Urban Transformations

RESEARCH

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The project-partnership cycle: managing city-university partnerships for urban sustainability and resilience transformations

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Abstract

Cities across the globe are striving to produce viable solutions to pressing urban sustainability and resilience problems. Despite aspirations, municipal governments often need additional support in terms of knowledge, capacity, or resources to achieve transformations. Partnerships between cities and universities are one mechanism for co-producing knowledge and achieving sustained progress on complex challenges. When properly structured and effectively managed, city-university partnerships (CUPs) are purported to increase transformative capacity in city administrations and support actions which accelerate urban transformations; but these outcomes are not always achieved. As CUPs grow in numbers, there is a pressing need to identify which principles and practices facilitate transformation. Therefore, we used iterative reflective focus group sessions to develop in-depth case studies of five sustainability and resilience CUPs across three countries. The CUPs were cross-compared to explore the partnership dynamics and management practices that aid progress towards transformative goals. Observations were then related to transformative capacity typologies, and mapped to the newly described project-partnership cycle – which is useful for the management of transformative partnerships.

Keywords: Urban transformation, Sustainability, Resilience, Co-production, City-university partnerships

Science highlights

- City-university partnerships are growing in number and can facilitate urban transformations.
- Partnership and project functioning influence each other in a positive-feedback loop cycle.
- High functioning city-university partnerships may increase transformative capacity.
- The project-partnership cycle can be used as a framework for adaptively managing co-produced initiatives for impact.
- Future research should advance understanding of city-university co-production dynamics and relate processes to impacts.

Policy and practice recommendations

- Cities and universities should formalize collaborative agreements to co-produce transformative urban projects.
- Ongoing monitoring and adaptive management of both partnership and project functioning is key to success.
- If collaborative efforts are struggling, Aim for small wins that deepen partnership and build a foundation for larger projects

Introduction

Cities are faced with urgent sustainability and resilience challenges, including the need to adapt to climate change while reducing carbon emissions and building resilient infrastructure and sustainable communities (Reckien et al. 2017; Spaans & Waterhout 2016). The complex challenges posed by climate change do not confine themselves to the structures of city administrations or the cadence of planning processes; they require action outside the normal operations of city governments (Koop et al. 2017). City governments are designed to be stable and consistent entities, which can often serve residents well, but in the context of a rapidly changing world, cities can find it difficult to adapt. At the institutional level, cities have varying capacity to identify these resilience and sustainability challenges and develop solutions commensurate with and capable of addressing them (Keeler et al. 2019). Partnerships and collaborations with a wide range of outside entities and organizations provide cities with the opportunity to expand their reach, analyze problems from multiple angles, and make the coordinated sweeping changes necessary to achieve sustainability and resilience (Caughman 2022; Maraña et al. 2020).

Transformative capacity

Solving complex sustainability and resilience problems requires transformative change and is incredibly difficult to achieve (Fazey et al. 2018). Transformative change completely disrupts the structures, cultures, and practices that have contributed to and inhibit progress on sustainability and resilience problems (Olsson et al. 2014). In the municipal context, transformation includes fundamental shifts in the fabric of the urban system, with "irreversible changes in infrastructures, ecosystems, agency configurations, lifestyles, systems of service provision, urban innovation, institutions and governance" (Elmqvist et al. 2020). Reaching these transformational goals necessitates flexible governance coordination across a wide variety of institutions spanning geographic, political, and sectoral scales, but currently, many city government configurations are entrenched in structures that reinforce vulnerability and inhibit transformation.

City governments must have the transformative capacity necessary to facilitate such transformational changes. Transformative capacity can be understood as a collection of competencies, resources, and processes that aid transformations (Wolfram et al. 2019). One framework for urban transformative capacity (Hölscher et al. 2019) describes four fundamental capacities for urban transformation governance:

1. Stewarding: Ability to anticipate, protect and recover from uncertainty and risk while exploiting opportunities beneficial for sustainability.
2. Unlocking: Ability to recognize and dismantle structural drivers of unsustainable path-dependencies and mal-adaptation.
3. Transforming: Ability to create and diffuse novelties that contribute to sustainability and resilience and to embed these novelties in structures, practices and discourses.
4. Orchestrating: Ability to coordinate multi-actor governance processes and foster synergies and minimize trade-offs and conflicts across scales, sectors and time.

These transformative capacities can be used as a lens to understand how conditions, activities, and actors in collaborative urban sustainability and resilience transformation efforts come together to create pathways towards transformative change, while also exposing barriers and gaps (Hölscher et al. 2019).

Transformative City-university partnerships

City-university partnerships (CUPs) are a typical kind of engagement between cities and universities and can take many forms, ranging from small one-off projects to comprehensive and deeply collaborative endeavors (Caughman et al. 2020b). There have been a substantial number of studies on CUPs and their role in urban resilience and sustainability. This research has shown CUPs' importance as intermediaries for boundary-spanning collaboration (Leal Filho et al., 2022), capacity building mechanisms (Wolfram et al. 2019; Keeler et al. 2019), and as test-beds for innovative research and practice (Wall et al. 2017). Additionally, sustainability and resilience focused CUPs exist within a larger spectrum of city-university dynamics, interactions, and debates, including town-and-gown challenges and cooperation (Martin & Smith 2019), higher education's role in n-helix models of innovation systems (Taratori et al. 2021), urban knowledge exchanges (Dickey et al. 2022), and the concepts of the entrepreneurial (Guerrero et al. 2012) and the civic university(Goddard 2018). Any of these classifications and arrangements can be present in the identity of a particular university, and/or experienced by a particular city, making the context and composition of every CUP unique, and impacting values, goals, outreach activities, and ultimately the outcomes of urban transformation endeavors.

In this context, universities can be strong partners for cities to build transformative capacity and advance the knowledge and skills necessary to devise, test, and implement resilience and sustainability solutions. CUPs oriented toward transformative capacity building: (i) impart knowledge and skills to city administrations; (ii) provide enthusiasm for resilience and sustainability solutions; and (iii) create new organizational infrastructure that can help cities overcome the structural limitations that impede comprehensively addressing these complex challenges (Keeler et al. 2019; Wolfram et al. 2019). A CUP focused on capacity-building can play a critical role in transformative change – facilitating the development of the capacities that accelerate urban transformations via co-production of practical and novel knowledge, and co-management of the design and implementation of interventions.

