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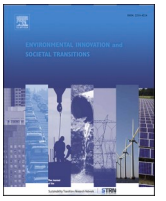

A practical tool for analyzing socio-technical transitions

Frank J. van Rijnsoever *, Jip Leendertse

Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands

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ABSTRACT

Understanding socio-technical transitions, let alone managing them, is complicated. This is especially the case for many practitioners, who are commonly not well-versed in the language of transition studies but deal with transition problems on a daily basis. To make the academic knowledge on socio-technical transitions available to practitioners, we introduce the transition model canvas (TMC) as a tool for systematically mapping the key elements, and their interactions, of socio-technical transitions. Based on the business model canvas (BMC) from entrepreneurship and the multi-level perspective (MLP) from transition studies, the TMC is an accessible tool that allows transition practitioners, students, and educators to evaluate and accelerate socio-technical transitions. The proposed canvas also helps further diffuse transition thinking into society and improve the quality of socio-technical policymaking and strategy development.

1. Introduction

Socio-technical transitions are uncertain processes. Moreover, the terminology used in the literature can be quite complicated. This makes applying insights from transition studies in practice a daunting task for anyone who is not well-versed in its language, such as many politicians, policymakers, and societal change agents.

To ease this challenge, an increasing stock of materials was developed with lessons for practitioners (De Vicente Lopez and Matti, 2016; EEA, 2019; Loorbach et al., 2016; Van der Hoeven and Horsten, 2010). Although these contributions are valuable, there is still no tool that provides a straightforward and structured understanding of abstract socio-technical transition challenges.

Therefore, we introduce the transition model canvas (TMC), an adaptive tool based on the multi-level perspective (MLP; Geels, 2002). It systematically maps the most important elements of a socio-technical transition, allowing practitioners to identify systemic strengths and vulnerabilities and use them to identify, design, or adapt change strategies.

Using the MLP, which is the dominant framework used in transition studies, we first outline the theoretical concepts used in the TMC. We do not intend to completely review the MLP; rather, we provide an introduction for those who are not familiar with its concepts.[1] Then, we introduce the TMC and apply it to the transition to a healthy food system in the Netherlands.

* Corresponding author at: Utrecht University, Princetonlaan 8a, 3584 CB, Utrecht, the Netherlands.
E-mail addresses: f.j.vanrijnsoever@uu.nl (F.J. van Rijnsoever), j.leendertse@uu.nl (J. Leendertse).

[1] The MLP has received much criticism and been extended beyond what we cover in this paper. Notable developments are the existence of different transition pathways (Geels and Schot, 2007), the idea of firm triple embeddedness (Geels, 2014), the concept of strategic niche management (Raven et al., 2010; Schot and Geels, 2008), and multisystem interactions (Papachristos et al., 2013; Rosenbloom, 2019). An overview of the MLP's criticisms can be found in Geels (2011) and Papachristos (2018).

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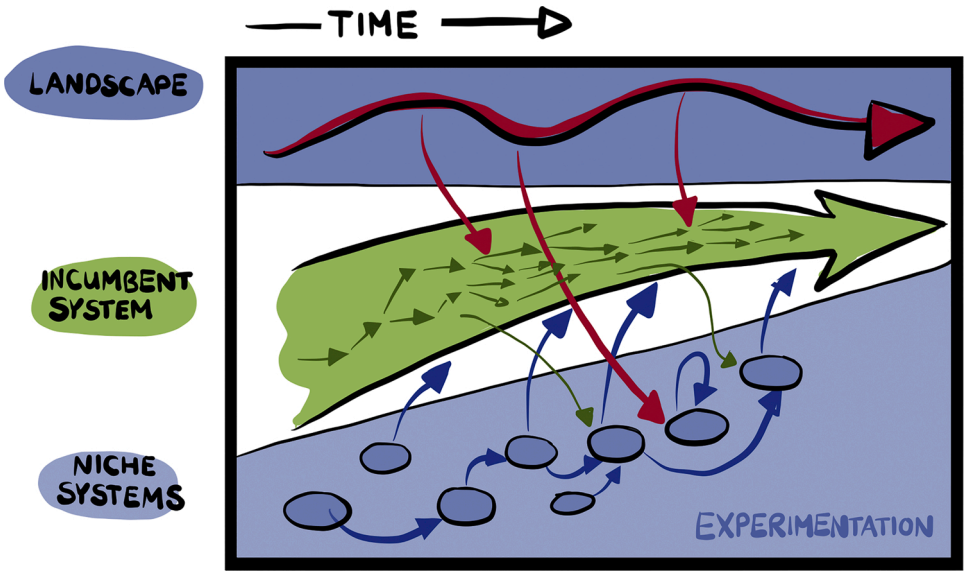

Fig. 1. A visualization of the MLP and the dynamics between the incumbent system and emerging niche systems under the influence of the landscape conditions (visuals provided by Mario Patrick Schwery).

Table 1
Examples of the three elements of socio-technical systems and the socio-technical landscape.

