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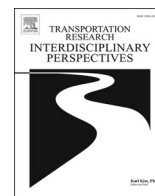
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City street experiments and system change: Identifying barriers and enablers to the transformative process

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ABSTRACT

City street experiments continue to be employed as a tool to improve urban mobility and liveability. Despite growing popularity, understanding of this transformative process, and more specifically, the barriers and enablers that exist for street experiments aiming to cause system change, remains an important knowledge gap. By way of a systematic search and review of 17 empirical studies, barriers and enablers to the transformative process are identified. Enablers include *embedding experiments in long-term policies including stakeholders, active promotion and institutional support*. Barriers include those within the experiment's control (*a lack of required resources, uncondusive design, lack of clear vision and low frequency*) as well as those out of the experiment's control (*opposition from stakeholders and institutional regulations and processes*). The relationships between these enablers and barriers are recounted, revealing concrete recommendations for experiment organizers as well as two dilemmas for consideration.

1. Introduction

Often described as 'stuck' (Moradi and Vagnoni, 2018) the urban mobility sector remains a highly unsustainable system burdened by deep-rooted problems related to private automobility (Castillo and Pitfield, 2010; Schiller et al., 2010). Since the advent of the automobile, walking and transit fabrics have been "obliterated" (Newman et al., 2016) to make way for individual motorized traffic (Norton, 2015). The dominance of private automobility- combined with increased urban growth - have led to negative environmental impacts (Smets and Jones, 2020), decreased biodiversity (Balikçi et al., 2022), worsened quality of life (Moreno et al., 2021) and system inequality (Vasconcellos, 2018) and mobility injustice, a growing research strand (Sheller, 2020). While the path towards increased sustainability lies in dismantling motorized, private automobility (Gössling, 2020), its dominance continues to be reinforced by user preferences, investments and policies, and existing infrastructure catered to the car (Moradi and Vagnoni, 2018).

In light of these challenges, a sustainability transition is needed (Grin et al., 2010). Transition scholars posit that radical niche innovations in the form of experiments can incur system change, initiating new ways of doing, thinking and organizing are needed (van den Bosch and Rotmans, 2008; Schreiber et al., 2023). One method for exploring such "radically different arrangements of the urban mobility system" (Bertolini, 2020, p. 736) are 'city street experiments'. City street experiments are defined

as: "intentional and temporary changes of the street use, regulation and or form, featuring a shift from motorized to non-motorized dominance and aimed at exploring systemic change in urban mobility, away from "streets for traffic" and towards "streets for people" (Bertolini, 2020). Examples include subtle modifications, like the re-purposing of parking spaces, to more radical interventions, such as the closure of entire streets to cars in exchange for active travel modes, greenery, and opportunities to socialize and play (Bertolini, 2020). By temporarily altering "a quintessential social public space" (Mehta, 2015), city street experiments allow citymakers to test and assess other scenarios, before making permanent changes to physical infrastructure and policy.

Because of their novelty, research on this topic remains nascent. While transition scholars offer several frameworks for understanding how experiments can cause system change in the context of sustainability transitions (Schreiber et al., 2023; Ehnert et al., 2018; Gorissen et al., 2017; Van den Bosch and Rotmans, 2008), they remain empirically understudied and have yet to be applied specifically to city street experiments and urban mobility (Bertolini, 2020). Moreover, existing empirical studies of street experiments primarily focus on their local impacts (e.g. changes in traffic, increases in feelings of safety) (Bertolini, 2020) and less on the relationship between street experiments and system change and the process of transforming current ways of doing, thinking and organizing (VanHoose et al., 2022). The lack of empirical studies combined with an increased popularity of such experiments (for

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a useful overview see [SET](#)), especially in light of sustainable policy goals and more recently, as a response to public space needs and fears of car recovery during the coronavirus pandemic (Glaser and Krizik, 2021; [Vecchio et al., 2021](#)), represents an important knowledge gap. Without a proper understanding of how to unlock the transitional capacity of experiments, the efforts made by experiment organizers could be rendered futile.

To bring more understanding to how such experiments create wider system impact and the barriers and enablers that can potentially further or hinder this ‘transformative process’, I perform a systematic literature review. The literature review is guided by the following question: *Which barriers and enablers exist for city street experiments while attempting to achieve system change?* To my knowledge, such a comprehensive overview of the barriers and enablers that street experiments encounter has yet to be conducted, representing an important contribution to the field.

The paper is structured as follows. Drawing from transition studies, I first provide a concise overview of the theoretical considerations concerning how transitions take place, the role of experiments and the transformative process, or how system change is reached through experiments. This is done in order to generate relevant search terms for the literature review, which is detailed further in the ‘Methodology’ section. Next, I present the identified barriers and enablers and discuss the implication of these findings for both transition and mobility scholars, and city-makers interested in experimenting with city streets to transform urban mobility.

2. Theoretical considerations

2.1. Transitions, the role of experiments and the transformative process

A sustainable transition within urban mobility has been noted as involving co-evolutionary developments between industry, markets, user behavior, policy, infrastructure and spatial arrangements ([Geels et al., 2017](#)). System change therefore involves a co-evolutionary development of *institutional* (policy, rules and regulations), *behavioral* (user habits, norms), *organizational* (collaborations and networks) and *material* (infrastructure) arrangements towards a new system ([VanHoose et al., 2022](#)). Several theoretical frameworks have been developed in order to conceptualize the transformative process that characterizes a transition. The multi-level perspective (MLP) was first introduced by [Rip and Kemp \(1998\)](#) and has been consistently applied to studies regarding transitions in urban mobility ([Moradi and Vagnoni, 2018](#); [Geels, 2005; 2007; 2011; 2012; 2014](#); [Næss and Vogel, 2012](#)). The MLP is characterized by a ‘nested hierarchy’ featuring three embedded levels: socio-technical landscapes (broader societal trends and shifts), regimes (user habits, norms and mindsets sustained by a diversity of actors and deep-structured rules) and niches (testbeds for radical alternatives that challenge and compete with the technologies, market, policy, culture, and industries of the regime) ([Geels, 2007](#)). While each transition is unique, an ideal-typical process according to the MLP would be as follows: as experiments build-up momentum and develop, shifts at the landscape level cause a destabilization of the embedded regime behavior which allows windows of opportunity to open up in which novel innovations can thrive ([Geels, 2012](#)).

