A cross-cultural study of nonprofit self-organized ridesharing

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Abstract
Nonprofit ridesharing presents an underutilized opportunity for increasing transportation sustainability, as well as users’ economic and social benefits, while reducing adverse environmental impacts. However, while app-based ridesharing has achieved only modest uptake, mostly limited to longer trips, in certain contexts, self-organized ridesharing (SORS) has shown significant achievements, even for the challenging short- and mid-range commuting trips. Still, knowledge regarding the key elements and mechanisms behind successful SORS is partial, hindering the ability to effectively leverage SORS diffusion and scaling potential. Following the premise that successful initiatives may provide learning opportunities, this study aims at narrowing this knowledge gap by performing a comparative cross-cultural systematic study of eight diverse SORS cases. The study uses a recently designed conceptual framework and multiple research methods (mainly online data exploration, personal interviews, observations, and documents analysis) to comprehensively examine SORSs’ attributes and evolution stages and processes. Study findings highlight repeated patterns as well as the role of context, official actors, and local practices in shaping initiative’s dynamics towards success. The study offers general and specific policy recommendations for supporting the early development, growth, and diffusion of SORS, as well as reflections on post pandemic ridesharing.

Keywords Nonprofit ridesharing · Self-organization · Carpooling · Cross-cultural · Case studies · Commuting

Introduction

Around the world, cities and regions attempt to reduce the harmful effects of the drive-alone habit by encouraging more sustainable travel modes. Still, according to 2019 American Community Survey (ACS), 76% of the commuters in the US use single occupancy vehicles (SOVs). One way which has been shown to potentially reduce the vehicle-milage traveled is carpooling, or nonprofit ridesharing (to be referred to as RS), where travelers

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share a common origin–destination trip (Shaheen and Cohen 2019), driven to share by cost-splitting or non-monetary benefits. To foster RS behavior outside the closer family and neighbors’ circle, where carpooling is common, various strategies and policy tools were designed (Shaheen et al. 2018). However, these attempts have achieved only limited and localized success. Thus, for instance, the rate of work-related RS in the US has dropped from 20% in the 1980s to 9% in 2019 (U.S. Census Bureau 2019). Even the recent prosperity of sharing-economy commercially-driven RS initiatives, such as BlaBlaCar (Shaheen et al. 2017), or Scoop (Martin et al. 2020) resulted in modest and contextually dependent uptake, restricting their applicability to longer trips and high concentration of users (Shen et al. 2021). As short- mid-range trips correspond to the vast majority of commuting trips, the low effectiveness of RS policies and commercial offerings, restrict their potential system-wide impact in reducing SOV externalities. This gap is of continuous concern also in the post-pandemic era where carpooling and other shared modalities use has declined in favor of SOV, as demonstrated by the surge in car sales.

Concurrently, nonprofit self-organized ridesharing (SORS) initiatives have achieved localized success in multiple contexts, even for the short- mid-distance range. SORS refers to initiatives created by participants for their peers, emerging in an organic fashion, responding to the contextual strains and opportunities (Shoshany-Tavory et al. 2020). While the well-known SORS cases of casual carpooling appeared about four decades ago in San-Francisco Bay area and in Washington DC (Burris et al. 2012), in the past decade, multiple self-organized digitally-assisted solutions have emerged. These initiatives use the available, low-entry-cost technology, of social media tools and even users-made apps to provide adapted solutions for their participants (e.g., Eskelinen and Venäläinen 2021). Shoshany-Tavory et al. (2020) postulated that a successful SORS represents a pattern of adequate contextual adaptations to place- culture- and social practices, from which valuable lessons can be learned to stimulate and increase RS uptake.

However, though many SORS initiatives exist, thus far they have received only limited research attention, especially regarding their common features, and diffusion and scaling mechanisms. While formal (i.e., provided by official actors such as public transportation authorities, or various commercial actors) RS cases had been comparatively explored, both nationally and internationally (Handke and Jonuschat 2013), existing publications on the informal (i.e., self-emerging, users provided) initiatives explored only specific cases, as unrelated phenomena, offering limited theoretical understanding. Additionally, the existing research body explored mainly personal choice of participants, rather than initiative-context relationship (e.g., Shaheen et al. 2016). Overcoming this theoretical shortsightedness may serve as a basis for promoting RS. Identifying these gaps as knowledge barriers to capitalize SORS learning opportunities, the authors have suggested in a previous paper a conceptual framework for systematic examination of SORS cases (Shoshany-Tavory et al. 2020). The framework, based on a multi-domain approach, offers constructs that allow contextual description of the characteristics and evolution processes of a SORS initiative. Such descriptive framework may be used to classify and qualitatively compare multiple cases and elicit similarities and differences.

Using the framework for methodic and comparative exploration of eight different SORS cases, the current study aims to (1) verify the notion of SORS as recurring pattern/s; (2) analyze its dependency on external and internal determinants—both for emergence and diffusion; (3) eliciting intervention insights to inform both self-organized initiatives and the official actors, guiding their RS offerings. To allow generalization, the selected cases represent diverse cultures, contexts, and operation periods. For in-depth exploration we used multiple data sources, including electronic footprints left by participants (i.e., ridesharing
messages and ridesharing users’ blogs), interviews with users and activists, observations of ridesharing activities, and analysis of published documents. The structured analysis allows identification of similar traits and evolution processes, as well as discovery of recurring patterns associated with the initiatives’ success and their contextual anchoring. It also allows assessing the comprehensiveness of the conceptual framework and validating its usefulness.

Based on the insights gained from this study, we suggest managerial and operational interventions to facilitate SORS initiatives, increase their uptake, and allow their successful scaling and diffusion. Study outputs may interest transportation and policy practitioners, and researchers of traveler behavior within sharing economy.

The following section contextualizes our study within the broader literature. Section three details the “Methodology” used; section four outlines the “Results”; and section five offers “Discussion”, recommendations, and implications for future research.

**Literature review**

Nonprofit ridesharing, also called carpooling, is defined as private vehicle rides where riders may exchange operating expenses, driving responsibilities, or other non-monetary benefits, while sharing the driver’s predesignated trip, (Article L. 3132-1 of the Energy Transition Law for Green Growth of 2015; Shaheen and Cohen 2019). Unlike shared ride-hailing services (e.g., Uber), which had been shown to negatively influence the overall transportation system (Tirachini 2020), RS can potentially provide numerous system-wide societal benefits. Specifically, for commuting, RS may reduce vehicle-miles travelled, decrease emissions and energy consumption, and improve the average travel time (Minett and Pearce 2011). It can also lower infrastructure demand in the form of congestion or parking allocation (Shaheen and Chan 2016; Shaheen et al. 2018). These promising benefits are recognized even in the post pandemic era (Tomás et al. 2021) which posed an unprecedented challenge, as mobility rates had dropped for all shared-modalities, by what proved to be a major disruptive event. While initially less travelling and more working from home resulted in world-wide emissions drop, currently, car ownership surge. For example, in Israel alone, sales grew by 55% in 2021, after several years of continuous drop. Consequently, SOV induced congestion is building up again, exceeding the pre-pandemic rates.

Over the years, different policy tools had evolved to support RS, acknowledging its valuable part in the arsenal of sustainable transportation solutions. As summarized by Shaheen et al. (2018), these include, inter alia, reduced parking fees and preferential parking; road and curb pricing strategies and infrastructure (e.g., HOV priority lanes); marketing and behavioral change campaigns; direct and indirect cash incentives (e.g., reward programs); funding for workplaces carpooling programs, coalitions, and demand management organizations; and complementary services to improve the convenience of carpooling (e.g., public transit passes and guaranteed ride home programs).

Another tool trialed by official actors through various technological applications is the ride-matching programs (Handke and Jonuschat 2013). More recently, the rise of the sharing economy resulted in multiple ICT-based platforms, providing ride-matching and cost-splitting services by commercial actors (e.g., BlaBlaCar, WazeCarpool), alone or in collaboration with official actors. In the ICT form, policy tools, such as priority parking (Martin et al. 2020), monetary incentives (Shen et al. 2021), hub-structure design
(Miklas-Kalcynska and Kalcynski 2020), or initiation events (Claburn and Lane 2009), were applied to increase motivation and participation uptake.

However, despite RS’s promising potential and the different supporting incentives and policy tools, RS initiatives are still experiencing localized, and highly variable success. While some trials report substantial uptake, success depends on location (Martin et al. 2020), mainly for longer-distance trips and for expense-sharing schemes (Finger et al. 2017; Rafiq and Mitra 2020; Shen et al. 2021). Consequently, many countries experience continuous drop in shared rides, such as the noted drop in US carpooling rates (U.S. Census Bureau 2019), reflecting the growing car availability, urban sprawl, social alienation (Handke and Jonuschat 2013), and the limited success of commercial RS apps.

Though RS and SORS cases had been researched for years (e.g., Beroldo 1990; Ferguson 1997), the lack of substantial success is associated with partial understanding of the phenomenon in general, and in particular, the variety of initiatives. Furthermore, Shaheen and Cohen (2019) noted difficulties in observing and recording RS, which was referred to by Paul Minett as the “invisible mode”. Even assessing the success of an RS initiative is challenging, as actual rides happen in multiple locations and are finalized by private arrangements. Taking a user-centric view (i.e., exploring what drives personal choice), scholars addressed users’ profiles (e.g., Shaheen et al. 2017), motivations (e.g., Neoh et al. 2017), or practices and activities performed by RS app users and their alternative styles of consumption (e.g., Guyader 2018). While latest ICT technology advancements are being harnessed to observe and approach RS participants, the reported results remain conflicting. Thus, for example, a recent review highlights participants’ time and money considerations, yet the mode choice and the scope of participation remain only partially explained (Olsson et al. 2019). Another RS-specific challenge is associated with trip-distance dependency, where the multiple offerings fail to affect shorter commuting trips, which are one of the main contributors towards congestion.

While the research- and best practices-based offerings struggle to achieve RS outside travelers’ kin circle, and success is mostly associated with longer-distance trips, SORS schemes for short- and mid-distance trips have been showing relative success for years. Using the taxonomy offered by Shoshany-Tavory et al. (2020) we define SORS to encompass self-organized, technology-less, casual carpooling, as well as ICT-based cases where the technology is provided or reshaped by the users. Thus, for example, SORS success is shown in the 40 years old known cases of casual carpooling of San Francisco Bay area (SF) and Washington DC, where thousands of potential riders wait in spontaneously emerging meeting places shaped into lines, for their ride into town and use HOV +3 benefits together (Mote and Whitestone 2011; Burris et al. 2012; Zmud and Rojo 2013; Shaheen et al. 2016). The current social-media trend spurred a multitude of digitally assisted SORS, using existing platforms, such as instant messaging (e.g., WhatsApp) and social networking (e.g., Facebook), as well as self-made platforms (i.e., apps created by proficient users). Such are the 160 ridesharing Facebook groups in Finland (Eskelinen and Venäläinen 2021) which qualify as successful SORS. While latent, these initiatives are widespread, and many of them are quite large, as revealed through an initial Facebook search for the term ridesharing.

As SORS achievements are indicated by its emergence even in locations where more formal RS-matchmaking schemes are provided, we postulate such cases may be driven not only by personal gain such as cost-splitting, exchanged rides, or third-party incentives, but also by better contextual adaptation, or the surrounding social processes. According to Shoshany-Tavory et al. (2020), SORS formulation and evolution processes follow repeated patterns, hence their systematic exploration holds learning opportunities for policy
improvements. However, despite being a seemingly repeated phenomenon, the sporadic and partial body of knowledge on SORS is hindering our ability to effectively leverage SORS diffusion or scaling potential. This is indicated, for example, by the failed trial to artificially jump-start casual carpooling (Salzman 2013). Thus, shedding light on SORS’s attributes and key processes that influence its contextual adaptation and success, can provide valuable insights for designing useful policy tools to encourage the illusive short/mid distance SORS. Furthermore, such insights may also improve the formal officially- and commercially-provided initiatives, by artificially stimulating similar processes.

