Chapter 11

Challenges in the transition to a circular economy: understanding the web of constraints to more efficient resource use[9]

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[9] This paper is based on collaborative work by Rene Kemp (ICIS, MU) and Teresa Domenech (UCL) within the Polfree project, especially on the following joint publications: Kemp and Dijk (2013), Dijk et al. (2015) and Domenech et al (2015).

Abstract

The concept of the circular economy has attracted the attention of policy makers and businesses in recent years. However, changing the current patterns of resource use, waste, and emissions is complex, since they involve causes, effects, and other interlinkages between economic, environmental, institutional, and socio-cultural processes. This chapter presents an example of an integrative approach to the study of innovation, one of the research lines at ICIS. We propose to move from the concept of a "barrier" to resource efficiency to the notion of a "web of constraints", in an attempt to consider the complex web of interlinked factors that interact with each other dynamically as well as simultaneously. We use the resource-intensive case of passenger mobility to illustrate how the interaction between supply and demand through aggregated outcomes creates conditions that drive and/or hamper resource-efficient practices. Implications of the web-of-constraints perspective for policy are discussed at the end of the chapter, where we draw conclusions about what policy makers can do to counteract the inefficient use of resources for the case of mobility.

11.1 Introduction: why are resources used inefficiently?

The concept of the circular economy has attracted the attention of policy makers and the business community in recent years. The circular economy is a system that is "restorative or regenerative by intention and design" (EMF, 2013) and in which waste is minimised by cycling and cascading resources through changes in the design of products, processes, and industrial systems. In a circular economy, resources are kept in use for as long as possible, and then recovered for re-use to make new products. Components of a circular economy include long product life, product repair and reuse, recycling of product components, re-use of waste, and service leasing. The circular economy is based on the 3 R's of Reduction, Recycling, and Reuse. In some visions, pollution, the use of fossil fuels and the use of toxic chemicals are to be strictly avoided, while in other visions, they are allowed provided that the pollution is used as a production input (for instance in construction materials) and environmental harms are minimised. Resource efficiency is a key component of any strategy aiming to increase the circularity of an economy and improve the way resources are used. Resource efficiency refers to the ability to use a reduced quantity or volume of resources to produce the same or an improved service or product. It is measured as the ratio between useful material output (Mo) and material input (Mi), both measured in physical terms (Dahlstrom and Ekins, 2005).

It has been argued that resource efficiency and the circular economy are win-win approaches that align with the environmental and economic rationale (Geng et al., 2014). Price increases in the commodity markets since 2000 have helped to promote the idea that resources are scarce and their preservation may bring economic advantages that range from cost savings to issues of resource security. A number of studies have also pointed out the business opportunities offered by increasing resource efficiency and circularity. The resource revolution report by McKinsey (2011) estimated that opportunities for improving resource efficiency could be in the region of USD 2.9 trillion globally in 2030. Net benefits for a number of key sectors in Europe are expected to be in the region of EUR 603 billion (AMEC&BIO IS, 2013).

If the benefits ensuing from resource-efficient behaviour are potentially high, one question that arises is why these opportunities are not being picked up by organisations and/or societies? Various studies have applied the notion of a "barrier to resource efficiency", suggesting there is a single and concrete factor that explains resource inefficiency, a factor that can be individually tackled and removed, for example by means of a specific policy instrument. Rational choice based approaches have dominated explanations of barriers to individual (pro-environmental) behaviour, including aspects such as individual perceptions of certain options for action, behavioural costs, the role of information, perceived utility or sanctions by others. Based on one of the three key research perspectives at ICIS, Innovation for Sustainability, Kemp and Dijk (2013) suggested, however, that there is a myriad of barriers that prevent more resource-efficient behaviour by different actors. Moreover, these barriers seem to interact and operate simultaneously, resulting in framework conditions that impede the efficient use of resources. They proposed the concept of a "web of constraints" to better capture the complex interaction between individual and institutional behavioural patterns, inertia, and direct and indirect linkages that result in inefficient use of resources. This concept of a web of constraints contributes to an understanding of why these opportunities are not being implemented and the decision making and rationale behind actors' behaviour. The focus of this paper is precisely to explore the question of why resources are being used inefficiently and to identify the challenges to achieving better resource use. It illustrates this for one resource-intensive sector, that of passenger mobility. Section 2 provides examples of the web of constraints preventing the uptake of more resource-efficient mobility systems and identifies avenues for policy intervention to help overcome these constraints. Section 3 draws some conclusions, discusses the lessons learnt, and identifies future research needs.

