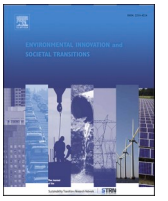
Environmental Innovation and Societal Transitions 57 (2025) 101007

Contents lists available at ScienceDirect

Environmental Innovation and Societal Transitions

journal homepage: www.elsevier.com/locate/eist



Research article

Beyond temporary measures: How experiential learning in street experiments shapes urban mobility transitions

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ARTICLE INFO

Keywords:
Tactical urbanism
Urban experimentation
Learning
Urban mobility transition
COVID-19 pandemic

ABSTRACT

Tactical urbanism aims to rapidly transform urban environments through iterative experimentation. However, we know little about how learning shapes the long-term effectiveness and transformative potential of these interventions. This paper examines the role of local government implementers' learning in sustaining tactical urbanism practices, specifically through the lens of street experiments implemented during the COVID-19 pandemic. Using experiential learning theory as a conceptual framework, we conducted and analysed interviews with 40 government representatives associated with 28 street experiments across 21 cities globally. Our analysis reveals three distinct learning processes among the implementers, arranged progressively: (1) implement and execute, (2) experiment and perpetuate, and (3) experiment and conceptualise. While implementers engaging primarily in the first two processes demonstrated responsiveness by leveraging tactical urbanism during systemic disruptions, they rarely generated transferable knowledge or sustained transformative impacts. By contrast, implementers who adopted the third approach – experiment and conceptualise – actively reflected on and generalised their experiences, leading to deeper learning and structural changes. These implementers effectively harnessed street experiments as catalysts for broader urban mobility transitions. By providing empirical evidence from diverse global contexts, this study advances our understanding of how learning processes influence the development of tactical urbanism projects. These insights could assist urban practitioners in seeking to embed meaningful, lasting change in urban mobility through iterative experimentation.

1. Introduction

Tactical urbanism emerged as a school of thought that advocates for path-deviating planning processes through temporary and experimental designs, diverting from blueprint city planning (Karvonen and Bylund, 2023; Wohl, 2018). Tactical urbanism is a concept of urban space creation that focuses on temporary and experimental processes. Its applications include street experiments – temporary physical or regulatory changes designed to promote people-centric street transitions (Bertolini, 2020). It entails intentional, temporary interventions implemented to test alternative urban design prototypes. As a "build-measure-learn" paradigm (Lydon and Garcia,

Acronyms and Symbols: PISEs: pandemic-induced street experiments; CE: concrete experience; RO: reflective observation; AC: abstract conceptualisation; AE: Active experimentation; >>: indicating progression

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https://doi.org/10.1016/j.eist.2025.101007
Received 18 February 2024; Received in revised form 7 May 2025; Accepted 18 May 2025
Available online 28 May 2025

2015), tactical urbanism delivers agile and adaptive urban developments that complement strategic planning (Vallance and Edwards, 2021). The paradigm involves implementing a temporary prototype, evaluating its effectiveness, and improving the design, forming an iterative design process to produce user-centric urban changes. The "measure" element involves collecting post-installation data to inform learning and iterative designs, transforming quick-build projects into permanent structures. Tactical urbanism is a subset of the broader concept of urban experimentation, which encompasses temporary interventions in land use and transportation to test alternative solutions for creating more sustainable urban environments. These initiatives often begin on a small scale but have the potential to scale up and challenge established urban practices (Hoogma et al., 2002; Köhler et al., 2019).

This experimental way of urban transformation has gained traction in recent years. Notable tactical urbanism projects include parklets, Times Square pedestrianisation, and Superblock street transformations (Herman and Rodgers, 2020; Sadik-Khan and Solomonow, 2016; Staricco and Vitale Brovarone, 2022). These projects started with low-cost and temporary prototypes using construction materials and paints, gradually converting into permanent street changes. More cities are adopting this street transformation approach, as evidenced by the street experiments during the COVID-19 Pandemic on a global scale (J. Zhao et al., 2024). The tactical urbanism approach is praised for its agility, cost-effectiveness, and capacity to accelerate people-centric street transitions (Semenza and March 2009; Verhulst et al., 2022).

While being innovative and community-driven, tactical urbanism projects faced criticisms for their short-lived nature and limited transformative impact. Research indicates that street experiments tend to be one-off events that fall short of achieving substantial and long-term urban transformations (Bertolini, 2020). Moreover, despite being an innovative approach, urban experiments often conform to existing structures rather than pushing for transformative change (Evans et al., 2021). Consequently, there is an increasing scholarly focus on bridging the gap between theoretical models and practical implementation to fully realise the transformative potential of these urban initiatives.

Research in urban experimentation highlights learning as crucial for achieving successful transformation. However, learning is vaguely conceptualised in tactical urbanism. We look at learning from a cognitive dimension, defining it as one's adaptation to the environment through transforming experience into knowledge (Kolb, 2015; von Schönfeld et al., 2020). It is essential for the sustainable transformation of societal systems (Stam et al., 2023). Effective learning enhances stakeholders' collective ability to implement path-deviating changes that promote sustainability (Wolfram, 2016). Learning is distinguished into superficial and deep learning (van Mierlo and Beers, 2020), in which deep learning is associated with more transformative outcomes, moving beyond fitting into existing frameworks towards stretching and transforming them (Evans et al., 2021). However, the build-measure-learn paradigm (Lydon and Garcia, 2015) often falls short of capturing the learning process beyond individual projects and fails to address the complexity of the iterative process. For tactical urbanism to incur longer-lasting changes and be integrated into mainstream planning practices, the implementers' learning needs to extend beyond an accumulation of data and facts. It requires a more profound, iterative process that can fulfil the broader vision of sustainable urban transformation.

This study explores how implementers in local governments generate new knowledge through tactical urbanism practices and how this learning alters their subsequent actions, thereby shaping the transformative potential of these projects. We used a series of case studies from pandemic-induced street experiments (PISEs) to examine how implementers derived inspiration, generated knowledge, and achieved transformative outcomes. Pandemic-induced street experiments are temporary street interventions implemented during the COVID-19 pandemic. Characterised by their experimental and tactical nature, these interventions were often executed under time constraints and with limited resources (Combs and Pardo, 2021; Glaser and Krizek, 2021). For this study, we selected 28 interventions from diverse geographical regions, including Asia, Latin America, and Oceania, using the Global PISE Database (Zhao et al., 2024). We investigated the development trajectories of these interventions, focusing on implementers' sources of inspiration, challenges faced, learning processes, and reflections. This analysis was conducted using thematic analysis of interviews and policy reports, providing insights into how tactical urbanism practices and their learning outcomes contribute to urban mobility transition.

2. Literature review

2.1. The key role of implementers in tactical urbanism

Tactical urbanism initiatives often rely on strong leadership, which is crucial for setting a vision and translating it into tangible changes (Wolfram, 2018). For example, the Plaza Program in New York was spearheaded by the then-commissioner of the New York City Department of Transportation (NYCDOT), with support from the mayor, facilitating labour, funding, and legitimacy for radical road changes (Sadik-Khan and Solomonow, 2016). Similarly, Bogotá's Ciclovías, a weekly temporary street closure initiative, was driven by a bike activist who coordinated resources and implemented prototypes (Montero, 2017). Since leadership plays a pivotal role in tactical urbanism, the leaders' knowledge generation process is crucial to their decision-making and project development.

Increasingly, local governments are taking the lead in tactical urbanism, marking a shift from citizen-led to officially sanctioned practices (Andres and Zhang, 2020). In the 2000s, small-scale, unsanctioned projects like Parklets and Park(ing) Day were typical (Herman and Rodgers, 2020). By the 2010s, NYCDOT's involvement facilitated street transformations at iconic locations like Times Square, and key figures like Janette Sadik-Khan further promoted these techniques globally through Bloomberg Associates (Sadik-Khan and Solomonow, 2016; Bloomberg Associates, 2024). The 2020s saw governmental agencies gain more legitimacy to transform public spaces due to climate change and public health emergencies, with city governments becoming the primary initiators of street experiments during the pandemic (Glaser and Krizek, 2021).

Local governments are pivotal in tactical urbanism, acting as enablers, facilitators, or partners (Kronsell and Mukhtar-Landgren, 2018). They possess key policy instruments – nodality, authority, treasury, and organisation – that empower urban

experimentation (Mukhtar-Landgren et al., 2019). As enablers, government actors can leverage these instruments to support transformative urban experiments from their inception (VanHoose and Bertolini, 2023). Since learning is inherently an individual activity, the learning experiences of key implementers significantly influence their leadership and decision-making, making it crucial for the initiation and development of tactical urbanism projects.

2.2. Experiential learning in tactical urbanism practices

Tactical urbanism serves as a means of exploring cities' complex and unpredictable nature (Stevens and Dovey, 2023). It envisions a temporary-to-permanent transformation analogous to the niche developments in transition studies. For niches to be transformative, learning is one of the key components boosting the urban transformative capacity (Wolfram, 2016, 2018). Learning improves stakeholders' collective ability to make path-deviant changes towards sustainability. Understanding how learning occurs or is reinforced in tactical urbanism applications is key to fostering transitions (Beukers and Bertolini, 2021).

Currently, learning in tactical urbanism is limited to first-order learning. It involves drawing lessons from data analyses such as traffic count, travel speed, and public feedback, to inform better design (Lydon and Garcia, 2015). While this learning process is practical and straightforward, its focus on the accumulation of data and facts does not lead to transformative outcomes, as it does not enable changes in frames and assumptions towards niches (Schot and Geels, 2008). For example, the lack of second-order learning leads to a lack of reflexivity, thereby hindering the transformative potential of street experiments (Beukers and Bertolini, 2021). Second-order learning is needed to achieve transformative outcomes, as found in strategic niche management (Markard et al., 2012). This form of learning aims to protect niches through changes in visions and expectations (Hoogma et al., 2002; Raven et al., 2010; Schot and Geels, 2008).

