How to design policy packages for sustainable transport: Balancing disruptiveness and implementability

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ABSTRACT

In order to achieve emission reduction targets in the passenger transport sector, the demand side and especially the mobility behavior of consumers deserve special attention. It is unlikely that such behavior will change without significant political intervention, nor will single policy instruments be sufficient to induce the needed changes. In this study, therefore, we analyze the design of so-called disruptive policy packages required to drastically reduce passenger transport emissions in industrialized countries and illustrate it for the case of Austria. Our research approach consists of three methods: a literature review to develop a policy category system, expert interviews to build effective policy packages and a stakeholder workshop to identify the specific needs of different geographical areas. For the design of successful policy packages, we identify two critical dimensions, disruptiveness (having high-level and rapid effectiveness) and implementability. A well-balanced combination of diverse policy instruments is required to adequately address both dimensions.

1. Introduction

Passenger transport is a key contributor to anthropogenic greenhouse gas (GHG) emissions and, as such, it is a significant driver of climate change. In addition to emitting large amounts of GHG, passenger transport has experienced one of the largest growth rates of all sectors in recent decades (Sims et al., 2014). Therefore, it poses a huge challenge to the successful achievement of emission reduction targets, especially with regard to staying below the global 1.5-degree temperature increase limit (IPCC, 2018). In addition, passenger transport is associated with other problems, such as noise, local air pollution, geographical sprawl, safety and health issues (Jochem et al., 2016; Santos et al., 2010; Steg and Gifford, 2005). With consumers habitually following unsustainable practices due to path dependencies (Berger et al., 2014) and fossil-based, motorized individual transport on the rise around the world, society desperately needs to rethink current system structures and support a transformation towards sustainable mobility (Geels et al., 2017).

In the present study, we address these challenges by focusing on the design of disruptive policy packages for passenger transport, as applied in the industrialized country case of Austria. These policy packages can be used to change the mobility system quickly and efficiently.

While it is clear that the current transport regime cannot be considered as sustainable, the question of what a sustainable transport system exactly could and should look like is still open, and no consensus on the matter has been found (Berger et al., 2014). In line with the concept of sustainability and its three pillars, the Council of the European Union (2001) defined sustainable transport as a system...
that (1) “allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promises equity within and between successive generations,” (2) “is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development,” and (3) “limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on land and the generation of noise”. A second and at least equally important question that has arisen in the discussion about the definition of sustainable transport is how to help people transition to this new system and understanding of transport. This will not be an easy task, as people generally are reluctant to change and are subject to inertia, especially in industrialized countries where transport systems and their supportive infrastructure are already quite mature (Seto et al., 2016).

While technological innovation will unquestionably play an important role in this transformation process, it has become steadily clearer that a system-wide regime shift will only be achieved if far-reaching changes occur (i.e., other than simply offering technological solutions) and, in particular, a stronger focus is placed on demand-side approaches (Creutzig et al., 2018; Gazheli et al., 2015; Geels et al., 2017; Shay and Khattak, 2010). Among the variety of different actors involved, policy makers play particularly important roles (Vergragt and Brown, 2007), as such a shift towards sustainable mobility is unlikely to occur independently, especially within the next few decades (Cohen et al., 2016; Kivimaa and Kern, 2016). If we refer to Banister (2008) and his sustainable mobility paradigm, we can distinguish four important types of measures that can be used to reach this goal: “actions to reduce the need to travel (less trips), to encourage modal shift, to reduce trip lengths and to encourage greater efficiency in the transport system”. This paradigm largely agrees with the so-called Avoid-Shift-Improve (A-S-I) concept, which summarizes three main policy approaches that can be taken to reduce the negative environmental impacts of transport: improving technological efficiency, shifting to low-carbon modes and avoiding transport overall (Dalkmann and Brannigan, 2007).

Scholars have underlined the fact that the current focus on incremental changes is definitely not sufficient (Berger et al., 2014; O’Rourke and Lollo, 2015). Instead, radical and immediate action must be taken to overcome the described challenge (Bailey and Wilson, 2009). In our study, therefore, we build on the concept of so-called disruptive policies (similar to the one of radical (cf. Sieniatycki, 2004), transition (cf. Nykvist and Whitmarsh, 2008), or discontinuation policies (cf. Hoffmann et al., 2017)), which are defined as policies that have been developed to drastically decrease transport-related emissions by promoting a fundamental shift in the current system towards more sustainable and carbon-neutral mobility solutions. Still, such policies are often harder to implement than others due to social change required and, thus, the need to create complementary measures. In recent years, the involved actors have come to the realization that single policy measures are not strong enough to effect the transformation to a sustainable transport system. Thus, there have been calls for the development of policy packages that increase policy effectiveness, minimize unintended side-effects of single policy measures and accommodate various interests (Berger et al., 2014; Givoni et al., 2013; Givoni, 2014; Stephenson et al., 2018).

