-level governance happens between three interlinked levels: the strategic level, the tactical level, and the operational level.

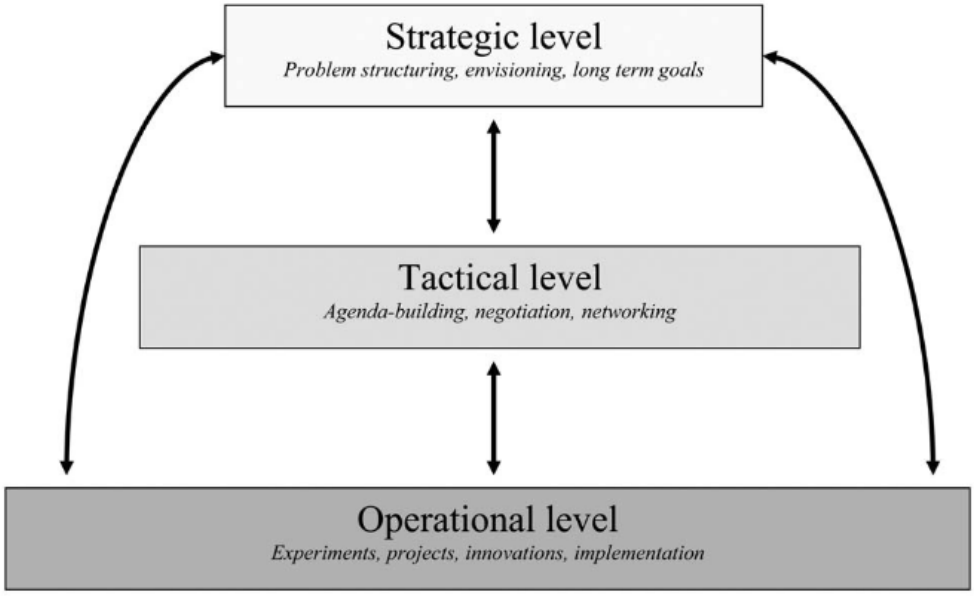


Figure 1 Multilevel approach to transition management

Figure 8. Multilevel approach to transition management

One example of the transition is in the Dutch waste management system. This can be understood as the co-evolution of the waste subsystem and the growing social consciousness of waste. There are three approaches to the co-evolution process: incrementalism as a bottom-up approach, comprehensive long-term planning as a top-down approach, and a combination of both. In this third form, transition management is an innovative amalgamation of long-term planning, incrementalism, and a goal-orientated reliance on networks and markets to change systems without trying to control the future. Long-term planning becomes both reflexive/adaptive and participatory.
Overall, transition managements distinctive features are “problem structuring, social learning, portfolios and strategic experiments, transitions arenas for envisioning and institutionalization of learning and capacity building in government and society” (p. 12). The complex systems approach, new governance, and social theory were all used to attain transition management.

Their use as an operational model is both descriptive and prescriptive which allows it to influence/analyze transitions. This is best described as directed incrementalism.

> 14) Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability transitions research: transforming science and practice for societal change. *Annual Review of Environment and Resources*, 42, 599-626.

In the context of sustainability, transitions are "large-scale disruptive changes in societal systems that emerge over a long period of decades" (p. 600). They serve as opportunities for radical change and the overhaul of dominant systems. This is shown in the ongoing energy transition and movement toward phasing out fossil fuels. Transition research aims to understand how to implement desirable transitions in large-scale nonlinear complex systems of governance. It is increasingly clear that actors involved in transitions need to do more than reduce sustainability (which adds to system lock-in) but instead work towards a systematic change of regimes. The first kind of regime in a multi-level perspective (MLP) is the socio-technical regime, which was combined with the multiphase model of transitions. This model lists predevelopment, take-off, acceleration, and stabilization as the four phases of change.
To better understand transitions, several concepts are important. First, nonlinearity or disruptive innovation. Second, multilevel dynamics, or the interaction between the landscape, regime, and niches to produce a breakdown and transformation of old systems. Third, coevolution, or the way systems change as a result of different phenomena interaction. Fourth, emergence, or the unforeseen/unplanned outcomes as a result of societal change. Fifth, variation and selection, or novelty from collective experimentation and learning-by-doing.
Furthermore, there are three research approaches in the transition field: socio-technical, socio-institutional, and socio-ecological. Based in science and technology, the socio-technical approach is strongly influenced by the MLP and Technological Innovation Systems framework. The socio-institutional approach involves a wide domain of culture, structure, practices, and their dynamics. Qualitative proactive methods are more common. The socio-ecological approach is centered around ecology and resilience theory and studies the (in)stability of interactions between people and the ecosystem.