Recently scholars have posited that CUPs doing transformational work must embody transformation themselves and therefore have the structure and function of

transformative partnerships. The concept of transformative CUPs (Keeler et al. 2023) describes partnerships that expand capabilities and competencies at both the individual and organizational level, thus developing the confidence of individuals and groups to contribute to long-term transformations. Transformative CUPs must also cultivate longevity via the formation of shared goals, with equal commitment to achieving said goals, and ultimately using their combined power to solve problems (Keeler et al. 2019). Despite this growing body of research, an underlying understanding how to design, implement, and manage transformative CUPs remains poorly understood. Additionally, CUPs themselves can fall into typical arrangements and stagnant patterns of operation that fail to the challenge the status quo or live up to their transformative potential.

In this study, we used iterative focus group sessions to collect in-depth case study data about five international CUP initiatives that are co-producing knowledge and aiming to advance transformative urban sustainability and resilience outcomes. The cases were cross-compared to expose common capacity-building pathways, co-production techniques, and barriers faced by transformative CUPs. We explore the processes and practices that make CUPs successful, relate them to transformative capacity building, and conclude with transformative CUP management practices that can enhance partnership longevity and organize activities for impact, while also highlighting potential pitfalls.

Methods

This paper studies five sustainability and/or resilience-oriented city-university partnerships (CUPs) in three countries. The five case studies represent all partnerships in the overarching CapaCities initiative, a network of CUPs funded by the Global Consortium for Sustainability Outcomes (GCSO) to (i) build capacity for transformative sustainability and resilience action in city administrations; and, (ii) transfer and scale insights across different cities and universities. The researchers leading this study were active PIs and staff affiliated with institutions involved in the CapaCities city-university partnerships at the time of the research, making the selection of these cases a convivence sample.

Each CUP was studied for the length of a full project cycle (~ 1.5 years). CUP managers from both the city and university sides of the partnerships (i.e. city bureau staff and university researchers) participated in quarterly focus group sessions throughout the project cycle (four total) to capture a rich picture of each CUP over time and at various stages of project and partnership initiation, development, and implementation. The focus group questions and prompts explored the Foundation, Action, Impacts—Interpersonal Context and Empowering Supports (FAI-ICES) of each CUP, and observed how these metrics evolved over time (Caughman, Keeler, et al., 2020). The FAI-ICES framework was specifically designed for transformative partnership-based initiatives and the indicators are described in the table below.

In the focus group sessions, researchers and CUP managers from the city and university sides of the partnerships used the FAI-CES framework as the starting point for reflective conversations about the relationship between processes and transformative outcomes, as well as adaptive management of the CUP activities. The facilitated conversations explored questions derived from the FAI-CES approach, including:

- At the university/city, how would you describe the level of understanding of the project topic? Do they have the skills and abilities needed to complete this project?
- Please describe the level of trust between the city and university regarding this project. What trust-building activities have you engaged in?
- What is the level of commitment to this project. Are both sides of the partnership fully dedicated? How do you know?
- Since this project began, what actions have been taken by the university/city to work towards the goal of this project?
- Do you envision future projects that build off this project and can utilize this partnership? Please explain.
- What drives the participation in the partnership? What do the partners hope to gain from partnering?
- Have roles and responsibilities in the partnership been outlined and agreed upon? Please explain.
- Does the partnership influence the internal strategies at both organizations? If so, how?
- Based on your own personal understanding and assessment of the project, do you feel that the goals of this project have been achieved? Please explain.
- Have there been any critical turning points or learnings in your project or partnership? If so, what impact did they have on your work?

Through the sessions, qualitative descriptions of key decisions, turning points, and outcomes were mapped to timelines tracing each CUP's co-production pathway (Punton & Welle 2015; Waldner 2015). Written comparative case-studies were developed alongside the timelines, and both were used to complete a cross-CUP comparison (Scholz et al. 2006; Vellema et al. 2013). An overview of each CUP is provided below.

CUP case studies

The five cases of transformative sustainability and resilience CUPs are described briefly below. For each CUP there is a summary of the actors involved in the project, the project goals, project process, their concept of capacity building, and the broader context for their work (e.g., cultural, political, and geographic factors). Each CUP focused on its own sustainability and/or resilience problem and developed a capacity-building strategy, comprised of projects like stakeholder engagement workshops or comprehensive analysis and reports. Tables 1 and 2 summarizes each CUP and the embedded sustainability and resilience capacity-building research and action that was undertaken, as well at the strategies that were used and the proposed outputs and outcomes of the work.

The focus group data were used to produce deep and longitudinal descriptions of each CUP, capturing key decisions, obstacles, learning, and changes over time. Timelines were developed showcasing the processes and key events that occurred throughout the life of each CUP and were used as a visual tool to aid cross-CUP comparison. A detailed description of CUP goals, context, and progress as well as process timelines, are described below.

Table 1 Shows each category for assessing project and partnership function of the CUPs based on the FAI-CES evaluative framework

Evaluation Category	Measures	Metrics	Indicators
Project	Foundation	• Interest • Competency • Capacity	Motivation, knowledge, processes, resources
	Actions	• Planning • Implementing	Goals, co-management, methods, co-production
	Impact	• Outcomes	Impact, achievement, future prospects
Partnership	Interpersonal Context	• Collaborative history • Mutual understanding • Engagement	Performance of partnership and collaboration, trust, transparency, partnership mechanisms, formalization
	Empowering supports	• Commitment • Resources	

National Autonomous University of Mexico and Mexico City, Mexico

At the time of this analysis, the National Laboratory for Sustainability Science (LANCIS-IE), in the Ecology Institute at the National Autonomous University of Mexico (UNAM) had engaged in two years of active collaboration with the Mexico City Resilience Agency. The goal of the partnership was to conduct transdisciplinary research and facilitate sustainability education to link science and decision-making, supporting sustainability transitions in the country. Over two years the partners held several meetings, interviews, and presentations, as well as six participatory workshops. Other actors engaged in these interactions came from academia, city level and municipal governments, NGOs, the private sector, and the agricultural sector. The collaborative activities produced data sources, databases, conceptual and empirical baselines for indicators and indexes for integrated assessment models (i.e. multicriteria decision analysis), and validation of results. The policy-relevant outcomes of these engagements were two specific collaboration agreements between LANCIS-IE-UNAM and the Mexico City Government to build sustainability capacity, implement the Resilience Strategy of Mexico, and reinforce collaborative governance mechanisms.

In the beginning, participatory events were either focused on building capacities related to resilience and risk management (through game-based workshops) or addressing the consequences of the earthquake of September 19th, 2017. The final reports for the formal agreements with the Resilience Agency were submitted at the same time as major political shifts in Mexico City. Simultaneously, the Mexico City government changed party and the Resilience Agency changed its administrative status and lost most of its staff. However, with close monitoring of the project and partnership, these impending changes were recognized far before occurring, and specific strategies for overcoming the alterations were developed. Due to advanced planning and specific attention focused on the partnership, LANCIS-IE retained a relationship with the new staff of the Resilience Office and work is expected to seamlessly continue into the future. Please see the project timeline in Fig. 1.