Although the MLP has become the dominant framework for conceptualizing sustainability transitions, some scholars criticize its lack of consideration for how system change is reached through experimentation ([Bögel et al., 2022](#)), or the *transformative process*. The interaction between such radical initiatives and locked-in systems represent a central challenge of the transformative process that experiments initiate. The transformative process involves extracting the lessons and experiences generated during experiments and bringing these to existing ‘ways of thinking, doing and organizing at the level of the societal system’ ([van den Bosch and Rotmans, 2008, p. 33](#)).

This process is most often referred to in the literature as ‘scaling up’, however, I refrain from using this term as it represents a highly

misunderstood concept within transition studies ([Dijk et al., 2018](#); [Bögel et al., 2022](#); [Augenstein et al., 2020](#)). Upscaling is often misconceived as the simple wider adoption of innovative products over time ([Dijk et al., 2018](#)), leading to an ‘oversimplified focus’ ([Bögel et al., 2022](#)) on multiplying and spreading innovations ([Augenstein et al., 2020](#)). This is tricky, as experiments and their goals are place-specific and cannot be simply copied and pasted to new social and material contexts ([Evans, 2016](#)). On the other hand, by placing too much focus on place, the scope of experiments and the lessons that can be drawn from them become limited ([Hansen and Coenen, 2017](#)). [Augenstein et al. \(2020\)](#) point out that the various understandings of upscaling are based on a variety of different underlying ontologies, epistemologies and also practice-based approaches. Another, albeit less popular, term to describe this process is ‘diffusion’ ([Von Wirth et al., 2019](#)). [Von Wirth et al. \(2019\)](#) delineate three types of strategies for diffusing experiment lessons and experiences: embedding, translating and scaling. The embedding of an experiment implies “the adoption and integration of its design, approach or outcomes into existing local structures (institutions, regulations, planning) and/or communities of practice ([Von Wirth et al., 2019, p. 232](#)).” Translation is the process through which characteristics of an experiment are replicated and reproduced in another spatial or institutional or organizational context (i.e. another city or, the same city, but by different actors). Scaling refers to the development and growth of an experiment, including “spatial scaling (geographical growth), content scaling (extending across domains and practices), actor scaling (extending towards different partnerships and actors involved), and resource scaling (expansion of funding)” ([Von Wirth et al., 2019, p. 233](#)).

Regardless of semantics, transition scholars acknowledge that the transformative process can be fraught with challenges. Many empirical and conceptual studies place the ‘blame’ of experiment failure on their own performance and choices ([Markard and Truffer, 2008](#)). Because experiments actively challenge entrenched regimes, they require a nourishing and protective niche environment ([Geels, 2012](#)) and are often constrained by their context, dominated by the stable regimes that are composed of institutions, organizations, practices, techniques, and beliefs ([Geels, 2012](#)). While the ‘system’ is characterized by obdurate networks and rules, the formal institutions behind regulatory processes can either hinder or allow experiments to flourish ([VanHoose and Bertolini, 2023](#)). This relates to the institutional capacity of urban governance to ‘enhance the ability of place-focused stakeholders to improve their power to ‘make a difference’ to the qualities of their place’ ([Healey, 1998, p. 1541](#)). Barriers and enablers to the transformative process are therefore both reliant on factors internal to the experiment, as well as factors external to the experiment. This is important to consider when conceptualizing the transformative process, detailed in the next section.

2.2. City street experiments: From streets for traffic towards streets for people

In the context of an urban mobility transition, city street experiments are an example of a niche innovation that aims to cause system change ([VanHoose et al., 2022](#)). City street experiments are grounded in the increasingly popular notion that streets are not merely routes from one place to another, but are where much of everyday life takes place ([Martire et al., 2023](#); [Von Schönfeld and Bertolini, 2017](#)). Considering this, city street experiments aim to challenge car-dominance, and at the same time, restore the balance between streets as places for traffic and for people ([Gehl, 2010](#); [Bertolini, 2020](#)).

Examples of street experiments range in complexity: re-marking streets (e.g. Intersection Repairs in Portland), re-purposing parking (e.g. Parklets), the flexible closure of streets (e.g. ‘School Streets’ in the UK, ‘Slow Streets’ in North America, Ciclovias in South America), partial re-purposing (e.g. Pavement to Plaza in New York) and entire re-purposing (e.g. Living Streets in Ghent) ([Fig. 1](#)). Regardless of type, city street experiments are always temporarily employed (ranging from several



Fig. 1. Left: Via Procaccini in Bologna, Italy is an example of a partial re-purposing that aims to limit car traffic and offer a new pedestrian space equipped with street furniture to encourage play and social interaction (photo credit: Ex-TRA). Right: The Steinheilstraße parklet in Munich, Germany is an example of re-purposing parking spaces as a place for interacting and greenery (photo credit: Ana Rivas).

days to one year) and can be easily realized in the short-term with available resources (VanHoose et al., 2022).

Two important characteristics set city street experiments apart from other interventions. First, street experiments purposefully explore street uses and forms that go *beyond* mobility (Bertolini, 2023). Contrary to pop-up bike lanes, which were increasingly implemented during the COVID-19 pandemic (Becker et al., 2022; Combs and Pardo, 2021) street experiments also focus on increasing livability and include space for socializing, relaxing, playing, eating and simply, being. Second, while street experiments feature similar characteristics found in examples of tactical urbanism (street art, urban furniture), they are different in their aim to cause system change. In other words, street experiments are not ‘one-off’ fun events, which they are often viewed as (Hipp et al., 2017) or beautiful murals painted on the ground, but are intentional and purposeful initiatives strategically employed by local governments to explore potential solutions to larger challenges (VanHoose et al., 2022).

2.3. Transformative process of street experiments

While street experiments are increasingly employed with the intention to explore paths towards system change and have proven to possess a ‘transitional capacity’ to do so (VanHoose et al., 2022), understandings of this transformative process remain lacking. Street experiments are not always taken seriously (Hipp et al., 2017) and their “embedding in a broader strategy of change seems more the exception than the rule” (Bertolini, 2020, p. 747). Moreover, empirical studies of city street experiments primarily focus on their immediate and local impacts, including a decrease in traffic (Nello-Deakin, 2022) increased physical activity (Zieff et al., 2016), increased feelings of safety (Meyer et al., 2019), enhanced social interactions (D’Haese et al., 2015) and increased social capital (Cortinez-O’Ryan et al., 2017). While these impacts are certainly important, they do not speak to the dimensions that characterize system change outlined in the theoretical section of this paper. This represents an under-utilized potential for street experiments and comes at an important moment, as local governments continue to employ these types of initiatives. Without a proper understanding concerning how to unlock the full potential of street experiments, these efforts could be rendered futile. Understanding why this is the case - i.e. identifying barriers that exist for the transformative process of street experiments - remains an important knowledge gap that should be addressed as street experiments grow in popularity.

