Chapter 2
Participative Governance of the Swiss Construction Material Industry: Transitioning Business Models and Public Policy

Daniel Kliem and Alexander Scheidegger

Abstract Insights from research into transitions of socio-technical systems start to influence policy design, pushing for more sustainable production and consumption systems. Policy implementation is often met with resistance from a variety of actors and faces systemic inertia to change. We examine this resistance and the role of business models within industry-sector transitions through a case study on the Swiss construction material industry. Business model logics can form barriers to change and inhibit the diffusion of alternative logics. Using a system dynamics perspective, we identify feedback loops that form barriers to transitions. These feedback structures promote the understanding of an organisation's role in a changing environment and to anticipate problematic future scenarios. Causal loop diagramming explicates the need for participative governance as it builds on shared mental models among relevant key actors. This study demonstrates the value of using dynamic systems thinking to understand the role of business models in industry sector transitions.

Keywords Business models · Transition management · Industry sector · Circular economy · Barriers · System dynamics

D. Kliem (✉)
University of Bergen, Bergen, Norway

University of Applied Science St. Gallen, St. Gallen, Switzerland
e-mail: daniel.kliem@ost.ch

A. Scheidegger
University of Applied Science St. Gallen, St. Gallen, Switzerland
e-mail: alexander.scheidegger@ost.ch

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C. Bianchi et al. (eds.), *Enabling Collaborative Governance through Systems Modeling Methods*, System Dynamics for Performance Management & Governance 4, https://doi.org/10.1007/978-3-030-42970-6_2

2.1 Introduction

Advocacy for sustainable resource management of the construction material industry has gained momentum in response to increasing global urbanisation, aiming at a transition towards circular economies (UNEP and ISWA, 2015; Uyarra & Gee, 2013). Material flows for construction activities make up to 50% of developed nations metabolisms (Leising, Quist, & Bocken, 2018; Spoerri, Lang, Binder, & Scholz, 2009) and account for 5–10% of Europe's energy consumptions (Iacovidou & Purnell, 2016). Societal acceptance for further expansion of the mining industry is decreasing, as mining activities collide with urban development, highlighting a need to close material loops and reduce energy demand (Abrahamsen, Graff, & Sturm, 2017). Industry sector transitions require a fundamental restructuring of existing markets, technologies, infrastructures, business models and legal frameworks (Bolton & Hannon, 2016), to decarbonise industries, close material loops and achieve emission goals of the Intergovernmental Panel on Climate Change (IPCC) by 2050 (Iacovidou & Purnell, 2016). Focussed on understanding long-term change dynamics, socio-technical transition research has emerged in response to call for more towards more sustainable production and consumption systems (Geels, 2002; Kemp, Loorbach, & Rotmans, 2007). Along with the uptake of the Sustainable Development Goals (SDGs), socio-technical innovation policies have gained momentum (Ludwig, 2019). Within these systems of increasing complexity and uncertainty, unintended consequences of policies as well as discrepancies between long- and short-term consequences appear omnipresent and potentially lead to systemic lock-ins to inferior practices (Edmondson, Kern, & Rogge, 2018).

Despite these transitions requiring rapid actions, vested interests in certain technologies, institutionalised routines and deeply rooted beliefs constitute regimes, forming barriers against fundamental transitions (Markard, Raven, & Truffer, 2012). Regime actors with vested interests to maintain a status quo are assumed to be a major source of policy resistance (de Gooyert, Rouwette, van Kranenburg, Freeman, & van Breen, 2016). Understanding the role of these actors, and the decision that lead to systematic pushbacks, can help to identify leverage points. A key challenge in socio-technical transitions is to build support for policy mixes that stimulate virtuous, rather than vicious system configuration (Edmondson et al., 2018). From an institutional perspective, policy research integrates transition concepts in the form of long-term visions for evolutionary system innovations (Rotmans, Kemp, & van Asselt, 2001). These visions need to build on leverage points for systemic change and require support from a relevant stakeholder group to accelerate transitions. To reduce the policy resistance of industry sectors, systemic lock-ins and leverage points for policymakers need to be identified (Geels, McMeekin, Mylan, & Southerton, 2015). To understand the phenomena of lock-ins of dynamic system, we want to understand *"What are regime-stabilising dynamics in an industry sector"?*

2.2 Theoretical Background

A central heuristic to conceptualise and describe the transition dynamics of socio-technical systems is the multi-level perspective (MLP). Central to the MLP are societal, political and market rules, as well as resource structures, that form stable and reinforcing relationships over time, resulting in a dominant regime (Geels, 2004). Relationships between technologies, infrastructure, regulations, cultural norms, user patterns and industrial standards manifest at the regime level and strengthen its stability through coalitions, synergies and the accumulation of political power (Geels, 2011). Greater landscape trends, such as the orientation towards more sustainable production and consumption system, exercise pressure on the regime (Foxon, Hammond, & Pearson, 2010). Regime challenging technologies emerge at the niche level, a safe space for the development of marketable production and consumption alternatives. Fostering and nurturing these safe spaces is central to transition management (TM). Focussed on active management of socio-technical transitions, transition management is an attempt to influence the diffusion of innovation and unlock pathways of socio-technical systems for sustainability (Geels, 2002). Innovations and alternative technologies challenge a dominant logic of how consumers and producers meet and exchange goods and services (Boons, Montalvo, Quist, & Wagner, 2013).