Leuphana University—City of Lüneburg

The city of Lüneburg and Leuphana University of Lüneburg (Faculty of Sustainability, Professorship for Transdisciplinary Sustainability Research, Lüneburg, Germany)

Table 2 Shows each CUP, the actors involved, and the stated goals in detail, as well as categorized strategies and proposed outcome/outputs from each CUP

City University Partnership	Actors	Transformative Capacity Building Goals	Strategies	Proposed Outputs & Outcomes
Arizona State University – City of Tempe, Arizona, USA	City of Tempe administration, senior department heads from all departments, sustainability manager, ASU researchers, professors, and graduate students	• Increase sustainability literacy among senior city officials • Increase sustainability competence among senior city officials • Identify goals for sustainability in Tempe among city administration • Identify actions that support sustainability goals that have support among the administration • Identify key partners in the administration for actions	Research and analysis Workshops Document/policy	Goals/vision/plan creation New and deepened partnerships Sustainability/ Resilience competency Actions and implementation
Karlsruhe Institute of Technology — City of Karlsruhe, Germany	Four city bureaus of Karlsruhe, the Consortium for Sustainability Outcomes (CSO), KIT students and three units of KIT,one masters student as accompanying research	• Support inter-bureau discourse on sustainability and cooperation with external partners • Foster a broader understanding of sustainability • Make sustainability more visible in the KIT and the City of Karlsruhe • Contribute to long-term cooperation city-KIT	Discourse and conversations Research and analysis	Sustainability/ Resilience competency New and deepened partnerships Political momentum and power
Leuphana University — City of Lüneburg, Germany	City Sustainability Manager; individuals from four city departments; a variety of local actors (businesses, community groups, associations), local press; university researchers	• City-wide visioning exercise for the year 2030 • Facilitating conversations on the local interpretation of Sustainable Development Goals • Cross-departmental conversation on feasibility and adaptability of good practices	Discourse and conversations Workshops	Goals/vision/plan creation

Table 2 (continued)

City University Partnership	Actors	Transformative Capacity Building Goals	Strategies	Proposed Outputs & Outcomes
National Autonomous University of Mexico — Mexico City, Mexico	Resilience Agency (new official govt. office) in the Environment Secretariat of Mexico City; others at local (borough) scale and across other sectors of the city; NGOs; researchers and professors from UNAM	• Assisting in capacity-building in themes related to resilience for a greater implementation of the Resilience Strategy of Mexico City, with a focus in one case-study where there is a planning process occurring for better management of the area (Xochimilco) • Capacity-building includes system, futures, & collaborative thinking • Assisting the creation & implementation of a Reconstruction Plan after the September 19 earthquake in the local case-study	Research and analysis Document/policy	Goals/vision/plan creation Actions and implementation
Portland State University —City of Portland, Oregon, USA	Four different bureaus working on asset management within the city. ~ 6 other bureaus that support asset management activities and coordination; Institute for Sustainable Solutions; graduate students	• Increasing inter-bureau conversations/understanding related to asset interdependencies under climate change and seismic scenarios • Empowering and activating individuals within those bureaus to collaborate together on cross-bureau planning and investments	Research and analysis Document/policy Workshops Discourse and conversations	Political momentum and power Sustainability/Resilience competency New and deepened partnerships

engaged in a project to realize the UN Sustainable Development Goals on a local scale. Though the two institutions had worked collaboratively together many times in the past, this undertaking was the most comprehensive to date, and involved a variety of actors at the science–society interface, including the sustainability manager of the city, the environmental office, the planning department, representatives of the civil society, and the academic research team. The project aimed to address five core topics, namely (i) joint planning and decision making, (ii) facing climate change, (iii) joint economic collaboration, (iv) networking and provisioning, and (v) crafting city life.

In the first phase an initial visioning process was dedicated to developing a shared vision for the city for the year 2030 and beyond, engaging in a dialogue about the Sustainable Development Goals and their meaning for the city of Lüneburg. These findings were combined with research on international best-practices, culminating in the creation of Climate Adaptation Measures for Lüneburg. The second phase involved evaluation of the new Climate Adaptation Measures. Both phases utilized collaborative meetings, outreach events, research, workshops, surveys, and demonstrations.

Throughout the second phase of the project, difficulties arose between the city and university, especially when there seemed to be a lack of understanding and political support from the mayor, and staffing changes on all sides of the partnership. Paying close attention to the shifting political environment and focusing on the partnership allowed CUP managers to see these challenges and create a plan for more vested relationship development, which in turn supported goal attainment. Assessment results indicated that the team needed to methodically shift to evaluate the Lüneburg partnership itself. This was achieved through the development and implementation of a participatory storyline-style interview approach that resulted in a better understanding of organizational components and skills of the group and informed what would shape a more productive partnership. Findings were integrated into the design of a gamified workshop that will be used to plan a stepwise procedure to institutionalize the partnership beyond the current project logic. Please see the project timeline in Fig. 2.

Portland State University—City of Portland

The city of Portland has a long-standing commitment to sustainability, being the first US city to draft a climate action plan and the first to include an equity lens in climate action planning. Portland State University (PSU) also has a strong commitment to sustainability and has made sustainability a campus-wide learning outcome, with a goal of carbon neutrality by 2050. The City of Portland and PSU have a long history of collaboration on a wide range of topics, many which focus on sustainability and climate change. So, when the City of Portland realized they had a deficit in terms of infrastructure resilience planning, PSU was a natural partner. Together, PSU faculty, staff, and students associated with the Institute for Sustainable Solutions (ISS) worked with city staff from several bureaus to co-create a method for enhancing actor-centric transformative capacity related to urban resilience (Caughman, Plemmons, et al., 2020). Through comprehensive pre-planning that included interviews, meetings, and analysis to understand city needs, the collaborative team developed and implemented two interactive extreme event scenario planning workshops. PSU convened the inter-departmental process and also provided staff and student time to enhance city capacity so that all departments came to the