While disruptive policies (or comparable approaches) have been discussed in the literature, most studies carried out on this topic have been either more theoretical/conceptual (cf. Berger et al. 2014), focused on single policies (cf. Hrelja et al., 2013; Kent et al., 2017; Shay and Khattak, 2010), or exclusively followed a case study design (cf. Brand et al., 2020; Hoffmann et al., 2017; Kivimaa and Kern, 2016). Our study approach is closely related to the approach taken by Stephenson et al. (2018) and Wicki et al. (2019). Wicki et al. (2019) conducted choice experiments in three countries to identify politically feasible policy packages for sustainable transport. Before conducting their main study, they identified six potentially effective policy instruments based on expert interviews, five of which were aimed directly at consumers: (i) taxes on fossil fuels (including (ii) tax-revenue-recycling options), (iii) restricting access of fossil-fueled cars to downtown areas, (iv) emission limits for newly registered cars and (v) information campaigns. Although all the presented packages include push measures and emphasize effectiveness, the primary focus of this study was on public policy support. Wicki et al. (2019) discovered that the policy package design and contextual factors seemed to be more important than the policy types. Stephenson et al. (2018) examined transport interventions that could be used to promote a sustainable transition in New Zealand, using a four-stage Delphi study. Referring to the four types of measures described by Banister (2008) introduced above, they summarized different policy measures that would be needed to achieve a sustainable transition, such as creating cross-modal ticketing systems (encourage modal shift), changing urban forms and functions (reduce trip lengths), ensuring information and communications technology (ICT) access in rural areas (reduce need to travel) and offering time-variable road pricing (encourage greater efficiency). They also found that, in addition to direct transport interventions, deeper changes in the governance structure itself would also be needed (e.g., a sustainable reorientation of the regulating and funding environment).

While a review of the literature indicates that policy packaging is a widely used approach (Givoni, 2014; Wicki et al., 2019), few studies have been conducted on packaging design to switch smoothly and ultimately to a low-carbon pathway for passenger transport in a short period of time. The present empirical study was carried out to address this gap. The objective of the study is to improve our understanding of how well-balanced policy packages can be designed to achieve a sustainable mobility transformation in industrialized countries. In this paper, we refer to such policy packages as “disruptive.” Policies that could potentially contribute to such disruptive policy packages were collected and categorized, and their designs were explicitly analyzed. A qualitative approach was taken during the research process, combining a range of methods that are described in section 2. In section 3, we synthesize the results and present the inductively created categories of promising policies, describing which factors are critical when combining policies to form effective transport policy packages. Moreover, we investigated the specific characteristics that need to be considered in different geographical areas (urban, suburban and rural areas) that are relevant in the Austrian context. The results of this investigation and their implications for policy making, as well as the generalizability of our findings, are described in Section 4, and conclusions are presented in Section 5.
2. Materials and methods

To identify policies that could potentially contribute to disruptive policy packages, we first conducted a literature review (Section 2.1) and developed a categorical system. These categories served as the basis for the interviews that were subsequently held with experts (Section 2.2). These experts critically assessed the policies we had identified in the literature review and combined them into draft policy packages. Finally, based on the obtained results, we designed a stakeholder workshop (Section 2.3) to integrate additional perspectives from representatives of different interest groups and focus on three geographical areas and their needs. These representatives described what they thought such policy packages could look like in detail. By using a mixture of these different methods to collect information about numerous disruptive policies and considering how they could be combined, we were able to provide a holistic overview of how to transform mobility.

2.1. Literature review

To obtain an overview of potentially relevant policies, we carried out a literature review between February and August 2019. We searched for these policies using the abstract and citation database Scopus, the Web of Science database search engine and the Google Scholar web search engine.

To include a broad range of implemented and proposed policies, we considered information from research articles, books and book chapters, as well as reports, policy papers and other gray literature. We examined a variety of different empirical qualitative and quantitative research papers as well as literature reviews and case studies. Boolean operators were used to combine search terms. An overview of the search terms and the number of results can be found in Table 1. When searching with Google Scholar, we introduced an additional search term to reduce the large number of results still further. The screening process used during the literature review was structured into three phases: First, all papers were screened based on their title (title screening); second, papers were screened based on their abstract and keywords (abstract screening); and, third, the remaining sources were fully screened (full paper screening).