Existing or emerging barriers to transitions have been found on various levels, such as firms or sectors (Bolton & Foxon, 2011), institutional and policy (Busch, Roelich, Bale, & Knoeri, 2017; Francart, Larsson, Malmqvist, Erlandsson, & Florell, 2019), consumer (Joshi & Rahman, 2015) and within larger system structures (Geels, 2012; Hall & Roelich, 2016). Overcoming regime lock-ins and opening potential windows of opportunities for niche players is a central promise of transition management (Turnheim & Geels, 2013). Governance of these complex systems involving a multitude of stakeholders from the public, private and NGO domains over time requires innovative, experimental and participative approaches (Loorbach & Rotmans, 2010). It requires systemic cooperation of policymakers, private actors and other relevant stakeholders, leading to the formation of coalitions among different levels of power and agency. Agency describes the ability of actors, technology and institutions to influence and shape their trajectories (Smith, Stirling, & Berkhout, 2005). Power can facilitate or circumscribe agency, for example, by prioritising certain actions or diminishing the feasibility of action for certain actors (Smith et al., 2005). Identifying the role of different actors within a system helps to assess their ability to interfere with a status quo. Such complex, dynamic relationships contain feedback mechanisms and mutual dependencies and involve actors from multi-level political powers (Hooghe & Marks, 2002). Based on the interaction and feedbacks within subsystems, transition management aims at coordinating interactions and influencing feedbacks on different levels, by involving stakeholders with participative methods. These participative methods focus on building shared visions among relevant actors, enabling real-world experimentation and providing a safe space for the development of alternative products or services (Foxon, 2011).

A key challenge to the operationalisation of socio-technical transitions research is the identification of relevant units of analysis, describing the narrative of transitions (McDowall & Geels, 2017). Bidmon and Knab (2018) operationalised the socio-technical regime and its emerging alternatives by looking at business models and focussing on the behaviour of organisations from a market perspective. Business models enable an abstract representation of an organisation and the logic it applies in a market, beyond the sole formulation of a strategy (Bidmon & Knab, 2018; Schaltegger, Lüdeke-freund, & Hansen, 2016). Business models are an intermediary between an organisation's strategy and its operations and capture relevant elements for the organisation's functioning (Nußholz, 2017). Bidmon and Knab (2018) identified business models (1) as part of the regime, (2) intermediates between the regime and niche and (3) non-technological niche innovation. Accelerating the diffusion of innovative technologies often means to develop new business models or to re-design existing business (Bidmon & Knab, 2018).

Along with the emergence of innovative technologies, changes to the practices of production and consumption among institutions, markets, technology and innovation are inevitable (Geels, 2002). Such changes manifest at the business model level, influencing the value creation and value capture mechanisms of organisations and thereby the logic of how the organisation functions (Teece, 2010). Research into the role of business models in transitions has focussed on emerging, rather than incumbent business models and lacks knowledge on regime-destabilising dynamics (Bosman, Loorbach, Rotmans, & van Raak, 2018).

Following the literature on transition theory and the identified research gap on regime destabilisation, we argue that the concept of business models could provide an operational perspective. Understanding business models and their regulatory environments in transitions requires a dynamic perspective on the system (Papachristos & Adamides, 2016). Limited understanding of systems can lead to an inefficient distribution of resources by public or private institutions or divert the attention away from the problem's cause towards treating symptoms. Understanding causal relations in a system, as well as the feedback among and within subsystems, is fundamental to understanding the behaviour of a system (Ulli-Beer, 2013). Abdelkafi and Täuscher (2016) focussed on the role of sustainable business model analysis from a socio-environmental perspective. They argued that system dynamics is equipped to reveal the impact of the natural environment on the organisation and to visualise the main feedback loops between the firm and the environment. This study takes a system dynamics perspective to understand the role of business models in socio-technical transitions, combining the perspectives of organisations and industry sector actors.

2.3 Methodology

Understanding the regime-stabilising dynamics from a business models perspective requires the identification of feedback structures and delays, which are crucial when moving from understanding towards managing complex systems (Papachristos,

2011; Ulli-Beer, 2013). Complementary to Loorbach and Rotmans' (2010) transition management approach, system dynamics builds upon tools and techniques to understand and improve system steering capabilities. In the context of transition management, system dynamics has predominantly been applied to study transition in descriptive ways, whereas simulation and modelling has only been applied in few cases (Bennich, Belyazid, Kopainsky, & Diemer, 2018; Papachristos, 2011; Papachristos & Adamides, 2016; Ulli-Beer, 2013; Valkering et al., 2017; Yücel & van Daalen, 2012). System dynamics modelling processes build around problem conceptualisation, testing of dynamic hypothesis, learning about the behaviour arising from the causal structure and ultimately testing of new policies (Luna-Reyes & Andersen, 2003;Sterman, 2001). System dynamics explicitly deals with feedback between subsystems, non-linear behaviour and their endogenous structures that create certain behaviour (Richardson, 2011). Capturing feedback loops within multiple subsystems and describing endogenous, dynamic interactions is a core strength of system dynamics (Sterman, 2000). Defining a regime in socio-technical systems is a challenging task, as potentially multiple regime co-exist among multiple levels. By eliciting mental models of dominant actors in the industry, a system boundary can be developed and shared problem perception developed (Vennix & Forrester, 1999). By capturing a shared perception of the regime, we attempt to create a boundary object to focus the discussion (Black, 2013; Black & Andersen, 2012).