Table 4: Three different perspectives on sustainability transitions

	Socio-technical	Socio-institutional	Socio-ecological
Disciplines	Innovation studies, history, technology, science and technology studies, practice theory	Sociology, governance, policy, economics, geography, political science	Ecology, biology, governance
Focus	Technology in social context Analysis of (historical) innovation journeys	Institutions, agency, power Analysis of networks, social innovation and governance	Ecology and socio-ecological relations Analysis of system vulnerability and transformative capacity
Main analytical lenses	Seamless web, multilevel perspective, path dependency, strategic niche management	Culture, structure, and practices; power in transition; transition management, multi-actor perspective	Panarchy, resilience, adaptive and transformative capacity, navigating, planetary boundaries
Approach to the energy transition	Emphasis on technological innovation, e.g., transition from combustion engine to electric car or from coal-fired power plants to solar panels in a societal context through dedicated innovation policy	Emphasis on political and institutional change, e.g., from central to decentral energy production as a shift in power from centralized monopolies to decentralized networks through countermovement and disruption	Emphasis on ecological thresholds and extraction of fossil resources to renewable resources within closed cycles through adaptive management

Transitions call for multi-actor participatory governance to facilitate solutions. Several different approaches exist that exhibit common characteristics including multi-actor dynamics, reframing the problem, having a vision, experimenting, and social learning. Additionally, to answer questions of agency, transitions either analyze governance transition, evaluate formal policy, and/or explore interventions with experiments.

> 15) Loorbach, D., & Geerlings, H. (2017). Ports in transition. In *Ports and Networks* (pp. 364-378). Routledge.

Transitions are non-linear processes that aim to transform the societal system. Transition management (TM) was introduced in 2001 in response to policy and market failures that aimed to reorientate societal development. TM sees shifts/crises in society as opportunities to use co-evolution to anticipate and guide change towards sustainable development. The multi-level model includes the regime, the micro-level for innovation (niches), and the macro-level of the societal setting (landscape).
The transitional process can be described as 'creative destruction' and goes through four phases (S-curve): the pre-development phase with experimentation, the take-off phase when system change begins, the acceleration/breakthrough phase when structural change is visible, and stabilisation when societal change decreases and reaches equilibria.
Regimes and persistent problems are prudent to transition studies. Dominant systems suffer from lock-in and path dependency, showing the need for disruptive power change. The framework for TM comes from using empirical studies/cases to go from descriptive to prescriptive. This happens through selective participation.

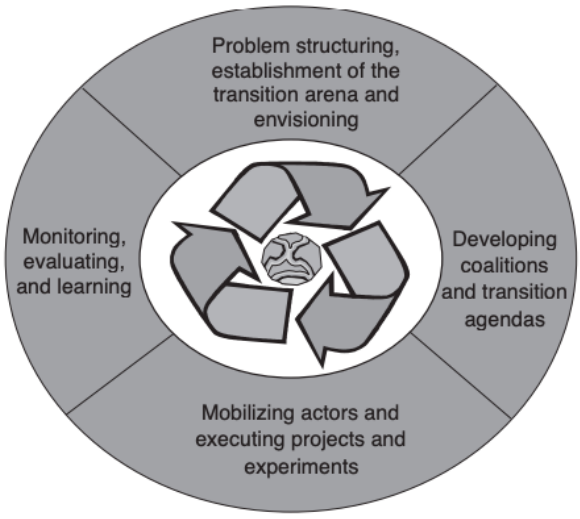


FIGURE 22.3 The transition management cycle

Source: Loorbach (2007).