We selected the final list of sources by applying pre-defined inclusion criteria: The publication recency (i.e., sources published from January 2000 to February 2019), topic (i.e., the source had to include one or several policies that primarily dealt with urban surroundings with an established infrastructure, sustainable mobility and placed a focus on the consumer/user side) as well as the reliability and validity of sources. To achieve this end, we evaluated the gray literature thoroughly for the consistency of the research findings reported and the quality of sources used.

We screened a total of 1475 (eight sources had to be previously excluded, as they were not traceable) and assessed the full texts of 322 sources (see Fig. 1). Out of these, 107 sources met our predefined inclusion criteria and were, therefore, further analyzed. Our final list included many types of documents, such as journal papers, reports, book chapters and conference/working papers. An overview of the included sources and their characteristics can be found in Supplement A.

The final list of sources was then screened for policies mentioned, which we clustered into different categories by following an inductive, content-based approach. Each policy could be assigned to one or several categories. We then conducted a distance analysis using the Jaccard index for catorgial data with R software (Version 1.1.456) to investigate the overlaps between categories, i.e., to evaluate similarities between the categories (Tan et al., 2014).

2.2. Expert interviews

Subsequently, we carried out 13 semi-structured, face-to-face expert interviews with a total of 17 persons from September to November 2019. Interviewees included public officials responsible for transport management and planning and worked in local and national administration offices in the major Austrian cities and their surroundings, as well as representatives of automobile clubs and a sustainable mobility initiative (NPO) (see Table 2).

We applied a key informant sampling strategy and selected participants with a mix of different competences (extending from local to national) and perspectives by including interest groups representing diverging opinions. Interviewees were contacted by e-mail. While most of the contacted persons agreed to participate in the interviews, in some cases, we were referred to colleagues in the same department. On average, the interviews took 67 min (min = 43’25”, max = 102’25”) and consisted of three topics/thematic areas. The recorded interviews were transcribed and analyzed using MAXQDA software (version 20.0.4).

First, questions were asked regarding the latest projects in the domain of sustainable mobility, such as local initiatives, ongoing mobility plans and personal experiences gained from past approaches taken in cities or municipalities. Second, to achieve the main purpose of holding the interviews, we asked the interviewees to state which policies they considered to be most effective and to rank them according to their potential for disruption from highest to lowest. To further refine the assessments, we asked interviewees to evaluate these policies on the basis of three different criteria: policy effectiveness (relevance for emission reduction), required time for

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1 Note that books were counted as a single source, regardless of the number of chapters used for the analysis.
2 The interviews were generally designed as individual interviews, and we also described them as such when contacting potential interviewees. Still, in two cases, two interviewees and, in one case, three interviewees were present without prior announcement to the interviewer. Due to the successful procedure as well as the interesting results, we also included these interview results in the overall analysis. All participants in the expert interviews and the stakeholder workshop were either informed verbally or in writing about the purpose of the study, as well as about their rights and data security requirements; they all approved the use of the collected information for research purposes.
implementation and expected public acceptance. The interviewees evaluated the policies by choosing one of three possible scale levels: low, medium and high for both policy effectiveness and public acceptance or short-, medium- and long-term for the time horizon. Regarding the assessment of the time horizon, interviewees were also asked to define specific time frames where possible. We asked the interviewees to write down the mentioned policies as well as their ranking and assessment abbreviations on provided cards. Third, we asked the interviewees to merge the identified policies into perceived effective policy packages. Finally, we asked (when applicable) additional questions on topics discussed in the literature that were not or were only partially mentioned during the respective interview to gather additional policy information. At the end of the interviews, we took pictures of the arranged set of cards to obtain a photo documentation.
Table 3
Overview of workshop participants.

| Stakeholder workshop                  | Participants |
|---------------------------------------|--------------|
| Automobile clubs                      | 1            |
| Chamber employees                     | 2            |
| Environmental agencies                | 2            |
| Industry/businesses                   | 6            |
| State-owned enterprises                | 8            |
| Non-profit organizations              | 4            |
| Public officials                      | 9            |
| Research institutes/universities      | 5            |
| Sum of participants                   | 37           |
| Project team + moderation             | 12           |
| Overall                               | 49           |

2.3. Stakeholder workshop

We contacted experts who worked on transport topics by e-mail (in a similar fashion as for the expert interviews) and invited them to join a full-day stakeholder workshop, which was conducted in January 2020 with 37 of these experts.

We again aimed to collect a wide range of perspectives and personal experiences from the participants, who included researchers, public officials from local to national level, people from industry, NPO representatives and those of other interest groups (see Table 3). The main goal of holding this workshop was to form disruptive policy packages for three geographical areas (urban, suburban and rural surroundings) that could fulfil the Austrian government’s 2040 goal to achieve carbon neutrality. The classification into three geographical areas was chosen, because both the topographical conditions and the differences between urban, suburban and rural areas are important aspects of transport management in the Austrian context.