System dynamics methodology suggests group model building and case studies research to elicit mental models and form causal models of individual realities (Richardson, 2013). A combination of both is applied in this research, integrating insights from various levels. Business models are analysed from a "firms-in-industries" perspective, generating insights into the role of specific business models in transitions (Geels, 2014, p. 275). Changes in the regulatory environment and potential changes in the "industry-environment" of the organisation are derived from the group model building sessions. Group model building builds on the mental model of stakeholders by eliciting variables and causal connection in interactive settings (Vennix & Forrester, 1999). A three-stage process is followed to connect different perspective.

2.3.1 Step 1: Group Model Building

Group model building workshops with stakeholders are used to define system boundaries and identify problematic behaviour and potential causal links to relevant business models. To avoid prescriptive problem identification by the researcher, the participants need to state problematic dynamics that are important in their mental model (Luna-Reyes et al., 2006). Throughout this process, the system boundaries are iteratively tested with regards to time, geography and the value chain of interest. Resulting from the discussion on problematic dynamics, reference modes of behaviour are developed. Reference modes describe problematic behaviour over time (Sterman, 2000) and frame the narrative for the business model analysis. The dynamic hypothesis developed by the participants is transferred to the

operational level of business models in step 2, to test the reactions of different business models to the hypothetical changes in their environment. The process of defining shared problems and eliciting mental models is at the core of group model building (Vennix, Akkermans, & Rouwette, 1996; Vennix & Forrester, 1999).

2.3.2 Step 2: Participatory Business Model Analysis

Addressing dynamics that impact existing business models is a way to identify the role of business models in transitions (Knab, 2018). Semi-structured interviews with the participating companies are conducted to understand the impact of external dynamics on business models along a value chain. The semi-structured interviews analyse the inner working of companies to understand the relevant decision rules that either hinder or accelerate transitions. Data from these case studies is collected based on Upward and Jones' (2016) extended version of Osterwalder & Pigneur, (2013) business model canvas. The dominant business model of each organisation is mapped, and the outcome of the group model building workshop serves as an input for the dynamic analysis of each business model. This dynamic input is used to understand adaptations to the business model, identifying key decision-making rules.

2.3.3 Step 3: Synthesis

The results of the group model building workshop and the case studies are synthesised in a causal loop diagram (CLD). It is an explicit method to map causal connections, specify relevant units of analysis and to study system behaviour (Sterman, 2000). CLDs uncover the hidden assumptions of stakeholders by mapping mental models that shape the system (Sterman, 2000). Understanding mental models of relevant actors and identifying key decision variables improves systemic understanding (Ulli-Beer, 2013). Thereby, the assessment of long-term consequences of current governance practices is improved (Sterman, 1989). Once fundamental causalities between business models and their regulatory policy environment are identified, causal loop diagrams can be used to generate insights that might be buried in linear displays of causal connections (Repenning, 2002). This feedback-based approach to complexity provides a comprehensive way to communicate knowledge among diverse stakeholders (Meadows, 1989). Incorporating collaborative designs approaches in transition management serves as a learning tool in multi-stakeholder environments (Ulli-Beer, 2013), which is key in transition management (Loorbach & Rotmans, 2010).

2.4 Case Study

Waste streams from construction activities, excavation and demolition material add up to 86 million tons per year in Switzerland (Schneider, 2016). Despite being among the countries with the highest environmental standards for the construction industry (Groesser, 2014), 15–20 million tons of mineral materials are disposed of annually, a significant part of the national metabolism (Schneider, 2016). High construction activities and decreasing access to mining and disposal sites provide a compelling incentive to redesign material loops and transition towards a circular economy. "Kies für Generationen" (Gravel for generations) is a project that aims at improving the capability of Switzerland to be a self-sufficient provider of gravel for future generations. Initiated by the Federal Agency for waste, water, energy and air, the platform gathers representatives from the gravel and recycling material industry, environmental NGOs and various public institutions. It assembles the characteristics of a transition arena, in which knowledge is generated and exchanged via an institutionalised platform (Loorbach, 2007). Political, institutional, social and market dynamics appear to form barriers to the diffusion of alternative products and policies. To overcome these barriers, system thinking and system dynamics are proposed to understand feedbacks and to identify leverage points for intervention (Meadows, 1999).

The participants of the group model building workshops, as shown in Table 2.1, constitute most relevant stakeholders in the construction material industry. The selection of participants was based on their availability for the workshops of step 1, as well as their role in current industry transitions.