	Element	Examples
Socio-technical systems	Actors	Knowledge institutes, universities, large firms, small- and medium-sized enterprises, start-ups, consumers, end users, governmental bodies, intermediaries, non-governmental organizations (NGOs), media
	Institutions	Formal: laws, standards, directives Informal: norms, values, habits, personal beliefs
	Infrastructure	Roads, railways, power grids, gas grids, elective vehicle charging stations, transmission towers, broadband internet
Landscape	Gradual factors	Regulations broader than the transition, regulations from higher levels of authority, long-held beliefs, religious convictions
	Exogenous shocks	Wars, economic crises, pandemics, natural disasters

2. Theoretical concepts

2.1. Elements of socio-technical systems

According to the MLP, societal functions (mobility, food production, or energy supply) result from socio-technical systems. The MLP also asserts that a transition entails an incumbent socio-technological system's disruption and eventual replacement by or merge with an alternative, newly developed socio-technical system(s) (Fig. 1), which often emerge from so-called niche systems (Geels, 2005). Both types of socio-technical systems consist of three basic interacting elements (Table 1). First, there are actors that exchange resources and form networks, such as supply chains. Together, they develop and deliver products or services. They do so under an institutional regime (the second element), which is a semi-coherent set of rules that guide actors' behaviors (Kemp, 1994).[2] These rules can be formal or informal. The regime is continuously reproduced by the actors that adhere to the rules. The third element is infrastructure, which is all the physical resources that are needed at minimum for the socio-technical system to function (Chappelow, 2019).[3]

[2] Some transition scholars refer to the incumbent system as the incumbent regime (De Vicente Lopez and Matti, 2016; Loorbach et al., 2017; Verbong and Geels, 2007). However, this can lead to confusion, as the word *regime* is also used in the context of the institutions in the system (Geels, 2011, 2004; van Mossel et al., 2018). To avoid this confusion, we follow Geels (2011) and limit a regime to a set of semi-coherent rules.

[3] Sometimes, the concept *soft infrastructure* is also recognized (Chappelow, 2019). Examples are a system that gives access to finance or a (higher) education system to develop human capital or knowledge. However, in the context of socio-technical systems, soft infrastructure is redundant, as it consists of a combination of actors and institutions. For example, banks are actors, and the way they distribute money is guided by institutions.

Table 2
An overview of the strategies with examples of each.

		Strategy target	
		Incumbent system	Niche system
Strategy origin	Incumbent system	*Defending the incumbent system* • Setting standards • Strategic patenting • Lobbying for favorable or protective legislation • Buying companies, brands, or intellectual property and exploiting them	*Inhibiting the niche system* • Buying companies, brands, or intellectual property and *not* exploiting them • Lowering prices to force competitors out of the market • Raising entry barriers
	Niche system	*Destabilizing the incumbent system* • Lobbying to change legislation that supports the incumbent system • Taxing undesirable behavior • Information campaigns • Media reporting about the negative aspects of the incumbent system • Voluntary agreements with incumbent system actors • Starting a societal debate • Mass demonstrations	*Strengthening the niche system* • Creating visions • Removing entry barriers • Allying with actors from the incumbent system • Stimulating grassroots initiatives • Supporting innovation and innovative start-ups • Devising protective legislation for the niche system