Figure 9: The transition management cycle

Using a governance approach for transitions requires co-evolution instead of revolution and actions which strengthen/feed into co-evolution, plus tipping points for an outpour of innovation. This informs several principles for governance which can be found in the article.

One case of applying TM happened in the port of Rotterdam. The goal was to make inland shipping more sustainable. In accordance with the growth of shipping containers, Rotterdam invested in infrastructure called the Second Maasvlakte. To facilitate a transition, there are three paths: using large-scale industrial corridors in the logistics chain, radical greening, and a detailed distribution network.
It is important to manage the negative effects of lock in and improve the competitiveness and efficiency of ports, spur economic growth, and limit/reduce environmental harm. Ports have four main challenges: fossil fuels to renewables, the infrastructure of the chemical industrial complex, achieving zero-emission sustainable transport and logistics, developing port areas, and connecting ports to the city.
Overall, TM contributes to a model of governance for sustainable and novel port development. Many sectors such as energy, agriculture, water management, and transport already benefit from its application. Social, environmental, and business changes for sustainability are inevitable and TM can be used to guide the transition.

16) Loorbach, D., & Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, *42*(3), 237-246.

Transition management emerged and grew between 2000 and 2010 as a new form of governance that enables a transition towards sustainable development by influencing governance activities. Four cases are shown as empirical examples that highlight transition managements advantages and disadvantages. First, at the regional level, Parkstad Limburg. Second, at the industry level, roof transition. Third, on a sector level, healthcare transition. Fourth, resource transition in Belgium. These will be further explored below. Implementing transition management in a structured co-production process creates the best learning-by-doing insights. Transition management became an official government policy when the fourth Dutch National Environmental Policy (NMP4) introduced it. Upon discussion, transition management is said to require the following: deadline with uncertainty, taking a multifaceted view that includes multiple actors, having a long-term aim to guide short-term action, incorporating international developments, and specifying government tasks. As a whole, the principles represent the operational model called the transition management cycle. Furthermore, this cycle can distinguish the type of governance activities into one of the following: strategic, tactical, operational, and reflexive.
As mentioned earlier, there are four case examples. The regional case deals with transitions in South Netherlands. This resulted in the Parkstad municipalities forming a single region focused on developing a better housing and living environment. Furthermore, many actors involved had a change in mindset from pessimism/gloom to opportunity for improvement. The industry and business case deals with transitions in roofing, focusing on the material used. Initiated by market leaders, the ESHA group, the goal was to transform roofs to contribute to local sustainability. The process has been successful in changing sectoral and government vision for roofs and getting it adopted as a national policy. The sector case was commissioned by the Ministry of Health and deals with transitions in the healthcare sector. The goal was to fundamentally change the way long-term care needs are fulfilled. The project has successfully reframed health care innovation and developed a strong transition narrative. For example, the District Care Model proved to be more cost-efficient and rewarding. The international case deals with sustainable waste and resource management in Belgium. The goal was to manage production to prevent waste, via a closed-loop transition.
Several general lessons came from these four cases. Many of these lessons have to do with managing transition arenas, a core part of TM. The lessons are context-specific and require different participatory practices. The selection of frontrunners is crucial. The transition arena

composition requires a majority of niche regime actors. Frontrunners need freedom and space. It is important to maintain transition process autonomy through close regime relations, prepare for uncertainty/chaos, develop a common language to specify results, intertwine substance and processes, and frontrunners need to be empowered.

17) Meadowcroft, J. (2009). What about the politics? Sustainable development, transition management, and long-term energy transitions. *Policy sciences*, *42*(4), 323-340.