Experiential learning is well-suited to analyse tactical urbanism as it is framed based on the process of experimentation. Experiential learning conceptualises learning as the process of adaptation to one's environment, whereby knowledge is created through the transformation of experience (Kolb, 2015; von Schönfeld et al., 2020). This approach can be applied to studying an individual's reflection and knowledge gained from a new experience. An individual's learning can then be socially transmitted through interaction in social networks (Stam et al., 2023), though the individual learning is the focus here. Experiential learning theorises learning as transactions among four adaptive modes. The concrete experience is at first apprehended by the learner and becomes divergent knowledge, which encompasses meanings and solutions specific to the experience. This stage is followed by reflective observation, where the learner generates assimilative knowledge through inductive reasoning and theory building. This is followed by abstract conceptualisation, a stage of creating concepts that integrate one's observations into logically sound theories, generating convergent knowledge through hypothetical-deductive reasoning. Finally, one applies the newly formed theories through active experimentation, generating accommodative knowledge in new contexts. Although called a learning spiral, it may not follow a unilateral order (Kolb, 2015). Using experiential learning as an analytical framework can help analyse the knowledge formation process in tactical urbanism practices, rationalise implementers' decision-making changes, and delineate tactical urbanism's contribution to transitions.

2.3. Development trajectories and relationship with experiential learning

The development of tactical urbanism projects is not a neutral or purely technical process determined solely by data collection and testing, as Lydon and Garcia (2015) outline. The way experiments are framed – whether ignored or encouraged – can significantly impact how they evolve. These projects can be manipulated by the institution's acceptance of them and influenced by policy and planning decisions (Savini and Bertolini, 2019a).

Research summarised four ideal-typical development trajectories: termination, marginalisation, assimilation, and transformation (Savini and Bertolini, 2019a). Projects that are not recognised as experiments may be ignored and unsanctioned by the institution, leading to their cessation, a process termed "termination." They can also continue to operate without institutional support, contesting the existing regime, which is referred to as "marginalisation." Even if experiments persist, they might reinforce the existing institution (fit-conform) rather than being transformative (stretch-transform) (Smith and Raven, 2012). In such cases, the institutions may support the projects but "assimilate" them into the existing system. Despite these challenges, an urban experiment can be "transformative" when it evolves from a niche into a newly established order, involving new actors, regulations, and urban spaces (Savini and Bertolini, 2019a).

Existing analyses of learning have underlined its influence on transitions, but often lack conceptual clarity, resulting in weak evidence of this direct relationship (van Mierlo and Beers, 2020; Van Poeck et al., 2020). Learning is conceptualised as a factor that stimulates niche-regime change within the multi-level perspective framework (Geels and Schot, 2007), but studies have struggled to provide convincing evidence (Stam et al., 2023). Previous studies have used qualitative data to analyse learning and outcomes, showing impact through verbal expressions by learners. For instance, Beers et al. (2016) used interview data to determine whether and to what extent decisions from learning episodes were acted upon in reality. Theories are available to help identify this process. Using transactional learning theory and multi-level perspective as analytical models, Van Poeck & Östman (2021) studied the effect of learning on habit enrichment and new habit formation in the context of sustainability transition. Practical epistemology analysis was used to understand how meaning is created in action when people encounter new situations.

Transition is a complex process influenced by multiple factors, making it difficult to isolate the influence of learning (Stam et al., 2023). Identifying the relationship between learning and transition is challenging. One challenge in analysing learning is distinguishing it from changes. Specifically, learning is often not sufficiently decomposed to identify its various components, such as the act of absorbing new knowledge versus the act of applying it (Stam et al., 2023; Van Poeck and Östman, 2021). Therefore, a clear set of

conceptual frameworks with well-defined learning theories is needed to identify the relationship between learning and transition. In the following section, we consolidate the reviews of key actors, learning processes, and development trajectories into a conceptual framework for understanding learning in tactical urbanism projects.

3. Conceptual framework: experiential learning in tactical urbanism

The leader's capacity to transform experience into knowledge significantly influences the development of experiments. While this study does not attempt to systematically evaluate learning through behavioural or social aspects, it focuses on individuals' knowledge formation through experimentation. To effectively analyse the influence of this knowledge on transitions, it is crucial to employ appropriate learning theories, detail knowledge generation, and substantiate their connections. To this end, we proposed a conceptual framework, based on Kolb's experiential learning theory, to explain the interplay between key implementers' experiential learning and the development of tactical urbanism projects. The process, described in Fig. 1, represents an ideal scenario that is tested through case studies.

In our conceptual framework, the experiential learning spiral represents the transformation of behaviour through the process of gaining new experiences to forming new knowledge (Kolb, 2015) (Fig. 1, left). In an ideal street experiment, the interventions would act as *active experimentation* (AE). Implementers would gain *concrete experience* (CE) by conducting these experiments. They then *reflectively observe* (RO) the implementations to identify desirable and undesirable outcomes. Through reflective observations, implementers can refine their *abstract conceptualisation* (AC) of tactical urbanism, building on previous learnings and completing a full learning cycle. When all four learning components – active experimentation, concrete experience, reflective observation, and abstract conceptualisation – are engaged, the iterative design process enables implementers to integrate new concepts into subsequent rounds of experimentation.

The transformative potential of street experiments can be understood through their development trajectories (Fig. 1, right). By progressing through the learning spiral, implementers can formulate new knowledge, derive new actions, and subsequently influence the development of a street experiment. Urban experiment development trajectories provide an analytical framework for studying street experiments (Savini & Bertolini, 2019). A 'transformative' street experiment is characterised by a newly established order, actors, and regulations that replace pre-existing conventions. It involves a path-deviating workflow compared to pre-pandemic norms and the sustained use of tactical urbanism methods. This trajectory is the most desirable, as it signifies a fundamental shift in how urban spaces are produced and infrastructures delivered. Other possible, but less desirable, trajectories include 'assimilation', where the experiment conforms to existing planning regime and loses its tactical characteristics; 'marginalisation', where the experiment continues but with limited momentum and visibility; and 'termination', where the experiment ceases altogether without reapplication.

While a transformative trajectory is ideal, it is not guaranteed. The formation of new knowledge, enabled by iterative learning, is key to achieving transformational outcomes. Implementers can influence the trajectory of street experiments by progressing through the learning spiral, generating new insights and actions. However, this process is not always realised, as indicated by the dashed arrow in Fig. 1. In urban experimentation, experiments are less likely to be transformative if they fail to deliver learning that applies beyond a single case (Beukers and Bertolini, 2021). Without effective learning, experiments may not lead to a far-reaching transition (Sengers et al., 2019). Consequently, in the absence of deep and transferable learning, street experiments are more likely to be assimilated into existing systems, marginalised, or terminated, rather than achieving meaningful transformation.

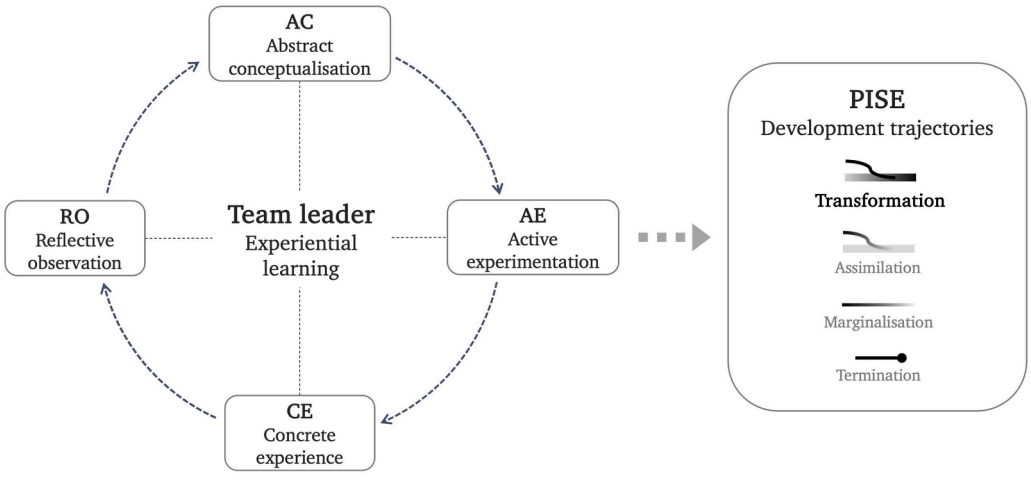

Fig. 1. Conceptual framework for experiential learning in tactical urbanism.

4. Research design and methods

4.1. Case study: pandemic-induced street experiments

The Pandemic-Induced Street Experiments (PISEs) provided a valuable opportunity to analyse tactical urbanism practices due to their broad geographical coverage and similar timeframe, all triggered or accelerated by the COVID-19 pandemic. In early 2020, COVID-19 had a sudden and global impact on urban street usage. As cities imposed lockdowns to kerb the virus, restrictions on vehicular traffic and the shift to remote work prompted city planners to reallocate street functions. PISEs were tactical, implemented quickly with limited time and resources, and experimental, with the possibility of removal as the pandemic situation evolved. These initiatives were mobilised by the pandemic emergency, making them a unique case to study.

The provision of people-centric streets, which accommodate more active mobility and social activities, has increasingly become a priority in urban political agendas. Cities like New York City and Amsterdam have spent years developing people-centric streets (Mould, 2014; Van der Zee, 2015). The pandemic accelerated these transitions in more cities (Combs and Pardo, 2021; Glaser and Krizek, 2021; Zhao et al., 2024). During the first seven months of the pandemic (March to October 2020), there were over 500 interventions in more than 300 cities, primarily in Anglo-European cities but also in Asian, Latin American, and, to a lesser extent, African cities, as documented in the Global Pandemic-Induced Street Experiment Geospatial Database (PISE Database) (Zhao et al., 2024). The majority (95 %) of PISEs were new initiatives triggered by the emergency, while others were plans accelerated by it (Combs and Pardo, 2021). Common practices included pop-up bike lanes, shared streets, and outdoor dining patios (J. Zhao et al., 2024). These initiatives were typically led by various government branches responsible for transport planning, road design, or transport management, predominantly at the municipal level.