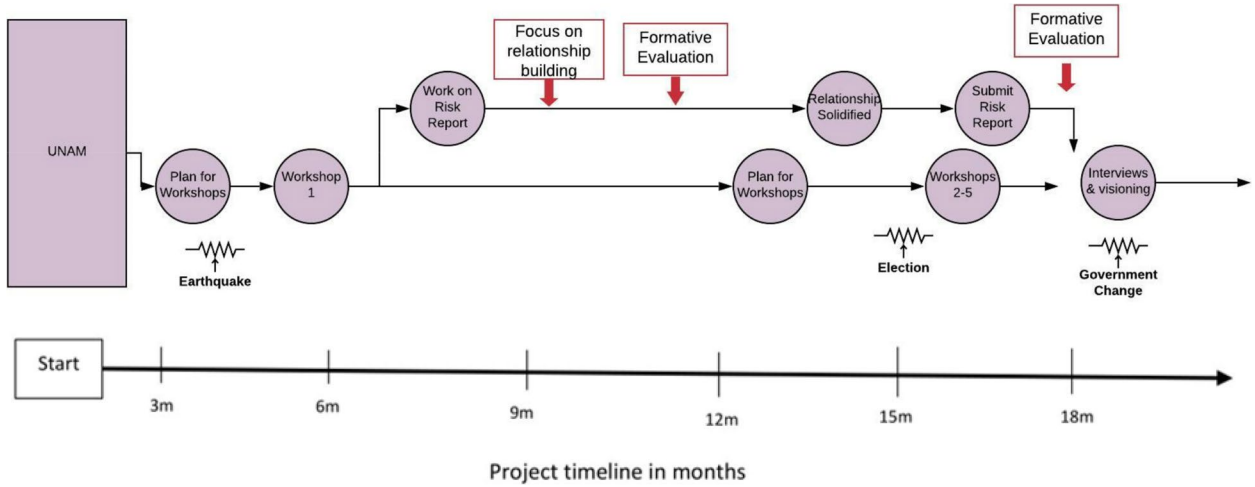

Fig. 1 Overview of the UNAM/Mexico City CUP project timeline with key milestones and actions

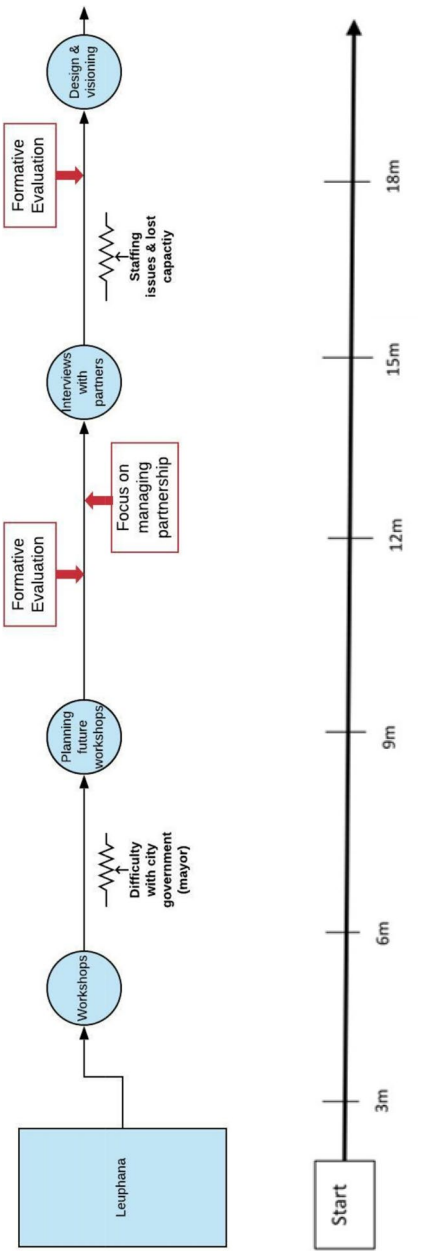

Fig. 2 Overview of the Leuphana/Luneburg CUP project timeline with key milestones and actions

workshops having executed initial planning activities. PSU collaborated with city stakeholders to develop a synthesis report that was immediately used for advocacy and also as a work plan for a newly formed resiliency advisory group made up of key stakeholders from across the participating bureaus, and coordinated in partnership with PSU.

This new advisory group is convened by PSU and backed by university staff and numerous interns to support planning and implementation efforts. Evaluation of the collaborative process showed the value of the university taking the time to listen to city needs, and attend to them; prioritizing relationship-building and tangible outcomes above academic publication. Additionally, the evaluation helped the team realize that in order to further the work the cross-bureau collaboration and knowledge sharing that occurred in the workshops would need to be both institutionalized within the city and bolstered by individual actors. Therefore, future work aims to continue the spirit of ad-hoc collaboration, while also aiming to produce policy to legitimize the work and funding to implement tangible projects. Additionally, this collaborative undertaking inspired the city and university to more intentionally formalize their relationship and they are beginning a process of identifying root-causes of sustainability and resilience problems that could be solved through deep partnership that transcends current organizational and operational structures. Please see the project timeline in Fig. 3.

Karlsruhe institute of technology and Karlsruhe, Germany

The Karlsruhe city government has developed an exemplary set of sustainability and climate protection documents and strategies and has a number of sustainability initiatives, for which it was voted the most sustainable city in Germany in 2015. However, implementation of existing strategies has remained the weak point. Across the municipality, the Karlsruhe Environmental Bureau is seen as the unit responsible for sustainability issues and the Karlsruhe Climate Protection and Energy Agency as the unit responsible for climate protection issues. The lack of co-responsibility for these issues across other municipal units as well as the lack of integrated understanding of sustainability actions beyond ecological aspects, and the quality of cooperation between bureaus and with further partners on sustainability and climate protection issues poses a significant roadblock to progress. Therefore, a partnership with the School of Sustainability at Karlsruhe Institute of Technology (KIT) was developed with the goal of building the capacity needed to mitigate these problems. The collaborative included work between KIT and several departments of city administration, with the Bureau of Environment and the Karlsruhe Energy and Climate Protection Agency (KEK) as the primary partners.

This project had two main phases. In the first phase, a city-wide *sustainability walk* was co-developed by researchers and partners to address abstract sustainability issues in a tangible, memorable way. This phase established a broad collective understanding of sustainability and strengthened cooperation between KIT and the city, but found limited success in supporting inter-bureau discourse. Therefore, phase two focused on the development of a culturally-specific serious gaming workshop that could be used to inspire cross-departmental collaborative planning.