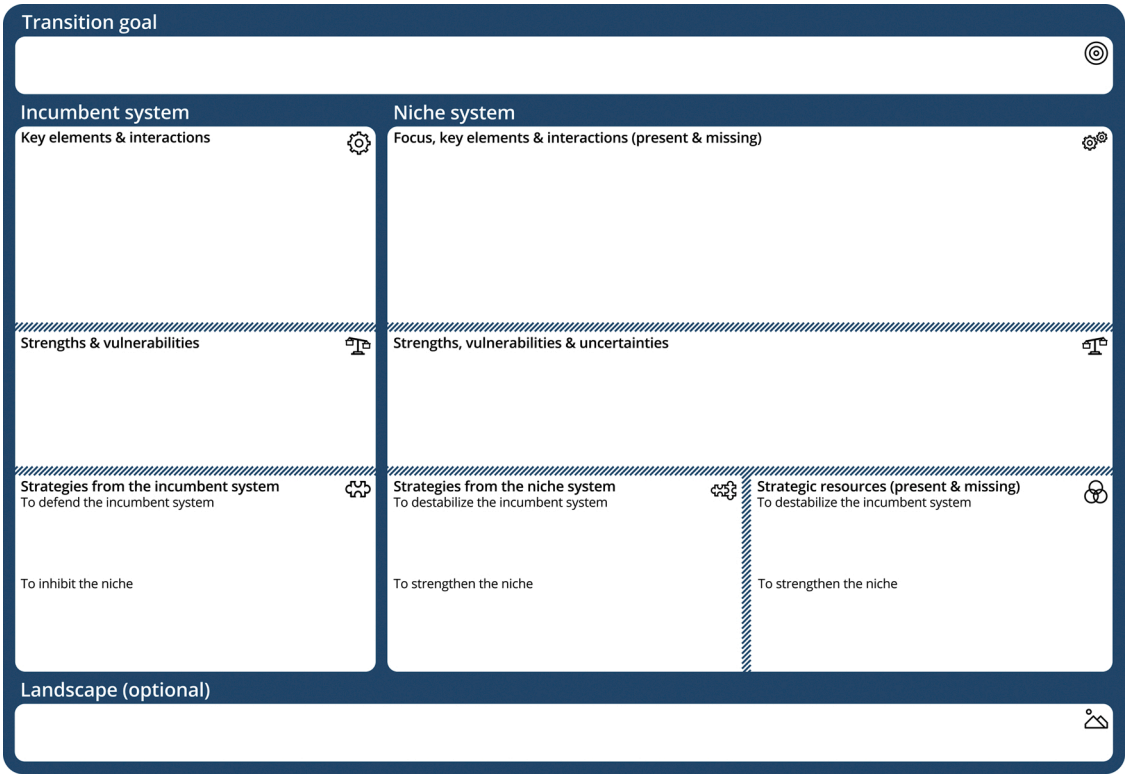

Fig. 2. The transition model canvas (visuals provided by Lydia de Boer).

2.2. Incumbent systems versus niche systems

Both types of socio-technical systems consist of these three basic elements. The difference between an incumbent system and a niche lies in their degree of structuration and stability (Geels, 2011). The interacting elements in the incumbent system are largely

Box 1
Outline of a transition model canvas workshop.

Duration: Approximately 120 min.

The length of the workshop depends on the target group, their knowledge, interests, and the complexity of the transition problem.

Goal: Explain the TMC and use an interactive method to let practitioners use the TMC

Preparations

- The workshop starts with groups of 3–5 participants who work (together) on a similar transition goal. These groups sit around a table.
- Materials: A1- or A0-sized printouts of the TMC, one per group, markers, sticky notes.

Schedule

Introduction: ***10 min (total time: 0–10 min)***

- Explain the concept of a transition and the purpose of the TMC, including its embeddedness in the MLP and with short descriptions of the incumbent system, the niche system, and the landscape.
- Explain that the TMC is an iterative tool and that participants can revisit earlier blocks if necessary.

Transition goal: ***10 min (total time: 10–20 min)***

- Explain that to fill in the TMC, the first (and crucial) step is to identify the transition goal: What do you/we want to achieve? A concrete transition goal will help in the transition process.
- The goal can also be two-fold, such as a short-term goal or a sub-goal, and a grander goal for the long-term.
- The transition goals should delineate the geographic scope and the sector/technology, and adhere to the SMART criteria (Specific, Measurable, Achievable, Relevant and Time-bound).
- The workshop participants define their transition goal.
- Reflect on the transition goals. Are they clear (achievable), and do all group members agree?

Incumbent system (1): ***20 min (total time: 20–40 min)***

- Explain the incumbent system and the meaning of the first two sub-blocks. Show the alternative ways of filling in this block.
- Workshop participants fill in the first two sub-blocks of the incumbent system sub-blocks.
- Reflect on results with the participants.

Incumbent system (2): ***15 min (total time: 40–55 min)***

- Explain the two types of strategies from the incumbent system and the meaning of the third sub-block.
- Workshop participants define the strategies of the incumbent system.
- Reflect on results with the participants.

Niche system (1): ***20 min (total time: 55–75 min)***

- Explain the niche system and the meaning of the first three sub-blocks. Provide the order that the participants have to consider them in. Clearly explain that we focus on what is present.
- Workshop participants fill in the first three sub-blocks of the niche system.
- Reflect on results with the participants.

Niche system (2): ***20 min (total time: 75–95 min)***

- Explain the two types of strategies from the niche system and the meaning of the fourth sub-block. Also explain the missing elements and resources.
- Workshop participants fill in and add to all sub-blocks of the niche system.
- Reflect on results with the participants.

Landscape: ***5 min (total time: 95–100 min)***

- Explain the landscape and its potential influence on the incumbent and niche systems.
- Workshop participants fill in the most relevant landscape developments.
- Reflect on results with the participants.

Iterate: ***10 min (total time: 100–110 min)***

- Workshop participants use the findings of the landscape or other insights to iterate their canvas.

Presentation and reflections: ***10 min (total time: 110–120 min)***

- Each group presents in about 90 s the strategies that must be undertaken in the niche system to achieve the transition goal.
- Reflect on results with the participants.

The premise behind this case is that people in Western societies consume too many calories. Excessive caloric intake is linked to higher levels of obesity (Finucane et al., 2011) and medical conditions such as cardiovascular diseases (Haslam and James, 2005). Changing food consumption patterns is seen as a key part of the plan to reduce obesity. We take the perspective of the Dutch government, which is trying to destabilize the incumbent system via a "national prevention agreement." This voluntary agreement with 70 stakeholders (including representatives from the food industry) from the Netherlands aims to reduce smoking, obesity, and problematic alcohol consumption (Rijksoverheid, 2018). Therefore, we use the TMC to evaluate an existing transition process. Fig. 2 presents the completed TMC for this case.