We chose projects from the PISE Database based on intervention size, type, status, size of the host city, and geographical region. This approach ensures a comprehensive and representative analysis of PISEs, highlighting the diverse ways cities worldwide have adapted their streets in response to the pandemic. The selection criteria were as follows: (1) initiation in major world cities, which are influential globally or regionally and serve a large number of beneficiaries, based on the Globalisation and World Cities (GaWC) rankings (GaWC, 2020) – larger cities were prioritised as PISEs often occurred in such locations, (2) city locations spread across six geographic regions as defined by the United Nations (Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania), (3) inclusion of major experiment types: outdoor dining, pop-up parks, shared streets, temporary bike lanes, and street closures (Gregg et al., 2022), and (4) coverage of various intervention statuses: termination, continuation, and permanence.

4.2. Data collection

We collected key implementers' learning in temporary intervention implementations from representative cities. With the shortlisted 58 interventions, we invited the key actors for interviews. The interviewees should be the initiators or managers who have been deeply involved in the projects and have held decision-making roles in the PISE developments. Our typical informants included transport planners, programme managers, deputy chief architects, and high-ranking city officials. Ultimately, 38 eligible informants from 28 PISEs across 21 cities participated in the study (Fig. 2). The remaining 30 PISEs were excluded either due to a lack of available interviewees or because the cases did not align with our definition of pandemic-induced street experiments.

Despite the attempt to reach a global data coverage, two factors contributed to the predominant presence of Global North cities in our study: a higher number of documented interventions in these cities and better interview retention rates. Projects that were excluded due to insufficient interviewees included street interventions from Quito, Jakarta, Lima, Quezon City, Mandaue City, Toronto, Montreal, Boston, and Rome. Projects removed for misalignment with the street experiment definition were Kampala and Jinja. Detailed information on the informants and cases can be found in Appendix Table A1. Informants are referred to by their assigned numbers.

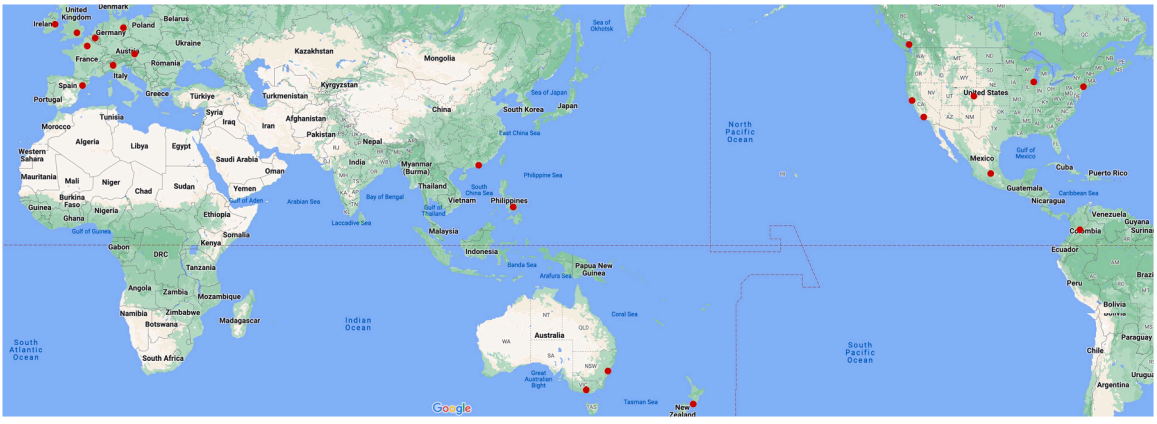

Fig. 2. Locations represented by the informants.

The semi-structured interviews were guided by the experiential learning framework, incorporating four learning components: concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC), and active experimentation (AE) (Kolb, 2015). Interview questions were designed to capture informants' experiential accounts, beginning with their inspirations for applying temporary implementations and their initial conceptualisation of tactical urbanism (AC). We then enquired about the implementation process, enabling policies, street intervention differences from pre-pandemic practices, and encountered challenges (CE). Informants were asked to reflect on their experiences, including post-installation evaluation channels, feedback processing, advantages and disadvantages of tactical urbanism, and shifts in their perspectives on street interventions (RO/AC). Finally, we asked what new practices were (or would be) adopted as a result of the pandemic street intervention experiences (AE). The general form of interview questions is presented in Appendix Table A2. Interviews, conducted virtually or face-to-face, lasted between 40–120 min and were conducted after the pandemic stabilised worldwide, between July 2022 and January 2024. All interviews were conducted in English, recorded, and transcribed. Secondary data were used to enhance context-specific knowledge and triangulation.

When studying similar applications in multiple contexts, it is important to understand the background to which the projects were inspired, initiated, and embedded (Stake, 2006). A case portfolio was compiled for each PISE program prior to the interview and continuously refined throughout the research. This key portfolio included the programme descriptions, key actors, key implementer backgrounds, host city planning contexts, experiment triggers, current status, development trajectories, outcomes, alignment with broader planning visions, public sentiments from news and social media, and any precedent street experiment attempts by the initiating agency. We sourced information from government documents, industry reports, media articles, scientific literature, social media posts, maps, and virtual town hall meetings to contextualise planning environments and informants' learnings. Photos and notes were taken around the intervention and the surrounding environment when in-person site visits were available. Key documents, selected from over 300 documents, are listed in supplementary materials.

4.3. Data analysis

We first identified the elements of knowledge formation emerging from tactical urbanism practices following our conceptual framework (Fig. 1). For abstract conceptualisation (AC), we searched for instances where informants formed generalisable knowledge from their experiences or education. We did not expect scientific theories generated from the ground up, but we were searching for a level of abstraction from the informants that would be transferable to other experimental practices. For active experimentation (AE), we identified actions demonstrating the application of this acquired knowledge. Although some interventions were not explicitly labelled as experiments, trials, or pilots, they were considered experimental due to their radical departure from previous practices and the implementers' limited prior experience. Concrete experience (CE) was identified through informants' descriptions of the implementation processes, which were expected to be neutral and devoid of personal views. Reflective observation (RO) was recognised when informants retrospectively and critically shared their perspectives on the street experiment experience. We then mapped the learning processes based on the chronological order and logical connections articulated by the informants.

Next, we examined the contribution of learning to development trajectories by identifying sequential and causal links between learning and development. We used the reflexive thematic analysis method to guide the coding process (Braun and Clarke, 2022). Development trajectories were traced through programme developments, policy changes documented in official records, and informant accounts of changes induced by pandemic street interventions. We coded pathways linking learning components and development trajectories by analysing informants' accounts of temporal sequences and causal relations in project development stages (e.g., "because", "therefore", and "then"). We also aimed to identify the factors influencing the learning processes and development trajectories by coding the informants' accounts and case documents. Finally, we synthesised the coding results to identify recurring patterns. The coding for all learning components and development trajectories are documented in the supplementary materials.

While our research design offers valuable insights, a few inherent assumptions and limitations should be acknowledged. We assume that key implementers' leadership plays a significant role in the development of street experiments. However, this leadership is influenced by factors such as political support, funding availability, and organisational structure. Although informants are deeply involved in these projects, they do not solely determine their development. Their insights, however, still provide valuable context on the decision-making processes and the factors influencing the continuation or discontinuation of experiments. Regarding case representativeness, we encountered limited responses from inactive projects, likely due to shifting priorities of project leaders. Despite this, we were able to gather feedback on the challenges of the tactical urbanism approach from informants with discontinued projects, thereby providing a balanced view. Additionally, our research design does not capture longitudinal learning or insights from the entire project team. We focused on key actors who provided an overview of the most pertinent learnings for street experiment developments. While there may be other aspects of learning not captured in our study, we believe the key insights provided by these informants are highly relevant. Lastly, while PISE outcomes primarily rely on narratives from government representatives, we addressed potential biases by triangulating data from various independent sources, including social media posts, public documents, news articles, and online comments. This approach ensures a comprehensive understanding of public sentiment and the broader impact of the interventions.

5. Learning processes and development trajectories

5.1. The baseline: experiment based on existing knowledge (AC>>AE<<CE)

This section outlines the various starting points of the learning process. We found that informants built their experience on prior

knowledge, which served as the baseline or starting point of their experiential learning spiral in PISEs. Tactical urbanism was already familiar to most informants before the pandemic, with a few having directly practised tactical urbanism interventions (CE). These prior experiences enabled them to develop an understanding of the strengths and weaknesses of this approach before applying it to PISEs. During the pandemic, many informants reported that their prior knowledge guided their street experiments, suggesting that the experimentation stage (AE) was strongly influenced by earlier learning components (Fig. 3). These learning sources ranged from direct experience (CE) to structured and unstructured forms of learning (AC), shaping the ways informants approached and navigated their learning processes.