Reformed governance for sustainability requires reflexivity exercised in two ways. First, it requires societal steering which aligns us on a desirable path, protects vulnerable groups, and reforms socio-technical institutions/systems. Second, it is interactive, involving a 'collective discovery' of the best social paths. Guiding structural change with transition management (as an alternative to established governance approaches) requires changing the 'rules of the game' step by step. This requires involving multiple stakeholders to create visions and transition experiments to understand obstacles and opportunities. The strengths of TM for sustainable development include making the long-term consequences/impact of current decisions clearer, transforming established societal practices/systems, starting interactive processes, fusing technological and social innovation, creating 'learning-by-doing,' as well as fostering competitive innovations.
However, it is difficult to manage large scale transitions. Specifically, the main challenges are specifying the ideal transitions, lock in (i.e. influencing system change), optimal decision making in a complex and open-ended context, and TM practical experience in the Netherlands. Overall, it would be an immense political and government struggle to define and orient change, get the necessary investment in new technology and infrastructure, and sway dominant regime actors due to a 'reflexivity deficit'. Each stage in the transition process would be contested but it may be possible for citizens to shape the markets and politics in a way that would allow for such transitions to succeed.

18) Mjelde, A., Endresen, Ø., Bjørshol, E., Gierløff, C. W., Husby, E., Solheim, J., ... & Eide, M. S. (2019). Differentiating on port fees to accelerate the green maritime transition. *Marine pollution bulletin*, *149*, 110561.

Shipping and port emissions of GHGs and air pollutants have societal costs including reduced wellbeing, health, and even loss of life. Ports are essential to the Maritime's green transition because they impact incentives and services of shipping. Port fees based on environmental performance can provide positive change if the fee rebate is large enough and correctly targeted, and the ports fees are scaled to cover sufficient ports. This study investigated Norwegian cruise ships using LNG fuel and allocated potential rebates to determine whether these conditions incentivized shipowners to invest in sustainable technology.
While the results depend on rebate size and the number of ports visited, they showed that port fees could be profitable for shipowners and provide enough incentive for green investment while reducing payback time for LNG/green ships. On average, the rebate equaled 1500 euros per visit. Additionally, social benefits from reducing negative externalities add to the success. Norway is ambitious about reducing GHG and giving priority to green ships in their port would bolster efforts to uptake green technology.
The main technologies currently being considered for reducing emissions are alternative fuels and energy carriers (ex: LNG), new technical and operational measures/efficiency, and treating nonrenewable exhaust gas. Ports' role in this maritime transition would be threefold. It would punish environmentally unsustainable choices, act as 'energy-hubs' providing electricity and alternative fuel infrastructure, and improve ship and port efficiency/coordination to reduce

emissions and fuel consumption. This would also require indexing and rating systems for the classification of environmental performance in ports. Existing data and reporting like the Environmental Port Index (EPI) system should allow for this possibility.

19) Rotmans, J., & Kemp, R. (2008). Detour ahead: a response to Shove and Walker about the perilous road of transition management. *Environment and Planning A*, *40*(4), 1006-1012.

This letter is a response to points made by an article cautioning TM. First and foremost, TM is a cyclical reflexive process that uses a social engineering method that greatly reduces uncertainty, as opposed to the more traditional "command-and-control mode" (p.1). Using learning experiences, TM explores multiple options and adapts to be more sustainable. At the core of TM is 'goal-oriented modulation' which takes into account changes/developments when considering societal goals.
The first caution is about the authority figure/managers in transitions. However, in TM, power is distributed between frontrunners, niche players, and other various actors. Rather than having managers, players each have their role in transitions but are interconnected with other actors. In many cases, the government oversees the process.
The second caution is about monitoring transition trajectories. However, transitions are nonlinear and complex, but by monitoring early developments and dynamics, analysis can be done. Reflexive monitoring, which includes quantitative and qualitative indicators, is important.
The third caution is responding to unsustainable transitions. TM seeks alternative solutions/systems at the expense of current unsustainable ones. Radical systematic changes, i.e. transitions, are necessary.
The fourth transition is that focusing on technical systems is too narrow a way to deal with societal change. While many TM literature focuses on technical infrastructure systems, case studies are much broader. Furthermore, TM was developed with the idea of the existing narrow sociotechnical focus.
Overall, TM is a new model of governance. It combines incrementalism and planning. It is still too early to say whether its scope is overstated, and its difficulties understated, but it is positive and full of potential in a society increasingly concerned with expanding transition research and policies towards sustainable development.