Block 1: Transition goal

We use the goal from the prevention agreement (Rijksoverheid, 2018): "The government creates a food system that reduces the obesity rate of the Dutch population to 7.1 % (currently this is 14.5 %)." This goal can be further refined to specific sub-groups that are at risk, such as children or lower-income individuals, to make it more effective.

Block 2: Incumbent system

Key elements and interactions: Many consumers demand cheap food products that are high in sugar and fat over healthier alternatives (Hoch and Loewenstein, 1991). To fulfill these demands, a complicated, large-scale, environmentally unsustainable industry emerged that is dominated by a relatively small number of powerful multinational firms and long but efficient supply chains (Brownell and Warner, 2009; Shnayder et al., 2015). The economies of scale achieved by this industry make it difficult for affordable healthier alternatives to obtain market shares, which limits the options for consumers who do seek alternatives. This mutual dependency ensures that the food industry and the consumption side are entrenched in a lock-in (Van Rijnsoever et al., 2011).

Strengths and vulnerabilities: The landscape institutions' freedom of choice (see Block 4), freedom of enterprise, and freedom of advertising from the landscape further solidify this lock-in (Van Rijnsoever et al., 2011). These are examples of strengths on which the system draws. Other strengths are stable consumer eating habits and consumer loyalty to brands and products. The system also has vulnerabilities that partially lie in the same landscape factors. The freedom of speech institutions, in line with the development of online sources such as fora or social media, give consumers the opportunity to develop their own opinions on a topic such as healthy foods. This increases heterogeneity in consumer preferences and, thus, the demand for alternative products. Fig. 3 gives an alternative graphical representation of the incumbent system, its strengths, and its vulnerabilities.

Strategies from the incumbent system: Based on this information, the canvas lists a number of possible strategies that incumbent parties can use to defend their system. A striking example comes from the United States, where firms attempted to have ketchup or tomato paste on pizzas recognized as a vegetable in school lunches (Nestle, 2011).

Technological strategies offer "light" products or develop high-quality replacements for fat and sugars (Calorie Control Council, 2020). Other strategies include purchasing brands from the niche system, such as Unilever did with the Vegetarian Butcher (Unilever, 2018), or joining coalitions, such as the prevention agreement. Many of these strategies can be seen as examples of an incumbent system incorporating the niche system. However, joining such coalitions might also be a way to delay a transition or control its direction (van Mossel et al., 2018). The prevention agreement, for example, does not include sugar or fat taxes, much to the satisfaction of the industry (Katz, 2018). Another subtle way to inhibit the niche system could be involvement in the education programs that deliver human capital to the sector by sponsoring or being on program boards, thus influencing the curriculum's content toward the incumbent system. Note that more strategies are conceivable.

Block 3: Niche system

Focus: The prevention focuses on technological innovation and behavioral change. Technological innovations entail reducing or replacing fat or sugars in food products, while behavioral change implies changing behavior to consume products that contain less fat and sugar. These alternative products can be the result of technological innovation, but can also be existing products, such as vegetables and products that are not artificially sweetened. The bulk of the prevention agreement focuses on behavioral change.

Key elements and interactions: Notable is that the agreement involves most parties from the incumbent system who are also in the niche system. Firms in the food industry are primarily responsible for the innovation part of the transition. Organizations that provide food to consumers, such as retailers, restaurants, sports clubs, hospitals, and schools, are partially responsible for the

behavioral part of the transition. They collaborate to a limited extent, but there are no strong mutual dependencies in the niche system yet. Overall, the niche system seems geared toward incorporation into the incumbent system.

Strengths, vulnerabilities, and uncertainties: The main strengths of the agreement are that many parties participate and that it focuses on consumers who are most vulnerable to obesity, such as children, the elderly, and low-income groups. A large vulnerability is that everything in the agreement is voluntary. Thus, the agreement adheres to the landscape institution of freedom of choice but does not include any hard sanctions if parties do not uphold their end of the bargain, as well as lacks "hard" interventions to steer consumer choices. Because of the latter omission, the Dutch National Institute for Public Health and the Environment (RIVM) concluded that the proposed measures would likely be ineffective (RIVM, 2018).

Strategies in the niche system: This part summarizes the prevention agreement's measures. Destabilizing measures are mainly comprised of informing consumers and substituting unhealthy products for healthier ones at certain outlets on a voluntary basis. The niche system is strengthened by developing new healthy alternatives (technological innovation) and helping people change their lifestyles by including it in health insurance (behavioral change). Finally, we list some hard measures in the TMC that are not in the agreement, but that could be used by governments to further the transition. These measures mainly serve as inspiration for TMC users.

When looking at the strategic resources, we see that the resources are mostly present to execute the agreement, save that the available funds are limited. The TMC also shows that many strategic resources for the harder measures to make the agreement more effective are missing, such as stakeholder support for hard interventions.