After giving a short introductory presentation, we asked participants to join one of eight focus groups, each with four to six people. While participants were invited to join groups based on their personal preferences and experiences, we put a special emphasis on creating heterogenous settings. Each group dealt with a different geographical area: Three groups were assigned to examine urban areas; three, suburban areas; and two, rural areas. The groups were instructed to each create one disruptive policy package, adding as many policies as they considered necessary. After the in-depth group discussions were completed, one person per group switched to another table to explain the collected ideas and get feedback; these could be integrated into the original concept, if desired by the group. Unlike the expert interviews, we could not record the discussions due to the nature of the workshop. However, one person at each table from the project team took notes to collect the group’s main ideas; these were then summarized and presented in the form of short protocols.

3. Results

3.1. Categorization of policies from the literature

The literature review enabled us to identify 1592 references to individual policies. We assigned these policies to one or more of the 19 inductively developed categories (see Table 4 for an overview, including examples per category) with a minimum of ten single policies per category.

In total, the categories were used 2488 times, meaning that a single policy was assigned to about 1.6 categories on average. The three most frequently selected categories are infrastructure provision and spatial planning ($n = 410$), pricing policies ($n = 268$) and alternative fuels and power trains ($n = 217$). The Jaccard index distance analysis results show categories 3 and 10 to be the closest ($d = 0.36$), followed by categories 1 and 4 ($d = 0.77$) as well as 1 and 6 ($d = 0.86$). A value of 0 would imply a perfect match, whereas a value of 1 indicates the maximum distance. In general, the categories used for this analysis were found to be rather distant from each other, with a mean distance of $d = 0.98$ (excluding category 13).

Next, we structured the policy categories in a matrix along two axes (see Fig. 2). On the x-axis, categories are differentiated according to the Avoid-Shift-Improve (A-S-I) concept (see introduction), whereas different kinds of instruments are depicted on the y-axis. Planning instruments involve policies that have been created to support long-term planning and development, such as category 1 (infrastructure provision/spatial planning). Secondly, command-and-control instruments rely on regulation (e.g., quantity restrictions or standard settings) and require government involvement through monitoring, such as transport restrictions (category 8) or standards (category 16).

Finally, incentives usually refer to (mostly financial) offers and inducements that are intended to support specific behaviors, including subsidies and attractive infrastructure. These offers and inducements can also take the form of disincentives that limit unwanted behavior, such as environmental taxes without external control (e.g., categories 4, 5 and 6). Note that category 13 (“others”) was not assigned to the matrix, as it encompasses a variety of different policies, making an allocation difficult. We located policy categories in the matrix by identifying their main foci. For example, we placed categories 4 (attractive active transport) and 6 (attractive public transport) accordingly in the upper row/middle column, as they encompass mostly planning instruments that support a shift towards other modes of transport. This example is supported by others: several categories are located on the edge of
different areas (e.g., category 12 = commuter solutions), as they can be assigned to multiple areas. The matrix also indicates the diversity of the different policy categories, as all nine sections are at least partially covered.

3.2. Quantitative assessment of expert interviews

In total, interviewees mentioned approximately 8.9 different policies per interview. Policies were again allocated to the (multiple) categories introduced in Table 1. On average, a policy was assigned to 1.7 categories. Table 5 shows the aggregated assessment results per category. The median values were used to differentiate between the effectiveness, public acceptance and time horizon of the policy (i.e., as measured on three scale levels: low, medium and high/short-, medium- and long-term), and the mean values were used for the time spans. In some cases, mixed forms of levels were also predominant, such as in the case of "commuter solutions" regarding the time
horizon. Category frequencies are also shown in Table 5. Note that category 13 ("others") was again omitted due to its low informative value. The four most frequently mentioned categories are infrastructure and spatial planning \( (n = 41) \), attractive public transport \( (n = 24) \), alternative fuels and power trains \( (n = 16) \) and pricing policies \( (n = 16) \). The mean distance between categories is \( d = 0.96 \) (excluding category 13). The closest categories are 3 and 10 \( (d = 0.45) \), categories 1 and 6 \( (d = 0.59) \), categories 5 and 10 \( (d = 0.64) \) and categories 3 and 5 \( (d = 0.74) \). Note that two categories were not addressed by interviewees in the quantitative assessment, namely, eco-driving policies and standards. Still, these kinds of policies were partly mentioned in the qualitative assessment.