University partners focused on developing and testing the workshop, but it soon became clear through real-time evaluation findings that the committed partnership needed to implement the workshops had deteriorated. Therefore, the university team began

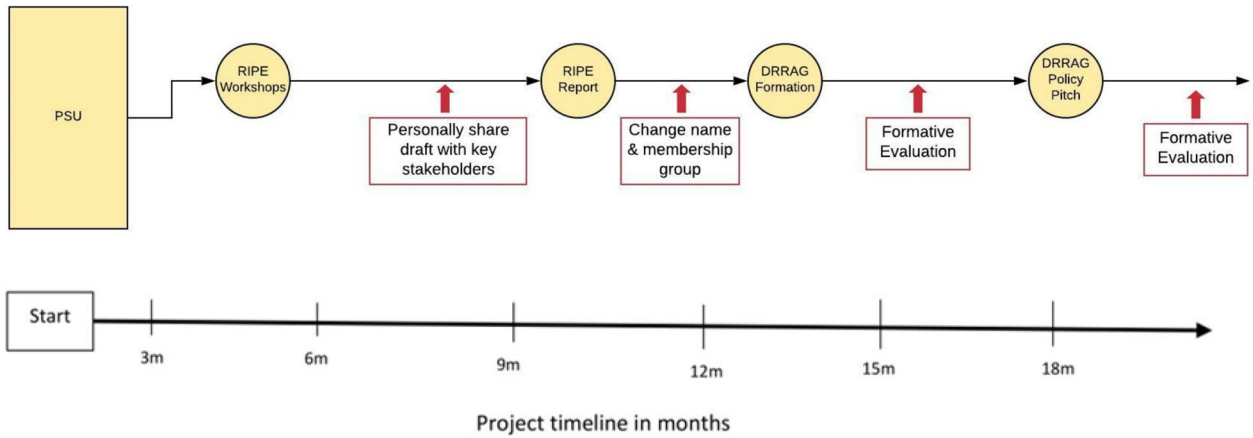

Fig. 3 Overview of the PSU/Portland CUP project timeline with key milestones and actions

attempting to find an appropriate time and place to fit it into the city workflow. Several different departments and city teams took interest in the workshop, but each had their own changes they wanted to make, causing the university partners to constantly re-think the approach. During this time, staffing changes and inconsistencies on the university side of the partnership also slowed progress. As staffing regained consistency on the university side of the partnership, a useful framework for the workshop was developed and an appropriate time and place for the workshop to be utilized was scheduled. The newfound alignment of interests is likely an indicator of better collaboration in the future, if staffing consistency and commitment is achieved. Please see the project timeline in Fig. 4.

Arizona State University—Tempe, Arizona

Faculty from Arizona State University and the Sustainability Director for the City of Tempe came together to create a mechanism to write the city's first ever Climate Action Plan and to grow the Sustainability Department. To do this, the partners conducted interviews with 41 city staff on potential actions for the climate action plan and the role of sustainability in the City of Tempe. From this, a report was produced with recommendations on how to structure the sustainability department at the City of Tempe.

Additionally, to support the development of the Climate Action Plan several engagements were co-developed and deployed, including: a stakeholder workshop on energy actions; a public forum on transportation actions; two expert forums on transportation actions; a scenario development workshop on the future of carbon neutrality in central Arizona; a public forum on energy and resilience actions; and expert workshops on internal carbon pricing and equity in climate action. Once input from the public and stakeholder workshops were compiled, the partners came together to conduct a public forum on all proposed actions for the Climate Action Plan and identify principles to guide future updates to the plan.

Collaboration between the ASU researchers and Tempe city staff proved to be consistent and productive throughout the entirety of the project timeline. However, formative evaluation revealed that the partnership between ASU and Tempe on climate action was primarily mediated by single faculty member interactions with single city staff members. This highlighted that the partnership, although fruitful, was vulnerable to changes in staffing or political shifts. Therefore, the partners went beyond workshops alone, and used workshop planning as well as interviews with city staff to deepen relationships and widen the collaboration. Overall, the group felt that these efforts have helped propel the formalization and institutionalization of the CUP so that it will be durable for years to come. Please see the project timeline in Fig. 5.

In the next section, the results of the comparative study are presented along with key takeaways that expose the functioning and dynamics of co-production and transformative capacity-building across CUP contexts.

Results

Understanding both the project and partnership side of each CUP

Routinely considering both *project* functioning and outcomes, as well as *partnership* stability and relationships (as specified by the FAI-ICES framework) was critical to understanding the interplay between actions and outcomes over time for each CUP.

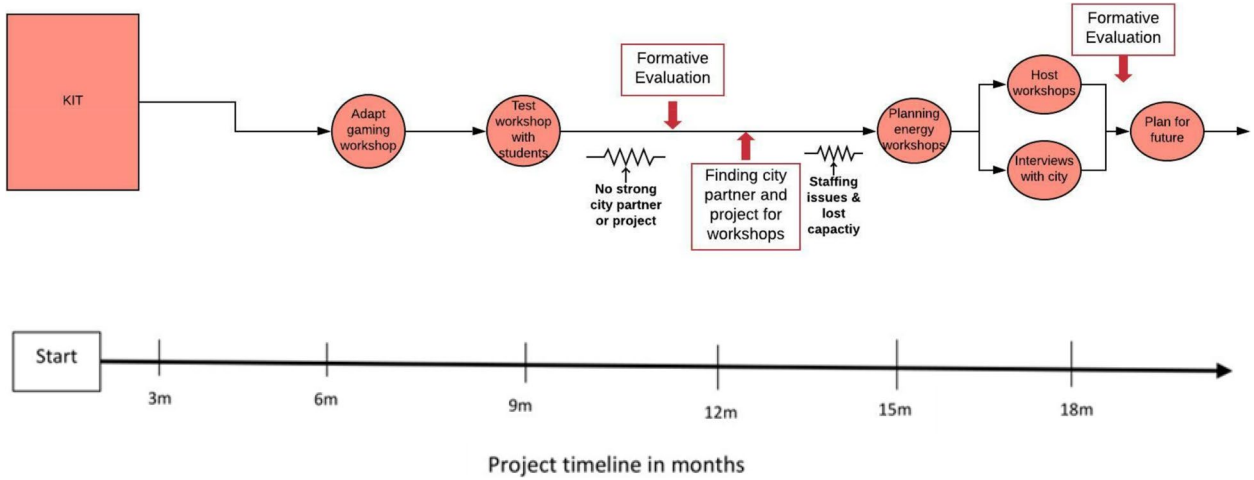

Fig. 4 Overview of the KIT/Karlsruhe project timeline with key milestones and actions