11.2 The web of constraints in the mobility sector

The mobility sector is the second biggest contributor to greenhouse gas (GHG) emissions in the EU, and about two-thirds of the transport-related emissions are associated with the road transport sector. Also, interestingly, while GHG emissions from other sectors have shown a decreasing trend since 1990, emissions from transport increased by over 30% between 1990 and 2007. Transport-related emissions started to decrease in 2008, but in 2011 they were still over 20% higher than 1990 levels (EUROSTAT, 2015). In addition to GHG emissions, the sector is also the source of other environmental impacts such as local air pollution, land use, etc.

Our integrative approach to innovation is rooted in the socio-technical study of innovation (which covers sustainability transition studies and actor network theory). More than, for instance, innovation system approaches, it seeks to put greater emphasis on actor perspectives. Our approach to exploring the web of constraints to resource efficiency improvement in the car-passenger sector broadly consists of three steps: innovation framing analysis, innovation dynamics analysis and innovation policy options. Making explicit the framing of the innovation issue by relevant stakeholders is an activity fundamental to (and part of) the analytical process. We acknowledge that where innovation issues are concerned, innovation may be desired or pursued by some but not by others - in other words: various stakeholders can have different views on the overarching issue: "how can this product or practice become 'better' (however defined) or more sustainable?" The first step of our analysis is the description of key stakeholder perspectives. The second is a systemic analysis of interlinkages between economic, environmental, institutional, and socio-cultural processes. In the third step, innovation policy options are formulated. We elaborate these three steps briefly for the case of passenger mobility.

Innovation framing: stakeholder perspectives

The key stakeholders in passenger mobility are travellers, car manufacturers, public transport operators and policy makers. Given the importance of car emissions, an ICIS study analysed how car users frame the drivetrain of cars, by means of a discourse analysis of 180 stories that were published in newspaper media in the Netherlands between 1990 and 2005 (Dijk, 2010). The study found three distinct perspectives. The first was that of a small group of green drivers who acknowledge that car emissions should be prevented and who admit they need to change something (e.g. accept higher prices or less convenience). For a larger second group, car mobility is merely “driving from A to B”. They have little attention for their emissions and price is a key attribute, followed by convenience. For the third and largest group, “power is pleasure ”. These drivers are willing to accept a higher price for a more powerful engine (with various motivations), and emissions are not on their radar.

Subsequently, the study analysed how global car manufacturers frame the development of new car engines, especially Low Emission Vehicles (LEV). It examined the framing used by firms by studying their belief systems and actual engagement in R&D, using a questionnaire survey developed after interviews at three global vehicle manufacturers and four local car salesmen. The central question was: which underlying beliefs drive the engagement in the development of LEV technology? Three distinct perspectives were found: that of “optimists”, who happened to be relatively strong on clean propulsion technologies; pessimists, with limited in-house clean-tech competences; and those uncertain about the issue. Finally, the study addressed how urban policy makers frame urban car use issues in general, and the effectiveness of Park+Ride facilities in particular, using a questionnaire survey in 45 major cities in Europe (after a round of interviews with urban transport policy makers). Policy frames ranged from parking policy being “a tool to attract visitors” to “a tool to restrain traffic” in other cities.

Innovation dynamics: integrative, systemic analysis

In order to understand the dynamics of car mobility issues, the same study developed a micro-macro (conceptual) model of the issue. At the micro level, the model includes stakeholder attributes such as perceived return-on-investment (for firms) and the relative importance of functionality, price, status, resource use, etc. (for consumers). At macro level, it incorporates aggregative variables such as total use (sales) and prices. The model regards actors (or groups of actors) as the basic element of analysis and maps out various cause-and-effect chains between micro and macro indicators (see Figure 11.1). The qualitative systemic analysis (QSA) goes beyond simple drivers and linear cause-and-effect relationships in that it emphasises mutually reinforcing developments and (sometimes unexpected) alignments, co-evolution, circular causality, knock-on effects, and hype–disappointment cycles.