Two policy categories, numbers 1 (infrastructure provision/spatial planning) and 14 (mode integration), achieved almost optimal combinations of evaluations (to be highly effective and accepted as well as implementable in a short amount of time), whereas speed

Table 5
Category assessments and size.

| Nr. | Category name                        | Effectiveness | Time horizon\* | Time spans | Acceptance | Frequency |
|-----|--------------------------------------|---------------|----------------|------------|------------|-----------|
| 1   | Infrastructure provision/spatial planning | H             | S/L            | 6.4 (0–30) | H          | 41        |
| 6   | Attractive public transport           | H             | M              | 6.7 (0–30) | H          | 24        |
| 3   | Alternative fuels and power trains    | H             | S              | 5.8 (0–20) | M          | 16        |
| 2   | Pricing policies (others)             | H             | S              | 3.5 (0–10) | L/M        | 16        |
| 11  | Parking policies                      | H             | S              | 4.8 (0–30) | M          | 15        |
| 9   | Intelligent transport systems/ Smart digitalization | M          | M              | 9.0 (0–25) | M          | 13        |
| 8   | Transport restrictions (others)       | H             | S              | 3.6 (0–20) | L          | 12        |
| 7   | Shared mobility/MAAS                  | M             | M              | 4.8 (0–30) | M/H        | 11        |
| 10  | Attractive low-carbon vehicles        | H             | S              | 3.2 (0–10) | M          | 11        |
| 5   | Taxation, subsidies and grants        | H             | S              | 1.5 (0–5)  | M          | 8         |
| 4   | Attractive active transport           | H             | S              | 4.0 (0–10) | M          | 8         |
| 14  | Mode integration                      | H             | S/L            | 6.9 (0–30) | H          | 8         |
| 12  | Commuter solutions                    | M             | S/L            | 7.8 (0–30) | H          | 7         |
| 15  | Soft policies/awareness-raising       | H             | S/L            | 7.1 (0–25) | M          | 6         |
| 17  | Speed limits                          | L             | S              | 0.5 (0–1)  | L          | 4         |
| 18  | Technology improvements               | H             | M              | 8.0 (5–11) | H          | 2         |
| 16  | Standards                             | –             | –              | –          | –          | –         |
| 19  | Eco-driving                           | –             | –              | –          | –          | –         |

Note. Assessments of three main scale levels: low/medium/high for effectiveness and public acceptance, short-term/medium-term/long-term for time horizon. Mixed forms of scale levels are also possible. Scale levels are abbreviated. Mean values of time spans are given in years; the upper and lower boundaries are shown in brackets.

\* Time horizon refers to the time span that is needed for the implementation of policies and not to the amount of time necessary for the policies to become effective.

Fig. 3. Bubble chart of policy categories. The sizes of the bubbles indicate the respective category in terms of frequency of mention by interviewees. The horizontal and vertical lines separate the graph into nine areas (differing positions within these areas are for illustrative purposes only).
limits were assigned to the group of policies with comparably lower scores. To further illustrate the results of the quantitative assessment, Fig. 3 shows the 16 assessed categories with policy effectiveness shown on the x-axis and public acceptance shown on the y-axis using a bubble plot.

For better illustration, different sizing was used for the areas, depending on the number of categories included per area. Positions on the edges between areas (for categories 2 and 7) represent mixed forms of scale levels for public acceptance. As Fig. 3 illustrates, most assessed policy categories are located within the right-hand areas, representing high effectiveness paired with different levels of acceptance.

3.3. General stakeholder workshop results: Geographical differences

The main goal of the stakeholder workshop was to design specific policy packages for urban, suburban and rural areas and gain a better understanding of the differences between these areas that are important for the implementation phase of policies.

In total, 47 policies were collected in the stakeholder workshop (including multiple mentions); these were assigned to the 19 categories introduced in Table 1. The most frequently mentioned categories are infrastructure provision and spatial planning (n = 12), attractive public transport (n = 11), soft policies (n = 11) and transport restrictions (n = 10). The results of the distance analysis show that categories 3 and 10 (d = 0.2), categories 1 and 6 (d = 0.56), categories 4 and 6 (d = 0.67) and categories 2 and 12 (d = 0.67) are most similar to one another.

Table 6 illustrates a variety of different policy areas that stakeholders considered as important for the respective geographical areas. Urban areas are typically extremely dense and space-limited, while suburban and rural areas are subject to sprawl and, therefore, longer transport distances. The latter make providing suitable public transport connections difficult. As a result, motorized individual transport is favored as the main mode of transport, especially in rural areas, and will be difficult to avoid completely in the future. Still, demand-oriented micro public transport can be offered as one way to tackle this problem. Suburban areas receive a high share of the daily commute into city centers; this makes it necessary to both offer attractive alternative modes and disincentivize motorized individual transport. In urban areas, however, green areas and living spaces need to be extended and accessible to pedestrians in order to limit their need to “escape the city” and increase their quality of life. Despite these geographical differences, some policies are mentioned as important in two or more areas, as depicted in the left-hand column in Table 6. Overall, awareness-raising was identified as an important complementary measure in all areas, for example, in the form of mandatory mobility education in schools.