The purpose of this paper is to increase the knowledge of the transformative process of street experiments. *Which barriers and enablers exist for city street experiments while attempting to achieve system change?* To answer this research question, a systematic search and review of empirical papers is presented. The objective of this paper is to analyze the empirical papers to determine which barriers and enablers exist for street experiments. According to the literature reviewed above,

experiments face challenges related to both their own design, as well as factors related to the governance system in which they occur (VanHoose and Bertolini, 2023). The barriers and enablers to the transformative process can therefore be classified according to two categories: those ‘internal’ to the experiment and those ‘external’ to the experiment. The first represents all factors related to the transformative process that are within the experiment’s range of influence (e.g. type, form, duration). The second category includes all factors outside of their control (e.g. public opinion, rules, regulations).

This paper is structured as follows. The design of the systematic search and review is described in Section 3, followed by the presentation of the results based on the research question and described according to these two categories. In Section 5 the implications of these findings are discussed, followed by the main conclusions in Section 6.

3. Methodology

To identify barriers and enablers to the transformative process of street experiments, a systematic search and review is employed as the primary method (Booth et al., 2016). Literature reviews provide a comprehensive and reproducible method to identify and evaluate relevant literature in a research field (Papaioannou et al., 2016) and are commonly utilized within transition studies and urban mobility research (Stam et al., 2023; Gottinger et al., 2020; Tsigdinos et al., 2022; Bertolini, 2020).

3.1. Research scope and search strategy

Based on the literature, search words related to the key topic of city street experiments are identified which guide the literature review (see Table 1). Recognizing the lack of empirical studies of city street experiments (source), any empirical study of an experiment that falls under the definition of street experiment as defined by Bertolini (2020) will be included, regardless of whether its focus is on the experiment as a success or failure in itself, or if it also reveals insights into the transformative process. This choice is further supported by the fact that the relationship between system change and experiments is still understudied, and it is expected that while most studies may not make a direct reference to the transformative process, they could still mention barriers and enablers that are relevant to this process and the research question.

Table 1

Key topic and related search words employed for the literature review.

Key topic	Related search words
City street experiment	experiment, pilot, trial, street, road, public space, reallocation, reuse, temporary, local, tactical, urban mobility, city, livability, sustainability, system change

While the intention of this literature review was to be as comprehensive as possible, there is a possibility that some articles may have been excluded as a result of the keywords that were chosen.

3.2. Search criteria

Elsevier’s Scopus database was employed as the primary source for identifying relevant papers. Scopus is the largest abstract and citation database of peer-reviewed literature and has been considered the most complete database (Stam et al., 2023). The following criteria structured the search. First, the time span was restricted to papers published over the last ten years (between 2013 and 2023), to present a contemporary and comprehensive overview. Second, only peer-reviewed articles were included in the search, leaving out book chapters and reports. This is common practice in literature reviews as peer-reviewed articles are considered certified knowledge (Stam et al., 2023; Saggese et al., 2016). Third, only articles written in English were included in the search. Fourth, only empirical studies featuring city street experiments as defined by Bertolini (2020) as the unit of analysis are considered for review.

3.2. Screening process

The keyword-based search took place in October 2023 and occurred according to the following steps (see Fig. 2). The identified search words were entered into the search field resulting in a first batch of 28,164 papers. The search for English, peer-reviewed journal articles, written between 2013 and 2023, returned 772 papers. The title and abstract of these papers were screened, resulting in the exclusion of 758 records which did not match the definition of city street experiments. The title, keywords and abstract of the remaining 14 papers were scanned to determine whether or not an article featured an empirical study featuring city street experiments as the unit of analysis, resulting in 13 papers. Because some empirical studies known to the author were not found in the database using these keywords, the search was

complemented using backward and forward snowballing (Wohlin et al., 2022) to include four additional sources.

This resulted in a final set of 17 full-text articles eligible for analysis (see Table A1 in the Appendix). To analyze these 17 papers, thematic analysis was employed (Booth et al., 2016) - in this case, barriers and enablers to the transformative process of city street experiments. The identified barriers and enablers were identified and classified according to two categories: (1) experiment internal and (2) experiment external. While these two categories structured the analysis, I remained open to the possibility that a barrier or enabler could be classified as both internal and external. Where possible, the identified enabler and barriers are supported by non-empirical literature sources on transitions and the transformative process. While 17 full-text articles were reviewed, two of these made no explicit mention of any barriers. The remaining 15 papers therefore serve as the basis for the findings presented below.

4. Findings

4.1. ‘Experiment internal’ barriers

4.1.1. Lack of required resources

Eight empirical studies noted a *lack of required resources* as a barrier for street experiments (Eyler et al., 2015; Glaser and Krizek, 2021; Hipp et al., 2017; Sarmiento et al., 2017; Stevens et al., 2023; VanHoose et al., 2022; Vitale Brovarone et al., 2023; Zieff et al., 2013). The empirical papers noted not only financial resources (funding sources), but also physical (materials) and human resources (both time and knowledge). The lack of necessary financial and staffing resources has been noted as a challenge for experiments more generally (Nevens et al., 2013), not just city street experiments. When funding and staffing are inconsistent or limited, the quality and sustainability of the initiative is less certain (Zieff et al., 2013). For instance, a lack of funding was mentioned as a barrier to the Open Streets initiative in various examples across the United States. Here, several cities wanted to host follow-up Open Streets but were faced with financial limitations, which also impacted the