Block 4: Landscape

The landscape contains institutions that stem from the principles of liberal societies (Van Rijnsoever et al., 2011): freedom of consumer choice, freedom of enterprise, and freedom of speech. Consumers are mostly free to purchase the products they want, and producers are mostly free to offer and advertise the products they want. Lastly, there are institutions involved in food that will not change in the transition and that very few people would want to change. That is why we consider these part of the landscape. For example, food is not only fuel for the body, but also has cultural and societal functions (Korthals, 2002). Moreover, most people believe that eating should be enjoyable, which considerably influences consumption patterns (Korthals, 2002; Van der Weele, 2006).

Conclusion

Based on the TMC, it seems that the prevention agreement is primarily based on incorporating niche system elements into an incumbent system. The question is to what extent this will lead to the desired transition goal. However, the agreement is probably the most that the government can achieve via an agreement, given the limiting landscape conditions and available strategic resources.

aligned, which leads to a relatively stable and self-reinforcing configuration of rules and actor behaviors. For example, consumers rely on firms to obtain many goods and services. To make a profit and survive, these firms in turn depend on consumers. Having sufficient demand allows firms to learn, innovate, and create economies of scale, which can lead to better products and lower prices (Utterback, 1996). In contrast, niche systems have room for radical innovation and experimentation (Geels, 2002). Their dominant technologies, behaviors, rules, actors, and interactions are not yet determined. Therefore, niche systems are generally smaller and less stable, but also more flexible than incumbent systems. During its development, the niche system often incorporates many elements from the incumbent system, such as actors that move into the niche system (van Mossel et al., 2018).

2.3. Processes in a transition

In a socio-technical transition, niche systems foster (a combination of) technological or behavioral change. In both cases, a socio-technical transition generally consists of two processes: (Kivimaa and Kern, 2016; Loorbach et al., 2017)[4] :

- Destabilizing the incumbent system can be accelerated by disturbing the interactions from which the system gains its stability: for example, when actors in the system are exposed to conflicting rules. These disruptions can happen by themselves, such as when a new idea enters the market from outside. In other cases, policies to facilitate or accelerate the transition are needed (Negro et al., 2012).
- Developing one or more niche systems facilitates the required form of change. This process is often uncertain because the technologies and behaviors that will eventually replace the incumbent system are typically unknown. A niche's success largely depends on the of its technology, system elements, and compatibility with the incumbent system and landscape. To help niche systems develop, protective policies can be implemented (Smith and Raven, 2012).

2.4. Strategies and strategic resources

Actors or collectives of actors can actively deploy strategies to influence both processes (Farla et al., 2012; Wesseling et al., 2014).

[4] Loorbach et al. (2017) graphically represent this substitution process as an x-curve.

Transition goal

To create a food system that reduces the obesity rate of the Dutch population to 7.1%.

Incumbent system

Key elements & interactions

- Actors: Food industry, retailers, consumers
- Institutions: Demand for cheap food. Demand for sugar, fat and salty foods.
- Interactions: Cost-optimized supply chain. Economies of scale. Lock-in between cheap food production and demand.

Strengths & vulnerabilities

- Strengths: Consumer loyalty and habits. Landscape level institutions. Influence and financial resources of the industry.
- Vulnerabilities: Low profit margins industry. Increasing consumer awareness about food and the "Obesity epidemic". Increasing heterogeneity in consumer demand.

Strategies from the incumbent system

To defend the incumbent system

- Advertise health claims online and offline
- Use role models/influencers
- Appeal to changing demand by offering healthier products
- Purchase alternative brands from the niche and offer them to consumers
- Lower prices so that the niche can't compete
- Lobby for government protection or favorable regulation
- Raise entry barriers by imposing rules for quality control

To inhibit the niche

- Lower prices so that the niche can't compete
- Hinder education programs that provide human capital to the niche

Niche system

Focus, key elements & interactions (present & missing)

- Focus: Behavioral change of consumers and retailers. Some technological innovation In the form of healthier products with similar tastes. This requires fundamental R&D by producers
- Actors: Incumbent food industry, retailers, consumers, government, social initiatives.
- Institutions: Prevention agreement that limits the offering of unhealthy foods
- Interactions: The actors voluntarily collaborate in the prevention agreement

Strengths, vulnerabilities & uncertainties

- Strengths: broad societal support by many parties. Focus on non-resilient consumer.
- Vulnerabilities: The agreement is voluntary, there are no sanctions if parties don't comply. Non-resilient consumer is not part of the agreement. People generally prefer short-term enjoyment over health. Budget relatively small. National Institute for Public Health and the Environment deems the plans ineffective.
- Uncertainties: Unknown how various consumer groups will respond to these measures. Retailers might not hold their end of the bargain. Technological innovation might be unprofitable.