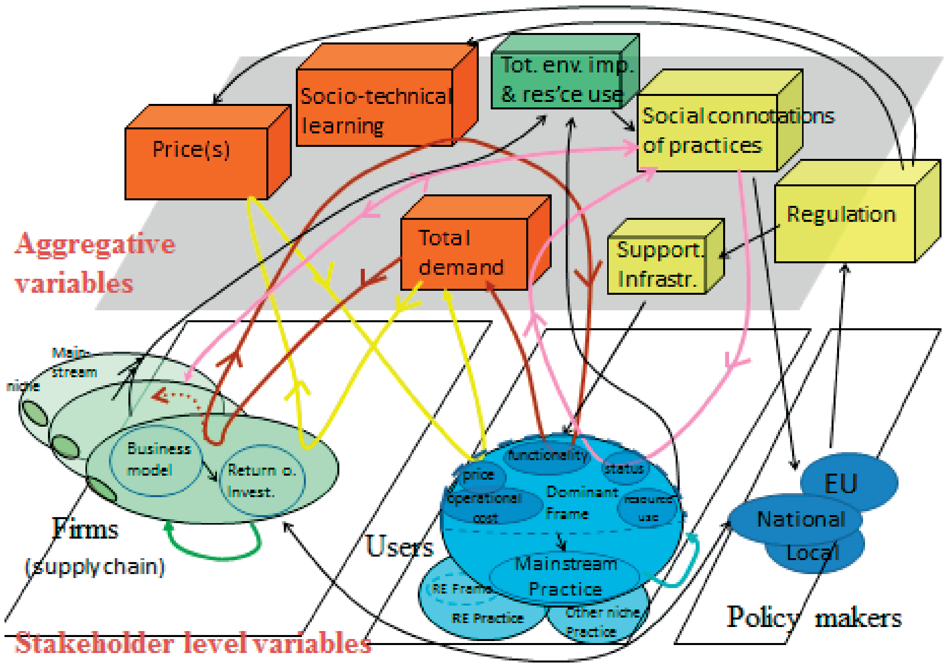

Figure 11.1 A conceptual model to understand passenger mobility, including six feedback loops: increasing returns-to-scale (yellow), learning-by-doing (green), learning by users (blue), learning from the market (brown), and cultural taste formation (pink), as well as competition between products. It also includes environmental externalities and regulation (black). See Kemp and Dijk (2013) for more details.

A number of policies have been put in place to reduce emissions by the sector. The EU has set binding emissions targets for light-duty vehicles and has put in place regulations to ensure that consumers are provided with relevant information through CO_2 labelling. However, the policy framework for transport policies is a complex one with multi-layered interactions between different policy areas and stakeholders. Trade-offs and counteracting effects have been identified, for example between measures to reduce road-transport associated GHG and the development of infrastructures and roads to promote the free movement of goods and people across the EU. Also, the number of cars per 1000 inhabitants in the EU increased since 1995, from 380 in 1995 to 487 in 2012 (ACEA, n.d.). Although CO2 standards have successfully reduced the emissions of new cars, there is still no coherent framework to provide incentives to consumers/

citizens to shift between transport modes and reduce car reliance or the mileage travelled by passenger cars.

Using a combination of a survey, focus groups and individual in-depth interviews across three different EU countries Kammerlander et al. (2014) explored the factors influencing individual behaviours in relation to mobility and car use. Findings from the study showed a willingness to reduce car use, with 49% of the respondents saying they would like to use the car less. However, reasons for doing so were mainly to do with reducing costs and saving money, and to “take more exercise”, while protection of the environment and resource efficiency came only in third place (with 39% of the respondents regarding them as a reason to reduce their car use). It is also relevant to note that 28% of the respondents indicated that they had already reduced their car use to a minimum. Interestingly, the main reason reported by car users as making it difficult for them to reduce their car use was that “public transport is not a good alternative”. This statement (in the form of a claim) was especially common in countries such as Austria and the Netherlands, even though these have good public transport networks. This suggests that subjective perception and objective fact may diverge, which may be partly explained by attitudes as to what is acceptable and convenient. Only a small proportion of the respondents did not own a car, and they reported that their main reason for not owning a car was to save money or because they did not have a driving licence, while the percentage of respondents do without a car for environmental reasons was around 15%. The study also revealed that there is a strong link between knowledge about existing energy labels for cars and knowledge about the existence of associated tax-exemption schemes, which seems to point to a relevant role of economic incentives in influencing consumer choice. Findings from the survey also indicated that only a small percentage of respondents were members of a car-sharing club (5% in the Netherlands, 4% in Austria and 7% in Hungary), indicating a lack of dense infrastructure of car-sharing stations as the key reason for the relatively low membership rate. The study also found that high-income households are more likely to own a car than lower-income households.

The web of constraints operating in car mobility is thus complex and built on the interaction between regulations, economic incentives/disincentives, attitudes to transport, infrastructure, and inertia. Some of these causal loops are shown in Figure 11.2 below.