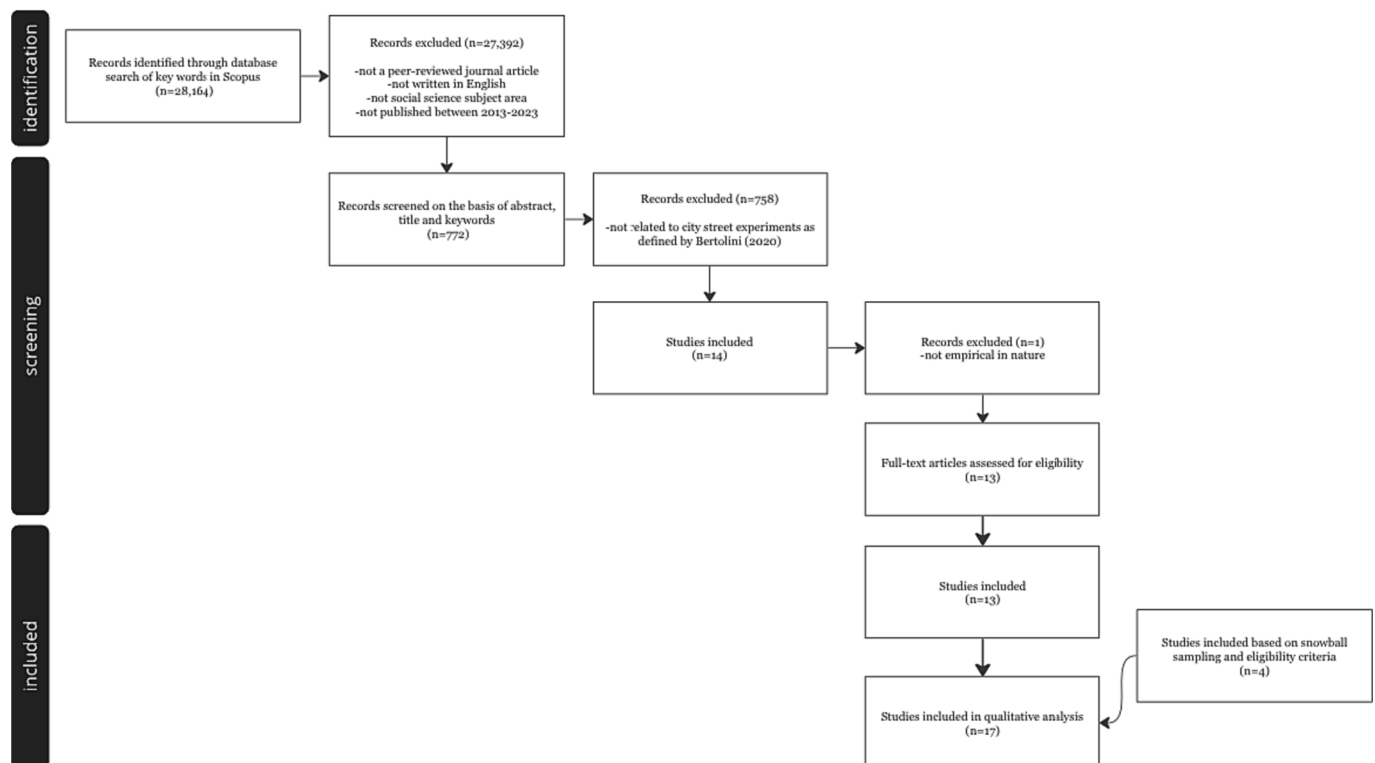


Fig. 2. Flow chart depicting the screening and selection process.

option to increase frequency of the events (Eyler et al., 2015; Hipp et al., 2017). In their assessment of Open Streets and Slow Street experiments implemented across the U.S. during the COVID-19 pandemic, Glaser and Krizek (2021, p. 151) stated that “limited staff time and availability of materials [were cited] as barriers to implementation” and were the main reason for the downsizing or discontinuation of programs, despite the presence of public support. Likewise, Sarmiento’s (2017) study of the Ciclovias in Bogota, Colombia echoed the importance of having stable and diverse funding sources. Lack of required resources can also have an impact on the focus of the experiment. While the Living Street Hugo de Grootkade initially aimed to include a study of the effects on traffic in the neighborhood, these ambitions were dropped in light of the social activities which ended up demanding more attention (VanHoose et al., 2022). While most of the empirical studies referred to financial resources, two also noted the importance of human resources in the form of knowledge. For instance, during the Torino Mobility Lab, a lack of know-how concerning organizing such an experiment was lacking and noted as one explanation for the experiment’s failure (Vitale Brovarone et al., 2023). Alternatively, the success of the Playful Parklet in Melbourne was a result of the time invested by academic researchers in urban design, who were further equipped with necessary expertise to design the parklet (Stevens et al., 2023).

4.1.2. Unconductive design

Three empirical studies noted that an unconductive design can act as a barrier for street experiments (Marcheschi et al., 2022; Scudellari et al., 2020; Smeds and Papa, 2023). For instance, in the car-free street experiments in Gothenburg and Malmo, pedestrians did not feel safe to walk in the middle of car-free streets due to the lack of separation between pedestrians and cyclists (Marcheschi et al., 2022). In the South Woodford parklet in London, users were unclear whether the experiment was for public use or if it was the terrace of an adjacent cafe, which led to its under-utilization (Smeds and Papa, 2023). The presence of urban furniture and pedestrians in the middle of the street posed several problems for cyclists who were also allowed to ride through the Superblock in Poblenou (Scudellari et al., 2020). The creation of places that support social interactions and positive social atmosphere, can therefore help to increase the acceptance of the intervention (Marcheschi et al., 2022).

4.1.3. Lack of clear vision

Another barrier is a *lack of a clear vision*, found in three empirical studies (VanHoose et al., 2022; Verlinghieri et al., 2023; Vitale Brovarone et al., 2023). When experiment goals are not made clear, this can bring the legitimacy of the project into question. In the case of the Torino Mobility Lab, the intentions of the experiment were not clear (Vitale Brovarone et al., 2023; Verlinghieri et al., 2023), which “appeared to many as motivated by the desire to seize a funding opportunity or a political move by an administration approaching the end of the mandate” (Ibid., 2023, p. 8). The experiment Weesperzijde Testbed in Amsterdam suffered from unclear vision stemming from its too-ambitious program which aimed to explore shared mobility options, solutions to parking and organizing social activities (VanHoose et al., 2022). The lack of a clear vision in this case was further rooted in the shared organization between the City of Amsterdam and residents, which led to unclarity surrounding who was responsible for what part of the project (Ibid., 2022).

4.1.4. Low frequency of experiments

The *frequency of street experiments* is also noted as a potential barrier (Hipp et al., 2017). This was found in a study of Open Streets in the United States by Hipp et al. (2017), which was the shortest example of a street experiment included in the empirical studies, typically lasting one day. Such one-time events are unable to generate transformative processes that may influence other contexts and practices (Savini and Bertolini, 2019) and the low frequency is a limitation to their impactfulness

(Hipp et al., 2017).