During the group model building workshop, participants identified a set of variables that could describe the state of the system, relevant to their organisation. Based on these variables, the discussion narrowed the scope of the problem to a set

Table 2.1 Group model building participants

Stakeholder
Industry association of construction material recycling
Industry association of builders
Industry association of gravel and concrete producers
Industry association of cement producer
Environmental NGO
Federal agency for circular economy, focus on construction waste
Cantonal agency for natural resource management
Cantonal department for building and civil engineering
Cantonal department for spatial planning
Municipal construction department

Table 2.2 Stakeholder scenarios

Variable	Tendency
Availability of disposal volume	Decreasing
Availability of primary gravel	Decreasing
Recycling of demolition material	Increasing/constant
Usage of recycling material	Constant/increasing

of key variables whose behaviour over time bears challenges to the industry. Table 2.2 summarises the key trends for the mineral material industry.

According to participants of the group model workshop, the availability of disposal volume and primary gravel, recycling of demolition material and the usage of recycling material are key variables. The relevant timescale of these developments varied between 10 and 30 years, according to the participants. A central discussion point during the GMB workshop was an increasing gap between the disposal volume and primary raw material availability relative to the uptake and usage of recycling. The resulting accumulation of excavation and demolition material was perceived as a central problem to all involved stakeholders. The gap between the deposition of excavated soil, demolition material and volume generation from extraction have been subject to various studies on material flows in Switzerland (Rubli & Schneider, 2018; Schneider, 2016).

Moving towards a circular economy appeared as a rational solution towards closing the gap between the material flows, by increasing the recycling of demolition and excavation material as well as quotas of recycling material. Participants debated whether the uptake of recycling quotas is likely to increase or remains constant, revealing different mental models regarding underlying dynamics. Motivated by this gap in perception around central concerns of the stakeholders, the focus for the case study with companies evolved.

2.4.1 Dominant Construction Material Regime

Based on the discussion of participants, we elicited their dominant regime of the construction material industry. The declared goal of the regime is to ensure long-term resource availability, from both a policy and business model perspective. Despite the increasing challenges to spatial planning and urban development, implementation of sustainability concepts for a circular economy faces barriers. Current policies and business model logics are implicitly built around a regime providing access to primary resources, but circular economy policies are part of the discourse. During the workshop, transitions phenomena ranging from explicit transition policies towards a circular economy to adaptations of business model practices have been discussed. The dominant transition areas are detailed in the remainder of this section.

2.4.1.1 Federal Waste Management Policy

The Swiss national regulations governing the avoidance and use of waste (VVEA) details the reduction and treatment of wastes, as well as the construction and operation of waste plants (Bundesamt für Umwelt (BAFU), 2018). Among the policies governing the transition, waste management is identified as a leverage point on a federal level. The goal is to provide a legal framework that strengthens the obligation for improved resource efficiency. Being implemented in 2016, material categories raise the barrier for disposal of material. Different categories of construction waste are defined based upon their direct impact on the usage of gravel pits as disposal sites. Mineral waste from construction waste is subject to inspection and can be disposed only to exclusive waste collection sites. However, according to participants, material flows from construction and deconstruction activities appear to exceed current disposal capacities, leading to further allocation of land. Enactment of the regulation is the responsibility of individual cantons. This structure exemplifies the multi-level nature transition processes, with federal legislation enacted by cantons. Local policymakers face multi-dimensional pressure, ranging from national agendas to local organisation.

2.4.1.2 Planning of Extraction and Disposal Volumes

Self-sufficiency plays an important role in the national agenda but is also an important concern on the local level. The availability of raw materials for construction purposes presents a central concern on the national level. Currently, building stock raw material consists mainly of primary material, sourced from gravel extracted in quarries. Linking gravel extraction to the creation of disposal volume carries implications for local political support for land allocation. The economic feasibility of long transport distances is low; hence, local networks of companies ally to voice industry concerns. Companies that depend upon the access to gravel quarries and disposal sites have a strong incentive to lobby for further land allocations. The resulting political power pressures spatial planning for disposal and extraction to account for the needs of local organisations. Analogue to the interests of companies, local planning policies tend to base strategic decisions for land allocation on rather conservative forecasts for improvements in recycling capacity. Following these allocation mechanisms, the provision of primary gravels remains rather high, enables price advantages compared to recycling and thereby reduces incentives for advances in recycling innovation. Cantons with abundant and low-cost access to mineral resources face different local pressure to consider strict enforcement of regulations, opposed to urban cantons. Consequently, local implementations of the national agenda differ regarding the strategic goal.

2.4.1.3 Recycling in Public Procurement

The provision of sufficient disposal volume is an important political concern for self-sufficiency. The power to allocate land is within the judiciary of cantons. Along with decreasing "Disposal volume", the "Political support for Land allocation" for gravel extraction forms on different political levels, from neighbourhoods, over local communities to cantonal policies. All levels bear political power to decisively interrupt the process of further "Land allocation". To accelerate a change in conditions for closed material loops, policies support recycling products with quotas in public tenders. Public buildings and infrastructure projects include standards that require certain minimum recycling rates. Standards and norms for the usage of recycling materials currently apply to non-critical building components, indicating a need for learning by experience feedback loops (Sterman, 2000). Increasing the usage of recycling material in buildings is a complex process since safety is a central concern; hence, adjusting standards and norms requires resources from both companies and institutions. Launching innovative products demands resources from companies, emphasising the need for institutional support during niche developments. Beyond the provision of financial resources, education regarding the potential of recycling materials is an important form of institutionalised support (van Mierlo & Beers, 2018). Thereby, public procurement policies can exceed the potential of recycling quotas within current frameworks and increase the overall market volume for recycling materials. A regulatory framework that allows for extended application of recycling material incentivises companies to experiment with innovative technology applications.