A framework for SORS exploration

SORs complexity stems from economic, behavioral, technological, organizational, and transportation origins (Amey 2010), therefore, user-centric approach, where participants’ characteristics and motivations are explored, is deemed insufficient to explain contextual dependency. Thus, more holistic methodology is needed where the context is better represented. Such approach is provided by a conceptual framework for SORS exploration (i.e., the “Framework”), recently developed by the authors (Shoshany-Tavory et al. 2020), using existing RS/SORS literature. As the SORS phenomenon evolves within its context, the Framework incorporates multi-layered transition theories. Specifically, Multi-Level-Perspective (MLP) theory is used, where a niche (micro-level), is encompassed by regime (mezzo) and landscape (macro) (Rip and Kemp 1998; Geels 2004). In the Framework (Table 1), the SORS initiative is described as a niche, where a set of constructs allow the description of its steady-state (i.e., quasi-static) situation, such as the resources used. Additionally, other constructs allow for regime and landscape description (e.g., geographic layout such as natural obstacles).

Using MLP terminology, the emergence and evolution of a niche within its regime/landscape context occurs where friction exists between the system parts (e.g., lack of adequate transportation solutions). Consequently, the niche evolves through the phases of predevelopment, take-off, and breakthrough, to reach stabilization (Rotmans et al. 2001). Furthermore, an established niche can undergo processes of scaling-up and diffusion to other locations. Köhler et al. (2019) advocated a combination of supporting theories for better understanding of changes in processes, practices, and people’s behavior. Therefore, to assist in niche-level specific understanding, the Framework incorporates constructs from Grassroot Innovation (GI) which addresses self-organized leadership, where activists lead bottom-up sustainable development by learning and norming through their communication channels (Seyfang and Smith 2007). Lastly, for regime-level processes, the Framework borrows from Social Practice Theory (SPT) where everyday practices (e.g., car use), encompassing elements, meaning, and competence are combined and interwind to create daily actions that produce the new practices of the niche (Shove et al. 2012). Figure 1 shows the combined theories influencing the Framework creation. Using these theories, the SORS niche (e.g., ridesharing group) innovatively respond to strains, opportunities, and cracks in the existing regime (e.g., car dominant culture, and high traffic congestion, where HOV + 3 incentive is offered), while the landscape provides the contextual socio-technical-geographical environment (e.g., available Facebook platform).

The comprehensive Framework provides additional constructs for describing the acting forces and the dynamic attributes of an initiative within its surrounding regime and landscape. Consequently, it allows rich annotation of any SORS case, including manifestation, collaboration among participants and stakeholders, and contextual considerations.
To simplify the exploration and discussion, regime and landscape contexts are classified together.

The multi-level analysis shifts the focus of exploration from the user-centric approach of what motivates participants to rideshare, to an initiative evolving within its surroundings. Therefore, it enables the examination of how the context influences emergence and evolution. Consequently, a more holistic discussion, of social, organizational, and contextual aspects is enabled, from which patterns can be elicited and intervention envisioned.

**Table 1** Key elements of the Framework for SORS analysis

| Category                                                                 | Sub-categories                                                                 |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| **Quasi-static attributes—niche**                                        |                                                                                |
| Form                                                                     | Acquaintance-based, casual, dynamic, hitchhiking                                |
| Matchmaking method                                                        | Meeting places, app/bulletin boards, signs                                      |
| Resources                                                                 | Users’ vehicle, smartphone, app, volunteers                                    |
| Exchange mechanism                                                        | Alternate rides, expenses, third party benefits, social goods                  |
| Roles                                                                    | Users, drivers, riders, leaders/activists                                     |
| Relations                                                                 | Kin, community, social networks, strangers, technology mediated               |
|                                                                          | Peer-to-peer (P2P), peer-to-community                                          |
| Collaboration base                                                        | Trust, reputation, reciprocity                                                  |
|                                                                          | Alternative establishing methods, market replacements                          |
| Side products                                                             | Rules, norms, social capital                                                   |
| **Quasi-static attributes—landscape and regime**                          |                                                                                |
| Context and environment constructs                                        | Geographical layout                                                            |
|                                                                          | Transportation network and facilities                                          |
|                                                                          | Available transit                                                              |
|                                                                          | Existing communities, social organizations                                     |
|                                                                          | Local culture                                                                  |
| Applicable practices                                                      | Existing, competing, integrated, abandoned, supporting elements, competencies,  |
|                                                                          | meaning                                                                       |
| **Acting forces**                                                         |                                                                                |
| Disruptors/barriers                                                       | Safety/stranger-danger, handling money transactions, transaction costs,       |
|                                                                          | Quality of Service (QoS), car driving habit, “my car is my home”, rule changes |
| P2P                                                                      |                                                                                |
| Initiative level                                                          | Lack of support, cooperation barriers, lack of trust, perception of value,     |
|                                                                          | critical mass                                                                  |
| **Dynamic attributes**                                                    |                                                                                |
| Phases                                                                    | Predevelopment (dynamic equilibrium), take-off, breakthrough, stabilization     |
| Patterns                                                                  | Empowerment, re-positioning, re-organizing                                     |
| Growth processes                                                          | Scaling-up, diffusion                                                          |
| Practice change processes                                                 | Change in material elements, meaning and competence; recruiting and defecting  |
|                                                                          | of practice carriers; a change in practice bundling; re-emergence of practice  |

*Source: Shoshany-Tavory et al. (2020)*
Methodology

To address repeated patterns, diversity, and contextual dependencies of SORS, we chose a qualitative case-based methodology of multiple occurrences. Such methodology allows in-depth understanding of why, how, and where questions (Yin 2009) that are hard to decipher by other methods. We selected the multiple comparative cases approach for this study, aiming to achieve better generalization. As the goal of the study was to identify individual variation but also to elicit and describe those aspects of the phenomenon that are common, eight diverse cases were selected for exploration. First, each case was analyzed separately, and then a cross-comparison of all cases was performed, as discussed by Ayres et al. (2003), using the Framework classifiers. The study applies a mixed-method approach to data collection, combining analysis of users’ digital footprints in social media platforms, personal interviews with key stakeholders and users, observations of ride arrangements, and reanalysis of available literature on the case studies. The Framework was used in an abductive fashion to guide the qualitative analysis (Timmermans and Tavory 2012), where its categories were used as initial themes, and emerging themes were either linked-to or set apart as variations of sub-categories. While there are some limitations to this data collection and analysis approach (to be discussed in Sect. “Research limitations and future directions”), it allows unintrusive, real-life, in-depth, and comparative exploration, which can also be carried retrospectively, from which we expect to draw generalization.

Case-based analysis

As Shoshany-Tavory et al. (2020) predict cultural, geographic, temporal, and technological variations of SORS initiatives, eight different cases were selected (Table 2). For cultural diversity, we selected SORS cases emerging in car-dependent societies (where congestion

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**Table 1**

| Theories | Structure |
|----------|-----------|
|          | Landscape |
| MLP      | Geo-transport layout |
| SPT      | Regime |
|          | Facilities |
|          | Local practices & culture |
| GI       | Niche (SORS) |
|          | Leadership |
|          | Phases and transitions |

Legend: MLP – Multi-Level-Perspective
GI – Grassroot Innovation
SPT - Social Practice Theory

![Fig. 1 Transition theories influencing the Framework’s construction](image-url)
Table 2 Selected SORS cases

| Code | Case name       | Country/culture                                 | Urban unit                          | Operation period | Technology reliance                        | Description                                                                 |
|------|-----------------|-------------------------------------------------|-------------------------------------|------------------|---------------------------------------------|-----------------------------------------------------------------------------|
| USA1 | Slugging        | USA/North Virginia-Washington DC; office workers | High density mega town              | Since late 70s   | Website, blogs, lately some Facebook groups | Casual carpooling from multiple locations, using HOV 3 + benefits          |
| USA2 | Casual carpool  | USA/San Francisco Bay area, CA; office workers  | High density mega town              | Since early 80s  | Website, blogs,                            | Casual carpooling from multiple locations, using HOV 3 + benefits          |
| USA3 | OnBoard Lawrence| USA/Lawrence, Kansas; Mixed users’ profile      | Medium density town, surrounded by small rural settlements | 2012–2015        | Test trial of an app at second phase        | Erasable boards used to indicate ride requests                              |
| CA1  | Car Stop        | Canada/Pender Island; Retiree                   | Low density island                  | Since 2008       | Website                                     | Assigned locations for thumbs-up request                                   |
| BRA1 | WhatsApp groups | Brazil/Rio de Janeiro; UFRJ students            | High density mega town              | Since 2014       | WhatsApp                                    | WhatsApp based ridesharing group to the university; expenses sometimes shared |
| BRA2 | Caronea         | Brazil/Rio de Janeiro; UFRJ students            | High density mega town              | Since 2016       | Students’ app                               | App for students ridesharing; expenses sometimes shared                   |
| IL1  | Ride-to-the-rail| Israel/Zichron-Ya’akov; office workers          | Medium density council              | Since 2017       | WhatsApp                                    | WhatsApp based ridesharing group to the rail station, using preferential parking 3 + benefits |
| IL2  | Shuttle         | Israel/Giv’at-Ada; mixed users’ profiles        | Small rural remote suburb           | Since 2014       | WhatsApp                                    | WhatsApp based ridesharing group of secluded settlement, replacing a canceled shuttle to rail station |
presented an issue) of four different countries (USA, Canada, Brazil, and Israel), with different traditions of hitchhiking and transportation governance. For geographical variability, we chose different urban and rural units, with service area ranging from large and densely populated (1500 + r/km²) cities with millions of residents (Washington DC and San Francisco in USA, and Rio de Janeiro in Brazil), through medium-density (~1000 + r/km²) rural towns with a few tens of thousands of residents (Zichron-Ya’akov in Israel and Lawrence in Kansas, USA), to rural/low-density (under 500r/km²) areas (Pender Island in Canada and Giv’at-Ada in Israel).

To represent temporal variability, we included old and new cases, with existence period ranging from 40-year-old initiatives, as the Washington DC slugging, to the recent four-year-old case of Zichron-Ya’akov. To avoid cluttering by less founded results, except for the Lawrence case, all selected cases persisted for more than a year and were active until the Covid-19 pandemic. Technology reliance varies between almost no technology in Pender Island to all technology (self-made app) in Caronea Brazil. Another inclusion criteria were data availability on the various stages of the initiative’s development (in electronic form or previous studies) and accessibility to interviewees to allow in-depth analysis. Aiming for variability, cases emerging in similar conditions were excluded. Table 2 provides typology and codes for each case, while the full description of each case is provided in Appendix A.

Data sources

Raw data on SORS and RS cases in general is hard to obtain, as the low-profile initiatives are hidden, especially during their initial stages. Therefore, after selecting our test cases, we designed a mixed data sources approach. The current digital era provides new data sources, encompassing social networks, forums, blogs, and other online platforms including Facebook, WhatsApp, and users’ forums—some of them publicly available and some requiring local knowledge. Such sources contain ride arrangement dialog but also other conversation threads reflecting perceptions and habits. These sources were preferred over the more customary survey methodology (e.g., Shaheen et al. 2016; Rafiq and Mitra 2020; Barbieri et al. 2021), as they provide data on otherwise-hidden social processes while being unintrusive, more reliable, and retrospectively accessible. They can thus reveal the evolution of users’ actions and perceptions, as well as their emotional reactions. Furthermore, as the electronic footprints remain until intentionally omitted, they also allow retrospective data collection and ex-post analysis. Analyzing such digital sources is gaining acceptance by multiple scholars for transportation and ridesharing exploration (e.g., Gal-Tzur et al. 2014; Li et al. 2019; Eskelinen and Venäläinen 2021). The ethical procedures were adapted to address privacy and anonymity concerns of such media.¹

However, as some of the explored cases had been explored before (USA1-3) and had limited coverage of electronic footprints, we supplemented our data with results previously obtained by other scholars. Although their SORS exploration did not follow a structured theoretical framework, they provided valuable insights on the performance and evolution of their case studies through time (e.g., Beroldo 1999 on USA2), social

¹ Ethic notes: Most of the electronic data used in the research appears in open public domain (e.g., message board in slug-lines web site). Where closed groups exchange was explored, consent of information owners (page and group managers) was acquired (e.g., BRA1 WhatsApp group). Personal details were omitted from the data during its processing, to conserve privacy, in line with university of Haifa approved ethical procedures 077/17.
processes (e.g., Mote and Whitestone 2011 on USA1), and users characteristics and motivations in the stable phase (e.g., Shaheen et al. 2016 on USA2). To complete our exploration, popular media stories were analyzed as well. As a complementary tool, for each initiative we conducted semi-structured interviews with users and activists, which allowed us to gain better insights into the explored cases. We have also performed several direct observations on the IL1 and USA2 cases. For eliciting contextual information, we used available reports and publications by official actors and NGOs.