4.2. ‘Experiment internal’ enablers

4.2.1. Including stakeholders

Four empirical studies noted the added value of *including stakeholders* in the decision-making processes concerning the design and implementation of city street experiments (Eyler et al., 2015; Oliver and Pearl, 2018; Scudellari et al., 2020; VanHoose et al., 2022). Interestingly, including stakeholders was noted as an important strategy for combating resistance from opponents of the experiments. In the case of the Superblock Poblenou, residents were included in a two-week workshop, however the experiment was implemented afterwards without being communicated to the residents. As a result, protests arose, and a participation process had to be activated, in order to mediate (Scudellari et al., 2020). In another study of the Superblocks, residents felt that they should have been part of the decision-making process from the beginning to decide if they even wanted a Superblock and where it should be located (Oliver and Pearl, 2018). Organizers of the Open Streets suggested ‘personal and consistent contact’ with businesses (Eyler et al., 2015, p. e54) and to include them in the process early on. Likewise, a better understanding of the preferences of potential users and giving more time to ‘warm-up’ to the idea was noted as having been potentially favorable for behavioral change during the Umparken Schwabing-West experiment (VanHoose et al., 2022).

4.2.2. Active promotion of experiments

Four empirical studies noted the *active promotion of experiments* as an enabler (Eyler et al., 2015; Montero, 2017; Sarmiento et al., 2017; VanHoose et al., 2022). Active promotion includes getting the word out about an event, but similar to the enabler *including stakeholders*, is again named as an important strategy to prevent resistance from stakeholders. For instance, organizers of the Open Streets noted that directly promoting the experiment tended to reduce resistance and prevent conflicts (Eyler et al., 2015). To do so, most experiment organizers used a combination of print material, social media to advertise, as well as walking door-to-door to explain the purpose of the experiment and address concerns (Ibid., 2015). Additionally, Sarmiento et al. (2017) noted that sharing the lessons learned during the Ciclovía program in Bogota, was key to expanding and repeating the project in other locations. This coincides with the notion that street experiments garner momentum by way of building coalitions (reaching-out) (VanHoose et al., 2022). This was further echoed in the Open Streets initiative, where most organizers reported that visiting or hearing about other city’s initiative was the impetus to organize their own event (Eyler et al., 2015).

4.3. Experiment ‘internal-external’ enablers

4.3.1. Embedding experiments in long-term policies

Four empirical studies mentioned *embedding experiments in long-term policies* as an enabler for street experiments (Eyler et al., 2015; Glaser and Krizek, 2021; Hipp et al., 2017; Vitale Brovarone et al., 2023). In the cases analyzed by Glaser and Krizek (2021), those cities that aligned street experiments with existing policy goals were able to increase their feasibility by employing existing staffing resources and ‘galvanizing political legitimacy’. One example was Oakland’s “Slow Streets” program which strongly leveraged their existing bicycle plan (Ibid., 2021). Eyler et al. (2015) noted that incorporating the Open Streets into broader citywide agendas related to active living, sustainability goals and transportation initiatives, seemed to be a component related to their success (Eyler et al., 2015). This enabler is classified as internal and external due to the fact that the connection to long-term policies is not solely dependent on an experiment’s efforts. For instance, during the Torino Mobility Lab, the impactfulness of the project was limited due to a lack of willingness on the part of the municipal administration to connect the experiment to broader policy goals (Vitale Brovarone et al.,

2023). This enabler is further related to opposition from stakeholders, as in the same case, residents “would have tolerated having to cope with less parking and reduced car access as long as this was geared towards something definite, such as a vision of improving sustainable mobility in the neighborhood and the entire city” (Ibid., 2023, p. 5).

4.3.2. Institutional support

Three empirical studies noted *institutional support* as an enabler for city street experiments (Eyler et al., 2015; VanHoose et al., 2022; VanHoose and Bertolini, 2023), which could be classified as both internal and external. According to the literature, institutional support includes political backing, leadership and provision of resources and can vary in terms of intensity. Perhaps most importantly, institutional support can be garnered by experiments vying for support (e.g. reaching out) or by external parties supporting experiments on their own initiation (e.g. reaching in) (VanHoose et al., 2022). For instance, most organizers involved in the Open Streets initiatives in the U.S., which were primarily organized by community organizations and supported by local administrations, viewed political support as crucial to the event’s sustainability and success (Eyler et al., 2015). This included mayors and city council members actively promoting the Open Streets initiatives through press conferences, on social media, attending events, and pledging public support (Ibid., 2015). While political support was crucial to the success of the events, it primarily involved promotion and most of the financial and organizing responsibilities fell on the experiment organizers (Ibid., 2015). In the cases where government funding was provided, organizers mentioned that moving away from these sources of funding relieved worries related to losing funding in the midst of reelections or changes in city leadership support (Eyler et al., 2015). In the case of the Living Streets of Ghent, where the municipality was the initiator and implementer of the experiment, the financial, material and human resources that accompanied their top-down role were crucial in the nascent stages of the project. This institutional support further legitimized the experiment, helping to justify it to resistant stakeholders (VanHoose and Bertolini, 2023).

4.3. ‘Experiment external’ barriers

4.3.1. Opposition from stakeholders

Six empirical studies noted *opposition from stakeholders* as a barrier for street experiments (Eyler et al., 2015; Marcheschi et al., 2022; Smeds and Papa, 2023; VanHoose and Bertolini, 2023; VanHoose et al., 2022; Vitale Brovarone et al., 2023). The most common source of opposition mentioned in the empirical studies is related to a preference for private mobility from car owners and the fear of being inconvenienced by rerouting traffic or the removal of parking spaces (Eyler et al., 2015; VanHoose et al., 2022). In the Umparken Schwabing experiment (VanHoose et al., 2022) where eight households exchanged their cars and parking spaces for public transport and shared mobility options while the leftover parking spaces were activated as public space, resistance primarily stemmed from residents living nearby who were no longer able to park their car as a result of the experiment’s implementation (VanHoose et al., 2022). Additionally, business owners are often afraid of losing business if car traffic is removed from their street (Eyler et al., 2015). This barrier can seriously complicate experiments (Verlinghieri et al., 2023), including being forced to employ more resources to explain and negotiate with opponents. For instance, in the Open Street experiments, the “new” concept of using the street for something other than automobility brought initial resistance from residents, businesses and policy makers (Eyler et al., 2015). Many organizers mentioned that residents felt “threatened” by the removal of cars from the streets, and described initial interactions with business owners as difficult and time consuming (Ibid., 2015). Opposition further stems from a disrupted place attachment of users. In the Piazza Zenneti experiment in Munich, which turned a former parking lot into a place for sitting and relaxing, local residents were initially wary of their neighborhood gentrifying as a