Strategies from the niche system

To destabilize the incumbent system

- Advertise healthy food advice with a broad coalition (intended)
- Outlets (cantina's, bars, schools) offer more healthy products, and less unhealthy products (intended)
- Government develops healthy food labelling system (intended)
- Taxing sugar and fat (missing hard measure)
- Maximize fat and sugar content (missing hard measure)

To strengthen the niche

- Lifestyle interventions become insured (intended)
- Develop healthier products using R&D subsidies (possible)
- Broaden the coalition in the agreement further (missing)
- Make the prevention agreement binding (missing hard measure)

Strategic resources (present & missing)

To destabilize the incumbent system

- Public and stakeholder support for most agreement measures (present)
- Scientific knowledge about effectiveness of measures (missing)
- Scientific support for effectiveness agreement (missing)
- Political and stakeholder support for harder interventions such as taxes or maximizing fat and sugar content by law (missing)

To strengthen the niche

- Broad coalition (present)
- Government support (present)
- 9,5 million euros in 2019 from the government. (present, but likely insufficient)
- Generic R&D subsidies (present)

Landscape (optional)

Freedom of choice, freedom of enterprise, freedom of speech and advertisement. Online information.
Eating is enjoyable, food has societal and cultural meanings.

Fig. 3. A TMC for the transition to a healthy food system in the Netherlands.

Box 2
A TMC for the transition to a healthy food system in the Netherlands.

The premise behind this case is that people in Western societies consume too many calories. Excessive caloric intake is linked to higher levels of obesity (Finucane et al., 2011) and medical conditions such as cardiovascular diseases (Haslam and James, 2005). Changing food consumption patterns is seen as a key part of the plan to reduce obesity. We take the perspective of the Dutch government, which is trying to destabilize the incumbent system via a "national prevention agreement." This voluntary agreement with 70 stakeholders (including representatives from the food industry) from the Netherlands aims to reduce smoking, obesity, and problematic alcohol consumption (Rijksoverheid, 2018). Therefore, we use the TMC to evaluate an existing transition process. Fig. 2 presents the completed TMC for this case.

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We categorize these according to what system the strategy originated from and which system is being targeted (Table 2):

- **Defending the incumbent system:** strategies from the incumbent system to maintain and strengthen itself.
- **Inhibiting the niche system:** strategies from the incumbent system to inhibit the niche system's development.
- **Destabilizing the incumbent system:** strategies from the niche system to destabilize the incumbent system.
- **Strengthening the niche system:** strategies from the niche system to develop itself.

The latter two strategies can be combined to form different transition pathways. For example, incumbent systems can defend themselves by incorporating elements from the niche system or vice versa. Alternatively, the niche system can completely destabilize and substitute the incumbent system (Geels and Schot, 2007).

The execution of transition strategies requires strategic resources, such as finance, legitimacy, network contacts, human capital, physical capital, and knowledge. In addition, some system elements can be strategic resources, but only if actors exert sufficient control over them. For example, a transmission system operator can influence who supplies electricity to the grid. If critical resources for a strategy are missing, actors must develop sub-strategies to acquire them.

2.5. The socio-technical landscape

The socio-technical landscape is the background against which socio-technical systems function and the transition takes place (Table 1). System actors have little influence on landscape factors (Geels and Schot, 2007), but changes in the landscape can influence socio-technological transitions. The landscape captures factors that change gradually and predictably, as well as unexpected shocks.

3. The transition model canvas

The TMC is inspired by the business model canvas (BMC; Osterwalder and Pigneur, 2010). The BMC permits mapping the most important elements of a business and analyzes the relations between these. This allows an organization to quickly find strategies to adapt in uncertain environments.

Similarly, the TMC helps transition practitioners map the elements of transition processes and identify or evaluate strategies to make transitions a reality. The TMC is thus designed for actors that participate in or evaluate transitions. These can be niche actors, such as start-ups or NGOs, but also incumbent actors that aim to become part of the transition, including governments and incumbent firms.

The TMC (Fig. 2) consists of several related blocks, including space for a transition goal and the MLP's levels. We suggest filling in the blocks from top to bottom. We emphasize that filling in the TMC is an iterative process. When new insights emerge, the blocks' content can be adapted.

The collaborative nature of a transition and the possibility of acquiring feedback raise the question of who to involve in filling in the TMC. One can use one's own vision for the transition, which avoids the need to make compromises with others. However, such a vision might not be attainable in practice, as it might receive insufficient support from other stakeholders or not fit with the socio-technical landscape. Alternatively, one can choose to fill in the TMC with allies, which often means that choices must be negotiated. This can