2.4.1.4 Business Models

Companies for the case study are selected based on the following key activities along the construction material industries value chain:

- Extraction of primary gravel
- Disposal/recycling of demolition/excavation material

Selected study partners compete in the same part of the value chain but depend on different resources. Two business models were idealised, describing the dominant logics behind the provision of primary raw materials and recycling alternatives.

1. The business model "Recycling" creates value from recycling demolition material. It generates profit by selling recycled gravel and treating excavation material.
2. The business model "Extraction" creates value from gravel extraction and filling the resulting volumes with excavation material.

In the business model "extraction", the gravel quarry generates multiple values, with the receipt of disposal material and sales of primary gravel. The incentive to generate disposal volume trumps the economic attractiveness of gravel extraction since disposal volume is a scarce resource.

In the dominant business model logic, a gravel quarry is a key resource to achieve dominance over emerging alternatives. Without regulatory pressure, regime stability of primary production and consumption systems around extraction activities persists. Organisational strategies tend to focus on increasing the outflow of recycled gravel or increasing the available disposal volume by extracting gravel. Innovation is currently concerned with improving the deconstruction capacity, adding more value to the raw materials for recycling activities. With improved sorting equipment and diversified sources of deconstruction material, organisations attempt to improve processes and quality of the material's origin. Companies in cantons with high construction and demolition rates, mostly in urban areas, lack local access to extraction and disposal resources; hence a tendency towards recycling materials is inevitable.

On the other hand, companies without spatial constraints and accessible gravel reserves lack the regime pressure to change practice and transition towards circular value chains. Despite a lack of pressure, innovative products and technologies are emerging in rural areas, yet the market acceptance for secondary materials remains low due to an existing abundance of primary materials. Without a significant shift in the political regime of resource security in rural areas, the market demand for recycling materials is expected to remain low. Consequently, a reinforcing business model logic to extract gravel for the creation of disposal volumes leads to a continuous demand for new mining concessions, a central argument in political discussions. To establish organisational legitimacy for land allocation, companies establish their value proposition as material managers of local waste streams.

Apart from geographical limitations to expansion, social acceptance of land allocation plays an important role and increases companies to adjust their activities. Company representatives highlighted the importance of managing stakeholders as part of their business model. Without the support of stakeholders, access to the key resource is limited. The pressure for stakeholder support demonstrates the important dual role of land allocation for political and private actors. Being a central concern for both business models and public policy, the perception of stakeholders regarding "Primary gravel availability" determines the "political support for further land allocation". If the "primary gravel availability" exceeds the market demand and raw material coverage is considered high, political support is likely to decrease. From a market perspective, the limits to gravel extraction form a relatively weak feedback loop since the sales of gravel is not a primary concern. One CEO stated, *"Profits can only be made with the receipt disposal material"*, indicating that a low "disposal volume" increases the "desired gravel extraction" and consequently the "gravel extraction". To account for the needs of local civil societies, companies are actively engaging in governance processes. Transparency of operations, long-term vision for local developments and active communication strategies towards the community are central to the social acceptance of organisational activities. Consideration of an extended range of stakeholders reflects that organisations are integrating sustainability concerns in their business models. A strong focus is placed on social value creation, along incremental increases in environmental efficiency. Schaltegger et al. (2016) frame this process as the result of co-evolutionary processes, in which business models adapt to external developments.