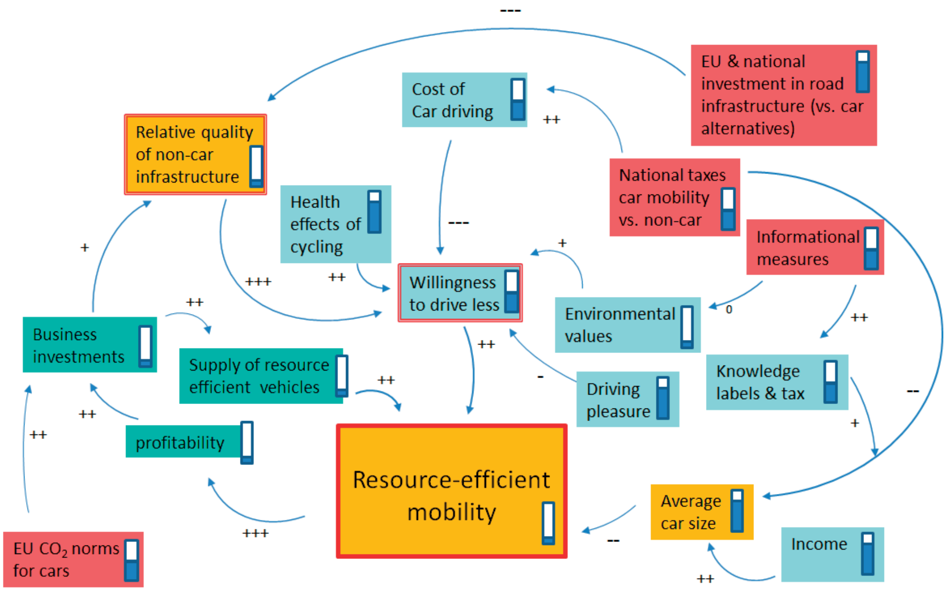

Figure 11.2 Web of constraints in passenger mobility. Legend: individual (blue), business (green), policy (red) and societal/infrastructural (orange) factors. The relationship between the factors is indicated (as positive or negative, varying from --- to +++). The level of the factor is reflected in the thermometer icons.

The analysis allows some conclusions to be drawn. The decision to own a car is influenced by the purchasing power of the prospective user but also by the extent to which ownership of a car of choice confers status benefits on a person (as a highly subjective element). Car purchasing decisions also depend on the infrastructural network aspects of roads available for use and the fuelling and charging infrastructure, and on personal attitudes to convenience, health, and, to a lesser extent, the environment. Regulations and policies were found to influence consumer choices by providing incentives to buy less polluting vehicles, but the same policies work out differently in different contexts. Tackling the web of constraints thus requires coordinated action in a number of policy areas, including technical standards, public transport networks, and transport infrastructures. Changes regarding attitude and inertia may follow changes in framework conditions but are also influenced by other factors such as the role of cars as status goods and the gratification of the experience of driving.

Innovation policy options for sustainability

The combination of the innovation framing analysis (step 1) and innovation dynamics analysis (step 2) was instrumental in helping us understand the difficulty of achieving more resource efficiency in passenger mobility and in delivering policy options for sustainable mobility (step 3). It found that sustainable mobility is not hampered by one or two factors but by a “web of constraints” and thus by “systemic blocking”. We found that effective policy (or very often policy *mixes*) needs to be mindful of this web of constraints, by aligning various policy instruments and avoiding policy inconsistency. Policy making should intervene not only on more objective indicators (such as price, density of infrastructure etc.) but also consider and shape perceptions (of e.g. sustainability), expectations, networks of actors, and potential strategic responses to policies.

Designing a comprehensive policy strategy for sustainable mobility requires systemic changes operating at different levels, including business models (which are committed to near-zero emission by 2050), mobility practices (e.g. combining car and public transport more often), and regulation. It therefore needs to combine “hard” policy instruments (such as taxing) with “soft” instruments such as public-private platforms.

11.3 Conclusions

This chapter has briefly explored the intricate web of factors preventing a more efficient use of resources, even when there seem to be opportunities to achieve win-win solutions. The concept of the web of constraints helps to understand the complexity of interlinked causal loops influencing consumer and business choices, which explain the low uptake of resource-efficient measures and lifestyles. The chapter used the mobility sector as an example, discussing it from the perspective of the web of constraints. This sector consumes large amounts of resources and generates significant environmental impacts, but also holds great potential to increase resource efficiency. The analysis has illustrated the complex web of obstacles that interact dynamically to prevent efficient use of resources. The notion of the web of constraints also helps to understand the complexity of designing policies that promote resource efficiency, as several areas need to be addressed in an integrated and dynamic way to overcome the web of constraints and modulate the dynamics into a web of drivers. The analysis also indicates important connections between different sectors, for instance between mobility and the building sector, since different types of housing options and planning strategies could give rise to new systems of mobility. Co-housing (people living together in an intentional community with the aim of sharing space and goods) and dense developments may favour the use of public transport and car-sharing platforms. The study has also noted that effective public transport networks are not sufficient to ensure less reliance on private cars, and that other factors, such as attitudes to convenience and adequateness, need to be considered. An analysis of the linkages across sectors and policy areas is beyond the scope of this paper, but these need to be addressed in the future to provide a basis for consistent and coherent policy mixes that help to overcome the web of constraints to resource efficiency.

Current policy measures to stimulate resource efficiency typically address barriers at the national, sectoral and company levels. However, policy *mixes* are necessary to deal with a myriad of barriers to resource efficiency and a circular economy. As the OECD (2007, p. 433) notes, “the complexity of many environmental challenges means that a mix of policy instruments will be needed … a well-designed instruments mix can be both environmentally effective and economically efficient.”

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