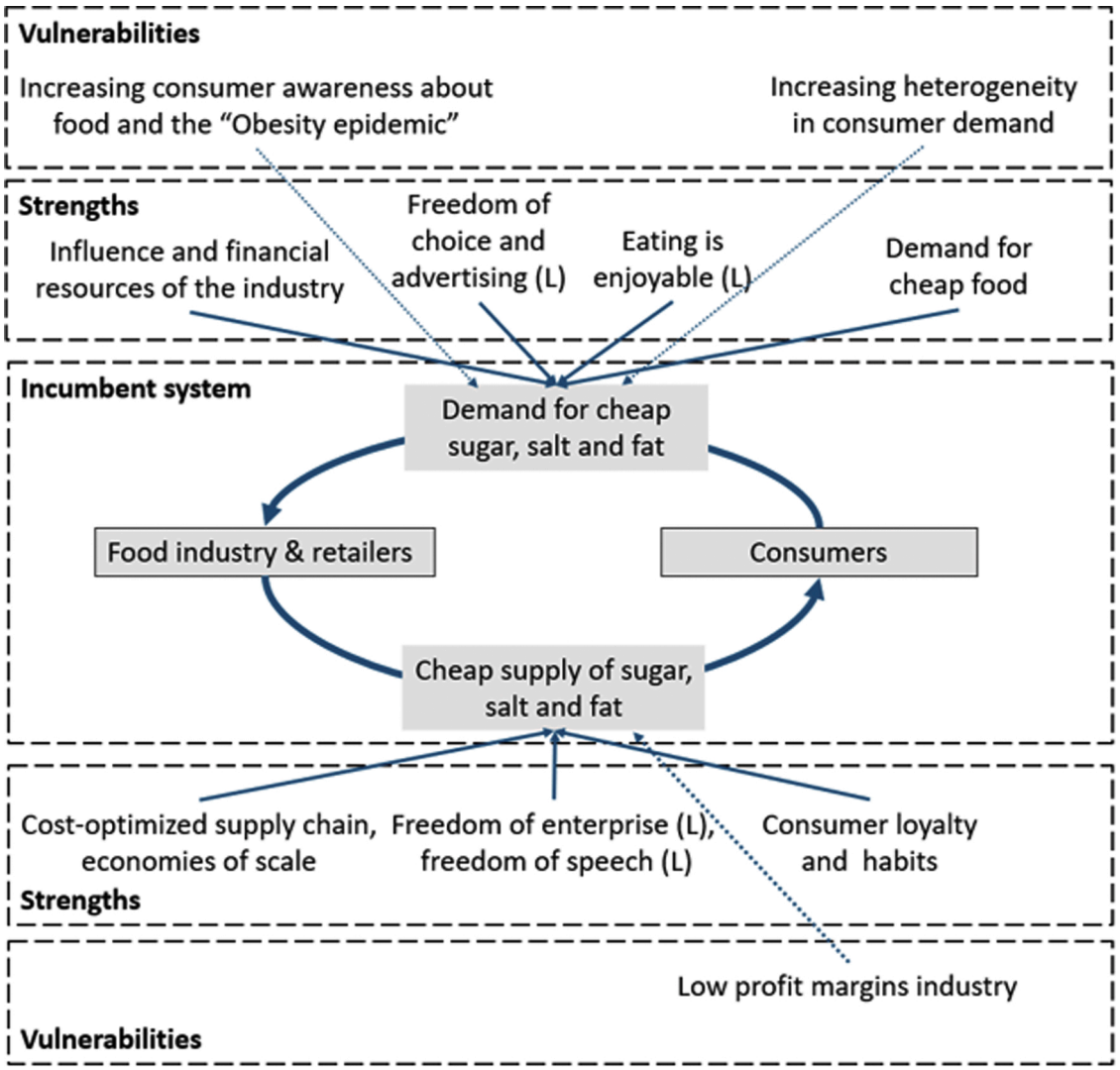

Fig. 4. A graphical representation of the incumbent system, its strengths, and its vulnerabilities. This can be used as an alternative for bullet points. (L) denotes landscape factors; the middle box in the figure represents the key elements and their interactions; and the top and bottom boxes represent the system's strengths and vulnerabilities.

lead to a more realistic view of the transition, but also requires making compromises. The choice of who to involve also depends on the purpose of the TMC exercise. In the case of evaluating a transition, it can be sufficient to include only experts. When designing and accelerating a transition, however, one might consider involving other stakeholders.

Box 1 gives an example description of a TMC introduction workshop of about 2 h. Fig. 3 and Box 2 give an illustrated TMC based on the national prevention agreement in the Netherlands, which, among other things, aims to promote the transition to healthy food consumption.

3.1. Block 1: transition goal

The first step is to formulate a transition goal. While doing so, one must consider at least two boundaries of the transition problem. The first is whether to focus on technologies or sectors. Technologies are characterized by how products are made, while sectors focus on the services provided to end users (Saviotti and Metcalfe, 1984). Sectors often have a few dominant technologies at their core, such as internal combustion engines in the automobile industry.[5] An abstract case is the food industry, which has no discernable core

[5] Even here, it is debatable whether the gasoline engine and the diesel engine are the same technology. Physically they function differently, but they deliver the same undesirable outputs that motivates society to consider these technologies problematic: carbon emissions and fine particles.

technology. The choice of a sector or technology depends on what must be changed: If production processes are undesirable (e.g., fossil fuel burning), it might make sense to focus on a technology. If the end product is undesirable (e.g., high-calorie food), one might focus on a sector.