Informants gained relevant knowledge through professional training, intercity learning, and past experiences, with examples emerging from cities like Bogotá, Barcelona, and Milan. For instance, the informant from Bogotá's Mobility Secretary had prior experience in implementing cycling routes and Ciclovías, which have been a weekly event in the city since the 1970s (Montero, 2017). Their familiarity with route selection and existing interdepartmental collaboration enabled efficient resource allocation during the pandemic emergency. "*[IDRD (English: Bogotá Institute of Recreation and Sport)] used to close streets or segregate avenues each Sunday during Ciclovías, so they have experience and the material to do what was needed for the temporary bike lanes.*" (LA01 Interview). Similarly, in Barcelona, the informant had already applied tactical urbanism through the city council's urban reform agenda, known as the Superblock project. "*[the city council] started with some tactical interventions in 2012, but it was just mainly paints … then the second part was in 2016, when the Superblock project was started … then the Superblock in San Antonio came in 2018–19, combining tactical interventions with the structural interventions*" (EU08 Interview). Building on this progression, the city council used tactical urbanism during the deconfinement period in April 2020 to promote active mobility and reduce private car use (EU08 Document). In Milan, informants for the Open Streets initiative (Strade Aperte) collaborated with Bloomberg Associates, a consultancy group, to implement tactical urbanism projects. "*2018 was the first step into the idea of transforming the city with just road paint, benches, tables*" (EU05 Interview). This experience informed their pandemic response, which became part of the Milan 2020 Adaptation Strategy (EU04 Document).

In addition to experiential knowledge, several informants gained conceptual understanding through study programmes. These structured learning opportunities provided both theoretical grounding and motivation to apply the acquired skills in relevant situations. For example, one informant noted: "*We've been to the NACTO Designing Cities Conference in 2019*" (OC01 Interview). The conference raised the programme manager's interest in tactical urbanism. Although the learning was unrelated to the pandemic, their pre-existing familiarity allowed them to adapt and apply tactical urbanism quickly during the crisis. Observing international trends further strengthened the case for adopting this approach. "*We were focused on the global situation and understanding what was happening.*" (OC01 Interview). While this learning was not initially intended for emergency situations, it was transformed into actionable knowledge during the rapid deployment of bike lanes. Other structured learning experiences included study tours (EU03 Interview), summer schools (OC05 Interview), and capacity-building workshops (AS01 Interview). Many informants cited Dutch and Danish cases of active mobility transformations as key sources of inspiration. The association of tactical urbanism with Western success stories, particularly from Amsterdam and Copenhagen, reflects the influence of elite education in Western institutions (Montero et al., 2023).

In contrast, other informants reported learning tactical urbanism during the pandemic from less structured sources, such as media and professional networks. For example, the representative from Berlin's District Office Friedrichshain-Kreuzberg, one of the earliest implementers, drew inspiration from media exposure. "*I saw a film about Bogotá in Colombia and Ciclovías… they used construction material which is used only temporarily for construction sites … I transferred [that idea] to our situation. Of course, we have a different situation in law … but the basic idea was from Colombia.*" (EU07 Interview). In this case, the informant conceptualised tactical urbanism through exposure to successful cases and then applied the concept in practice.

Fig. 3. Experiment based on existing knowledge (AC>>AE<<CE) (Diagram: author, images: NACTO).

Professional networks also played a critical role in knowledge transfer, often facilitated by shared language and institutional similarities. For example, Vancouver informants reported learning from other Pacific West Coast cities where similar institutional contexts facilitated policy transfer (NA01 Interview). In Vienna, an informant who maintained correspondence with Berlin officials implemented pop-up bike lanes early on, in March-April 2020 (EU01 Interview). In New York City, the NYCDOT informant recalled mutual learning among cities pursuing similar strategies. "*There were a lot of lessons learned and shared experiences from other cities that we all learnt from. [The learning] was as more, person to person, and then, reading news articles about what was happening in other cities.*" (NA08 Interview). These street intervention initiatives emerged as the result of collective learning among government representatives, driven by a combination of independent thinking and mutual exchange.

5.2. Learning process 1: implement and execute (AE>>CE(>>RO))

The "implement and execute" learning process is characterised by an incomplete learning trajectory, typically progressing from experimentation (AE) to concrete experience (CE), and sometimes extending to result observations (RO) (Fig. 4). Among the cases analysed, five informants demonstrated progression through two steps of this learning process (AE>>CE>>RO), while one informant exhibited only a single step (AE>>CE). This partial progression was insufficient to generate meaningful or sustainable changes.

The general learning pattern can be summarised as follows: implementers applied PISEs during the emergency and made a binary decision to either perpetuate or remove the interventions after the experimental period. Tactical urbanism was used to enhance resilience, but it was not integrated into governments' standard workflows for street changes. For example, in Mexico City, pop-up bike lanes were implemented when roads were free of traffic. As the pandemic eased, one intervention was made permanent while another was removed (LA02 Interview). Reflecting on this, the informant acknowledged the benefits of tactical urbanism in enabling flexible and unconventional street changes (LA02 Interview), yet their perspective on the approach remained unchanged. They viewed tactical urbanism as unsuitable under normal traffic conditions, framing its application during the pandemic as a one-time opportunity afforded by the reduced traffic flow. With the return of normal conditions, there were no plans to install additional cycle lanes tactically, nor were any regulatory changes made to support tactical urbanism post-pandemic. This reflection highlights that their learning was context-specific. While they recognised tactical urbanism's utility in an emergency, the lessons learned were not transferred to other contexts, resulting in one-off applications and a termination of the learning trajectory.

The baseline experience may have prematurely shaped the informants' views on tactical urbanism, sometimes limiting their capacity for further learning. In Mexico City, the informant had prior experience with tactical urbanism on a major road, but the experiment was deemed ineffective as moving cars displaced the temporary traffic cones and barriers (LA02 Interview). This earlier failure informed their reluctance to adopt tactical urbanism again, despite its success during the pandemic. They attributed the success not to the approach itself but to the unique circumstances of reduced mobility during the pandemic. Similarly, in Barcelona, the city council applied pre-pandemic experience to the pandemic situation (CE>>AE). They widened sidewalks and cycle lanes on several arterial roads (EU08 Document). However, since the city did not evaluate the outcomes of the interventions, the learning process resembled a one-step trajectory (AE>>CE). These interventions were scheduled to be made permanent after the pandemic (EU08 Document). "*For [City of Barcelona], it was clear that it was just a temporary measure in [the pandemic] case … We are now working [on implementing structural changes to add new trees and street furniture]*." (EU08 Interview). The informant viewed the pandemic street changes as an intermediary step in a larger process of street transformation. Tactical urbanism was treated as an instrumental tool, with no expectation of generating new insights or learning. The informant and their organisation's existing experience may have reduced their motivation to adapt or explore new approaches when confronted with novel circumstances.

Although without prior experience, some implementers took a task-oriented approach and followed the *implement and execute* process. In Milan and Paris, temporary cycle lanes were rapidly installed to address both short-term needs and long-term agendas

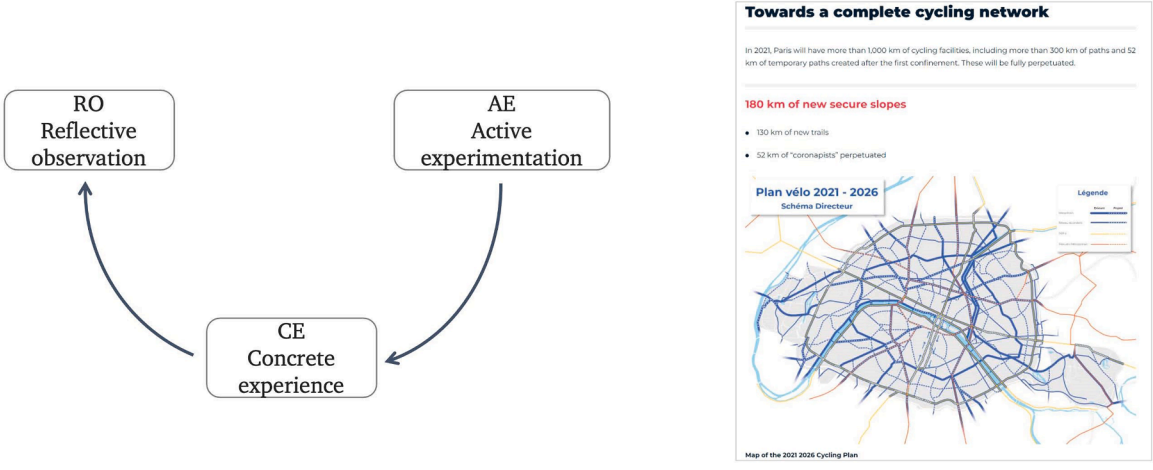

Fig. 4. Implement and execute (AE>>CE(>>RO)) (Diagram: author, image: City of Paris).

(EU04 Document, EU06 Interview). The Paris informants framed the intervention as a temporary solution aligned with political objectives. "*During the lockdown, it was clear to the government officials and the city departments that we had to find a solution to accommodate people for their everyday commute… cycling was the logical answer to that problem…[Developing bike infrastructure] was part of the campaign of Anne Hidalgo to get re-elected*" (EU06 Interview). In Milan, the pandemic elevated cycling's political priority, enabling swift infrastructure development. "*[Cycling] was never a priority of politics. During the pandemic, there was the opportunity for this discussion and change… The pandemic emergency gave us the real opportunity to change the way we plan and make the infrastructure for cycling*" (EU04 Interview). In both cases, the emergency was leveraged to achieve street changes at scale, but the process did not foster meaningful learning. Although post hoc evaluations – such as traffic data analyses, surveys, and interviews – were conducted, informants did not use the findings to inform future decisions. "*We already knew that it is useful to have [cycling priority design] solutions… For example in the UK, Germany, or in the north of Europe, they have been used for a lot of years. It's just something new for us… Now it is a rule.*" (EU04 Interview). In Paris, all temporary lanes were subsequently converted into permanent infrastructure (Mairie de Paris, 2021). These decisions to continue interventions reflected a task-focused process driven by execution rather than reflection or conceptualisation.

In these cases, informants prioritised policy execution over individual learning. Administrative mandates overshadowed personal learning trajectories, and the PISEs associated with these cases were either marginalised or terminated after their initial deployment. As a result, they lacked the momentum to influence how active mobility infrastructures are developed and delivered in post-pandemic contexts.