Table 3 summarizes the various data sources, including: (a) group correspondence in social media; (b) twelve semi-structured interviews with users/activists; (c) direct observations; (d) research papers, books, dissertations; (e) technical reports; and (f) popular media stories. Sources a-c were collected and analyzed exclusively for the purpose of this study while sources d-f were used as secondary sources and reanalyzed. The interviews and unpublished or unsearchable data are marked in ‘[]’ brackets (Table 3 and in the following text). Aside from the interviews, for the more recent cases (IL1/2, BRA1), we used users current digital footprints almost exclusively. For the older and technology-less cases (USA1/2), where matchmaking occurs in the physical-space, we combined users’ digital footprints (e.g., blogs or Facebook groups) for recent history with the analysis of available publications for earlier history. Data collection for all active cases was carried-out until the beginning of 2020, and some limited data sampling of IL1, USA1/2 and CA1 cases continued through the Covid-19 pandemic period.
Data analysis

Data analysis of the various sources established success indicators, initiative and regime/landscape features and timeline evolution. To support cases selection, we had to establish success criteria. However, traditional measures of success (e.g., counting daily rides) are mostly inapplicable, specifically in technology-based SORS, as actual rides occur in multiple locations or arranged by private messages, and users’ alternative modality can only be indirectly inferred. Therefore, alternative measures had to be devised. As success indicators, we combined case persistence over time, users’ positive perceptions (through thematic exploration), positive recruitment vs defection rates (produced by statistical analysis) and estimates of matchmaking traffic. Where previous surveys were available (USA1/2, IL1, and CA1 cases), we used the exiting estimates and counts (e.g., Beroldo 1999 or Shaheen et al. 2016 for USA2) as additional measures of success.

From the mixed data sources, we reconstructed for each initiative the regime/landscape attributes. For contextual description we perform content analysis of documents and correspondence according to the Framework’s constructs. For example, we established exiting transportation deficiencies such as congestion and high parking prices through official authorities’ publications, prior studies, and users’ comments appearing in the digital platforms. For initiative characteristics and its users’ perceptions we analyzed discourse (both users’ forums and ride arrangement messages). Through content analysis, we established the types of communicative acts performed in the SORS group, including shape, dialect, conveyed meaning, and emerging conversation clusters. Norms were either established from this analysis or through existing sources (e.g., website-defined norms for USA1). Additionally, we explored the roles being carried by different users in the groups’ correspondence. We used the Framework’s categories to support the analysis (e.g., considering disruptors forces), while allowing the themes to emerge. For evolution examination, in the digitally-supported cases, we carried statistical meta-analysis on the tagged messages (e.g., message rate over time) and produced timeline analysis, to elicit distinct phases. Once distinct phases were established, we associated them with external events (e.g., new tolls or metro disruptions in USA2 creating disruptions). For older initiatives we further used prior accounts on phase transfer (e.g., LeBlanc 1999 for USA1), or analysis of newer replications (e.g., Facebook groups in USA1). For interviews’ exploration, we used content and thematic analysis. The interviews provided both validation of the results and better contextual understanding of hidden processes (e.g., goals driving the activists).

The results of each case were synthesized to reveal structure, phases, and evolution, as well as emerging patterns and causal relationship. Next, we conducted cross comparison of the cases via the Framework constructs to reveal repeated patterns and variations. Where our exploration revealed missing themes, we appended the Framework to accommodate such insights.

While the original Framework follow a flat table form, based on our findings and to provide more concise presentation we suggest a generic hierarchical architecture for capturing SORS. We synthesized the results into this common architecture by using the semantics of Object Process Methodology (OPM). OPM was designed for capturing knowledge and analyzing systems and is specified by ISO/PAS 19450. Such graphical presentation depicts the system components and subcomponents (i.e., objects, such as niche), the active processes (e.g., diffusion), components and processes association (e.g., emergence in), and components internal states (e.g., stable state).
Results

The next two sections present findings from the cross-comparison of the SORS cases through the Framework’s lens. To simplify the presentation, in the first section we examine and describe the integrative results at the stable operation phase (i.e., quasi-static state), highlighting the multilevel context. Following the Framework’s constructs, for each of the cases, manifestations are compared and emerging patterns are presented, of both the niche and its surroundings. In the second section, we capture the evolution of SORS through adding a dynamic layer to the generic hierarchical architecture and providing comparative findings of the cases’ dynamic processes.

Architecture of SORS

The SORS’s features are described through a components-association architectural view (Fig. 2), using the OPM semantics. The components and subcomponents are shown in Fig. 2 as rectangle shapes, while the association between the components is provided by a labeled connecting arrow. The arrows point at the direction of the labeled association. The top-level components include the Regime and landscape (denoted as 1); and the Initiative itself (denoted as 2). The initiative emerges within the regime and landscape, borrowing its context, habits, and resources. While other initiatives may emerge in the same regime bearing no relations to each other, the generic architecture shows the case where a niche expands by diffusion to create Sister initiatives (denoted as 3), borrowing some or all its features. This diffusion may occur in the same regime or a similar one. The Regime and landscape component encompasses the following sub-components: (1.1) Geographical-transportation layout that enables this emergence; (1.2) Local culture that influences the initiative structure; (1.3) recurring Practices typical to the contextual regime; and (1.4) relevant Authorities with whom the initiative interact. The Initiative component includes: (2.1) Incentives motivating the initiative; (2.2) Norms by
which it operates; (2.3) Activists and mediators who define it; and (2.4) Infrastructure that supports it.

Using these outlined components and subcomponents, in the following subsections we first highlight the Regime and Landscape and then their influence on the Initiative which emerged within this context. The classified findings for each case are summarized in Table 4 at the end of this section.

**Regime and landscape**

Following the outlined architecture, the geographical-transportation layout examination reveals that SORS emerges within similar contexts. All the explored cases were stimulated by some major recurring transportation problem, as follows: traffic congestion and parking shortage in USA1/2, parking unavailability and unsynchronized PT in IL1/2, and low QoS of PT or no-PT in BRA1/2, USA3 and CA1. Additionally, all the enduring cases share choke corridor or a chokepoint’ structure, along which meeting points can be set to enable efficient RS. USA1 and USA2 are defined by the few routes crossing a natural barrier (Potomac River and Bay bridge respectively); BRA1,2 serve the secluded campus on Fundão island; IL1/2 are connected via one road to the rail station; and CA1 island is connected to the mainland by a ferry. Only the abandoned USA3 stands-out as having no natural chokepoints, especially coming out. Accessibility is provided to these chokepoints and the defined meeting locations through walking (in IL1/2, BRA1/2, CA1) or by safe and available parking and accessible pickup locations (in USA1/2). Successful meeting places are supported by existing PT as backup, which mitigates low QoS or emergency returns.

Local culture of the regimes represents different countries, regions, and users’ groups. The study reveals that in general, rural communities (CA1 and IL2), younger, needy, and flexible students (BRA1/2), as well as cultures of lower personal distance (IL1/2, BRA1/2), are more prone to share rides. However, it was also found that urban, or semi-urban middle-class office-workers chose to share under the right conditions (USA1,2, IL1). The specific influence that local culture has on the initiative characteristics will be explored in Sect. “Contextual anchoring”.

When considering the local practices and their influence on SORS, existing or abandoned regime practices are found to bundle and interwind with the SORS practice, borrowing both meaning and competencies. The following practices are considered: (a) car-use; (b) hitchhiking; and (c) social-network use. As car-dependent regimes, car-use competencies allow for trip planning and parking searching. However, the meaning of car-ownership as a status-symbol or my-car-is-an-extension-of-my-home competes with RS, mainly in cases where vehicles are potentially affordable (all the cases aside from BRA1/2). One of the artifacts of this competition is that participants with stronger habit of car-use take the role of drivers, while riders are at least initially drawn from the PT riders crowd (e.g., USA1,2). In cases where prior vehicle withdrawal habit exists (e.g., train users of ISR1,2 who plan to leave their car at the rail station), no such competition is evident, and users tend to alternate between driver and rider roles.

The influence of Hitchhiking practice is more complex, multifaceted, and variable. On one hand, it offers an abandoned practice to borrow competencies, such as selecting meeting points or signaling (USA3, CA1). However, the associated meaning varies between countries-landscapes and age-groups, ranging from unlawful deviation (e.g., USA3), through free-riders (USA1/2), to hitchhiking reminiscence (IL1/2, CA1). In USA3, O’Brien and Dunning (2014) found generation specific responses: while baby boomers
| Case  | Regime and landscape                              | Local culture                          | Influencing practices | Authorities’ relations         | Initiative | Norms                                      | Activists / media tors | Infrastructure                                      |
|-------|-------------------------------------------------|----------------------------------------|-----------------------|-------------------------------|------------|-------------------------------------------|-------------------------|--------------------------------------------------|
| USA1  | Traffic congestion and parking shortage, choke corridor and points | Urban, middle class, office workers    | Car-use               | Acknowledged, partly supported | HOV 3+     | Meeting places, language, line functionality, queue order, in-car behavior, merci lines | Type 1                  | Self-made: website; Borrowed: HOV lanes, Park-and-ride, Mass transit, available parking; Arena: physical, community dialog supported by digital means |
| USA2  | Traffic congestion and parking shortage, choke corridor and points | Urban, middle class, office workers    | Car-use               | Acknowledged, supported       | HOV 3+     | Meeting places, language, line functionality, queue order, in-car behavior, bridge toll sharing, social ties in longer lines | Type 1                  | Self-made: website; Borrowed: HOV lanes, Park-and-ride, Mass transit, available parking; Arena: physical, community dialog supported by digital means |
| USA3  | Main hub                                        | Semi-Rural                             | Car-use, hitchhiking  | Exemption from anti-hitchhiking | Pre-set    |                                             | Type 2                  | Self-made: signs                                    |
| CA1   | Secluded, single point of entry, no mass transit| Rural, many retiree                    | Car-use, hitchhiking  | Supported                      | Solidarity | Pre-set: meeting places, gestures         | Type 2                  | Self-made: information poles at lift places        |
| BRA1  | PT low QoS, choke-points                        | Younger-needy-and-flexible, low personal distance | Hitchhiking, social-network | None                          | Expense sharing | Language, format, timing, allowed content, sharing life experience | Type 1                  | Self-made: cell phones + WhatsApp; Arena: digital |
| Case | Regime and landscape | Local culture | Influencing practices | Authorities’ relations | Initiative | Norms | Activists/mediators | Infrastructure |
|------|----------------------|---------------|-----------------------|-----------------------|------------|-------|---------------------|----------------|
| BRA2 | PT low QoS, chokepoints | Younger-needy-and-flexible, low personal distance | Practice diffusion from BRA1 | Supported | Expense sharing | Pre-set, use of comment field | Type2 | Self-made: cell phones + special app; Arena: digital |
| IL1  | PT low QoS, parking shortage, choke corridor | Semi-urban middle-class, low personal distance | Hitchhiking, car-use, social-network | Acknowledged only by municipality | 3 + parking, free return trips | Language, format, timing, allowed content, sharing transportation knowledge | Type1 | Self-made: cell phones + WhatsApp; Borrowed: preferential parking; Arena: digital |
| IL2  | PT low QoS, parking shortage, chokepoint | Rural, low personal distance | Hitchhiking, car-use, social-network | None | Following a canceled free shuttle | Language, format, timing, allowed content, sharing transportation knowledge | Type1 | Self-made: cell phones + WhatsApp; Arena: initial emergence in physical space, digital conduct |
fondly recalled hitchhiking in their youth, generation Xers, growing at the height of USA anti-hitchhiking campaigns, expressed wariness.

The last apparent practice influencing the all-digital BRA1 and IL1/2 is social-network use. The competencies of mastering group dialog, provided by the widespread WhatsApp use in Israel and Brazil (e.g., Culture Atlas, n.d.), as well as the collaborative meaning, are borrowed and used to support SORS. The same is observed in the recent SORS Facebook groups of USA1 (Saratoga Sluglines 2018). Associated with this bundled practice, is a change in privacy perception. While anonymity was one of the cornerstones of USA1 (LeBlanc 1999), the technological platforms expose some key personal data (profile or phone number), and their users seem to relax some of their privacy requirements for better connectivity.