The second boundary is geographical scope. Typical delineations are nation-states, cities, (administrative) regions, and supra-national entities, such as the European Union (Truffer et al., 2015). The choice of geographical scope depends on the transition problem and the means that actors have to intervene. Geography becomes more important when a support infrastructure is needed or when the success of an innovation depends on the presence of local actors, networks, culture, or resources (Coenen et al., 2012).

An example goal to start with is "carbon-neutral passenger transportation by 2050 in Germany." However, this goal is a bit generic as it captures multiple technologies and sectors, and it runs the risk of ignoring specific geographic conditions that can influence the transition. This is not a problem when there is sufficient knowledge and, if needed, an action perspective to meaningfully change each local socio-technical system. Otherwise, it might be prudent to split the problem into different more specific and short-term sub-goals, each of these sub-goals can have its own TMC. Another potential caveat to consider is that the envisioned system might have multiple goals. For example, one can demand that a healthy food system must be carbon-neutral, should not damage ecosystems, and consider animal welfare. It is important to articulate these goals. Additionally, the goal might be adapted and made more specific over time.

3.2. Block 2: incumbent system

This block has three parts.

3.2.1. Key elements & interactions

The top part is a brief description of how the incumbent system works. It focuses on the elements and interactions required to keep the system functioning, rather than meticulously mapping all possible elements and interactions. We refer to these as key elements and key interactions. Filling in this part is generally easy. It is often clear what the societal problem is, and incumbent systems are usually well-documented. Arguably, the bullet points in the example TMC in Fig. 3 do not do justice to the systemic nature of the incumbent system. Alternatively, the user can choose to graphically represent the system (Fig. 4).

3.2.2. Strengths & vulnerabilities

Based on this, strengths and vulnerabilities are identified in the middle part of this block. Strengths comprise the most stable key elements and interactions in the system, as well as the factors that give a socio-technical system its stability (e.g., legitimacy or key actors' defensive actions). Strengths can come from the system, but also from the socio-technical landscape. Vulnerabilities are the points that can be targeted to destabilize the system. These can be the least stable key elements or interactions, but also supportive factors.

3.2.3. Strategies from the incumbent system

The top two parts and the landscape provide input for this block's strategy part. This entails identifying the actors' strategies that are currently deployed or likely to be deployed in the future to defend the incumbent system and inhibit the niche system. This exercise helps the practitioner devise strategies that come from the niche.

3.3. Block 3: niche system

This block is similar to that of the incumbent system. However, completing the niche system means that choices must be made. When multiple stakeholders fill in the TMC, they might not agree on what the alternative for an incumbent system should look like or how this should be achieved. Therefore, the niche system can be a source of contention.

3.3.1. Focus, key elements & interactions

It is important to establish the focus of the niche system and what it should look like. This can be done by answering the following questions:

- Does the niche system focus on changing specific technologies, behaviors, or both?
- If technologies are the focus, what are they, and do they require any form of innovation?
- If behaviors are the focus, what are they, and what institutions lie at the root of these behaviors?
- How must the system elements interact to stimulate the development and diffusion of the niche system technologies and/or behaviors?
- Which of these system elements and interactions are already present, and which are missing? The TMC has room to distinguish these.

Depending on the transition path, many elements, such as certain actors in the niche system, are likely the same as in the incumbent system.

3.3.2. Strengths, vulnerabilities & uncertainties

The middle part of this block is similar to that of the incumbent system, but there is extra room to list uncertainties about the niche

system's development or whether certain system configurations will work. Over time, some uncertainties can be resolved, and the TMC can be updated accordingly.

3.3.3. Strategies from the niche system and strategic resources

The top two parts, together with the landscape and incumbent system, provide input for the strategy part. This part consists of strategies for destabilizing the incumbent system and strengthening the niche system. The strategies can receive extra qualifications, such as those that have been implemented, those that are currently feasible, and those that are currently infeasible due a lack of strategic resources or to landscape conditions. A lack of strategic resources can lead to formulating strategies to obtain these. Finally, the niche system block contains room for strategic resources needed to deploy these strategies.

3.4. Block 4: landscape (optional)

The landscape block captures all external factors that influence either the incumbent or niche system now or in the foreseeable future. In the TMC, this can also include influences exerted by related socio-technical systems (Papachristos et al., 2013; Rosenbloom, 2019). Mapping the landscape can be important because it can strengthen or weaken socio-technical systems and thus influence certain strategies' effectiveness. However, this is not always the case. As such, we listed it as optional.

4. Conclusions

The TMC is a practical outlet of the MLP. It allows practitioners to systematically analyze, accelerate, or evaluate transition processes. The TMC facilitates the diffusion of transition thinking into society and can help improve the quality of transition policymaking and strategy development. To keep the TMC accessible, we did not include all MLP concepts. More advanced concepts lend themselves as follow-up tools. For now, we are confident that we have made transition studies a little less complicated for practitioners.

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Declaration of Competing Interest

The authors report no declarations of interest.

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