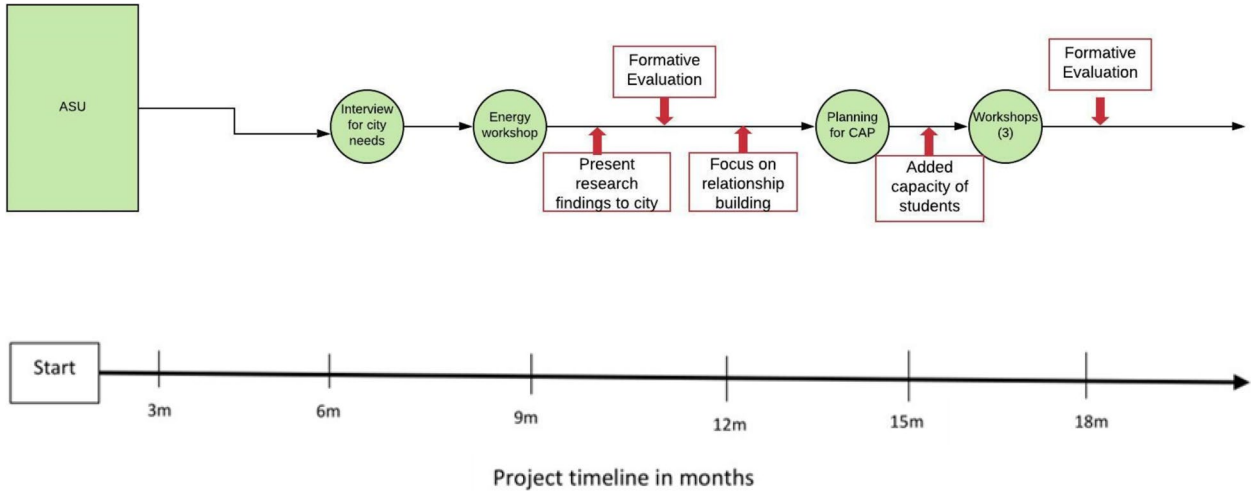

Fig. 5 Overview of the ASU/Tempe CUP project timeline with key milestones and actions

- Projects represent single, focused endeavors. The components of a project are specific and exact, with well-defined scopes goals, and outcomes. For instance, designing, building, and installing a shade structure is an example of a project.
- Partnerships describe the action of multiple entities working together, and the processes and methods of collaboration that are used to produce or create something. For example, partnership components include relational activities like sharing needs and visions for shaded walkways, and committing time and resources towards working together.

When CUP sites explicitly reflected on the state of their partnership in isolation from the state of their current project, and then specifically considered their project in the context of the overall partnership it exposed factors that impacted CUP functioning and success. Considering these two components individually, and then collectively, offered new insights to CUP managers, and significantly altered the trajectories of the CUPs. For example, in one focus group session, the ASU/Tempe CUP mangers took time to specifically reflect on the strength of their partnership beyond the current climate action planning project. They noticed that the relationship underlying the ASU/Tempe CUP relied on only one city staff person and one university faculty member. Though they had an excellent history of collaboration and strong working relationship, they remained vulnerable to staffing changes or political whims. The CUP managers realized that they might be taking the stability of their partnership for granted, and that more specific attention needed to be paid to the growth and development of the partnership itself if they wanted to have longstanding transformative outcomes, despite generally successful project outcomes. The ASU/Tempe team realized that by expanding and ingraining the partnership further, they could undertake progressively more advanced and transformative project initiatives together, that would likely outlive the legacy of only two people. Through this, and several other similar observations from the other CUP cases, our analysis showed that *project functioning impacts partnership development and partnership functioning impacts project outcomes*. We explore this phenomenon in more detail below with several examples from the case studies.

How projects impact partnerships

Project functioning, defined by the interest, competencies, capacities, co-development, co-management, and ultimately, the outcomes from tangible projects showed to have immediate and lasting impact of the status and development of the partnership itself. This dynamic was seen across all five CUP case study sites; a selection of examples is shown in Table 3. It was noted that when projects were functioning at high levels (+), there was a positive impact (+) on the partnership; when projects were dysfunctional (-), the partnership was negatively affected (-).

A clear example of project functioning impacting a partnership can be seen via the work at the KIT/Karlsruhe CUP. In this case, there was an ill-defined project that was not being mutually managed or implemented. The university side of the CUP hoped to create workshops for use by the city but created and tested their products solely within the university. Although well-intended, this one-sided implementation of the workshop made it difficult for the city partners to fully see themselves and their needs represented

Table 3 Chart showing how project functioning impacted the partnership across sites, with positive project function (+) correlating with positive relationship outcomes (+) and negative project function (-) correlating with negative relationship outcomes (-) and

CUP Site	Project Functioning	Partnership Impact
Mexico City & UNAM	(+) Successful completion of project with mutually expected outcomes	(+) Stronger collaborative history and interest to engage solidified via formal written agreement
Luneburg & Leuphana	(-) Project activities paused due to personnel changes	(-) Desired reformatting of partnership structure
Portland & PSU	(-) Co-management of the project diminished as project focus shifted	(-) Less desire to contribute time and resources
Karlsruhe & KIT	(-) Project not being co-implemented	(-) Reduced dedication towards partnership
Tempe & ASU	(+) Co-managed project produced tangible and useful results	(+) Motivation to engage improved and participation increased

in the work. This led to a reduced level of motivation to continue partnering and less dedication to the partnership overall, from both city and university participants. The KIT/Karlsruhe CUP team considered the how their project functioning was impacting their collaborative relationship and determined that their next steps should be to successfully complete a small co-managed project which could boost morale, and give the team a win, positively impacting their partnership and enhancing their future projects. Similar experiences of project outcomes impacting feelings towards partnership were noted at each case study site.

How partnerships impact projects

In the previous section, results showed that successfully co-managed projects enhance feelings of partnership and failed joint-projects degrade feelings towards working together; complementing this, we discovered that the status of the partnership itself also has a direct impact on project outcomes. Across all case studies, we found positive changes (+) in partnerships functioning were seen to create positive outcomes (+) for projects, and dysfunction (-) in the partnership resulted in negative (-) project impacts. Examples of partnership functioning and their impacts on project outcomes are shown in Tables 4 and 5.

Examining the Luneburg/Leuphana CUP shows this dynamic in action. At a point in the course of the study, the CUP began to stagnate and all involved were unsure of the path forward. However, by focusing on the previous strengths of the partnership and the strong collaborative history between the two institutions, partners from all sides were able to come together and consider future work. The team realized that the structure and configuration of their partnership needed to change to best suit their current context. Then, when the new form of the partnership was agreed upon, new opportunities for projects were quickly generated.