As to regime authorities, multiple agencies are directly and indirectly interacting with SORS initiatives. These include transportation authorities, local municipalities, police authorities, and public transportation operators. They differ in their perception of RS and the policy tools they enact to effect it. Whereas experts view RS as an easy and efficient way to transport commuters, requiring modest infrastructure investments, using unharmed resource, and demanding little government involvement (Burris et al. 2012), different authorities had traditionally voiced conflicted attitudes towards SORS (National Academies of Sciences, Engineering, and Medicine 2012). While some have advocated RS through the policy tools explored in our literature review, others have seen high volume SORS initiatives as undermining their traditional responsibility as transport regulators, raising concerns of disruptions and disorder. For example, in late 80s, BART (local metro) experienced reduced service demand due to USA2 emergence, resulting in attempts to discourage the practice (Beroldo 1990). In more current examples, described in USA1 forums (LeBlanc, n.d.), some SORS lines report over-policing and clashes with residents over parking scarcity. Authorities’ concerns may also include lack of hard evidence of SORS/RS’s impact and policy tools’ performance. Thus, the invisibility of SORS raises effectiveness questions, specifically by transportation planners (IL1). Additionally, hitchhiking-like initiatives may be perceived as deviant, raising liability concerns (USA3). Lastly, the bundling together of expense-sharing RS with the disruptive ride-hailing, also hinders SORS acceptance.

These conflicting perceptions are reflected in policy decisions, such as anti-paid-ride laws (e.g., Brazil and Israel ban on expense-sharing RS until recently), or anti-hitchhiking laws (e.g., in USA3, CA1). It is also indicated by the decision to stay at arm’s-length where SORS becomes evident (e.g., behind-the-scenes sponsorship of USA1 slug-lines website). In some cases, even without hard evidence of its impact, the authorities are cooperating in response to civil engagement or to the phenomenon becoming well-known – providing that the additional investments are minimal. Thus, USA3 was granted exemption from anti-hitchhiking laws; CA1 local police exempted the “organized hitchhiking” and the local government sponsored materials for the Car-Stop project; Arlington County of USA1 posted direction signs at pickup locations; the UFRJ university allowed registration and access authentication via its Single-Sign-On (SSO) process; and the SF Metropolitan-Transportation-Commission embraces USA2 casual carpooling as a valid mobility option, and published (SF Metropolitan transportation commission 2019) and sponsored engagement activities in collaboration with BART and an RS platform provider (Martin et al. 2020).

Authorities usually expect some representative body to collaborate with—directly or through public hearing. However, such bodies are undefined in many of the SORS initiatives. For example, when IL1 feared preferential parking closure, members had to
roundaboutly approach their local politicians to contact rail authority, as they had no direct channel to the rail authority. Therefore, while many initiatives respond to policy tools (e.g., HOV + 3 or preferential parking), they tend to stay unassisted by official actors for extended periods. Although this situation is sometimes praised by participants, proud of the fact that the system exists and thrives without any official intervention (Spielberg and Shapiro 2000), it may undermine efforts to encourage RS, causing early cancelation or change of policy tools due to misperception and unawareness of their influence.

**Initiative**

Incentives are the prime drivers of the SORS cases. The more common ones are third-party provided, as users abstain from monetary friction and the associated disturbance of in-car power-balance. Thus, the well-known USA1/2 were driven by HOV3 + benefits and IL1 by 3+ priority parking offering. IL2 was motivated by the cancelation of free-shuttle service offered by the rail authority. Among the more mature crowds, CA1 stands-out as relying solely on small place solidarity, requiring no external incentive. On the other hand, BRA1 and BRA2 younger users are motivated by common concerns and sometimes by expense sharing, and their emergence is associated with technology availability. However, during the lifecycle of an initiative, the personal gain incentives may evolve from to include community gain, where reorganization, and repeated participation are considered. For example, IL1 offers free return trips.

Each initiative was found to develop specific norms for regulating its members’ behavior. These include: (1) ways of conduct—how participants behave; (2) exchange mechanism – what is being exchanged between driver and passengers and how; and (3) language—the specific jargon used by the participants. In USA1/2, ways of conduct include self-defined etiquette, line functionality, and in-car behavior rules, as well as best practices of parking search and public transport backup. The established ways of conduct of BRA1, IL11, and IL2, which use the same type of platform but are otherwise unrelated, include similar message format and timing, differing mainly in the allowed content. While IL1/2 allow only functional SORS or transportation-oriented discourse (e.g., rail status, traffic status), BRA1 group norms allow for university life (e.g., electricity outage status), personal safety (e.g., a lecturer was shot), and local know-how (e.g., where to fix an iPhone).

Safety concerns are also evident in the etiquette of USA1/2 which state, “no women should be left last” and “pass the ride if uncomfortable”. Participants also claim the 3+ requirement reduces the “stranger danger” barrier. Similarly, in USA3, recording license plate pre-embarkment was recommended, though abandoned soon. Other cases show no direct reference to the safety subject. This may be attributed to a sense of seclusion achieved by place attachment (CA1, IL1/2, BRA1), or the sense of security provided by the digital platforms, in the form of an identifiable cellular number (IL1/2, BRA1) or the SSO of BRA2.

Following the incentive findings, the main exchange mechanism used in most of the explored cases is non-monetary, third-party benefit trading. The long-term non-monetary exchange of USA2 was altered in 2010, when the introduction of a new Bay Bridge toll resulted in a modified arrangement, where passengers are expected to contribute a dollar towards the toll. However, exchange is not limited to what incentivizes the P2P ride itself, as some initiatives offer community added value. For example, group-solidarity exchange is shown in the incentive-less IL2/CA1 rides, the return home rides of IL1, and the “merci lines” of USA1. The latter serve riders who missed the HOV
opening hours when going home. Additionally, transportation knowledge is offered as part of the exchange in the Israeli cases and the newer USA1 Facebook groups. Moreover, while social interaction is not driving SORS, some groups socialize. Thus, for instance, the remote lines of USA2 developed social relationships, and BRA1 students are known to share online life experience and even off-line activities. These extra-value transactions evolve through the initiatives’ lifecycle to serve as group exchange mechanism, supporting the on-going participation.

As part of the emerging norms, a local language, including specific jargon, initiatives naming, and abbreviated meeting-places naming, are evident in all the explored cases, allowing for efficient dialog, as well as recognition of fellow collaborators. While the influence of hitchhiking practice is evident, all but the Brazilian cases chose rebranding—apparent by the choice of initiatives’ names that obscures these origins. However, the hitchhiking vocabulary and terminology are evident in IL1/2 and BRA1 discourse and the thumb-up symbol used in CA1 and USA3. Local context is also evident in the abbreviated names of meeting places, known only to locals. Additionally, in the digital cases, the dialog follows lean grammatical structure, e.g., BRA1 groups use specific wordings for ride request, and “ride full” messages, as well as specially crafted emojis.

Contrary to these evolving norms, USA3, BRA2, and CA1 norms were well defined from the start. In USA3 and CA1, norms address signage, best practice of how to select pick-up locations, where to stand, names of places, and code of etiquette. In BRA2, the app interface dictates participants’ workflow and dialog, allowing open discussion only among the final ride-partners. These optimized settings are the work of activists, who are a major component of grassroots innovation to which SORS may belong (Seyfang and Smith 2007). Activists usually form a small, dedicated working group, driven by sustainability vision, and communicate among themselves to define their niche and recruit participants. USA3 activism was led by O’Brien, CA1—by MAP association of several dozen volunteers, and BRA2—by a group of students, all driven by environmental concerns.

The other cases seem to develop organically within optimization seeking crowd, without an apparent activists-based structure. While being activists-less, specific individuals acted practically as mediators and played a vital role at certain times. In USA2, for instance, Kirshner attempted matchmaking platform ended up being used as a community arena; similarly, in USA1, optimization-driven Leblanc wrote a book recording the slugging phenomena and established the website serving for information dissemination and community blog; in BRA1, some obscure individual created the first group but every member holds management privileges; and in IL1, the manager, who targeted initially a handful of cohabitants sharing the same challenges, did not envision the scope of her creation and seldom practices her role.

While organic emergence of activist-less initiatives occurs given the right conditions, diffusion to other locations or friction with authorities may prove problematic, requiring some level of activism from its mediators. For example, in USA1, the construction of the Rosslyn line is attributed to a lady who actively replicated other lines by handing-out leaflets, setting a timeline, and urging her fellow riders to join (LeBlanc 1999); and in USA2, during metro service disruptions, Dan Kirshner and his environmentally conscious co-workers had shaped the return-home lines after more than a decade of incoming lines. However, the recent digital platforms allow for easier active participation, making any participant a potential couch activist, sending complaints, signing petitions, running surveys, or opening Facebook groups. Through the years, this type of low-scale, yet community-wide, activism resulted in meaningful accomplishments (such as the bridge-toll-agreement
to be discussed later). It also led to an elevated sense of ownership, shared among all participants.

As established by these observations, two patterns of SORS can be identified: participatory-initiatives and activist-based. The first pattern, which we denote as type1, emerges and evolves organically, without long-term agenda, and is driven by self-organized optimization seekers. Specific participants are self-appointed mediators, serving a significant role in sustaining these initiatives and enabling recruitment and diffusion. The second type, denoted as type2, is organized by an upfront group of activists, and follows their guiding vision and well-defined structure and norms. While its activists usually adhere to environmental messages, participants of type2 are driven mainly by time-optimization concerns and are less involved in the initiative evolution, nor develop a sense of ownership.

Regardless of its typology, each initiative uses some form of infrastructure, both physical and technological, which are either borrowed from the regime or self-made. The allocated HOV and preferential parking, designated for carpool, are used in USA1,2 and IL1. Other resources, such as local parking (at meeting points), stopping bays (for collecting passengers), and PT backup, are borrowed as well. In some cases (USA1,2, CA1, BRA2), the physical infrastructure was adapted by the local authorities (USA1,2), or by activists with some authorities’ sponsorship (CA1), to better support SORS by defining safe and comfortable pickup locations, and posting instructions signs.

In-line with the trend of digital sharing-economy, all SORS initiatives currently use some form of technological infrastructure for a variety of services, as follows: USA1,2 and CA1 use websites for information dissemination (e.g., pickup locations); USA1,2 users’ forums allow internal communication, as well as lost and found sections; BRA1 and IL1,2 WhatsApp groups and the recent USA1 Facebook groups are used for matchmaking, location negotiation, information dissemination, and extra value provision; BRA2 uses the self-developed app for matchmaking; and USA3 tested a matchmaking app by Carma Technology.

Another infrastructure component common to type1 cases (participatory-initiatives) is the arena, as a place where practitioners meet, shape their norms, re-organize, and learn. In USA1,2, for instance, the public areas adjacent to PT stations served as initiation arena, where potential collaborators met, negotiated, and observed others in action. The rising availability of digital platforms relocated some of its functionality to the virtual arena. For example, reorganization once a bridge toll was imposed occurred in the available users’ forums of USA2. In the more recent digital cases, the arena functionality was fully relocated to the virtual domain. The WhatsApp or Facebook arenas, superseded the physical arena, resulting in faster and higher exposure. These virtual arenas supported new line formation in USA1 (SlugLines Springfield Official Group 2018), and online norm definition in IL1 [Riders to the rail, 2020]. While also disseminating information digitally, type2 cases (activist-based initiatives CA1, USA3, and BRA2) lack notable users’ arena, confining self-organization to their circle of activists.

**Dynamic processes**

While the generic components’ architecture (Fig. 2) serves as a powerful tool for describing and aligning SORS initiatives, it lacks the ability to capture dynamic change processes. As SORS is highly susceptible to change, especially during its initial stages when it relies on rapidly achieving critical mass (Shoshany-Tavory et al. 2020), such extension is deemed necessary to understand these mechanisms. OPM
Transportation

offers the appropriate extending semantics in the form processes and objects’ states, where transition is achieved through processes which lead to state change. State-based analysis is envisioned to provide better reflection on the current situation of each component while considering alternative state transitions. Figure 3 identifies the top-level states of each of Fig. 2 components. States are depicted as rounded rectangles inside the respective component. Thus, for example, the regime needs to be in strained state (e.g., increased congestion) for successful SORS to emerge. It also outlines the processes (depicted in oval shapes between the components), that change the component’s state. For example, the process of recruitment alters the state of the Initiative from take-off into breakthrough.