5.3. Learning process 2: experiment and perpetuate (AE>>CE>>RO>>CE)

The *experiment and perpetuate* learning process is characterised by an iterative cycle between reflective observation and concrete experience following initial experimentation (Fig. 5). This process creates a feedback loop between experiences (CE) and reflections (RO), allowing implementers to adjust street experiments based on post hoc evaluations and stakeholder feedback. The experiment and perpetuate process generates context-specific solutions, which can be described as divergent knowledge in experiential learning (Kolb, 2015). This approach aligns with the concept of single-loop learning, which involves refining strategies and actions to address specific problems (Armitage et al., 2008). However, divergent knowledge typically lacks generalisability, as it does not lead to the convergence of broader knowledge applicable across contexts.

In Bogotá, the informant and their team deployed 84 km of temporary bike lanes in March 2020 (AE). After the initial implementation, they evaluated the pop-up bike lane ridership (CE>>RO). "*The monitoring of the TBL is carried out through quantitative and qualitative variables*" (LA01 Document). The evaluation provides a systematic way of observing the experiment result (RO). In addition, the informant was pressured by stakeholders with conflicting interests to decide whether to continue the temporary bike lanes. "*We had some cyclists fighting for the [cycling] space, but the community people lost a lot of travelling time because there was one lane less for buses and cars. We had to decide which bike lanes to be perpetuated and which ones to discontinue.*" (LA01 Interview). Through continued monitoring and deliberation, the informant decided to maintain 35 km of bike lanes (RO>>CE). However, these adjustments were not considered active experimentation, as the intervention ceased to be experimental after its initial deployment. While the pandemic experience accelerated the city's workflow and led to some perpetuated bike lanes, the informant ultimately reverted to delivering permanent bike lanes post-pandemic (LA01 Interview). This suggests that the learning process remained highly contextualised, leading to limited transformative change in how tactical urbanism was perceived and implemented.

In Melbourne, the pandemic accelerated a pre-approved bike infrastructure implementation plan. The city council's high-profile actions sparked significant debate regarding the quality and safety of the temporary cycle lanes (OC02 Document) (CE>>RO). In response to this criticism, the council paused the implementation plan in the most contested district (OC02 Document) (RO>>CE) and scaled back their public campaigns (OC02 Interview). Through this process, the council learned that maintaining a high-profile approach to implementation may not have been effective (RO). Consequently, they adjusted their strategy by slowing down the pace of actions (CE) (OC02 Interview). However, this feedback loop lacked deeper reasoning about the root causes of the vocal opposition (AC) and failed to experiment with new methods for improving the initiative (AE). In this case, the informants' personal learning pathway diverged from the organisation's approach. "*The communication strategy has to be well resourced and constructive and positive ahead of the projects, during their construction, and following the period after they've been installed*" (OC02 Interview). The informant framed conflicting interests as a persistent issue to be navigated and managed rather than avoided. In contrast, the city council appeared to lack a conceptualisation process, which limited their ability to address opposition strategically. This gap ultimately

Fig. 5. Experiment and perpetuate (AE>>CE>>RO>>CE) (Diagram: author, left image: POLIS Network, right image: Jason South, The Age).

contributed to the programme's marginalisation.

5.4. Learning process 3: experiment and conceptualise (AE>>CE>>RO>>AC(>>AE))

The *experiment and conceptualise* learning process is characterised by the integration of all four learning components (Fig. 6). This process follows two possible pathways: one concludes with abstract conceptualisation (AC), while the other extends conceptualisation into further experimentation, forming an iterative cycle. Through concrete experience (CE) and reflective observation (RO), informants expressed intentions to reapply the tactical urbanism approach in post-pandemic scenarios and identified key principles for successful implementation (AC). Conceptualisation plays a critical role in transforming observations by creating concepts that integrate observations into logically sound theories. When circumstances and resources permit, informants used the updated, refined conceptual understanding to initiate new experiments (AE). Unlike the *experiment and perpetuate* learning process, where new actions primarily become non-experimental, abstract conceptualisation in *experiment and conceptualise* enables the development of new experimental approaches that build on and adapt previous learnings.

The informant of Berlin's pop-up bike lanes showed an example of conceptualisation, in the form of abstracting practical knowledge. Berlin was among the earliest to initiate installations during the pandemic. Bogotá and Berlin had significantly different regulations, road conditions, and cultures. Yet, they drew inspiration from Bogotá's Ciclovías and adapted the concept to suit Berlin's legal framework. Without prior experience, the informant actively reflected on where and how tactical urbanism techniques could work in Berlin. They summarised that the tactical approach is most effective for simple road conditions where no major construction is required. Further, they expressed intention to reapply this approach where appropriate, reflected in their sharing that installing pop-up bike lanes symbolised agility and should be applied when road conditions are appropriate (EU07 Interview). Moreover, they derived principles regarding installation speed. They emphasised that the transition from temporary to permanent infrastructure should be swift to minimise uncertainty and ensure quality (EU07 Interview). "*We should have a good idea of when we can take the second step (making temporary intervention permanent). Tactical solution needs to be quick. The first step is not a question of engineering but a question of courage*" (EU07 Interview). By detailing the duration and conditions for tactical interventions, the informant enriched their conceptual understanding of tactical urbanism. This knowledge extended beyond the initial experimentation, as they continued to apply the tactical approach when suitable and generalised its application into creating public spaces. "*[Planners should] think of other situations of infrastructure development in a step-by-step manner*" (EU07 Interview). The transformative feature of this case is that the informant changed their normal workflow and continued to apply tactical urbanism beyond the initial experimentation.

In another case, Dublin City Council implemented temporary cycle lanes on city centre streets in 2020, marking their first experiment with temporary street interventions (EU03 Interview). The trial period, set at 6–12 months, allowed the informants to collect traffic data on pedestrians, cyclists, and vehicles, as well as gather public feedback (EU03 Interview, Document). These processes represent experimentation (AE) and experience (CE). The informants observed increased public acceptance of cycle lanes during the pandemic (RO). Public participation in consultations also surged, with overwhelmingly positive feedback (EU03 Document). They attributed this increased support to two factors: first, the temporary nature of the intervention allowed the public to experience the changes firsthand; second, the simplified public consultation process, conducted through non-statutory online surveys, facilitated broader engagement. They hypothesised that pre-pandemic opposition to cycle lanes was partly due to the lengthy statutory consultation processes, which disproportionately amplified the voices of organised opposition groups, even when they represented a minority (EU03 Interview). In contrast, the non-statutory consultation for temporary cycle lanes garnered significant public support.

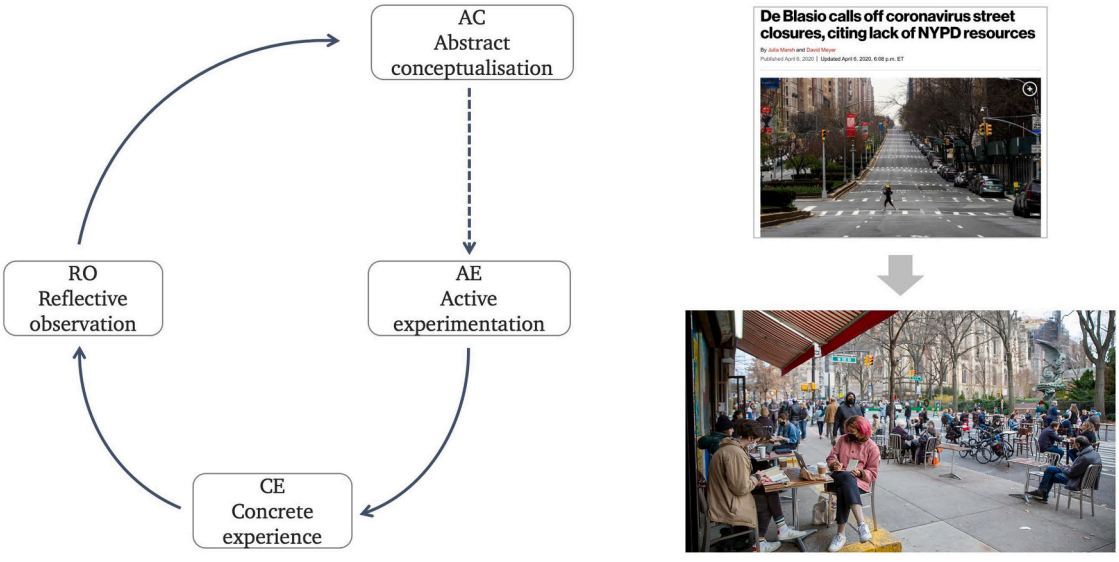

Fig. 6. Experiment and conceptualise (AE>>CE>>RO>>AC(>>AE)) (Diagram: author, upper image: Reuters, lower image: Ted Shaffrey, AP).

This reasoning reflects the informants' conceptualisation of why the tactical approach was effective in their context. They viewed this approach as an improvement over Dublin's previously stagnant active mobility infrastructure delivery process (AC). Consequently, the informants and their organisation advocated for changes to the national implementation guidelines, allowing medium-sized projects to be trialled without statutory public consultations (AE) (Department of Transport, 2023). The city has since continued to use the trialling approach post-pandemic.