20) Sondeijker, S., Geurts, J., Rotmans, J., & Tukker, A. (2006). Imagining sustainability: the added value of transition scenarios in transition management. *Foresight*.

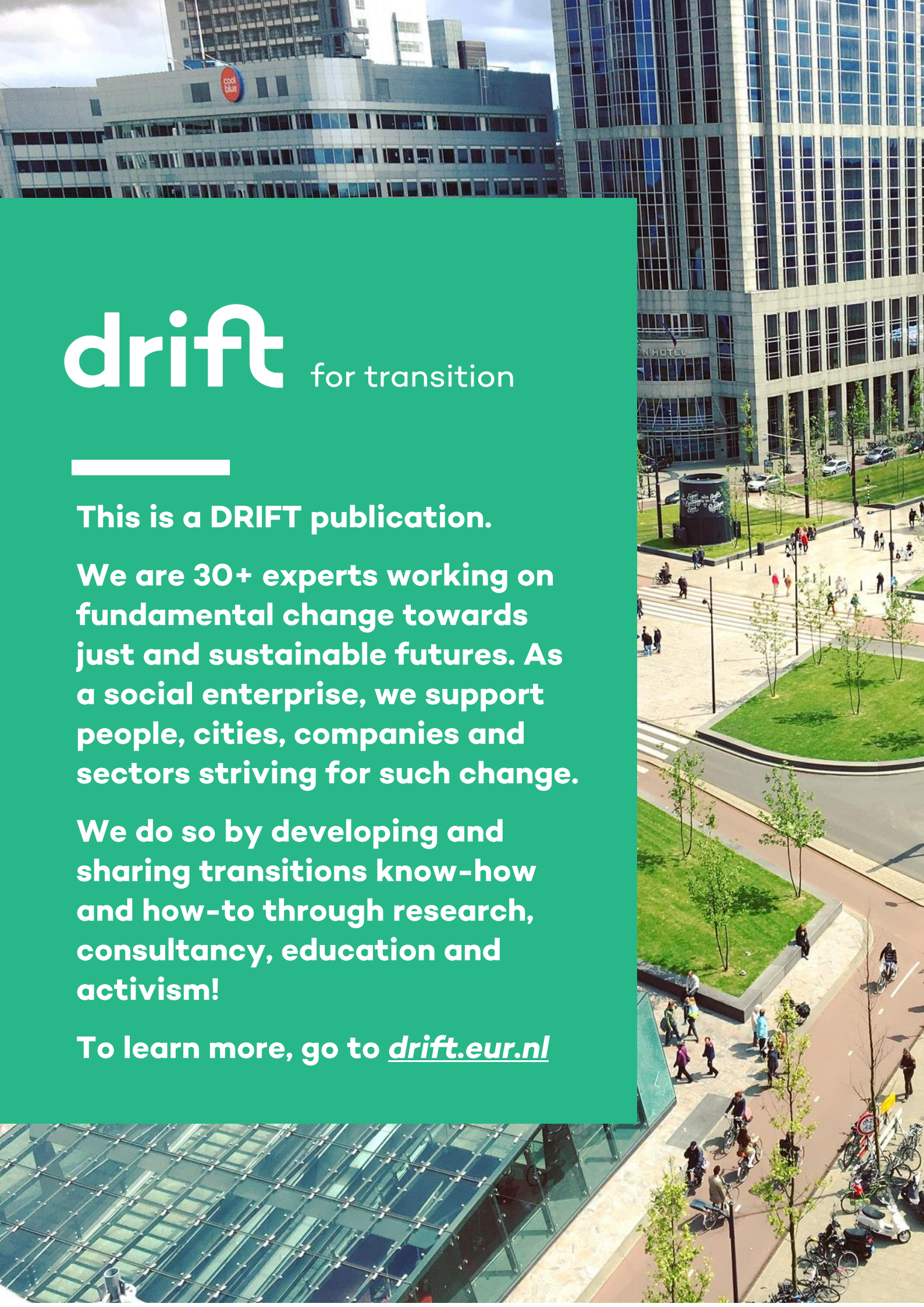
TM is a systematic governance model aiming to guide innovation towards sustainability. To realign and mobilize actors, TM provides a long-term perspective/scenario which is used to steer short-term actions that reframe the current paradigm in an innovative way. This model of TM has already been adapted in The Energy Transition and Parkstad Limburg, with the government playing an important role in mediating interactions between relevant parties. Although the process of TM has recognized potential, its use is limited due to a lack of belief in its ability to handle the complex transition dynamics. Further developing the theory and real-life process of TM for sustainable development is necessary.
TM acknowledges the multiplicity of transition challenges in order to outline and anticipate potential uncertainty, avoid premature lock-in, and give room for niche-led and alternative solutions. The main tool to operationalize transitions is the transition arena, where-in actors take part in the TM-cycle. TM includes a transition scenario, which produces a project goal, process design, and scenario content. The scenario can be understood as a hybrid tool which combines process and product functions with both an explorative and normative basis. It focuses on