3.4. Elements of a disruptive policy package

The results presented in Sections 3.1–3.3 show that certain categories are central across all stages of the research process, but also highlight some differences. In all methodological approaches, the importance of infrastructure provision and spatial planning was emphasized. Furthermore, attractive public transport and pricing instruments were identified as highly relevant. Interestingly, soft policies were mentioned very frequently in the stakeholder workshop, whereas they were less commonly mentioned in the literature review and in the expert interviews. Overall, eco-driving measures, technological improvements, standards and speed limits were the least frequently discussed categories across all methodological approaches. Below, we take a closer look at the elements that were identified as important to design a disruptive policy package.

The respondents (expert interviews and stakeholder workshop) reached a broad consensus: In order to achieve a shift towards a sustainable mobility system, policies from multiple categories would need to be combined into effective policy packages to simultaneously guarantee effectiveness and achieve other goals, such as public acceptance. Respondents identified the most crucial but also most challenging long-term task as making changes in spatial planning, transitioning from the currently car-centered structures to new forms of living. They agreed that new living environments need to be created, whereby necessary aspects of daily life (e.g., working, shopping, leisure time) can be fulfilled within short distances, reducing the need for car travel. This means densifying living spaces, on the one hand, which is especially relevant in more rural areas but, on the other hand, also redesigning the existing spaces (e.g., greening cities or turning car lanes into spaces for people and active transport). The respondents noted that it is especially important to provide infrastructure by establishing specific, separate biking lanes and paths, as people need to feel safe and comfortable in order to switch to this form of transport.

Another step that needs to be taken to achieve sustainable mobility is to spatially and temporally expand public transport offers to provide good alternatives for groups such as commuters and reduce private car transport. Cities need to both provide additional

| Table 6 Main policy areas for different Austrian geographical areas. |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|                             | Overall                      | Urban                       | Suburban                    | Rural                        |
| Planning                    | Higher quality of and more space for active and public transport systems; electrification of (public) transport | City of short distances; greening of areas | Multimodal planning, better public transport connections to cities | Densification; change in spatial distributions |
| Command and control Incentives | Phase out of conventional cars | Road dieting; driving bans | Entry restrictions for cities to limit car commute | Ecologization of land-use designation |
|                             | Mobility/CO₂ pricing/taxation | Incentive active transport; reduce parking areas | Higher parking prices to limit car commute; car sharing offers | Priced parking at shopping centers, demand-oriented micro public transport |
infrastructure (together with active transport solutions) and create connections from cities to suburban areas or neighboring communities, also including the “first and last miles” of trips. It is also essential to increase the capacity to create easy and convenient connections between different modes of transport. Several respondents stressed the need not only to provide additional services, but also to encourage people to actually use these services to make them worthwhile. Reducing travel time and offering pricing incentives for public transport represented crucial elements that would enable public transport to compete with the car, making public transport either more or private transport less attractive. Most interviewees stated that an attractive public transport system would be directly linked to potential changes in spatial planning. They considered this as a necessary precondition for other policies, such as pricing mechanisms. This aspect especially applies to restrictive measures, as respondents considered it crucial to form alternatives first and complement push with appropriate pull measures.

The most important technologies discussed with regard to alternative fuels and powertrains were electromobility for passenger transport and, in the long term, hydrogen for public transport and heavy-duty transport, although some respondents were uncertain as to which of the two will dominate or whether several technologies will coexist. While electromobility was seen to be relevant in terms of reducing transport emissions, critical voices were also raised regarding its primary energy, range, the potential use of bus lanes, costs and spatial restrictions, especially in urban areas. Most interviewees underlined the need to reduce motorized private transport, irrespective of the specific powertrain or fuel used (avoid/shift focus), stressing that simply replacing one car with another would not result in sustainable transport. As far as hydrogen was concerned, although it is seen as a potentially powerful technology – unlike electromobility – the interviewees perceived it as only being in the early stages. They remarked that crucial aspects, particularly in relation to production and storage, need to be resolved first. Opinions differed regarding the role and effects of alternative fuels (biogenic and synthetic fuels): While some emphasized the immediate potential impact of such fuels as necessitating no change in technology, others criticized precisely this aspect and sharply contrasted it with the concept of sustainable mobility. Still, most respondents agreed that old, less efficient vehicles should be phased out and that the purchase of low-carbon vehicles should be encouraged and supported (e.g., by offering financial subsidies or other purchase incentives).