result of the project (VanHoose et al., 2022). Likewise, an association between levels of attachment and acceptance towards car-free streets was highlighted in the study of experiments in Malmo and Gothenburg, Sweden, suggesting that greater levels of attachment might hinder residents’ attitudes about car-free street implementations in their neighborhood (Marcheschi et al., 2022). Opposition from stakeholders can be so strong that it has the potential to completely change the experiment’s aims. During the Living Streets of Ghent, which featured the temporary closure of streets to car traffic for several months in the summer, originally challenged mobility norms, however the resistance from car owners resulted in a polarization, eventually morphing the project into a project aimed at increasing social cohesion, rather than tackling urban mobility challenges (VanHoose and Bertolini, 2023). This coincides with findings from three different experiments in London, Munich and Bologna, where use value and the social cohesion resulting from the street experiments were valued higher than mobility-related goals (Smeds and Papa, 2023).

4.3.2. Institutional regulations and processes

Five empirical studies noted *institutional regulations and processes* as a barrier (Eyler et al., 2015; Hipp et al., 2017; Stevens et al., 2023; VanHoose and Bertolini, 2023; VanHoose et al., 2022). This barrier recalls the incompatibility between “innovative, especially human-scaled, modes and with existing street regulations” (Glaser et al., 2020). While many street experiments feature the local government in at least a supporting role, it is important to realize that municipalities are composed of different departments and individuals with—at times—“diverging interests, resources and priorities” (VanHoose and Bertolini, 2023), which helps to explain why institutional regulations and processes remain a barrier, even for experiments that are organized by the municipalities themselves. Municipalities represent the formal institutions behind established transport planning traditions, which are ultimately at odds with the nature of experimentation (Dijk et al., 2018). For instance, the Umparken Schwabing experiment was characterized as not fitting into “the usual processes of the city of Munich at all” (VanHoose et al., 2022, p. 8). Nearly half of the organizers of Open Streets who wanted to expand their initiative noted, alongside funding, arranging permits as a barrier (Hipp et al., 2017). During the Weesperzijde testbed in Amsterdam, resident’s application for a Living Street was denied by the Municipality on the grounds of insufficient funds, doubts about public support and the lateness of the application, which should have been submitted ten weeks prior to the start of the event (VanHoose et al., 2022). The residents managed to find a loophole in the bureaucratic system, applying and receiving temporary parking permits intended for moving or construction (Ibid., 2022). This chain of events stunted the relationship between two parties, ultimately leading to a less successful experiment (VanHoose et al., 2022). Likewise, in Melbourne, obtaining a short-term event permit rather than long-term appropriation of on-street parking spaces was key to the Playful Parklet’s implementation (Stevens et al., 2023). In Ghent, the civil servants responsible for the organization of the Living Streets strategically decided to set up a non-governmental organization when the experiment became limited by bureaucratic processes (VanHoose and Bertolini, 2023). This move was further made in order to accept funding from external parties (Ibid., 2023). After years of experimenting, the Living Street project was adopted by the municipality and modified to fit into formal institutional processes (e.g. dedicated start and end date, using a crane to place street furniture instead of letting residents do it themselves). This, however, resulted in a ‘watered down’ version of the experiment, suggesting that institutionalizing experiments may be a barrier as it undermines their insurgent quality (Ibid., 2023).

5. Discussion

5.1. Implication of results

Based on the literature review, barriers and enablers to the transformative process of street experiments are identified and categorized according to the ‘experiment internal’ and the ‘experiment external’ categories. The implications of these findings are discussed below (see Fig. 3 for a graphic overview).

Four barriers which could be categorized as ‘experiment internal’ or falling within the experiment’s control, were identified: *a lack of required resources, uncondusive design, a lack of a clear vision* and *low frequency*. The most cited internal barrier identified in the literature review is a *lack of resources*. City street experiments require a great deal of resources. These range from financial support to physical materials to human resources like time and knowledge. In regards to financial means, the empirical sources noted that diverse and stable funding sources can be helpful should political leadership change and support from local administration be discontinued. When the necessary resources for organizing an experiment are absent, organizers can be forced to adapt the project and downsize their aims and ambitions. The second and third internal barriers are *uncondusive design* and *a lack of a clear vision*. According to the empirical studies, street experiments should be designed with users in mind. This includes designing for safety (i.e. separating pedestrians and cars) and promoting social interactions. Street experiments should also be clear in their ambitions and goals, and be weary of overly planning and being too ambitious. Lastly, the *low frequency* of experiments, which was only mentioned in regards to the one-day long Open Streets initiatives, was identified as one reason for their limited impact. These one-day experiments significantly differ to those featured in the other studies, which lasted on average several months. While the exact duration necessary for street experiments to be impactful was not explicitly mentioned, it can be concluded that they should at least be longer than one-day events.

Two enablers internal to the experiment were identified: *active promotion* and *including stakeholders*. By embedding experiments in long-term policies, support can be galvanized and existing resources can be utilized. Including stakeholders allows the stakeholders involved in the experiment to ‘warm up’ to the idea, and active promotion helps to get the word out about the project and inspire repeated versions or new initiatives elsewhere. Institutional support takes on different forms and varies in terms of involvement. Political backing, formal leadership and provision of resources can all help to support experiments, which as explained above, are a necessary component to street experiments.

Two additional enablers were classified as belonging to both the experiment ‘internal’ and ‘external’. These included *embedding experiments in long-term policies* and *institutional support*. These two barriers were classified as such because they are both dependent on the experiment’s own effort to garner support and to lobby for a position within long-term policies, as well as the willingness of formal institutions to allow them to do so. These two enablers seem dependent on the role that municipalities adopt towards street experiments, the dichotomies between different municipal departments, and the political climate at the time.