societal transition dynamics at a systems level and are used to motivate short-term action. However, the idea that transition scenarios can consider future discontinuity is problematic because they don't incorporate the possibility for surprises or sudden changes in the system. Therefore, under uncertainty and complexity, scenario tools need a more balanced comprehensive methodology.

21) Voß, J. P., & Bornemann, B. (2011). The politics of reflexive governance: challenges for designing adaptive management and transition management. *Ecology and Society*, *16*(2).

As a result of a mindset shift toward reflective governance, multiple fields have adapted their governance design based on common characteristics. These are participation, experimentation, and collective learning. Two prominent reflexive governance designs, adaptive management (AM) and transition management (TM), have been criticized for their insufficient consideration of real-world interactions. Both approaches aim to understand the complexities of systems and their dynamics but are criticized for excluding politics and its implications.

The politics of reflexive governance can be distinguished between three dimensions and levels. The dimensions are policy, polity, and politics proper, and the level of interactions occur at the micro level, meso level, or macro level. TM is centered around the coevolution of sociotechnical systems, aiming to modulate the path from A to B. TM's principles fit within a four-step cycle which includes creating the transition arena, developing transitions and agendas, mobilizing actors and executing experiments, and lastly, constant evaluation and monitoring. However, it is criticized for only considering politics at the micro level. On one hand, TM describes using the political process, political margins, and negotiations to transform political regimes. Simultaneously, politics seems to be separate and outside the transition arena, avoiding any potential 'nasty politics'. To overcome these challenges, it may be valuable to reorient design strategies as robust, open-ended searches with less control and sophistication. Two topics of further research could focus on 'horizontal' expansion on the micro level that handles 'nasty politics' with safeguards and new instruments, and 'vertical' expansion to cover politics on the meso and macro level. It would be an innovative and critical evaluation of experiences and political practices, shaped by both actors and critics.



drift for transition

This is a DRIFT publication.

We are 30+ experts working on fundamental change towards just and sustainable futures. As a social enterprise, we support people, cities, companies and sectors striving for such change.

We do so by developing and sharing transitions know-how and how-to through research, consultancy, education and activism!

To learn more, go to *drift.eur.nl*