The Framework-identified transition phases, namely: predevelopment—before emergence, take-off—once an initiative is created, breakthrough—when critical mass is achieved, and stabilization—when outcome is becoming sustainable, are translated in the suggested architecture (Fig. 3) into the corresponding states of the appropriate component. Thus, the top-level component Initiative include the states take-off, breakthrough, and stabilize, whereas predevelopment corresponds to Regime being at strained state. Additionally, the exploration identified the Initiative’s perturbed state, which was not originally included in the Framework. This state results from external forces causing some disruption. From that point, the initiative may return to stability or collapse and terminate, as typical to many RS initiatives.

The processes by which state transitions occur may implicate the road to sustainability and support recommendations for policy tools. Based on timeline analysis we identified the processes of: creation, when an initiative is created and takes-off; recruitment—initiating users into participating and required to support breakthrough; disruption, when temporary changes shift the initiative into perturbed state; and diffusion, when one initiative is replicated to form a “Sister Initiative”. Additionally, exploration reveals nudging process, where specific reminders keep users’ participation by gentle nudges, retaining stabilize state. These processes are elaborated next.

Fig. 3 Transitions processes and states of SORS
Creation

The **geographical-transportation layout** analysis established that the creation of all types of initiatives was pre-conditioned by some existing mobility problem in its immediate environment, causing the regime to be in the strained state. Strained conditions included congested highways (USA1/2), parking unavailability (IL1/2), or PT’s low QoS (BRA1/2, USA1, CA1). Successful initiatives emerge during some triggering event, synchronized with incentive offering. These events include sudden deterioration, such as PT strike or service cancelation (e.g., USA2 return lines, IL2 shuttle cancelation), traffic and PT renovation works (e.g., USA1 current Facebook groups), rising oil prices, and other significant disruptive events. Unlike gradual changes in driving conditions (e.g., growing congestion), disruptive events serve as “semi-disaster” triggers for road users, causing them to reconsider their mobility options. Creation can be also associated with sudden opportunities, such as the HOV becoming available or some initiation event (e.g., publicity campaigns of BRA2, USA3, IL1). Unlike gradual adjustments, sudden changes create instantaneous mass-concentration of solution seekers, accompanied by higher social cohesion, typical to time of crisis. To some extent, initiation events, which are common in type2 cases, seem to imitate this natural process. While the alignment of incentive offering and triggering events had been shown to support successful RS initiatives, type1 creation requires some local arena for emergence. The physical arena of the PT station of USA1/2, and the about-to-be-canceled shuttle bus of IL2, served this purpose. Open-access platforms, such as Facebook groups, can also serve as initiation arenas (IL1) to be later replaced by the more private and dedicated WhatsApp group.

Once created (the take-off state), type1 initiatives norms begin to evolve. The analysis of WhatsApp messages since the inception of IL1 [Riders to the rail, 2020] reveals that learning and setting of norms appear as a gradual process in which matchmaking dialog schemes are trialed by different users, and the fittest schemes survive in a follow-the-lead type of learning. While the matchmaking dialog is shaped, additional discourse norms are set, where the group rejects certain type of messages (e.g., residential protests), while allowing others (e.g., transportation related messages). Take-off lengthy and unoptimized dialog serves to establish an initial sense of community, defining the boundaries of “us” (the collaborators) versus “them” (all the others, including solution providers). Similar observations are made in USA1 (Saratoga Sluglines 2018) latest efforts.

While successful type2 initiatives are driven by some transportation problem, their creation and triggering event is the work of activists, who communicate, plan, shape norms, negotiate terms with authorities, and guide others in the proper way of participation. Thus, CA1 MAP association designed guidelines and posted them at meeting places, in liaison with local authorities; O’Brien of USA3 composed the guidelines, designed handheld boards for signaling destination, instructed the volunteers, and negotiated regulation adaptation; and the students’ coalition of BRA2 designed the app and negotiated SSO use. To set-of the initiatives, all type2 cases reported an initiating event, e.g., a publicity campaign in BRA2.

Recruitment

A fast-recruitment process is shown to be mandatory to achieve critical-mass, required to pass from the take-off to the break-through phase before initial collaborators will
despair and withdraw (e.g., in USA3). Recruitment process of users consists of becoming aware and overcoming barriers to active participation. In type1 cases, awareness was achieved through word-of-mouth or through direct exposure. In USA1, recruitment was conducted via word-of-mouth process—for example, Leblanc (LeBlanc 1999) noted commuting is considered one of the top conversation starters. Similarly, IL1 and BRA1 followed the digital equivalent through link-sharing via contact list (a feature of WhatsApp). Direct visual exposure also raises awareness, for example when USA1/2 participants observed others mounting their rides.

However, these processes are usually too slow to defeat initial defection associated with low QoS, especially of drivers. While the hub structure (either at source or destination) and the geographical chokepoints raise the odds of match-finding, potential participants are hesitant to gamble on unfavorable statistics when it comes to waiting (in-line or in-car) and maybe failing initially. Thus, recruitment through mass-concentration of potential users is usually associated with the earlier phases of successful cases. For example, IL1 breakthrough occurred when the link was shared among several local WhatsApp groups created for different purposes; IL2 initial recruitment occurred onboard the soon-to-be-canceled shuttle service; and USA1 reported recruitment among potential collaborators’ concentrations at PT stations. The onset of semi-disaster conditions, such as oil-crisis or PT temporal disruptions reported in USA1/2, also created an instantaneous higher demand and fast recruitment—both of drivers and riders.

Recruitment process needs to continue at least until minimal QoS is reached. USA2 publications suggest that at least 180 daily participants (of which 60 are drivers) are required to sustain a single line replication—as inferred from previous counts (Beroldo 1999; Shaheen et al. 2016). To jump-start a new line, Leblanc of USA1 [2018] claims at least 30 daily drivers are needed, for several weeks. Digital platforms seem to be more accommodating, as groups of 257 participants (the maximum number of WhatsApp group members) show sustainability (BRA1, IL2), and breakthrough had been observed to occur when total membership surpasses 80 (IL1).

Type2 initiatives usually target existing communities, recruiting through events, such as publicity campaign, during earth-day in USA3 or green campaign in BRA2. Additionally, recruitment was achieved through visual exposure, as drivers of CA1 or USA3 observed riders under signposts or carrying written placards.

Once road-users become aware of the initiative, to actively participate, efficacy needs to be achieved, including both the know-how and the perception-of. In well-established type1 cases, information is centrally disseminated through mediators’ websites (LeBlanc, n.d.) or official actors’ publications (SF Metropolitan transportation commission 2019), providing the necessary details. Perception of efficacy is found to be promoted by following others in action in the physical or virtual space, and potentially asking for guidance (e.g., new recruits of BRA1 in [Students of UFRJ 2019]). This is accomplished in the USA1/2 out-in-the-open arenas, and in the IL1/2 and BRA1 virtual arena. In Type2 initiatives, dissemination venues are design by activists (e.g., app design of BRA2), who provide further clarifications when needed.

Type1 participation continue evolving, even after the initial recruitment, into affective participation. Repeated collaboration results in users developing a sense of belonging, becoming ready to defend their initiative (e.g., protest potential cancelation of parking in IL1), or behaving altruistically towards fellow users (e.g., USA1 merci lines).
Nudging

Old habits die hard, and car-owners with strong drive-alone habit are quick to revert to their old ways, as shown for example during summer vacation (USA1, IL1). Consequently, RS requires repeated nudges when participation dwindles. For type1 initiatives, the main cues found to nudge users into staying with the group include repeated visual or digital exposure to successful collaboration. In digital schemes, further nudging is provided by the added-value messages, sent in the shared arena, such as the transportation alerts of IL1/2 [Giv’at-Ada habitants, 2017; Riders to the rail, 2020], or life experience messages in BRA1 [Students of UFRJ, 2019]. The effect of nudging is shown for example in IL1 or BRA1, where ride offers appear in clusters within 15 min of a reminder, in the form of offer/request or some added-value reminders. Nudging also influences commitment to the group, as shown by recruitment surges following successful adaptation, e.g., reorganization during rail closure in IL1 [Riders to the rail, 2020]. However, there is a fine line between nudging and spamming, as the latter might cause participants to leave. This is seen for example when the discourse strayed from its appropriate course in IL1 (ibid).

Disruption

Service disruptions or external events may cause the initiative to move to perturbed state, inducing defection and even its termination. Such is the case where service disruptions, due to platform instability, led to sub-critical participation in BRA2. However, some type1 initiatives show resilience to disruptions by adapting to the changing circumstances. In the case of USA1, for instance, economy crisis and higher gas prices of 2008 created unmet demand, resulting in norms adaptation, which allowed an extra passenger, over the 3+ required for HOV, once the waiting line became too long (Oliphant 2008). Another example is USA2, where the introduction of a bridge toll in 2010 disrupted the otherwise non-monetary exchange. It triggered a heated and lengthy discussion on the message-board arena, where undercurrents emerged among the users (Kirchner, n.d.), such as: is the driver doing a favor while picking a rider? will monetary exchange change the in-car power balance limiting the control of the driver? and, how essential is the for-free arrangement for the existence of casual carpool? These dilemmas presented an exception in the otherwise positive dialog. The debate led to the formation of new norms, where riders were advised to contribute one dollar towards the toll, becoming the de-facto standard (though 10% participation reduction was later observed). Similarly, in IL1, the 2017 rail closure for renovations undermined the group’s goal. The group responded by adapting its offering to long-distance trips, with shared expenses implied, returning to normal course with vigor once service was reestablished [Riders to the rail 2020].

These type1 examples seem to rely on the noted sense of community among its members, as well as the existence of an arena where reorganization can occur. Thus, when the disruption carries temporary crisis meaning, type1 initiatives can persist and adapt. However, this collective response depends on disruption interpretation. For example, temporary defection was observed in IL1 when the preferential parking had become dysfunctional after the enforcing guard was reassigned to other duties. This removal of policy tool was interpreted as initiative closure, regardless of its growing benefits.

Disruptions in type2 cases are harder to deflect. For example, the service disruptions of BRA2 deflated the initial surge of 75 daily rides (achieved within 2 months) to a small
handful after 5 months. In this case, even repeated recruitment campaigns failed to regain the lost momentum, and users reverted to their functioning BRA1 solution.

**Diffusion**

*Diffusion*, through which one initiative is replicated to one or more sister initiatives, is crucial if SORS is to be considered a meaningful transportation mode by policy makers, and not just some local anecdotal phenomenon. By size criterion, even the well-established North Berkeley USA2 line (220 daily rides, Shaheen et al. 2016) would have been considered marginal without the diffusion of practice and norms into multiple lines, serving 6,000 riders a day in the area. Similar diffusion was revealed in the following initiatives: BRA1 multiple groups, also in Telegram and Facebook, which can be considered as sister initiatives, serving the students’ communities of different neighborhoods of the city; BRA2, which is BRA1 direct offspring, inheriting both crowd and practices; CA1, which diffused its practices to multiple neighboring islands, such as the Bowen Lift initiative (Bowen LIFT, n.d.); IL1, which diffused to a local general-purpose RS group, created by an IL1 member and using the same users’ base and norms; and IL2, which diffused from the canceled shuttle service serving the same crowd.

However, on multiple occasions, diffusion, even in similar contexts, was proven difficult. The following examples had been noted: (1) local authorities failed an attempt to jump-start Alexandria VA line, despite using best practices provided by an expert (Salzman 2013); (2) USA3 and its inspired Haliburton County initiative (Johnston 2017) were soon canceled; and (3) even the successful IL1 was not replicated by similar local councils, and the single attempt to create a separate group for a specific neighborhood failed.