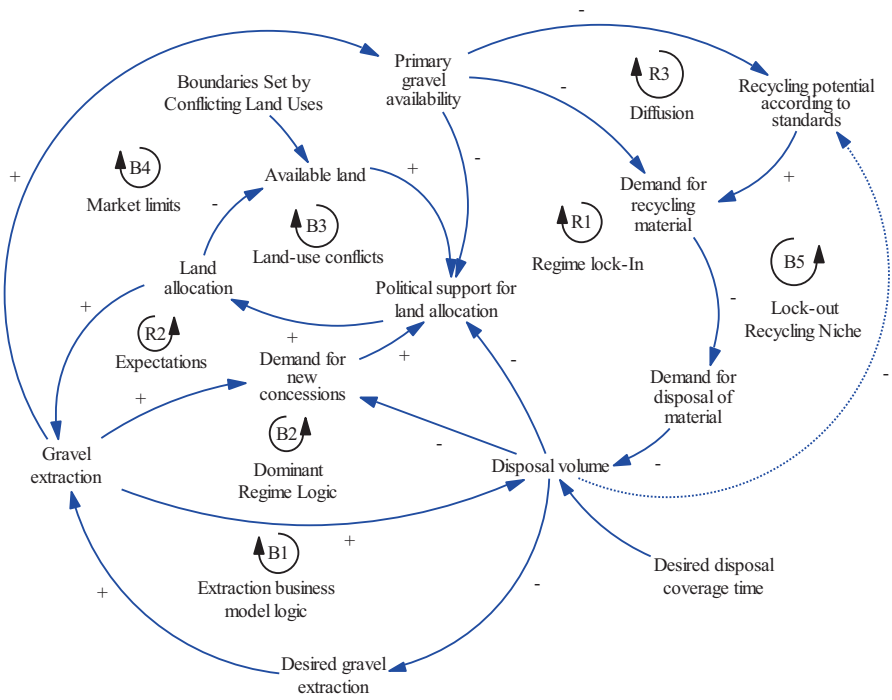

Fig. 2.1 Governance dynamics of Swiss construction material industry

Shifting the value generation from gravel extraction to disposal volume enables extracting gravel enables companies to reduce primary raw material prices, blocking the "Demand for recycling material". Evidently, these reinforcing feedback mechanisms make recycling an unattractive alternative compared to extracted materials. R1/R2/R3 form a dominant regime where the reinforcing incentive to extract gravel persists as long as the demand for disposal of material is high, potentially tipping towards recycling if these conditions swop dominance. The CLD in Fig. 2.1 shows the multi-level nature of this complex system, highlighting the interconnectedness of certain business models, its regulatory context and various political governance layers. Understanding the structure of these attributes within complex systems could improve guidance on the governance of transitions. A system dynamics perspective on relevant policy levers helps to classify and understand the potential barrier on the landscape, regime and niche level. By identifying dominant logics (B1/B2), lock-in to a local extraction regime (R1/R2), a lockout of recycling niches (R2/R3) and landscape and regime conflicts (B3/B5), the complexity of the problems is reduced and made explicit for further discussion.

2.5 Discussion

Barriers to transitions can result from a multitude of factors, ranging from technical to social barriers. The CLD suggests that mental models of incumbent actors support the dominant extraction regime. Placing these mental models in transitions dynamics shows that barriers to transition can emerge as side effects of policies. The case study found the dominant regime evolving around the availability of primary resources, exercising the most pressure on the political support for land allocation. This feedback loop dominates the diffusion of alternative products, as there is not enough institutionalised support for the development of recycling alternatives. Policies to intervene do not suffice to change the dominance of the regime stabilising loops towards the diffusion on niche alternatives. The recycling industry has not fundamentally redesigned the production and consumption system of the construction industry, suggesting that recycling alternatives currently exist at the crossroads between niche and regime. Business models as the enabler of innovation place the current states of recycling between take-off and stabilising phases. As intermediates between the technological niche and the socio-technical regime, business models potentially form new rules and accelerate the breakthrough of innovations (Bidmon & Knab, 2018). The regime-stabilising dynamics and leverages to nurture niches, derived from Table 2.3, are detailed in the following section. The following discussion demonstrates the relevance of mental models, dynamic feedback structures and delays, some of the fundamental attributes of complex systems (Sterman, 2000).

2.5.1 Mental Models Stabilise Regime Dynamics

Different time horizons have shown to be a decisive factor for policy inertia, a well-known driver for misperceptions in system behaviour (Sterman, 1989). As described by case study partners, decision making in organisations is rather a short-term oriented process and prone to business cycles (end of year reports/financial statements) than spatial planning policy by governmental agencies. Guided by significantly different time horizons, governmental spatial planning policies determine mineral reserves for the next 25–50 year. These reserves are not necessarily freed for extraction, yet they provide the basis for discussion on multiple political levels. Based on the current projections for the development of the built environment, cantons plan reserves for around 20 years. Depending on the gravel extraction and the resulting disposal volume, the window of opportunity for recycling standards opens. This chicken or egg situation assembles characteristics of the discussion on electric vehicle infrastructure, where mental model regarding “range anxiety” delays the diffusion, depending on the local context (Turnheim et al., 2015). In a rural context, increased demolition material in combination with policy effects (such as VVEA) might reduce disposal volume. The incentive of extraction business models is to increase the available disposal volume in the short term by extracting gravel.

Table 2.3 Policy overview

Policy area	Actor	Policy goal	Feedback loops	Potential barriers to transition	Associated policy lever	Transition lever
Waste management	Federal state	Dissociate gravel extraction and creation of disposal volume	B2	Federal law prescribes filling gravel quarries	Phase-out of extraction activities	Landscape changes
Waste management	Federal state	Recovery obligation	R1	Limited authority on local implementation and auditability	Increase demand for recycling material	Niche incubation
Spatial planning	Canton	Security of supply	B2, R3, R2	Supports the extraction business model	A circular economy-based spatial planning policies	Regime mental models
Public procurement	Federal, cantonal, municipal departments	Create additional demand for recycling material within the current regulatory framework	R2, R4, B5	Reinforces current recycling practices	Increase recycling potential by adjusting the regulatory framework	Niche incubation
Concessions	Business model extraction	Extract gravel to secure disposal volume	R1, R2, R4	Reinforces the lock-in of extraction and lock-out of recycling	Incentivise recycling activities	Regime legitimacy
Compensations	Municipalities	Balance community and enterprise interests	R2, R3, B2, B3, B5	The societal and economic relevance of gravel quarries	Primary resource taxation and disposal fees	Regime legitimacy

Consequently, the supply of gravel exceeds the actual demand, while at the same time, the demand for recycled gravel is artificially kept low, despite norms and standards. Therefore, the long-term strategic planning of resource allocation emphasises securing gravels pits rather than incentivising investments in recycling capacity. "*The incentive to invest in processes and techniques depends on policies to stimulate demand and provide a long-term perspective*", as stated by case study partners.