Even experienced implementers require the *experiment and conceptualise* process to develop new street programmes. The New York City Department of Transportation (NYCDOT), a pioneer in street transformations since the 2000s, initially deployed pandemic street closures in April 2020 based on pre-pandemic experience. However, these actions faced significant public opposition due to heavy policing and limited street use (NA08 Interview). Deploying police officers had been standard practice for NYCDOT during event street closures, but under the stay-at-home order, heavy policing intimidated residents and fostered public distrust. This approach also strained city management, as pandemic street closures lasted far longer than typical event closures. As a result, the interventions were discontinued (Robbins, 2020). The informant recognised that pre-pandemic practices were unsuitable for the new context. Additionally, the initial location choices – central business districts (CBDs) – proved ineffective, as these areas were deserted during the stay-at-home order. The empty, closed streets reinforced the perception that such measures were unnecessary. Identifying these issues (RO), the informant conceptualised that tactical actions should involve softer control measures to foster public acceptance and be implemented in residential areas to ensure relevance (AC). In their second attempt, NYCDOT relaunched the programme, collaborating with community volunteers in residential neighbourhoods (AE). This Open Streets programme has since evolved beyond the pandemic. By interpreting observed outcomes, the agency was able to conceptualise alternative solutions and develop a more adaptive approach.

The *experiment and conceptualise* process differs from the first two learning processes by incorporating a strong conceptualisation element. Abstract conceptualisation enables implementers to extract knowledge that transcends specific contexts, making it transferable to future applications.

5.5. From learning to transformative change

Revisiting the conceptual framework (Fig. 1), we found that the *implement and execute* process is generally achievable in tactical urbanism projects. However, the pathways from reflective observation (RO) to abstract conceptualisation (AC) and subsequently to active experimentation (AE) are less likely to occur. The frequency summary (Table 1) shows that 13 out of 28 projects reached transformative trajectories, with informants from 12 of these 13 transformative projects exhibiting an *experiment and conceptualise* learning process.

Informants following the *implement and execute* or *experiment and perpetuate* learning processes were less likely to develop transformative interventions. While they leveraged the timeliness and appropriateness of tactical urbanism during emergencies, they failed to extract knowledge that could be applied in normal conditions. As a result, they reported a "closed window of opportunity" and made minimal changes to their pre-pandemic workflows. For example, in Bogotá (LA01), Milan (EU04), Paris (EU06), and Barcelona (EU08), tactical urbanism interventions were perceived as context-specific solutions unsuitable for adoption under normal circumstances. "*We are trying to be faster [in bike lane installations after the pandemic], but it's the same process we had before*" (LA01 Interview). "*Today, we wouldn't go through a temporary phase because all the quick decision makings [that were available during] the pandemic are not there anymore*" (EU06 Interview). Without the conceptualisation process, these informants struggled to continue applying tactical urbanism approaches post-pandemic.

The *experiment and conceptualise* model, by contrast, fosters longer-term project development and transformative change. Informants whose learning processes included abstract conceptualisation (AC) and active experimentation (AE) were more likely to integrate tactical urbanism into their workflows. For example, the Victoria State Government in Melbourne planned and installed 100 km of pop-up bike lanes during the pandemic. In their initial attempt, the agency deployed temporary bike lanes using traffic cones and barricades with minimal consultation, adhering to the original tactical urbanism approach. This strategy reduced the delivery time for cycle lanes from years to weeks (OC01 Interview). The informants believed that frontloading the intervention made it easier to communicate with stakeholders. "*People don't read a drawing, so the best way is to build it so they can see and use it*" (OC01 Interview). After the installation, they spent 12 months monitoring user and community feedback. While the temporary infrastructure was functional, it faced criticism for its aesthetics – yellow markings and orange barricades were perceived as low-quality and unsafe. This feedback prompted the informants to reflect on their consultation processes and material choices (RO). "*Interestingly, the feedback is not about [if it is] working or what are the treatments doing or safety, they're just like 'oh, I just don't like what it looks like'*." (OC01 Interview).

Table 1
Learning process and trajectory frequency.

Learning processes (Col.) Trajectories (Row) No. of cases	Implement and execute		Experiment and perpetuate	Experiment and conceptualise		Sum
	AE>>CE	AE>>CE>>RO	AE>>CE>>RO>>CE	AE>>CE>> RO>>AC	AE>>CE>> RO>>AC>>AE	
Termination	0	4	0	2	0	6
Marginalisation	0	0	3	0	1	4
Assimilation	1	1	0	1	2	5
Transformation	0	0	1	0	12	13
Sum	1	5	4	3	15	28

Addressing these socio-technical nuances, the informants developed custom-made materials with a more permanent appeal to improve both aesthetics and durability (OC01 Interview). Tackling this major concern enabled the informants to justify their initiatives to the administration. Post-pandemic, they received administrative support to continue delivering trial cycle lanes (AE), marking a departure from their pre-pandemic workflows. By summarising deficiencies (AC) and iteratively improving their approach, the project became transformative, legitimising tactical urbanism as a long-term method.

Conceptual knowledge derived from research also played a significant role in driving transformative change. For instance, the informant from the Innovative Streets programme in Wellington, New Zealand, initially adopted a classic tactical urbanism approach, deploying rapid installations with minimal communication (OC05 Interview). However, after receiving training on systems thinking and transition management from a programme in The Netherlands, the informant gained new insights into effectively engaging with the public and politicians. Early on, the initiative faced public backlash for the inappropriate use of construction regulations. Through training (AC), the informant realised the importance of managing the emotional stress and expectations inherent in transformative processes (Fig. 7). Drawing on the multi-level perspective framework (Geels, 2005), they envisioned a full street transformation process and translated research concepts into actionable steps. This learning prompted the team to significantly expand public engagement efforts by increasing their outreach staff to seven members, representing 50 % of their workforce (OC05 Interview). They reintroduced pre-installation stakeholder engagement programmes and engaged politicians earlier in the process. Setting realistic emotional expectations eased the pressure on politicians to make supportive decisions (OC05 Interview). The informant also institutionalised learning practices, integrating them into their workflow to sustain capacity building. *"We have a monthly retrospective workshop, where our whole team gets around for 90 min and reflects on what went well, what didn't go well, what the risks are ahead of time, and what we can do about those… It's kind of the discipline of doing that a lot in the team and then immediately building those actions back into the process"* (OC05 Interview). Conceptual knowledge provided the informant with a concrete framework for continuous learning and team improvement.

While conceptualisation does not always lead to transformative change, it helps preserve and extend the positive outcomes of PISEs. For example, in Denver, the transport department implemented shared streets to provide additional space for social distancing. Positive community feedback extended the temporary interventions for two years before being formalised through a permanent design process. Through this experience, the informant recognised the potential of tactical urbanism to achieve innovative outcomes (RO). "*[The shared street] was a good opportunity to try something completely unique, and it worked out really well*" (NA05 Interview). When considering how to integrate temporary approaches into their standard practices, the informant appreciated the flexibility and efficiency of tactical urbanism (AC). "*We are more comfortable doing things quicker and not having to make them perfect, knowing we can change stuff when it's done*." (NA05 Interview). However, they also identified limitations in its resource intensiveness. "*To do temporary, it takes a lot of resources. It is quicker, but more maintenance, more conversation, more things to change… We don't like to just strictly do temporary things.*" (NA05 Interview). They concluded that tactical urbanism is most effective when there is a clear pathway to permanence. For example, they reapplied the tactical approach to bus lane designs but avoided interventions intended solely for exploration. Conceptualisation enabled them to convert contextual experiences into broadly applicable knowledge.

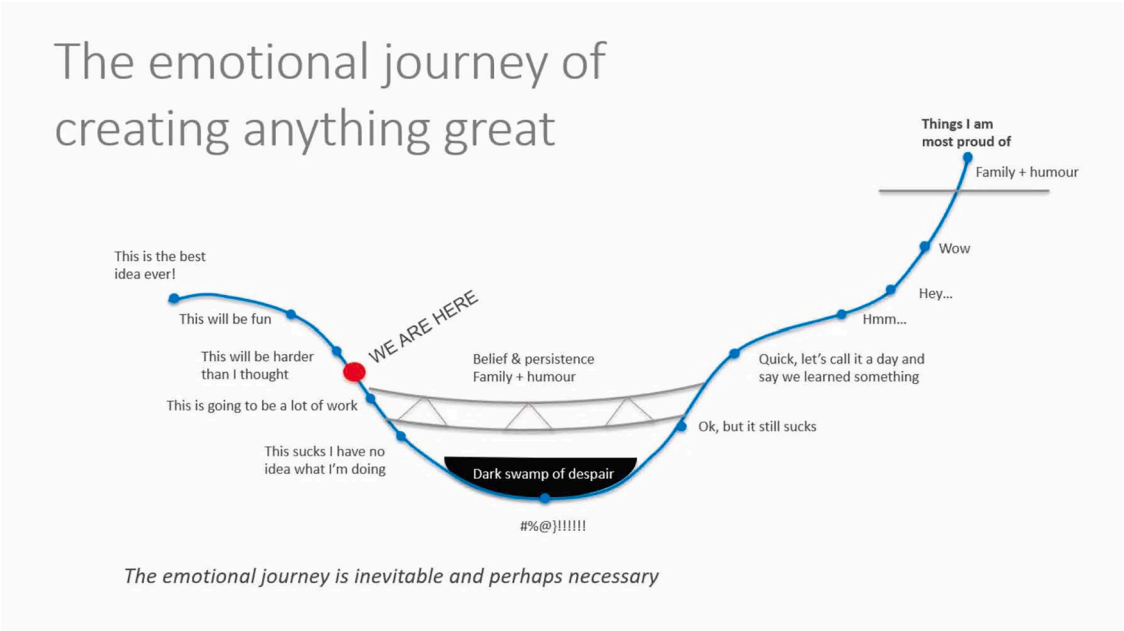

Fig. 7. An example of converting conceptual knowledge into practical guidance to manage multi-stakeholder expectations (OC05 Interview).

5.6. A global observation of tactical urbanism learning

Analysing geographical differences provides an exploratory lens to understanding variations in learning processes across regions. Our findings reveal distinct regional patterns in learning and development trajectories. Tables 2 and 3 summarise the distributions of learning processes and development trajectories across geographical regions. While global comparisons require deeper regional insights – an area for future research – this section attempts to explain how existing planning cultures may have shaped implementers' approaches to pandemic-induced street experiments.