**Discussion**

Using the conceptual Framework to systematically analyze eight diverse case studies allows us to portray SORS as a repeated phenomenon, where recurring patterns emerge. The examination of the multi-level niche-regime-landscape structure and evolution processes provides better understanding of the phenomenon within its context than previous studies. While the details may vary, the comparative classification, using the different analysis units, complements the existing user-centric case studies (e.g., Burris et al. 2012; Shaheen et al. 2016) and allow us to gain wider perspective on SORS. By highlighting both the recurring success contributors and the different locational interpretations, through our comparative analysis we suggest that SORS potential can be estimated in advance, externally influenced, and replicated beyond its current localized context. Thus, SORS/RS promotion policies may be offered to improve solutions to mid-short distance commuting in variable conditions, and for difficult to attract crowds. Such policies can complement the sustainable-transportation toolbox and consequently increase RS uptake in areas that meet SORS-based criteria.

Our discussion is structured as follows: first we rationalize about SORS relative success in short-mid range commuting; second, we outline the emerging patterns; and third, we use these patterns to examine diffusion and scaling failures. Next, we suggest operational and technological interventions to increase SORS uptake and RS effectiveness, to be used by policymakers and technology designers. Finally, we elaborate on RS as part of the sustainable transportation toolbox and its future in the post-pandemic era. To complete the
discussion, we reflect on the role of the Framework in enabling SORS understanding, as well as research limitation and future directions.

**SORTS for short-mid range commuting**

Our literature review indicated limited success of commercial RS applications for the shorter commuting trips. Additionally, on several of the explored cases, a commercial app was rejected by SORS users in favor of their “own” solution (e.g., IL1, BRA1). While our research did not attempt to systematically explore RS apps, we may offer deliberation on these findings, by using acting forces attributes of the Framework, and specifically, transaction-costs and QoS.

Where commercial apps may provide effective matching, their use is associated with various cost-incurring activities, such as creating a profile, listing a ride, reserving a seat, negotiating terms and meeting places, riding together, monetary exchange, conversing, and rating peers (Guyader 2018). However, while these costs are acceptable for longer-distance travel, relatively higher transaction-costs are associated with shorter distance RS for the following reasons. First, it is performed by strangers destined to meet in person and share a limited space for a limited time. While pre-planned longer-distance RS allows for more planning time and partners screening, as well as more in-car interaction time to improve socialization, short just-in-time commuting rides allow neither. Second, shorter trips are less expensive, thus expense-sharing schemes value, which is the prime motivator of commercial-app use, is negligible compared to the overall direct and indirect costs. Consequently, drivers of short-mid distance trips are mainly driven by time saving motivations and their flexibility is lowered compared to longer trips, making detours costly and less acceptable. This in turn reduces the number of potential collaborators and the initiative QoS through lack of critical mass and reduces the service effectiveness for this range.

Our findings suggest that both the structure and perceptions of SORS initiatives serve to effectively compensate these gaps by lowering transaction-costs to an agreeable level and mitigating periods of low QoS. The easier-to-use locally adapted solutions reduces the relative transaction-costs, while low QoS is being offset by harnessing a true sense of mutuality (Guyader, 2018). The following discussion explores the compensation mechanisms offered by the emerging SORS patterns and their context dependencies, in the initiative’s stable state and during its lifecycle.

**Emerging patterns**

The comparative analysis of the evolution processes of different SORS cases revealed several main recurring patterns of significant similarity that allow SORS emergence, as well as provide the abovementioned compensation mechanisms. Each pattern serves a role in making SORS an applicable solution for short-distance commuting. These patterns, which are further discussed in the following sub-sections, include social dynamics and types of supporting organizations, SORS enabling preconditions, “line” structure, technology role, diffusion vectors, and contextual anchoring.

**Social and organizational dynamics**

While commuters outside the kin and family circle seldom rideshare for social or environmental motivations, social processes have been shown to dictate SORS style and its...
evolution, as exhibited in the explored cases. Similar observation was made by Mote and Whitestone (2011) for USA1. From transaction-costs perspective, the emerging communal-like collaborative-consumption of SORS, eliminates several of the activities associated with commercial RS, where participants follow consumerist or opportunistic sharing styles (Guyader 2018). Specifically, the need for P2P app-based trust mechanisms was replaced by relying on mutual commitment to the emerging community, thus P2P trust is delegated to community trust. Such emerging community of practice along with its associated Sense-of-Community (SOC) (McMillan and Chavis 1986; Blanchard and Markus 2004) are introduced by the evolutionary process of the multi-level interacting units. We claim that repeated, social-like sharing within well-defined enclaves (i.e., line structure), results in defining the boundaries of “us” versus “them”, using common symbols and trust among peers to fulfill their needs—which are the essential signs of SOC. These dynamics occur in specific spaces. While type2 activists are internally driven and create their own collaboration spaces, type1 initiatives need a common arena, where large crowds can meet. Where once the public space adjacent to PT stations provided a physical arena for self-organization, such as the cases of USA1/2, the faster pace of mobility drives similar self-organization efforts into virtual spaces.

As to organizational dynamics, the niche-level may comprise both types of SORS: the participatory style (type1) and the activists-driven (type2). They operate within the regime and landscape level which encompass existing communities, from which SOC and participation may be drawn and practices borrowed. The regime also lends its supportive infrastructure and incentive opportunities. Unknowingly, the regime interacts with the SORS-niche, as the existing friction stimulate SORS, and offerings of external actors provide incentives and solutions to tap into. For example, USA1 may be seen as the product of congestion and oil prices (i.e., friction) while subverting the official actors’ intentions in applying HOV + 3 rules (Mote and Whitestone 2011).

**Emergence preconditions**

Study findings indicate that successful SORS develops only where favorable transportation network structure is combined with depletion of some transportation-related resources (e.g., parking sparseness, limited road space, low QoS of PT). The latter may be viewed as frictions of the regime, known to produce niche emergence. Additionally, it was observed that gradual changes only cause minor drive-alone habits’ adaptation, whereas sudden semi-crisis events (e.g., PT disruptions, rising gas prices, construction works) promote SORS best – driving road users to search for alternative solutions. Similar triggering event that elevates willingness for mode change is noted after residential relocation (Zarabi et al. 2019). These conditions create an instantaneous critical mass of potential collaborators, overcoming the stranger-danger and the QoS barriers. To tip the transaction-costs equation for the short commuting distance and the more mature crowds, third-party incentives are needed where monetary incentives show less effectiveness. These incentives reduce the associated costs of negotiating exchange and payment. Moreover, they retain the driver’s status as ride-owner and eliminate in-car stress associated with monetary awkwardness (Deakin et al. 2010). While type1 initiatives directly respond to these preconditions, type2 activists may attempt emergence with partial or no supporting conditions. These attempts tend to fail (e.g., USA3 or the Haliburton initiative), as only environmentally-committed participants join, and critical mass is unachievable.
Line structure

SORS is shown to operate efficiently when shaped into fixed lines, as noted before in ridesharing (Handke and Jonuschat 2013). Such fixed route structure may comprise of several meeting points, where limited detours are acceptable. While some of the explored cases can be defined as one line (e.g., IL1), larger scale SORS cases (e.g., USA2, BRA1) consist of many small, replicated lines that evolved to become their own alternative solution. This shape, along accommodating chokepoints or bottlenecks structures, serves short- mid-distance commuting best by providing compensating mechanisms to the higher transaction-costs. Emergence is also associated with accessibility to a concentration of participants is provided (either their origins or accessible chokepoints), thus providing better QoS and consequently improved matchmaking odds. While the such structure establishes a large-enough users’ base, it still retains localized familiarity. As a result, norms can be contextually adapted to reduce the associated transaction-costs by simplifying the ride arrangements negotiating, as recurring crowds use familiar landmarks, local facilities, and known exchange mechanisms. Additionally, line structure supports generation of SOC between recurring collaborators who meet physically or virtually. Thus, strangers become part of a community and repeated rides are more likely to occur, reducing the overall ridesharing related stress and allowing the exchange of social goods. Commercial apps lack the same structure and benefits, and the standard interface provides no similar compensations, thus their limited success in those distances is understandable.

The role of technology

Both types of SORS and all active cases are facilitated to some degree by technology advances. These innovations have created new alternatives for sharing, for both communal and utilitarian purposes, simplifying the process compared to pre-accessible internet age (Belk 2014). Technology had been shown here to support multiple goals such as information dissemination and matchmaking, but also to serve as the arena where self-organization can occur. This includes recruitment, norms building, and reorganization, as well as extra-value exchange, nudges, and messages of community-at-work. Compared to mainstream sharing-economy RS apps, most of the explored cases use low-entry, easy-to-use technology solutions commonly practiced in their context. These ready-made available tools can be easily adapted by mediators with no technological background and limited time to invest. Such are the available social-network platforms (WhatsApp, Facebook, Telegram), or the self-made websites. In the sole case of BRA2, the skilled engineering students-activists opted for offering an app-based solution drawing upon BRA1 structure of service areas. The rise and fall of this app-supported initiative, compared to the ongoing BRA1 traffic, can be attributed to high transaction-costs induced by low QoS, and no compensation mechanisms due to absence of technology support for social mechanisms.

Several participants’ groups could have potentially enjoyed the services of commercial apps (e.g., Moovit and WazeCarpool in IL1/2), but refrained from their use. The given reasoning stated security-supporting registration and reputation-ranking processes as “complex”. These were replaced in SORS by the less strenuous requirements, where participants rely on strangers known mainly by cellular number or available Facebook
profile. They may perceive their peers as safe since they belong to the same limited-purpose group, were recruited in the same way, and have the arena as a dispute-handling (or shaming) platform – all supported by their low-entry technology choice.

Contextual anchoring

Adaptation to the context is a key determinant of SORS success. The addition of the regime/landscape view in our holistic multi-level approach, allows understanding of the contextual anchoring, the recurring patterns, and the differentiating attributes. First, it highlights structural considerations—lines are self-organized to optimize the context geographic-transportation layout. Using local knowledge of the area, its services, and its constraints, experienced road-users select optimized routes and meeting locations for recurring engagements. While seemingly tacit, Hansen et al. (2010) had shown that such knowledge can be harvested through public engagement. Second, local practices influence SORS. Technology choice is derived from the local orientation—WhatsApp serves the IL cases while Facebook serves the USA1 case and the Finnish example (Eskelinen and Venäläinen 2021), but some tech-savvy crowds would opt for apps. Additionally, hitchhiking practices are integrated into the SORS practice, where appropriate, providing the needed competencies, mind-frame, and vocabulary. Third, the local culture (specific to country and users’ group) and travel distance dictate what is an acceptable exchange and how far can familiarity go in reducing stress-related anxieties. Lastly, as our recruitment analysis shows, the amount of “energy” required to jump-start and maintain SORS is contextually dependent on the ability to produce affective participation. It comes at different shades, even among replications of the same initiative: longer lines of USA2 developed social ties and offer longer detours on rainy days; semi-rural IL1 developed return trips; BRA1 participants are rumored to enjoy great parties; while shorter lines, such as Berkeley North of USA2, stay business-like but committed. Therefore, though participants seldom report social motivation as driving their recruitment, our observations associate the process with existing and emerging SOC. The amount of observed SOC is contextually dependent. Some SORS cases own preexisting high SOC (e.g., small and rural CA1), but in general prior SOC level is found to be defined by cultural traits, traveled distance, urban density, age, and economic state. Thus, for example, USA2 North Berkeley line and BRA1 reside in dense urban structures and serve short travel distances. Yet, BRA1 rises within younger and needy crowds, sharing culture of low physical distances and preexisting SOC of homogeneous student community, therefore easier to create and follow faster recruitment, without any official intervention. With repeated collaboration, some cases, specifically of type1, show emerging SOC—achieving higher levels of community engagement.

Existing and emerging SOC compensate for periods of low QoS, and support initiatives resiliency thus increasing the chances of SORS prevalence over time. For example, BRA2’s initial SOC resembles BRA1’s SOC, which explains its initial high recruitment. However, being of type2, BRA2 did not develop further, and its SOC was unable to compensate for app malfunctioning which introduced low QoS. Using SOC level as one of the explaining attributes we can predict that students’ communities will always be ready to participate, while mature crowds will need external triggers and build-up process to be activated. Similarly, the determinants cultural traits, traveled distance, urban density, age, and economic state can be estimated in advance to predict users-groups’ willingness to participate, engage in altruist behavior, and provide transportation and social value to their peers.
Diffusion and scaling vectors

To explore diffusion, we first need to address diffusion failure. The internet is filled with the remains of failed ridesharing initiatives and the research literature mentions application that no longer operate, for reasons which are difficult to explore for lack of substantial data. However, in our findings, on several occasions, failed diffusion and scaling is revealed, even in similar contexts. Using the adapted Framework constructs (Table B) we can explain these occurrences: (1) the failure to replicate USA1 line to Alexandria VA, may be attributed to unfavorable geographic landscape in the form of missing separated HOV lanes; (2) USA3 and Haliburton cancelation due to running costs and low uptake, may be contributed to lack of regime strains and geographical opportunities required for phase shift. While the involved activists were passionate about their mission, no true transportation deficiency exists for car-owners, and no supportive infrastructure (e.g., chokepoints structure); and (3) the failed diffusion of IL1 to similar local councils, can be attributed to missing arena for self-organization and insufficient critical mass.