In general, different kinds of pricing instruments (e.g., road pricing, congestion charges, or tolls) were seen as powerful tools to change transport behavior, especially when combined with parking policies (e.g., parking management and parking spot reductions). Both types of instruments can be implemented relatively quickly and are expected to have a high impact on transport emissions. Taxation was also mentioned in this context, and the need for an eco-social tax reform was underlined. Additional restrictive measures, such as car bans or quotas, were also mentioned in many cases as an important aspect. Still, at the same time, respondents stated that such restrictions are classically linked to low expected public acceptance; therefore, they are hard to implement without making additional arrangements or offering incentives. However, some respondents also stated that the public acceptance of restrictive measures tends to be higher after their implementation than initially expected. Thus, they emphasized the need to display political courage and also include (initially) relatively unpopular policies.

The most frequently discussed soft policy approach was awareness-raising in society to increase the understanding and support of measures (even restrictive ones), for example, by making informative, interesting and comprehensible media reports. Several interviewees mentioned the need to communicate the positive effects of sustainable mobility measures in order to gain public acceptance
and encourage societal change as a foundation to implement the policies outlined. Other examples of soft policies include marketing campaigns for promoting public transport, mobility education in schools and mobility counseling for new mobility services.

4. Discussion

4.1. Design of disruptive policy packages

Based on the results from the distance analyses, the quantitative analysis from the expert interviews, the most discussed categories per methodological approach as well as additional qualitative statements from the expert interviews and the stakeholder workshop, we created a generic model for disruptive policy packages as depicted in Fig. 4. While some of our results are context-specific for Austria and may not be applicable in countries with different characteristics (e.g., topography, population density, or dispersion) and circumstances (e.g., political situation, stage of economic development, or culture), the generic nature of the model allows us to draw general conclusions to some extent. In particular, we believe that our findings will be especially useful with regard to industrialized countries with similar structures, such as the current stage of development of the public transport system, or that are facing similar challenges, such as the prevalence of geographical sprawl. Still, the specific policies included in the package and their intensities certainly have to be adjusted to fit the requirements and particular characteristics of the specific context.

In general, the model emphasizes the fact that a disruptive policy package needs to be designed with two competing goals in mind. On the one hand, we are striving to decarbonize the mobility system as quickly and extensively as possible; in other words, the policy package needs to be effective in order to have the highest possible potential for disruption (Givoni, 2014). On the other hand, the policy package should also have a high degree of implementability (Serensen et al., 2014). To this end, a high degree of public acceptance for the measures and available resources to finance them are essential (Banister, 2005). The distinction between disruptiveness and implementability is closely linked to the distinction between pull (positive incentives for desirable behavior) and push (providing negative incentives or restrictions for undesirable behavior) measures. If push measures dominate, radical and rapid decarbonization could theoretically be achieved, but the policy package is unlikely to be implementable due to its low acceptance. However, if pull measures dominate, the measures will have a higher chance of acceptance, but decarbonization is less likely to be achieved within the next decades (Givoni, 2014). Although these concepts share some similarities, our results reveal interesting differences between them: Whereas public transport expansion (a typical pull measure) was considered to be highly effective in terms of emission reduction, our respondents viewed stricter speed limits (belonging to the class of push measures) as relatively ineffective. In general, the classifications used in Fig. 4 describe tendencies; policy measures that address both objectives naturally exist.

Regarding the composition of the policy package, we found that this is more a matter of design than a question of the specific policy measures selected. In fact, we hardly found any arguments that could be used to exclude individual policies from the policy package, since most of these can be deployed such that they complement and reinforce the effects of other measures included in the package. However, the inclusion of infrastructure provision and spatial planning cannot be omitted, as they form the basis of all disruptive policy packages. This is due to the fact that other measures can only successfully support the decarbonization of the mobility system if the infrastructure and the respective spatial conditions allow for it, as underlined in Kent et al. (2017).

In addition, the policy packages should contain measures from the disruptiveness dimension, such as pricing and parking, taxation and general transport restrictions (see Fig. 4, left side of the scale). But they should also ensure attractive active and public transport as well as alternative fuels, all of which are key elements for implementability (see Fig. 4, right-hand side of the scale). If we refer back to the classifications used in Fig. 2, the generic model comprises policies from all A-S-I categories by avoiding traffic where possible (e.g., through restrictions), shifting to alternative modes of transport (e.g., by developing attractive public transport systems) and improving existing technologies (e.g., by phasing out fossil fuels and switching to alternative low-carbon solutions) (Dalkmann and Brannigan, 2007). In this context, it needs to be stated that many of the policies presented above have already been implemented in parts of the world, and few of them are uniquely innovative. This supports the argument that their disruptive potential originates from well-planned policy design and successful combination of different policies, rather than from the innovative characteristics alone.