All of the CUP sites experienced times when the status of the partnership was either uncertain, or mis-matched with the goals of project, however, when focus shifted from managing the project to attending to partnership-related needs, the projects tended to naturally right themselves and improve. This shows the intimate connection between relationship building and the ability to complete projects, and poses the question: why do transformative outcomes necessitate stronger collaborative relationships? One

Table 4 Chart showing how partnership functioning impacted the projects across sites, with positive partnership function (+) correlating with positive project outcomes (+) and negative partnership function (-) correlating with negative project outcomes (-)

CUP Site	Partnership Functioning	Project Impact
Mexico City & UNAM	(-) Partnership not solidified with official documentation	(-) Increased uncertainty about ability to tackle complex problems with extensive projects in the future
Luneburg & Leuphana	(+) Strong collaborative history was recognized and previous allies convened	(+) Re-energized interest in project and found place for project to be integrated into city work
Portland & PSU	(+) Partnership roles and responsibilities defined	(+) Tangible project work-flows developed
Karlsruhe & KIT	(-) Lack of stable and consistent partnership participants	(-) Difficult to devise useful project
Tempe & ASU	(+) Motivation to engaged increased as mutual understanding of need improved	(+) More participation at workshops and integration into city planning

possible reason for this could be that relationships underpin transformative governance capacity building, as noted in examples and observations in the next section.

CUPs and transformative capacity

This study explored the ability of CUPs to take on increasingly complex problems and generate impactful solutions over time; these observations were used to consider changes in transformative capacity (the ability of city and university actors to complete urban transformation work). To explore areas of change in transformative capacity, the partnership and project actions and outcomes were related to four transformative governance capacities including: 1) Stewarding, 2) Unlocking, 3) Transforming, and 4) Orchestrating (Hölscher et al. 2019). Findings from across the CUP case study sites indicate that CUPs themselves do not innately generate increased transformative capacity for sustainability and resilience transformations. However, observations suggest that when CUP projects and partnerships are functioning positively, transformative capacity improves, and when either the partnership or project is dysfunctional, transformative capacity can stagnate, or even diminish. The table below shows examples of CUP processes and outcomes and how they influenced the four transformative capacities.

To elaborate on these changes in transformative capacity, we will explore in more depth a positive example from the PSU/Portland CUP and a negative example from Leuphana/Luneburg. Growth in transformative capacity can be best seen in the case of the PSU/Portland CUP where positive changes in both project and partnership functioning were reinforcing each other. Here, successful collaboration in the planning, management, and implementation of resilience workshops (unlocking capacity) led to the generation of a new co-managed working group aimed at making high level changes to governance systems and identifying and executing tangible city-wide resilience projects (orchestrating capacity). Further, these CUP initiatives ignited the interest of city and university leadership, who are now working to explicitly define and build a path towards urban sustainability and resilience transformations that can be achieved through deeply integrated institutional partnership (stewarding and transforming capacities). Therefore, the ability of the CUP to tackle complex problems and produce impactful solutions

Table 5 This table defines four transformative capacities (Hölscher et al., 2019) and gives examples from the CUP cases that show how partnership and project functioning can impact transformative capacity in positive or negative ways

Capacity	Definition	CUP Observations	
		Increasing Capacity	**Decreasing Capacity**
Stewarding	Ability to anticipate, protect and recover from uncertainty and risk while exploiting opportunities beneficial for sustainability	UNAM/Mexico City: Partnership enhanced stewarding capacity by providing space to plan and navigate government transition and possible dissolving of resilience office	KIT/Karlsruhe: Not including city partner in testing of research methods/workshops indicated less stewardship of previous collaborative work and thwarted identification of new opportunities
Unlocking	Ability to recognize and dismantle structural drivers of unsustainable path-dependencies and mal-adaptation	PSU/Portland: Project activities highlighted local governance structure and system was barrier to collaborative infrastructure planning, unlocking pathways for future work and change	Leuphana/Luneberg: Personnel changes on multiple sides of the partnership increased structural barriers to sustainability action implantation and reinforced path-dependencies
Transforming	Ability to create and diffuse novelties that contribute to sustainability and resilience and to embed these novelties in structures, practices and discourses	ASU/Tempe: Partnership created opportunity for City's first ever Climate Action Plan with implementable projects. Grew partnership participants and imbedded collaboration into city workflow	UNAM/Mexico City: Lack of formal recognition of collaboration reduced CUP's power and therefore ability to implement structural changes
Orchestrating	Ability to coordinate multi-actor governance processes and foster synergies and minimize trade-offs and conflicts across scales, sectors and time	PSU/Portland: Outcome from CUP is new collaborative team (Disaster Resilience and Recovery Action Group) that will facilitate multi-sector resilience planning in Portland	Leuphana/Luneberg: When one project phase ended, a new project was not immediately identified and the partnership began to falter, signifying significant challenge in moving from ideation phase to coordination and implementation phase

is much greater now than it was at the conception of the CUP, as observed through increases in multiple types of transformative capacity.

Stagnation or diminishment of transformative capacity was also noted. In the case of the Leuphana/Luneburg CUP, the level of transformative capacity grew, waivered, and ultimately stagnated over time. In the beginning of the initiative, the perceived transformative capacity of the CUP was substantial, and the potential for increased transformative capacity was high. The institutions had a strong history of collaboration and shared goals for working together to envision the future of their community in the context of sustainable development goals, which offered the potential for highly impactful projects (stewarding capacity). However, as the initiative concluded phase one and transitioned to the next, a lack of shared direction, evolving political context as well as leadership and staffing changes eroded the partnership side of the work and put a pause on shared CUP project activities (stagnating/reduced unlocking capacity and orchestrating capacity). This faltering of co-created CUP activities led to a diminishing ability of the CUP to take on complex problems and produce impactful solutions, indicating a decrease in overall transformative capacity (transforming capacity). However, the university team is using exploring new ways to engage and partner with the city, focusing on strengthening the partnership to co-create meaningful projects in the near future.

These cases studies begin to demonstrate how CUPs' project and partnership functioning might relate to changes in transformative capacity, across four theorized subtypes of transformative capacity. However, this research does not directly measure transformative capacity, nor does it measure transformative impact; this study merely reflects on observations and experiences of those involved in managing the CUPs. Additionally, the four types of transformative capacities we explored are not an exhaustive or fully validated list. Further studies that directly measure CUP management practices and functional impacts on transformative capacity are needed, as well as longer studies that can continue to track tangible transformations towards sustainability and resilience in the urban environmental over time.

Discussion

Reflecting on the five CUPs profiled in this article provides useful insight into CUPs potential to improve transformative capacity. However, not every CUP in the selected case studies was noticeably different from typical CUPs, despite transformational intentions. Each CUP had aspects of transformative design and impact, but some were more successful at actualizes those results than others. Our findings show that how CUPs are (or are not) intentionally managed is a key factor in determining whether or not they will reproduce the status quo, or move in the direction of transformation across multiple scales. Moreover, findings from the cross-comparison of case studies informs CUP development and management practices. In particular, our case studies show how the structure and functioning of projects and partnerships impact each other, and influence the level of capacity the collaborative institutions have to complete increasingly complex sustainability and resilience initiatives. CUP managers can use these insights to better structure their CUPs, and manage them for increasing transformative capacity that leads to tangible impacts.