Interestingly, all of the enablers were explicitly mentioned in relation to the primary external barrier, *opposition from stakeholders*. This barrier stems from the deep-rooted belief that streets are for cars, and such experiments ‘undermine the principle of ‘automobility as a right’” (Vitale Brovarone et al., 2023, p. 2). For this reason, opposition primarily stems from a behavioral preference for individual car owners and fear of being inconvenienced or from business owners with a fear of losing clients if car access is removed. Moreover, because street experiments’ aim to transform urban mobility, which can be viewed as a collective good (Nikolaeva et al., 2019), they automatically include a diverse set of actors. Any person who uses the street or passes becomes a participant in the experiment, which can lead to feelings amongst

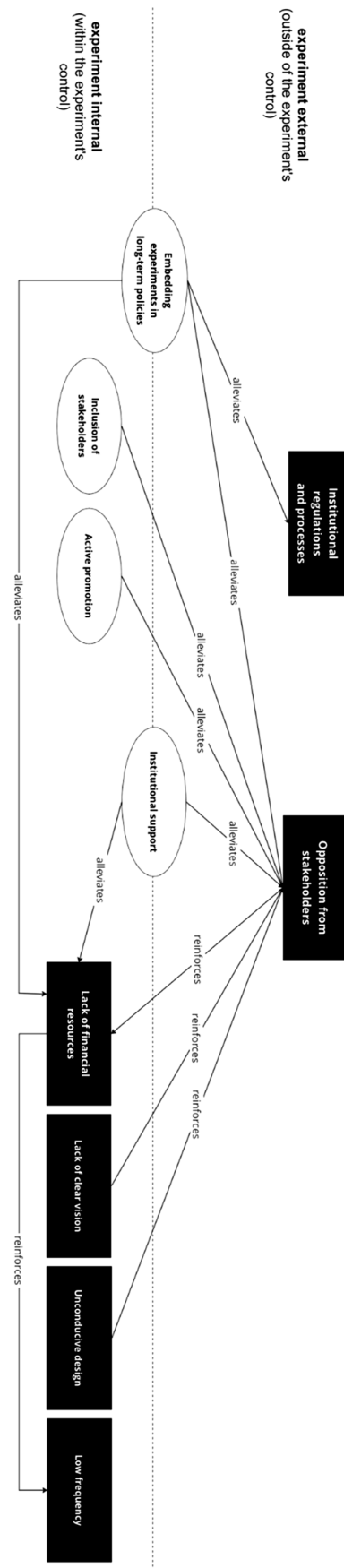


Fig. 3. Relationship between the barriers and enablers. The white circle icons indicate enablers and the black rectangles indicate barriers.

stakeholders that an experiment is happening to them, rather than participating on their own accord, resulting in conflict and opposition. The second external barrier, *institutional regulations and processes*, is related to an inherent difference between experimentation and traditional methods of urban planning. These include rules and regulations related to road use, and the permits required in order to temporarily transform streetscapes. Because city street experiments aim to transform urban space, they are forced to ‘dance’ with established rules and processes. Despite the fact that most street experiments are implemented by municipalities, or at least have to collaborate with them, institutional regulations and processes remain a barrier. While finding loopholes is possible, as shown by the Weesperzijde testbed in Amsterdam, this can lead to damaged relationships between involved parties.

5.2. Relationship between the identified enablers and barriers

Interestingly, these findings revealed explicit links between the enablers and barriers (see Fig. 3). First, *opposition from stakeholders can reinforce the lack of resources*. These two barriers can be traced back to two inherent characteristics of city street experiments and are therefore inextricably linked. As niche innovations, street experiments are vulnerable and require a great deal of support, especially in light of opposition from stakeholders as a result of their inherent aim to challenge the status quo. The required resources increase when street experiments have to defend their position, negotiating with opposing residents, business owners and policy makers, as made clear in the study of Open Streets across the United States.

Second, *unconducive design and a lack of a clear vision can reinforce opposition from stakeholders*. If the design of an experiment is not user-friendly, this can lead to its underuse and complaints from users, like in the South Woodford parklet in London or the car-free experiments in Malmo and Gothenburg where pedestrians didn’t feel safe while occupying the street. Similarly, when a clear vision is absent, stemming from too many goals or unclear ambitions or role division, stakeholders begin to question the legitimacy of the project, increasing opposition, like in the case of the Torino Mobility Lab.

Third, *embedding in long-term policies, active promotion, including stakeholders and institutional support can alleviate opposition from stakeholders*. As mentioned above, all four of these enablers are referred to in the empirical studies as ways to combat resistance. As shown by the Torino Mobility Lab, contextualizing experiments in already existing policies can help to legitimize their intentions and alleviate opposition. Active promotion not only gets the word out, but also reduces resistance and prevents conflicts by explaining the intentions of the experiments to stakeholders. In several of the studies, *including stakeholders* was referred to as a strategy for combating resistance from opponents of the experiments, enabling the process, rather than a necessary condition when organizing street experiments. Backing from formal institutions helps to justify the experiment’s aims and ambitions to stakeholders, which in turn can lower the amount of resistance.

5.3. Two dilemma’s for city street experiments

These findings and the relationship between the barriers and enablers highlights two dilemmas. The first is the balance between the enabler *institutional support* and the barrier *institutional regulations and processes*. First, and perhaps most conspicuous, it is intriguing that city street experiments, which are often initiated by local governments, continue to face hurdles that stem from their own institution. This highlights a disconnect between established regulations and the flexibility of experimenting, which continue to exist parallel to each other. Second, formal institutions have access to the much-needed resources street experiments require (e.g. financial, material, time), and can additionally provide them with legitimacy. Political backing can further give experiments clout with opposing or wary stakeholders. However, once experiments are established, tensions arise between the once-

needed support offered by local governments and the restraining nature of the institutional processes that characterize such formal institutions. The latter was clearly described in two empirical studies. First, the Living Streets in Ghent, in which the organizers who worked for the municipality formally split from their institution in order to be able to accept funding from outside parties and work outside the confines of bureaucracy. Second, in the analysis of the Open Streets, empirical studies noted the necessity of institutional support for the sustainability of the initiatives, but also mentioned that not having to depend on their support alleviated worries related to financial support amidst local political administration changes. These two points raise important questions regarding the balance between institutional support and the longevity of such experiments. How can local governments support and implement street experiments without constraining them?