4.2. Challenges regarding the implementability of disruptive policy packages

Although we emphasize the importance of maintaining the balance between the two objectives when designing the policy packages illustrated in Fig. 4, empirical evidence shows that policy makers tend to focus on the implementability dimension by, for example, preferring technological solutions (Banister et al., 2007; Creutzig et al., 2018). One reason for this seems to be the lack of public acceptance for more restrictive policies and, therefore, the lack of political willingness to bring such measures forward. This often leads to an “implementation gap” (Banister and Hickman, 2013; Cohen et al., 2016) or watering down of policies (Hrelja et al., 2013) due to the existing “transport taboos” (Gossling and Cohen, 2014). These taboos are often respected because administrators do not want to lose potential voters in the next election phase, a phenomenon that is also known as “short-term bias” (O’Rourke and Lollo, 2015) or “political myopia” (Gazheli et al., 2015). Nonetheless, our results also underline the need for political courage to implement controversial policies, as public acceptance can often be much higher than initially expected once people have had the chance to experience the new measures. This claim is supported by positive experiences that have been made after the introduction of, for example, pedestrian areas (Gazheli et al., 2015) or the congestion charging scheme that was enacted in Gothenburg (Andersson and Nåssén, 2016; Börjesson et al., 2016). An important aspect of acceptance, therefore, could be the introduction of pilot projects or pilot roads, so that the general public can gain initial experiences with the new conditions, or other forms of participation that involve and engage people in the process (Stephenson et al., 2018). However, Kent et al. (2017) underlined that not only willingness, but also the
ability of consumers (providing them with the necessary infrastructure, resources and skills to change their behavior), represent crucial aspects that enable a sustainable mobility transformation.

The availability of financial resources due to the high costs is another challenge that potentially blocks the implementation of new projects. Although we underlined the essential role of spatial planning and infrastructure provision, these measures are usually especially costly (Blainey and Preston, 2019; Leibowicz, 2018). Furthermore, as the budgets are generally limited, high costs can lead to competition between different interest groups, lobbying efforts and other stakeholders (Banister, 2005). On the other side, the involvement of different groups as well as their cooperation can also be fruitful, as often one actor alone (e.g., a city or a municipality) does not have the competencies or resources to carry out such large infrastructure projects, unless support is provided by neighboring communities or federal states. In general, the inclusion of revenue-generating push measures can alleviate these cost-related issues. While such measures tend to be rather unpopular, their public acceptance can be significantly increased by earmarking the revenues generated for green investments or attractive public transport (Drews and van den Bergh, 2016; Kalibekken et al., 2013).

5. Conclusions

The focus of policy makers has, until now, mostly been on altering behavior marginally, but an extensive shift in passenger transport will be required to achieve the necessary emission reductions. The present study, therefore, was carried out to design a disruptive policy package that fits the Austrian context, based on the results of a thorough literature review and the collection of extensive expert knowledge. We found that, in order to have a truly disruptive impact, a policy package needs to strike a balance between being highly effective (disruptiveness dimension) and being socially acceptable (implementability dimension). While our results show that this classification is crucial for policy packaging, our findings also enable us to connect to two other prominent concepts: (i) the Avoid-Shift-Improve framework, which is used to classify policies based on how they primarily make transport more sustainable (see section 1) and (ii) the distinction between push and pull measures (also known as the ‘carrot and stick’ approach), which refer to the way behavioral change can be induced. Our results indicate that it will be necessary for the package to address all areas of the A-S-I concept as well as the push and pull measures, raise awareness and run effective information campaigns. The basis of such a policy package is formed by extended infrastructure provisions and revised spatial planning. While some policy makers might fear receiving low amounts of public support for such packages, this fear is not necessarily justified, as it seems to depend heavily on the specific package design, the ways different needs are considered and how much the public participates in the decision-making process. In the future, a stronger collaboration between researchers, policy makers and other key actors in the policy implementation process will be necessary to foster transdisciplinary approaches and mutual learning. Furthermore, it may be interesting to conduct research in the future on comparative research designs that can be used to create disruptive policy packages for several countries or contexts. Although it is completely clear that the near-term decarbonization of passenger transport remains a mammoth task, fear of encountering conflicts or public resistance should not be an excuse for stagnation, as potential tensions will always exist.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trd.2021.102714.

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