Along with norms and standards, institutionalising usage of recycling materials requires aligned mental models of the different stakeholder. The creation of a common vision, unifying the perspective of policy designers and private organisations, is a central leverage point (Kemp et al., 2007). The recognition of leverage points bears the potential to turn the feedback loops in which the extraction regime dominates in favour of recycling alternatives.

2.5.2 Top-Down Goal-Setting Versus Local Implementation

Implementation of circular economy concepts via policies results from landscape changes, where broader sustainability concerns manifest in political action. The introduction of policies is a top-to-bottom process, where national agendas determine top-down goals for local action. It appears that policies such as the VVEA have a direct impact on local business models. Organisations react bottom-up, by mitigating perceived negative consequences on their operations with political action on intermediate political levels, ranging from municipalities to cantons. Since enforcement of the national regulation takes place on these intermediate levels, local resource-planning carries conflict potential. Depending on the mental models regarding regional materials flows and the perceived interdependencies between land use for extraction and disposal, the adaption of national policies can diverge on a local level. Thereby, transition inertia evolves along with the expectations of actors. The locally perceived urgency of extraction and disposal of raw materials results in conservative estimations regarding the potential of niche alternatives. On a firm and industry sector, the lack of demand for recycling alternatives drives a chicken or egg situation in which insufficient capacities prohibit a virtuous feedback loop.

2.5.3 Systemic Niche Incubation

Institutionalised support via safe operating space, in which product innovation can be harmonised with the management of natural resources is vital to the diffusion of alternative materials. Business model insights suggest that the competition with primary extraction materials results in low prices and tightens the window of opportunity for alternative products. SMEs that supply alternative building materials criticise frameworks and laws that impose too many restrictions in building law and

standards. In their view, this limits the freedom for designing and implementing innovative solutions. Thereby, more inclusive public procurement can provide businesses with a variety of market opportunities to diffuse innovations. Cantons at the forefront of advancing sustainability policies provide incentives for local companies to invest in recycling capacity. Stimulating demand by setting minimum rates of recycling material in project calls, as well as increasing implementation of certification schemes, are being used. Public procurement policies thereby spiral in co-evolution with norms and standards towards higher usage of alternative materials and designs. Cooperation is needed to achieve greater impact, and the role of planners and architects was emphasised, as the first instance in the planning process. On the builders' side, various factors were highlighted, such as incentives for sustainable construction, willingness to take risks and the role of specifications in construction processes. Due to the high relevance of costs in decision making, it was once again emphasised that without the right signals from public policies, there will be no incentives for companies to invest in more sustainable materials and processes. Levelling the quality of primary and secondary raw materials is key to turn the discussion of whether primary or secondary material is used redundantly. This cultural change requires a rethinking of political processes in which communities and cantons actively involve a variety of stakeholders.

2.5.4 Legitimacy of Business Models

Business models as a unit of analysis enabled an integrated perspective of multiple levels, ranging from decision making within an organisation to industry sector-wide impacts. Business models in transition as potential barriers to transitions follow the logic of both regime and incumbent actors. Regime business models focus on maintaining favourable conditions that allow them to keep their competitive advantage, whereas niche business models seek to open windows of opportunity. In several cases, adaptations to the extraction business models were observed, acknowledging the negative externalities of their business models. These companies expressed a tendency to "give back to society", mitigating the impact of their operations on society, such as pollution, impact on local capital (ecological and social), consequences of operating heavy machinery and traffic. Beyond the remuneration of communities for local business externalities, companies integrate communities and municipalities as part of their stakeholders. These stakeholders play a central role in the political process of allocating of land, negotiating multiple interests. Especially the role of municipalities as a local enforcer provides power and agency, hence making them a key stakeholder of extraction industries. Municipalities have expanded their stake in the financial success of companies by introducing various forms of compensation. The principle of indemnity is applied by an increasing number of communities, to compensate for the disturbance caused by proximate extraction, processing and disposal activities. Demands for remuneration for local stakeholders have created an urgency for companies to assess their strategy for community

reimbursement. Statutory fees for concessions and ongoing charges for extraction activities reduce the profitability of gravel extraction, further shifting the profit margin towards incoming disposal materials. Balancing the financial gains from extraction activities, acceptable reimbursement of local stakeholders and securing local raw material supply reflect political challenges to municipalities.

Table 2.3 provides a summary of the policies that different actors apply within the construction material industry. Based on the insights generated through the development of the CLD, policy goals and the associated barriers for the transition towards a circular economy have been discussed. The following sections discussed the wider implications of these results.

2.6 Conclusion

The main contribution of this study is not the identification or emergence of new theories but improved understanding of relevant factors and their role in governing sustainability transitions. Introducing business models as a unit of analysis and using system dynamics to identify regime stabilising feedbacks has proven to add understanding to transition dynamics.