The second dilemma concerns stakeholders. Perhaps most astonishing is that the enabler *including stakeholders* is explicitly mentioned as a strategy for dealing with opposition, rather than as a necessary or standard part of organizing a street experiment. This highlights an important question related to participatory processes and procedural democracy in the context of urban experimentation. Because they occur parallel to standard urban planning procedures, there are little to no ‘rules’ regarding the inclusion of stakeholders in the organization of street experiments. This represents an intriguing insight. In their transformation of urban mobility and public space, street experiments automatically involve a diverse range of stakeholders, however purposefully involving those stakeholders in the process is viewed as anything but essential. In many cases, it appears as if stakeholders are usually included when opposition arises. However, as the findings of this literature review show, opposition from stakeholders is a major and very common barrier, one that I would argue, is inherent to city street experiments. Taking this into account, it is therefore crucial to realize that opposition as a result of transforming the streetscape is very likely. Including stakeholders, both those for and those against, should be precedent rather than an afterthought, especially in light of the lack of resources already posing as a barrier to street experiments and the extra resources this requires.

6. Conclusions

As city street experiments continue to be employed, understanding the transformative process, or the process by which experiments cause system change, represents an important knowledge gap. By way of a literature review, this paper identified barriers and enablers to the transformative process of city street experiments. The findings, rooted in empirical studies, feature a direct link to practice and represent important lessons for practitioners and more generalizable implications for scholars concerned with the link between city street experiments and system change.

Interestingly, the literature review resulted in the majority of barriers and enablers for street experiments being identified as ‘experiment internal’. While the purpose of this study was to make a first step in simply identifying barriers and enablers to the transformative process, and not to qualify them or determine hierarchies, this result suggests that the majority of the identified challenges for street experiments fall within their own control. These barriers are related to practical issues of planning and organizing, including frequency, determining clear goals, remaining manageable in terms of ambitions, and considering users in the design. Moreover, the enablers that are internal to experiments, including embedding in long-term policies, institutional support, actively promoting experiments, and including stakeholders all fall within an experiment’s arsenal to combat external barriers. Taking this into consideration, it can be concluded that street experiments have a great deal of agency and control, and are perhaps not as vulnerable as the literature regarding experimentation suggests (Geels, 2012).

Still, as shown by the empirical studies, the transformative process does occur in a vacuum, and street experiments are at least somewhat

dependent on external factors. Two barriers in particular represent more wicked problems for such experiments. Established institutional processes and opposition from stakeholders remain serious barriers for these initiatives. Discovering how to support street experiments without constraining them represents an important dilemma for municipal administrations. Additionally, understanding how to involve stakeholders and accommodate for the inevitable opposition that will arise constitutes an important consideration. These implications for the transformation process demand further speculation, including where to invest precious resources and time, and where not. Determining the further relationship between these barriers and enablers, which are indispensable and which are not, and the full agency that experiments possess represents an important next step for research.

CRedit authorship contribution statement

Katherine VanHoose: Conceptualization, Data curation, Formal

Appendix A

Table A1

List of selected peer-reviewed, empirical studies of city street experiments published between 2013 and 2023 (in alphabetical order).

Author(s)	Year of publication	Focus of empirical analysis	Name (if applicable) and type of experiment (Bertolini, 2020)	Location(s) of experiment(s)	Duration	Mentions barrier and/or enabler
Brovarone et al.	2023	Analysis of actor conflicts in street experiments	Turin Mobility Lab, entire re-purposing	Turin, Italy	12 months	Yes
Eyler et al.	2015	Analysis of success factors for experiments	Open Streets, flexible closure	United States	1 day ¹	Yes
Glaser and Krizek	2021	Inventory of street experiments during COVID-19 pandemic	Open Streets and Slow Streets, flexible closure	United States	6 months	Yes
Hipp et al.	2017	Analysis of success factors for experiments	Open Streets, flexible closure	United States	1 day	Yes
Marcheschi et al.	2022	Analysis of resident's acceptance of street experiments	entire re-purposing	Malmö and Gothenburg Sweden	4–5 months	Yes
Montero	2017	Shifting rationalities and constellations of local and transnational actors and networks in street experiments	Ciclovias, flexible closure	Bogotá, Colombia	Closed on Sunday's for seven hours (72 events per year)	Yes
Oliver and Pearl	2018	Analysis participation tools in relation to street experiments	Superblock, entire re-purposing	Barcelona, Spain	4 months	Yes
Torres et al.	2013	Assess physical activity, safety, social capital, and equity of street experiments	Ciclovias, flexible closure	Bogotá, Colombia	Closed on Sunday's for seven hours (72 events per year)	No
Sarmiento et al.	2017	Analysis of barriers and enablers for scaling-up experiments	Ciclovias, flexible closure	Bogotá, Colombia	Closed on Sunday's for seven hours (72 events per year)	Yes
Scudellari et al.	2020	Explore the potentialities and constraints when implementing street experiment in an existing neighborhood	Superblock, entire re-purposing	Barcelona, Spain	4 months	Yes
Smeds and Papa	2023	Analysis of citizen perspectives on street experiments	partial re-purposing, parklet	Munich, Germany London, UK Bologna, Italy	Not stated	Yes
Stevens et al.	2023	Analysis of success factors of street experiment	Playful Parklet, parklet	Melbourne, Australia	Not stated	Yes
VanHoose and Bertolini	2023	Impact of the role local government adopts towards street experiments	Living Streets, entire re-purposing	Ghent, Belgium	2–6 months	Yes
VanHoose et al.	2022	Exploring relationship between transitional capacity of street experiments and system change	entire re-purposing	Amsterdam, Netherlands Munich, Germany	3–6 months	Yes
Van Wymeersch et al.	2018	Analysis of the political ambivalences of participatory planning processes during street experiment	Living Streets, entire re-purposing	Ghent, Belgium	2 months	No
Verlinghieri et al.	2023	Analysis of conflict which occurs during street experiment	Turin Mobility Lab, entire re-purposing	Turin, Italy	12 months	Yes
Zieff et al.	2013	Analysis of success factors for street experiments	Sunday Streets and Open Streets, entire re-purposing	San Francisco and St. Louis, USA	1 day	Yes

The frequency and duration of the Open Streets were unique to the location. Some cities hosted only one event per year, while others were more structural, implementing five-hour long closures one Sunday a month for a period of eight months (Eyler et al., 2015).

analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Katherine VanHoose reports financial support was provided by JPI Urban Europe.

Data availability

The data is in the form of empirical studies which are already available given they are open access.

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