In Asia, learning processes often stemmed from grassroots activism, though the outcomes varied significantly. In the Philippines, the government's decision to provide financial support for large-scale cycling infrastructure was largely driven by pressure from cycling advocacy groups (Sunio and Mateo-Babiano, 2022). Informants highlighted how learning from non-governmental organisations influenced government actions. Nevertheless, with funding secured and an executive order in place, cycling infrastructure was bound to stay, leaving little room for experimentation. Conversely, in Hong Kong, the government delegated experimentation to grassroots collaborators while retaining discretion over the use of results. However, the government's risk-aversion left little opportunity for government staff to learn or implement meaningful changes to the incumbent regime (Villani and Talamini, 2023; Zhao et al., 2025).

In Europe, 6 out of 11 cases did not follow the *experiment and conceptualise* learning process. Mobility interventions in cities like Milan, Paris, and London were largely facilitated by policy changes and funding support (Buehler and Pucher, 2021). These interventions were often embedded within long-term mobility plans, which made their continuation less dependent on implementers' reflections (Verhulst et al., 2022). The availability of resources and clear political agendas reduced the need for experimentation. Consequently, five out of these six cases did not result in transformative change, highlighting the interplay between learning motivations and decision-making autonomy.

In Latin America, learning processes often lacked a conceptualisation component. This was likely due to the strong political support for sustainable mobility infrastructure in the region. Cities rely heavily on centralised municipal decisions to drive progress (Vecchio et al., 2021). During the pandemic, this political backing accelerated infrastructure delivery (Vecchio et al., 2021). With mobility departments equipped with well-defined policies, technical expertise, and financial resources (Vecchio et al., 2021), emergency actions largely involved the execution of pre-existing plans, leaving little room for new learning. (Vecchio et al., 2021)

In North America, informants frequently followed the *experiment and conceptualise* process, emphasising self-motivated and experimental approaches to street changes. The region's long-standing tradition of tactical urbanism, which originated in North America, played a significant role in shaping these learning processes (Douglas, 2014; Talen, 2015). Tactical urbanism, rooted in bottom-up, unregulated urban interventions designed to meet emerging needs, was widely adopted by city officials during the pandemic (Andres et al., 2021). These implementations often involved deep engagement with community members and user feedback, fostering a reflective and iterative approach to learning.

In Oceania, the *experiment and conceptualise* process was also prominent, but with a stronger focus on securing political and public support. Tactical urbanism in Australia, initially imported from the UK and USA, has become increasingly institutionalised within local councils and state government agencies (Stevens et al., 2021). Most projects were led by local councils, which provided resources such as funding, sites, and materials. This top-down emphasis was complemented by efforts to promote community engagement and foster collaboration among diverse stakeholders (Stevens et al., 2021). This characteristic was evident in Melbourne and Wellington, where informants' learning processes centred on gaining public and council approval, reflecting the political and social dimensions of tactical urbanism in the region.

6. Discussion

Amid the pandemic emergency, the concepts of tactical and temporary urbanism gained widespread acceptance within local governments (Stevens and Dovey, 2023). This research contributes to the understanding of tactical urbanism by identifying the key learning components essential for achieving transformative outcomes. Through a multiple case analysis, this study offered a timely opportunity to explore the processes and long-term impacts of street experiments. Drawing on insights from 40 interviews across 28 PISEs, we found that effective learning requires the integration of both conceptualisation and experimentation to establish a complete and continuous learning spiral. In the following discussion, we examine how these learning processes shape diverse development trajectories and contribute to the broader potential of tactical urbanism.

Table 2
Distribution of learning process types.

World Regions	Implement and Execute	Experiment and Perpetuate	Experiment and Conceptualise	Sum
Asia	1	0	1	2
Europe	4	2	5	11
Latin America	1	1	0	2
North America	0	0	8	8
Oceania	0	1	4	5
Sum	6	4	18	28

Table 3
Distribution of development trajectories.

World Regions	Termination	Marginalisation	Assimilation	Transformation	Sum
Asia	1	0	1	0	2
Europe	3	1	2	5	11
Latin America	1	1	0	0	2
North America	1	0	1	6	8
Oceania	0	2	1	2	5
Sum	6	4	5	13	28

6.1. Advancing learning in tactical urbanism

This study advances the expectation of learning in tactical urbanism by highlighting the vital role of conceptualisation during experiments. The empirical findings demonstrate that learning in tactical urbanism extends beyond the build-measure-learn paradigm. Conceptualisation – abstracting experiences and reflections – is critical for achieving meaningful physical, regulatory, and organisational changes. Street experiments were more likely to deliver transformative outcomes when informants completed full learning spirals. Therefore, implementers should emphasise on generating conceptual knowledge and engaging in continuous experimentation in tactical urbanism projects.

The *implement and execute* process (AE>>CE(>>RO)) led to limited development of street experiments. Informants following this approach often treated interventions as task-oriented executions, resulting in trajectories that either terminated prematurely or, in the best-case scenarios, assimilated into existing systems without significant transformation. Our findings suggest that implementers' capacity to make independent decisions is critical in motivating experiential learning. Providing appropriate incentives may further stimulate this learning process.

The *experiment and perpetuate* process (AE>>CE>>RO>>CE) represents a learning trajectory that generates divergent, context-specific knowledge but lacks the generalisation and convergence necessary for path-deviating, transformative change (Kolb, 2015). While this process is effective for problem-solving and achieving predefined goals – such as reaching 100 % bike lane coverage – it is insufficient for fostering the broader systemic shifts required for transformation. As a result, PISEs guided by this learning process often became marginalised: they existed but had limited and rarely transformative potential.

The *experiment and conceptualise* process (AE>>CE>>RO>>AC(>>AE)) is particularly desirable because it forms a complete learning spiral, transitioning from knowledge abstraction and generalisation to new experimentation within the post-pandemic socio-political context. As Van Poeck & Östman (Van Poeck and Östman, 2021) note, there is a critical distinction between knowing and learning – the latter requires internalising knowledge and applying it in practice. Without knowledge application, the learning process remains incomplete and ineffective. Our analysis of development trajectories showed that cases wihtout continued experimentation did not achieve transformative change. The *experiment and conceptualise* process demonstrates that sustained experimentation following conceptualisation is essential for fostering transformative urban mobility transitions through tactical urbanism.

Revisiting the build-measure-learn paradigm, we argue that learning in tactical urbanism should be understood beyond its immediate results. It should focus on extracting generalisable knowledge that can enhance the application of tactical urbanism across diverse contexts. While context-specific learning is undoubtedly important, incorporating more conceptualisation would enable implementers to generalise tactical urbanism principles and adapt them more effectively to local conditions. Beukers and Bertolini (2021) caution that pressing goals often overshadow the importance of learning. Therefore, it is essential to maintain a *learning space* – a designated environment where learning is deliberately facilitated (Kolb, 2015). Internally, such a space nurtures practitioners' capacity for innovation and change; externally, it provides a platform for dialogue and collaboration between governments and the public.

6.2. From existing knowledge to new learning

The way informants acquired baseline knowledge, to some extent, shaped their learning processes. Those who participated in training through conferences, study trips, or educational programmes were more likely to adopt the *experiment and conceptualise* process. Conferences and study trips have been identified as key learning arenas for urban mobility practitioners (Glaser et al., 2021; Glaser and te Brömmelstroet, 2020). Informants frequently cited inspiration from cities regarded as pioneers in urban mobility transitions, such as Amsterdam and Copenhagen. These cities are often held up as exemplars of "best practices", tying back to the dominant influence of elite education and training in Western institutions (Montero et al., 2023). The role of training programmes and best practice models underscores the effectiveness of educational initiatives and highlights the need to prioritise conceptualisation in training programmes to foster transformative learning.

Implementers with greater autonomy in problem-solving were more likely to demonstrate proactive learning, particularly in responding to community feedback. Examples from New York, Vancouver, and Denver illustrate this feature. These informants reported not needing approval from political leadership, which allowed for quicker, bottom-up decision-making informed by direct community input. In contrast, informants from cities like Paris, Milan (EU04), and London (EU10) acted primarily in an executive capacity to execute administrative orders. This may have limited their motivation to conceptualise the practical knowledge gained during the pandemic or to rethink how urban infrastructure could be delivered in the future. Instead, these informants regarded the

pandemic as an opportunity to accelerate pre-existing political agendas. However, as the pandemic opportunity waned, so too did the opportunity to apply lessons learned in the new context. Many informants expressed that tactical urbanism had become less applicable in non-pandemic contexts, citing reduced feasibility for temporary projects and diminished support from internal and external stakeholders (EU01, EU06, LA02, OC04 Interview). Even when some informants expressed a desire to continue using tactical urbanism approaches, they faced increased difficulty in convincing stakeholders to pursue non-standard projects outside of an emergency context (NA07 Interview).

Implementers with pre-pandemic experience showed limited learning during the pandemic window of opportunity. Their existing expertise appeared to reduce motivation to update their knowledge base or experiment with new approaches. For instance, the informants of Barcelona's street intervention (EU08) viewed the interventions merely as intermediary steps toward permanent street changes, bypassing the experimentation entirely without extensive post hoc evaluations. Similarly, Bogotá's informants (LA01), despite being pioneers in delivering pop-up bike lanes during the pandemic, reverted to their pre-pandemic workflow of permanent bike lane installation without incorporating more experimental or iterative methods. This suggests that prior experience can lead to a plateau in the learning curve, where implementers become less inclined to absorb new knowledge or adapt their processes. This relationship between existing expertise and the ability to embrace new learning remains underexplored in the literature and warrants further investigation.