2.6.1 Operationalising Transition Management

Conceptually linking business models and transition management operationalised research into the stabilisation of regime and leverage to potentially weaken these feedbacks. Linear business models and the competition with circular business models exercise a dynamic relationship among themselves as well as between their environment, supporting Geels' (2014) findings on co-evolutionary dynamics. Choosing business models as a unit of analysis enabled the detection of endogenous drivers of policy resistance and provided a narrative for change. A deeper understanding of business models within transition contributes to accelerating the emergence and diffusion of required innovations (Geels, 2017). Using a "firm-in-sector" perspective, linked to regulatory frameworks for innovation, can help to identify economic factors that incentivise companies and consumers to act upon and utilise innovative products and services (Vértesy, 2017). The concept of business models elevated the discussion to a discussion on a level which was relevant to both individual organisation and policymakers. System dynamics thereby helped to uncover the feedback loops to connect the lock-in of the current regime with dominant business model logics. We identified micro-dynamics within business models that helped to understand the impact of public policies on the organisation-relevant business models, and on the other hand, identified policy-relevant macro-dynamics. Eliciting decision-making rules of actors in the system helps understanding underlying patterns,

which can manifest in lock-ins of the regime and policy resistance. By either reinforcing existing structures or breaking dominant paradigms, active transition management needs to understand these mental models and decision rules.

2.6.2 Tools for Participative Transition Management

Improved understanding of transitions and about desirable pathways lies at the heart of managing stakeholders in transitions. This active management builds on a sense of urgency of societal actors and is required to define the scope (Loorbach, Frantzeskaki, & Avelino, 2017). Combining instruments, such as group model building and case studies, helped to develop a shared language among experts. It served as a flexible methodology to facilitate learning in multi-stakeholder processes, which can be used as a foundation for further research about causal mechanisms that accelerate or hinder transitions. Using institutional theory and the concept of agency has helped to select a relevant group of participants, which has been shown as central to transition management (Fuenfschilling & Truffer, 2016). The applied methodological combination helped to understand how actors, technology and institutions evolve and shape their mutual trajectories (Geels, 2014). Transition management is built on the need to "develop a feeling of mutual interdependence among heterogeneous actors, meaning that they can achieve more together when dealing with a complex situation than on their own "(van Mierlo & Beers, 2018, p. 8). System dynamics modelling and simulation can help to create such a participative learning environmental for different political actors (canton, community, neighbourhoods), NGOs and industry associations, by providing a safe space for learning and experimenting. Such environments can train systems thinking capabilities regarding trade-offs between short-term gains and long-term consequences (Sterman, 2002). Identifying unintended consequences on different levels and identifying structural causes among different stakeholders stimulates a social learning process, a central aspect to the governance of transitions (Safarzyńska, Frenken, & Van Den Bergh, 2012).

2.6.3 System Dynamics in Transition Management

The involvement of different actors, via a participatory process of visioning, learning and experimenting (Ulli-Beer et al., 2017), is crucial to the different transition levels, ranging from strategic visions, over tactical processes (networks, agenda building, lobbying) to operational processes (experiments, innovation) (Loorbach et al., 2017). The goal is to "create a societal movement through new coalitions, partnerships and networks around arenas that allow for building up continuous pressure on the political and market arena to safeguard the long-term orientation and goals of the transition process" (Loorbach & Rotmans, 2010, p. 239). Building

shared visions among stakeholders that take feedbacks into account can be a key artefact in transition management (Kemp et al., 2007). The visions trigger stakeholder involvement and serve as boundary object in participative processes, providing critical social learning for accelerated transitions (Black, 2013; Ulli-Beer et al., 2017; van Mierlo & Beers, 2018). The relevance of unifying the problem perception of key actors and the resulting social learning has recently been highlighted in the literature on transitions as a leverage point for change (van Mierlo & Beers, 2018). Integrating system dynamics to understand key dynamics and leverage points can sharpen the focus for intervention in early-stage processes and improve the efficiency of resource usage.

2.6.4 Limitations of the Study

The case study analysed the causal mechanism among two idealised business models, competing on primary and secondary gravel supply, a specific step in the supply for construction material. We excluded complementary material flows; for example, the production of cement was excluded, and thereby, policies regarding energy consumptions and CO2 emissions. Even though this represents a limitation of the study, the central argument for business models as a relevant unit of analysis has proven valid. More fundamentally, discussing transitions implies the questions: Transition to where? Sustainability has many definitions and is subject to changes in values and perspectives, hence requires continuous negotiations among stakeholders. System dynamics has a tradition of providing an explicit perspective on long-term systems sustainability and encompasses the possibility to understand different value systems (Király & Miskolczi, 2019). Since this study focused on the regime-stabilising dynamics, the role of destabilisation in favour of alternative policies must be explicit about defining a concept of sustainability.

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Daniel Kliem is a Ph.D. candidate at the System Dynamics Group of the University of Bergen, Norway. His dissertation focusses on the governance of private and public actors towards more sustainable modes of production and consumption. He is a Researcher and Lecturer of System Dynamics at the Institute of Modelling and Simulation, University of Applied Sciences of Eastern Switzerland.

Alexander Scheidegger is a Researcher and Lecturer of System Dynamics at the Institute of Modelling and Simulation, University of Applied Sciences of Eastern Switzerland. He applies his quantitative background on policy analysis and policy design, using tools and methods of engineering. His research covers energy, environmental and care systems.