The accumulated insights can assist in defining successful diffusion vectors, which may elevate SORS from an anecdotal solution to a substantial mode. First, replication may naturally occur, within similar regime, landscape and triggering conditions, empowering the same users’ base to join a new line with similar norms. Conversely, the original lines of USA1/2 followed such diffusion vector. Second, controlled diffusion may be achieved by employing practitioners or mediators who become short-term activists, using their accumulated experience to replicate the initiative to nearby locations, targeting similar crowds and adapting the norms to the new context. Some lines of USA1 and IL1 offspring follow such pattern. The third replication method is through knowledge sharing by media (academic or popular) publications, or through official or informal organizations. Such a diffusion pattern was shown to succeed only when engaging activists and mediators in similar landscapes and recurring emergence conditions. Therefore, successful diffusion needs to incorporate not only knowledge, meaning, and specific context understanding, but also replicate SORS evolution processes. To extend the limited scope of the first and second diffusion patterns, the more general policy-assisted pattern needs to be improved. By better documenting and understanding of SORS evolution phases and mechanisms since creation, we expect to overcome the diffusion hurdles and achieve efficient contextual tailoring. As a result, official organization may replicate and stimulate SORS processes to produce better RS initiatives.

Policy and technology implications

Exploration of the authorities’ relations revealed that even when regime actors aim at sustainability, they are locked-in by their self-perception as service/solutions providers and consequently fail to grasp SORS as a valid alternative, until it becomes a widespread phenomenon. However, while SORS may appear on its own accord, creating value for its participants and for the system at large, the analysis suggests that regime actors can play an important and proactive role in its emergence, sustainability, and diffusion. Therefore, these actors should actively pursue SORS-like emergence through adapting existing RS-oriented policies and adding new targeted ones. Such interventions ought to focus on lessons learned from the earlier stages of SORS and the specific users’ group that needs activation.
The revised RS supporting tools should encompass situation assessment, adapted incentives, supportive facilities, and monitoring. First, using the “chokepoints” and “lines” logic, assessment can be made of the current transportation situation and the local geography characteristics. Based on this assessment, the viability of line alternatives can be evaluated, analyzing existing enclave-shaped demand concentration, potential meeting points, and existing supporting services (e.g., parking, PT at meeting points). The assessment should also consider the potential target-group attributes: age, cultural traits, commuting habits, and existing communal enclaves that can be harnessed. If an accessible community exists, it can be approached to provide recommendations for routes and meeting points, using their tacit knowledge, and ensuring early public engagement through which SOC can be established. Such assessment can predict where and when to promote RS and align it with upcoming strains. Second, an adapted incentive plan for short-mid range commuting can be developed. Our exploration indicates that direct P2P monetary incentives in the form of expense-sharing, which have been shown elsewhere to positively influence long-distance travelling (e.g., Finger et al. 2017), are less effective for commuting range, activating mainly younger and needy crowds (e.g., BRA1/2). More mature audiences respond positively to indirect and more comfort-based incentives, such as 3+HOV or 3+designated parking. These incentives reduce monetary eversion (Deakin et al. 2010) and potential in-car strains (Zmud and Rojo 2013), and improve the utilization of resources. The 3+ requirement presents a better opportunity for self-organization outside kin circle, and this in turn overlays the sharing with social meaning that is found to better influence sustainable decisions (Riggs 2017). In rare cases (e.g., CA1), the mere existence of small-place solidarity is enough to incentivize RS and only minimal nudging is required. These insights should be considered when developing the incentive plan and personalizing the incentives according to the specific target group.

Supporting facilities can then be envisioned, including an arena for reorganization, complementary information regarding transportation options, and minor adaptations to the infrastructure. An initiation arena can be externally provided, such as in IL1 case, where an existing Facebook group envisioned to support matchmaking was used inadvertently as an initial arena. The provided information should include the offered incentives, the suggested (or operating) lines, and potential pickup locations. However, complementary information needs to address services, such as available parking and PT backup, or other available shared modes. Additionally, initiation campaigns are advised, where messages are tailored to the targeted group. These efforts should be synchronized with the incentives offering, but also with some forecasted local transportation crisis. Finally, where lines become operatives, adaptation of meeting points, such as posting signs or relocation to safer corners, should be considered.

However, this is not a one-time effort. Authorities are advised to actively monitor the livelihood of these initiative, identify potential mediators, provide more supportive information, and update policy tools where needed. This can be accomplished directly or by semi-official interfaces (e.g., through NGOs or mediators). Monitoring the impacts of such efforts on potential infrastructure conflict-areas (such as residential parking), and establishing communication channels with mediators, can be used for restructuring and identifying integration opportunities. Such an active role reduces RS deviancy perception while mitigating official actors’ liability concerns. Through monitoring the RS activity, official actors can ensure its sustainability—for example by removing local hurdles to specific threatened lines. Effective monitoring further allows tailoring to the local context and deriving insights leading to more effective replications.
The integrated approach embraces self-organization and offers a set of low-cost adaptations of policies. This optimization of the existing RS toolbox may support SORS, but also RS in general. Specifically, value-for-money decisions can be made in advance and intervention test-trials may have better success rates. However, care should be exercised when removing policy tools, such as changing HOV to toll lanes, which might lead to loss of value, signal lack of appreciation of the initiative, and hinder the communal spirit. These might consequently result in the initiative’s termination.

Technology implications can also be derived from our analysis. SORS and RS can be assisted by technology for elevating ride-matching odds, while maintaining low transaction-costs. As no one needs to wait-out, and transaction is evaluated in advance, this value can be immediately achieved. Thus, more grace period is provided for the digital initiatives to stabilize. However, developed applications should adapt their provision to our study findings, supporting the outlined structures and processes for the short-mid distance range. First, the offering should be arranged according to the same “lines” logic to support efficient structure for short- and mid-distance commuting. Second, at least for the initial phases, the design should provide a virtual arena, where participants can negotiate norms. Third, applications should offer integration with ridesharing-enabling options – providing information concerning potential meeting points, parking options at these locations, and available PT backup. Additionally, users should be allowed to contribute their local knowledge and technology should facilitate its delivery. Once critical mass is achieved and the initiative reaches stabilization, social content and interactions can be more regulated, matching the target group SOC. However, these tools should be maintained (for example in the form of users-forum) to allow reorganization when needed.

It is also advisable to consider the current state-of-art technology choice of the local context, at least for the initial stage. For example, while Facebook is superior in its searchable property, allowing faster and wider exposure and recruitment, some crowds are weary of its use, preferring less spam-infested and more just-in-time platforms, such as WhatsApp.

Framework’s value assessment

Our study demonstrated the descriptive power of the Framework and its value for systematic comparison of different cases, exposing context and temporal dependencies that were previously hidden. The cross-cultural evaluation of the Framework proposed by Shoshany-Tavory et al. (2020) allowed us to identify several minor adjustments needed for increasing its sensitivity and comprehensiveness and improving its performance (see Appendix B for details). These adjustments were incorporated into the Framework used for analyzing the selected case studies. First, we structured the constructs of the Framework hierarchically to allow for the identification of relations between constructs; second, we added the perturbed state, caused by the disruption process, from which an initiative can either return to stability or fade, as many SORS and RS cases do; third, we identified the processes which produce states’ change; fourth, we highlighted the role of mediators and the importance of an arena for reorganization, specifically in type1 cases; and fifth, we added SOC as a sub-category to the Context and environment constructs of the adjusted Framework. Hence, this version of the Framework should be applied in future SORS exploration.
Ridesharing future

The current vision of transportation planners regards PT and Mobility-as-a-Service as the future of sustainability. However, if private ownership of vehicles and drive-alone habits persist, RS should be perceived as a valid complementary solution to reduce the explored negative externalities, specifically in challenging locations. However, RS commercial services are not successful as expected, and SORS cases are shown to provide limited diffusion. We assert that using the policy and technology recommendations offered in Sect. 5.4 may not only encourage SORS and its diffusion, but also ease the hurdles faced by commercial RS services. Applying those so called “carrots” in parallel to upcoming “sticks” may improve the uptake of RS.

The unprecedented challenge posed by the post pandemic era, was revealed in our continuous observations to halt sharing, but affect revival of cases differently. Unlike previous transportation semi-disasters (rising oil prices, PT strikes), which resulted in higher sharing, the current shared-mobility fears (Barbieri et al. 2021) grasp even the most dedicated communities, reducing RS to nil. However, as of early summer of 2021, some revival of SORS had been shown—for example, CA1 reports almost back to normal, providing participants use face masks, and USA1 message boards in Facebook indicate people are willing to start sharing again, as traffic/parking situation is back to normal. However, once again authorities hesitate to actively nudge SORS. For example, in USA2, the MTC had posted safe carpooling instructions to be used “whenever you’re ready to carpool”, advising to use caution and stay with consistent carpool partners. Regrettfully, we believe that without an arena for reorganization and in cases where mediators terminated their support (e.g., USA1/2), SORS will be slow to revive. Unlike PT, where service can be instantaneously restored, SORS may need jump-starting assistance, while recovering from this disruption. Thus, policymakers should consider taking a more active role and providing adaptations to reinstate initiatives once safety is retained.

In the long-term future, low-occupancy rate may continue being a city-wide issue. While some scholars envision autonomous vehicles (AV) to reduce car ownership, alter travel behavior towards ridesharing, and consequently improve the transportation network performance (Etzioni et al. 2021), others (e.g., Lavieri et al. 2017) predict that some user’s groups, such as older, suburban, and rural individuals, will remain entrenched in their ownership patterns. Unlike riding together in third-party owned vehicles which may resemble the current ride-hailing habits, encouraging ridesharing in privately owned AVs, for these users’ groups, may require interventions and SORS-like stimulations similar to our presented work. Finally, digital platforms present an integration opportunity of SORS and commercial RS into Mobility-as-a-Service. In this vision, network-level service may be envisioned, where RS “lines” can be linked into multi-hop routes, similarly to the PT system, trading trust across the different lines’ groups. These multiple fixed-route RS lines can exchange information and integrate with other sustainable travelling modes.

Research limitations and future directions

Studying a complex phenomenon, which is hidden and often performed by private individuals and groups, presents a research challenge, both for selecting cases and data sources. Data availability also dictates different source types for each case. Consequently, the information base might be misrepresenting or biased. To increase study’s validity, we opted for
multiple cases, using qualitative exploration, and combining information extracted from
digital footprints, personal interviews, and earlier explorations of some of the selected
cases.

As to cases’ selection, we attempted to represent longitudinal variability, as explored in
the methodology section. However, data availability was a key concern limiting our acces-
sibility to additional cases and leading to somewhat comfort sampling. Similarly, bias may
be introduced through our selection of persistent cases (except for USA3), where data was
available, limiting our ability to reflect on failed attempts. To mitigate this concern, we
highlight several failed replications in the vicinity of the explored cases.

The interviews’ role was supplementary, hence we performed only a small number (12)
of interviews, until saturation was reached. Specifically, for additional information on pre-
viously studied cases, we interviewed only key stakeholders (activists or mediators) and
appended our data with documented interviews and surveys. Another common exploration
challenge is estimating RS and SORS impact (i.e., success). Counting the actual rides is
almost impossible, and users’ alternative modality can only be indirectly inferred. Thus,
we combined existing impact assessments (e.g., surveys performed by other scholars) with
meta-analysis of electronic footprints. Specifically, users’ perceptions, elicited through
content analysis and interviews, were combined with estimates of recruitment/defection
ratio and online traffic rate. Through these indicators, success of seven of the selected cases
was established. Assessing the participants socio-demographic parameters is also challeng-
ing, since many cases use platforms that do not support users’ profiles. Here again we had
to rely on platform-available profiles, interviewees accounts, and previous studies. While
these research deficiencies may limit the generality of our findings, the emerging patterns
were consistently repeated. Therefore, we believe generalization was achieved.