7. Conclusion

From an urban mobility transition perspective, tactical urbanism projects should not be viewed as isolated, one-off actions but as potentially transformative initiatives capable of instigating longer-term changes in planning systems. This study investigated how knowledge generation through experiential learning influenced the development trajectories of tactical urbanism projects. For practitioners, this research provides a diverse range of practices and shareable lessons, illustrating how tactical approaches were adapted to different contexts. For urban scholars, this research challenges the build-measure-learn framework by highlighting the importance of the experiential learning spiral, an essential mechanism for delivering transformative experiments.

Theoretically, a learning spiral involving abstract conceptualisation is more conducive to achieving transformative outcomes. For practitioners aiming to apply tactical urbanism, this study highlights the importance of producing generalisable lessons. When implementers generated higher-level knowledge, they were more likely to proceed with further experimentation, resulting in transformative development trajectories. For urban scholars, this finding enriches the concepts of tactical urbanism by detailing the type of learning required to instigate transformative outcomes.

Empirically, we identified three distinct types of learning processes within PISEs. The *implement and execute* process capitalised on the window of opportunity the most, but informants did not view their PISEs as experiments, leading to limited and unintentional learning. The *experiment and perpetuate* process lacked sufficient conceptualisation, resulting in an inadequate understanding of why tactical urbanism succeeded or failed. In contrast, the *experiment and conceptualise* process involved more deliberate conceptualisation and iterative adjustments.

The above findings demonstrate that PISEs can catalyse broader efforts to activate public spaces. Nearly half of the PISEs examined were transformative, evolving into longer-term programmes where tactical urbanism became a preferred approach. This outcome highlights the capacity of governmental actors to enact path-deviating changes during periods of acute disruption. Furthermore, government-initiated tactical urbanism projects were found to have greater longevity than those initiated by communities. These insights underscore the importance of encouraging government actors to experiment with public space transformations while employing structured and reflective learning processes.

This study opens several avenues for future research in urban mobility transition. Despite being influenced by the COVID-19 pandemic, street experiment outcomes varied significantly across cities. Future studies could investigate these variations by examining factors such as organisational learning, policy alignment, and each city's stage in the sustainable mobility transition. Additionally, our findings suggest that cities with strong political mandates can expedite processes but may also face heightened controversy. Understanding how controversies facilitate multi-stakeholder learning is critical, as street interventions increasingly spark political and public debates. Exploring strategies for integrating ongoing experimentation into these processes could help address such challenges and improve the sustainability of tactical urbanism projects.

CRediT authorship contribution statement

Kristen J. Zhao: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Writing – review & editing. **Guibo Sun:** Writing – review & editing, Supervision, Methodology, Data curation, Conceptualization, Investigation, Resources.

Declaration of competing interest

No conflict of interest

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.eist.2025.101007.

Appendices

Appendix I. Case information

The *main operating agency* refers to the government branch that oversees the programme. The *programme name* refers to names used during the pandemic, differentiating from post-pandemic programme names. The *programme type* includes the three most prominent street experiment types – outdoor patios, shared streets, and bike accommodations.

Table A1
Case information.

Case ID	Main operating agency (Case City, Country)	Programme name	Programme type	Informant number and role
AS01	Active Transport Program Management Office, Department of Transportation (DOTr) (Mandaue, Philippines)	Bayanihan II Bike Lane Networks	Bike accommodation	1. Office Chief 2. Architect 3. Lead Engineer
AS02	Transport Department, HKGOV; Social Lab, MaD (Hong Kong, China)	Healthy Street Lab 2.0	Shared street	1. Senior Engineer 2. Programme Manager
EU01	Department of Traffic Organization and Technical Traffic Matters, City of Vienna (Vienna, Austria)	Pop-up Radwege	Bike accommodation	1. Head of Department
EU02	Mobility, Public Works and Road Safety, Government of the Brussels-Capital Region (Brussels, Belgium)	nouvelles pistes cyclables (new bike paths)	Bike accommodation	1. Deputy Director 2. General Policy Advisor
EU03	Transportation Section, Dublin City Council (Dublin, Ireland)	Protected cycle lanes	Bike accommodation	1. Chief Executive 2. Head of Technical Services
EU04	Municipality of Milan; Agency Mobility Environment and Territory (AMAT) (Milan, Italy)	piste ciclabili (bike lanes) of Strade Aperte (Open streets)	Bike accommodation	1. Senior Specialist and Architect
EU05	Municipality of Milan; Agency Mobility Environment and Territory (AMAT) (Milan, Italy)	Piazza Aperte (open squares) of Strade Aperte (Open streets)	Shared street	1. Architect and Consultant
EU06	Department of Roads and Travel, Paris City Hall (Paris, France)	Coronapistes (Pop-up bike lanes)	Bike accommodation	1. Staff of Mission Velo (Bicycle Mission) 2. Cycling Infrastructure Expert, Collectif Velo Ile de France
EU07	Senate Department for Mobility, traffic, climate protection and the environment, City of Berlin; District Office Friedrichshain-Kreuzberg (Berlin, Germany)	Pop-up Radwege, Temporäre Radfahrstreifen	Bike accommodation	1. Head of Roads and Parks Office
EU08	Office Area of Urban Ecology, Barcelona City Council (Barcelona, Spain)	Una nova mobilitat sostenible en un nou espai public (A new sustainable mobility in a new public space)	Bike accommodation; Shared street	1. Deputy Chief Architect
EU09	Mobility, Public Works and Road Safety, Government of the Brussels-Capital Region (Brussels, Belgium)	Bruxelles en Vacances	Shared street	1. Deputy Director 2. General Policy Advisor
EU10	Transport for London (London, UK)	COVID-19 Cycleways; Liveable Neighbourhoods	Bike accommodation; Shared street	1. Portfolio Sponsor (i.e., Programme Manager) 2. Portfolio Sponsor (i.e., Project Manager)
EU11	City of London (London, UK)	Pedestrian Priority Streets Programme	Shared street	1. Assistant Director
LA01	Bicycle and Pedestrian Affairs, District Mobility Secretariat, City of Bogota (Bogota, Colombia)	Ciclovías Temporales	Bike accommodation	1. Chief of Advisory 2. Deputy director
LA02	Ministry of Mobility, Government of Mexico City (Mexico City, Mexico)	Ciclovias Emergentes COVID-19	Bike accommodation	1. Director

(*continued on next page*)

Table A1 (*continued*)

Case ID	Main operating agency (Case City, Country)	Programme name	Programme type	Informant number and role
NA01	Transportation Planning, City of Vancouver (Vancouver, Canada)	Slow Streets	Shared street	1. Senior Transportation Planning Engineer 2. Neighbourhood Traffic Engineer
NA02	Transportation Planning, City of Vancouver (Vancouver, Canada)	Pop-up Plazas	Outdoor patios	1. Branch Manager
NA03	Chicago Department of Transportation (CDOT) (Chicago, USA)	Shared streets	Shared street	1. Deputy Commissioner
NA05	Denver Department of Transportation & Infrastructure (DOTI) (Denver, USA)	Shared streets	Shared street	1. Transportation Innovation Manager
NA07	Los Angeles Department of Transportation (LADOT) (Los Angeles, USA)	Slow streets	Shared street	1. Transport Planning Associate
NA08	New York City Department of Transportation (NYCDOT) (New York City, USA)	Open streets	Shared street	1. Deputy Commissioner
NA10	City of Oakland Department of Transportation (OakDOT) (Oakland, USA)	Slow streets	Shared street	1. Senior Transportation Planner
NA11	Transportation Planning, City of Vancouver (Vancouver, Canada)	Temporary Patio	Outdoor patios	1. Branch Manager
OC01	Active Transport, Department of Transport and Planning, Victoria State Government (Melbourne, Australia)	Pop-up bike lanes	Bike accommodation	1. Team Leader 2. Manager
OC02	Strategy, Planning and Climate Change, Melbourne City Council (Melbourne, Australia)	Pop-up bike lanes	Bike accommodation	1. Senior Strategic Planner (Former)
OC03	City Sustainability and Strategy, Yarra City Council (Melbourne, Australia)	Pop-up bike lanes	Bike accommodation	1. Councillor 2. Senior Project Officer
OC04	Night Time City, City of Sydney (Sydney, Australia)	Sydney Alfresco Dining	Outdoor patios	1. Manager
OC05	Wellington City Council (Wellington, New Zealand)	Innovating Streets	Bike accommodation	1. Transitional Programme Manager

Appendix II. Interview questions

Table A2
Interview questions according to experiential learning framework.

Interview Framework and Questions	
Abstract conceptualisation	What was the inspiration for the temporary implementation? Was it before or after the pandemic outbreak? Which examples were inspirations? Have you heard of tactical urbanism, parklets, open streets, shared street? Did they provide inspiration towards forming the action this time? Do you think this project is experimental? What did it take for this project to be passed?
Concrete experience	Why was the policy able to be issued timely? How was the approval process like before the pandemic? Was the pandemic emergency response part of a bigger scheme? Or was the pandemic the main trigger? How was emergency response different from previous ways of carrying out the plan? And why? Have you encountered any challenge? What are they?
Reflective observation	What was good about the rapid implementation? What's not good? How was the project measured? Have you received any user response after the implementation? How much did the public response influence your decision in extending the measures? For example, which response led to what change? What were the other influential factors determining the success or failure of the street interventions? Any other outcomes measured? Road safety? Usage count? Business vibrancy?

(*continued on next page*)

Table A2 (*continued*)

Interview Framework and Questions	
Updated abstract conceptualisation	When tactical urbanism techniques were to be applied again, what would be more suitable applications? How were your understanding of tactical urbanism changed after the experience?
Active experimentation	Do you see any change in possibly making experimentation, temporary orders easier under normal time? What changes? If not, what would hinder the process?
Learning arena	What did the discussion on the implementation take place? How did you obtain these views? Do you observe others in the team holding similar views or not?

Data availability

The data that has been used is confidential.

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