Future research should attempt to tackle these challenges by exploring more cases, from
other countries, and providing more detailed accounts of specific cases, both of success-
ful and failed diffusion efforts. An addition to the knowledge body can be achieved by
performing controlled action-based research, where the study recommendations are imple-
mented. In this controlled setting, survey methods can be used to quantify the driving fac-
tors and their impacts.

Additional venues to pursue may include: (a) comparing SORS cases to commercial
ridesharing initiatives and analyzing how these diverse forms of ridesharing coexist and
what contextual factors influence their relative success and acceptance; (b) as ownership
may remain a pervasive issue in the AV future (Mohammadzadeh 2021), future research
should address not only personal choice (e.g., Etzioni et al. 2021), but also the context-
ual situation, similarly to our study; and (c) the cooperation driving SORS can be further
investigated through Game theory and behavioral economics (Klein and Ben-Elia 2016).
Finally, the post pandemic period presents an opportunity to explore re-initiation of differ-
ent initiatives which were shut down and need to be revived.

Appendix A: Outline of the selected initiatives

To familiarize the reader with the selected initiatives, a brief description of each SORS
case is presented. It should be noted that the better-known cases, where abundant literature
exists, are only briefly presented, while highlighting the digital manifestations which had
not been explored before.
Slugging, Washington DC (USA1)

USA1, known as “slugging” or casual carpooling, is the largest and oldest SORS at Washington DC. It exists since the I395/I95 HOV from North Virginia into town was opened for carpools of 3+ in the mid-70s (LeBlanc 1999; Oliphant 2008; Burris et al. 2012; Zmud and Rojo 2013). In locations known to sluggers, passengers wait in line to be picked-up by passing drivers, following self-generated etiquettes. Though having no prior acquaintance, they ride together into the business hub of Washington DC, sharing solely HOV benefits. These pickup locations emerged by self-organization, where parking, backup public transportation (PT), and HOV access were available. The same method applies for getting back in the afternoon, as the HOV lanes reverse their direction. Some merci lines are shown to exist, where drivers pick riders who missed the HOV +3 hs. The slugging community of purpose is organized into 28 morning lines and seventeen evening lines, generating trips for about 6000 users per day (Burris et al. 2012), and for trip distances of 15–50 miles. Each slug line is an autonomous entity, serving its own community of commuters, oblivious to other lines, as early indications suggest (LeBlanc 1999). This alienation was rectified twenty years ago by David LeBlanc, an enthusiastic user who wrote a book documenting the phenomena (LeBlanc 1999) [LeBlanc 2018], and created a community website (LeBlanc, n.d.) that provides lines information, as well as lost and found and users’ forums.

During the past decade, several digital platforms have attempted, with limited success, to relocate the physical space where ridesharing matchmaking occurred to an electronic one, by offering apps or social-networks groups. Lately, during 2019, efforts to initiate new lines using Facebook as self-organization platform were underway, as PT disruptions were predicted due to metro and parking maintenance (e.g., Saratoga Sluglines 2018). These efforts seemed to be gaining better acceptance than previous ones.

California Bay Area Casual Carpooling (USA2)

Similar in structure to USA1, USA2 serves the SF Bay Area casual carpool, emerging at about the same period following the similar HOV 3+ offering. Though sharing no direct link (Burris et al. 2012), both initiatives show similar traits. The HOV 3+ lanes on the toll bridges leading from the northern and eastern cities into SF business hub attract about 6000 commuters per day (Shaheen et al. 2016) from 24 inbound line locations and one outbound, for distances of 10–30 miles. Casual carpooling in SF is acknowledged both by local authorities and popular media. It has been monitored since the 1980s, e.g., in reports sponsored by the SF Metropolitan Transportation Commission (MTC) organization (Beroldo 1990, 1999) and the Federal Highway Administration (Burris et al. 2012; Zmud and Rojo 2013), as well as in a recent scientific paper by Shaheen et al. (2016). It is advertised by MTC as a mobility option (SF Metropolitan transportation commission 2019) and most line locations are post-signed as pickup-points by the local transportation authorities. Twenty years ago, Dan Kirshner [Kirchner 2018], an environmentalist and enthusiastic user, attempted to create a web-based matchmaking platform (Kirchner, n.d.) to replace the physical meeting points, which ended-up being used by participants as a communal area, providing lines information, as well as lost and found and users’ forum.
OnBoard-Lawrence (USA3)

In USA3, “OnBoard-Lawrence”, a ridesharing demonstration, was developed serving Lawrence, Kansas, which is a medium, civic minded, rural university town, with 90,000 inhabitants (O’Brien and Dunning 2014). O’Brien [O’Brien J. 2019], an enthusiastic activist, was trying to achieve flexible inexpensive ridesharing system to address problems of low availability and long headways of PT, low connectivity of surrounding smaller towns, and limited accessibility to main work hubs. The initiative was inspired both by the abandoned SORS form of hitchhiking, as presented by Alan Pisarski, Freakonomics Radio podcast (2011), and a 1996 community initiative of GoGeronimo (O’Brien and Dunning 2014).

In the demo, potential passengers (volunteers) signaled to drivers their required destination by writing on a logo-branded handheld-whiteboard. At a later stage, the initiative partnered with an app provider (Carma) for an advanced demo, re-branded as CarmaHop. At this phase, online features were added to enhanced ride matching by safety measures, messaging capabilities, and a map of the best locations to thumb-ride. Drivers were encouraged to register by gas gift-cards offers. The initiative was abandoned at the end of the trial period, due to low uptake and unsustainable business model, as required for commercial partnership.

Car Stop (CA1)

Pender Island, one of the Southern Gulf Islands of British Columbia, Canada, is a small island populated by about 2500 permanent residents, including many retirees, and has a large summer tourists’ influx. It is connected to the mainland by ferry, but has almost no PT. CA1, the Car-Stop initiative, was established and managed by a volunteers’ association named “Moving-Around-Pender” (MAP) in 2008 (MAP, n.d.), [Mathias 2021]. It consists of meeting points installed at roadsides around the island, with green information poles and benches, where riders wait or signal with their thumb out to passing cars, for a free ride (Johnston, 2017), [Mathias, 2021]. The service was ranked as the fourth mobility option in a survey conducted by MAP. This initiative was later adopted by other Southern Gulf Islands (e.g., Mayne Island) and further islands of British Columbia (e.g., Lift-Stops in Bowen Island, Bowen LIFT, n.d.).

Students of UFRJ groups (BRA1)

The Fundão Island campus of UFRJ in Rio de Janeiro, the largest federal university of Brazil, is accessed daily by more than 80,000 travelers, mostly students. The students are self-organized to share rides together by multiple WhatsApp groups (total number unknown), as well as some Telegram and Facebook ones [Student 1st, 2019]. Each group serves a different urban neighborhood, 10–35 km away from the university, and is estimated to generate at least 60 rides per day [Students of UFRJ, 2019]. Sometimes, several groups are needed to serve one location, as they exceed the limit of WhatsApp group capacity (currently 257). By sharing rides, the students bypass their otherwise crowded and slow PT, cutting their travel time by more than half.
Caronea, UFRJ (BRA2)

The same users’ base of BRA1, at the same coverage area, use Caronea (Students of UFRJ, n.d.), a ridesharing application developed in 2016 by a group of UFRJ engineering students, who were inspired by their previous experience with BRA1 [Student 1st, 2019; Student 2nd, 2019],(Teixeira 2018). Winning a sustainability-promotion university competition, they were granted initial funding to develop the app and publish it, as well as permission to use the university single-sign-on (SSO) process to register users. Through the app, university commuters can offer rides to different neighborhoods of Rio de Janeiro. Riders can register to these rides and correspond with the drivers and fellow riders (only of their chosen ride). During the first months, the SORS app managed to service about 50 rides per day (Teixeira 2018), experiencing a substantial drop afterwards.

Carpool-to-the-rail from Zichron (IL1)

“Carpool-to-the-rail from Zichron”, an Israeli WhatsApp group for ridesharing, serving rides from Zichron-Ya’akov to the nearest railway station, was established in 2017. A rail user of the semi-rural council (population of about 23,000) established the pre-Covid19 257 participants group. According to interviewees, while sharing no prior acquaintance, the participants joined the group after originally incentivized by preferential parking for 3+ vehicles right next to the railway station’s entrance. The users opted not to use a matching-making platform by a commercial provider who collaborated with the rail authorities and local NGO, when the preferential parking was first introduced. The station, which is located 9 km away, was known at the time of the study for its parking overflow, induced congestion, and medium to low quality of service (QoS) of connecting PT. In addition to sharing rides to the station, group members also provide return trips with no apparent incentive. The group was estimated to provide 30+ rides per day at the end of 2019 [Riders to the rail, 2020].

“Shuttle” Giv’at-Ada (IL2)

Another Israeli WhatsApp group for ridesharing is the “Shuttle”, which serves Giv’at-Ada, a secluded suburb of a small rural council (population of about 4000/12,000 respectively). The 257 members group is offering/requesting rides, mainly to the local railway station (the same station as IL1) located about 6 km from the suburb [Giv’at-Ada habitants, 2017]. Back in 2014, a free shuttle bus provided by the rail authority to the nearest station was canceled and replaced by an unsynchronized (at the time) regular bus line [EM, 2017]. On the cancelation date, a user created the now fully utilized WhatsApp group, naming it after the canceled shuttle. The initiative service is estimated to generate about thirty rides per day [EM, 2017; Giv’at-Ada habitants, 2017].

While located only 15 km from IL1 and using the same rail station, the two initiatives are unrelated, and the newer IL1 makes no reference to its predecessor. Furthermore, IL2 discourse makes no reference to the preferential parking that drives IL1.

Appendix B: Updated Framework

See Table 5.
### Table 5  An adapted framework (new constructs are shown in Italic)

| Category                                           | Sub-categories                                                                 |
|----------------------------------------------------|-------------------------------------------------------------------------------|
| **Quasi-static attributes—niche**                  |                                                                               |
| Form                                               | Acquaintance- based, casual, dynamic, hitchhiking, *type1*, *type2*            |
| Matchmaking method                                 | Meeting places, app/bulletin boards, signs                                     |
| Resources                                          | Users’ vehicle, smartphone, app, volunteers, *arena*                          |
| Exchange mechanism                                 | Alternate rides, expenses, third party benefits, social goods                 |
| Roles                                              | Users, drivers, riders, leaders/activists, *mediators*                        |
| Relations                                          | Kin, community, social networks, strangers, technology mediated                |
|                                                    | Peer-to-peer (P2P), peer-to-community                                          |
|                                                    | Alignment (geographical, social)                                              |
| Collaboration base                                 | Trust, reputation, reciprocity                                                |
|                                                    | Alternative establishing methods, market replacements                         |
| Side products                                       | Rules, norms, social capital                                                  |
| **Quasi-static attributes—landscape and regime**   |                                                                               |
| Context and environment constructs                 | Geographical layout                                                           |
|                                                    | Transportation network and facilities                                          |
|                                                    | Available transit                                                             |
|                                                    | Existing communities, social organizations                                    |
|                                                    | Local culture                                                                 |
|                                                    | *SOC*                                                                         |
| Applicable practices                               | Existing, competing, integrated, abandoned, supporting elements, competencies, meaning |
| Acting forces                                       |                                                                               |
| Disruptors/barriers                                | Safety/stranger-danger, handling money transactions, transaction-costs, QoS, car driving habit, “my car is my home”, rule changes |
| P2P                                                |                                                                               |
| Initiative level                                   | Lack of support, cooperation barriers, lack of trust, perception of value, critical mass |
| **Dynamic attributes**                             |                                                                               |
| Phases/states                                       | Predevelopment (dynamic equilibrium)/strained, take-off, breakthrough, stabilization, perturbed |
| Change Processes                                   | Creation, recruitment, nudging, disruption                                     |
| Patterns                                           | Empowerment, re-positioning, re-organizing;                                   |
| Growth processes                                   | Scaling-up, diffusion                                                         |
| Practice change processes                          | Change in material elements, meaning and competence; recruiting and defecting of practice carriers; a change in practice bundling; re-emergence of practice |

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