The project-partnership cycle

Taken together as a whole, our work reveals that CUPs thrive when they are more than a series of collaborative projects, and instead are intentionally formed as transformative partnerships with specific attention paid to the relationships involved and a shared vision of transformation. Our findings indicate that collaborative sustainability and resilience initiatives must equally prioritize partnership and project development (where historically projects dominate focus). This increased understanding prompts the development of a new framework for transformative CUPs, based on the observed positive feedback system of the project-partnership cycle (Fig. 6). The key assumption behind the model is that the strength of the partnership and the project are inseparable; both must be managed in tandem to have successful urban transformation outcomes and long-term viability.

As shown in the figure, the partnership side and project side of a CUP deeply influence one-another. The status of the partnership (i.e. motivation to partner, mutual understanding of needs, and level of partnership formalization) influence the type and quality of projects (i.e. how well they are co-developed, co-managed, resourced, and implemented), which subsequently determines project outcomes (i.e. goal attainment and real-world impact), and the nature of these project outcomes reinforces the relationships between the individuals and institutions involved (with positive or negative influence), which all leads to a new partnership status.

Further, as the cycle is repeated, the transformative capacity of the collective CUP evolves. Therefore, the project-partnership cycles itself progresses along a third axis, which indicates how the CUP's transformative capacity is increasing or decreasing, based upon project and partnership functioning. When the cycle can be successfully completed, it moves in the positive direction, towards increased transformative capacity; when the cycle is broken, dysfunctional, or negatively reinforcing, it moves in the opposite direction indicating decreased transformative capacity.

Although the project-partnership cycle may seem intuitive (and perhaps even rudimentary) it has not previously been described in collaborative work, and may be particularly critical for achieving transformative outcomes by bridging divides in inter-institutional endeavors. For instance, the success of CUPs can be limited by higher education's narrow focus on project outcomes and the constraints grant timelines and publishing requirements, often being accompanied by "helicopter research" and a

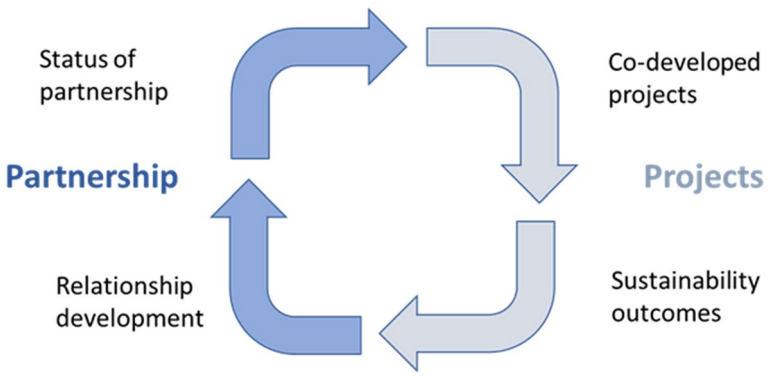

Fig. 6 The partnership project cycle and positive feedback loop

constant turnover of students. The project-partnership cycle is novel because it provides a framework for understanding why these practices inhibit sustained progress towards increasingly complex and transformative goals; the cycle makes a strong case for why academic timelines and culture may inadvertently diminish transformative capacity by too heavily focusing on projects and not investing enough into healthy partnerships. Similarly, the project-partnership cycle highlights that cities partnering with universities need to challenge assumptions that university researchers are consultants or knowledge holders who can only provide specific short-term solutions, and instead see them as invested members of a coalition towards long-term change, thus making it worthwhile to continually invest in deepening the relationship beyond discrete outcomes.

For transformative sustainability and resilience focused CUPs, recognizing project-partnership dynamics may be useful for CUP management and can help conceptualize pathways towards building and maintaining transformative capacity. Therefore, we suggest that the project-partnership cycle be used for the adaptive management of CUPs. This can support careful reflection on both relational and tangible activities, allowing for intentional interventions to be applied and attainment of durable, impactful, and ultimately transformative CUPs (possible examples of which are described in the next section).

Finally, the reinforcing feedback loop formed by these project-partnership dynamics could of course apply to many different types of partnerships, and is likely not unique to the case of CUPs working towards transformative urban sustainability and resilience goals. The research team is currently exploring how the cycle persists in a variety of contexts, and plans to describe its usefulness for the management of a wider range of collaborative work in the future.

Project-partnership adaptive management

The project-partnership cycle can aid in adaptative management of CUPs, providing opportunities to consider how the status of the project or partnership might be impacted by various actions or interventions before making decisions. The project-partnership cycle works well in tandem with iterative monitoring and assessment approaches (like formative or developmental evaluation), that encourage ongoing reflection. This tactic encourages CUP managers to understand intricate details about their CUP, consider relational contexts, and monitor decisions made over the course of CUP activities. In this way CUP managers can contemplate movement across the project-partnership cycle and manage for impact.

Now, we will retrospectively explore examples from the CapaCities CUP case-studies that highlight the workings of the project-partnership cycle and expose how this framework can aid in decision-making and inform CUP management strategies. Throughout the CapaCities CUPs timelines, the focus group sessions doubled as an opportunity for CUP managers to reflect on their progress and discuss management techniques. The reflexivity developed through this approach often caught problems before they started and allowed CUP managers to look at their initiatives and interactions from a different perspective.

For instance, partners at Mexico City and UNAM were able to think through various scenarios of how an impending governmental shift would impact their CUP work. They

reflected upon the parts of their work would be most able to withstand change, and the parts that would likely become dismantled. While it was impossible to know how the elections would play out, they were able to think deeply about their network and strategically strengthen the informal bonds that supported their work, which in turn allowed them to develop formal agreement for continued collaboration. If the CUP had not completed thoughtful, iterative consideration of the status of the partnership they may have simply finished their immediate projects and then disintegrated upon the governmental shift – leaving any future work little foundation upon which to build. Instead, they were able to take control of the situation and navigate the changes, coming out with a stronger partnership than ever before and more power to implement transformative resilience solutions.

Similar examples of partnership and project observations leading to intentional interventions and subsequently positive impacts were seen across all the CUPs. Table 6 shows a selection of specific insights that were generated through the focus group sessions which describe project/partnership observations, the management strategy chosen, and the subsequent outcomes of those choices.

The interventions chosen by CUP managers in the context of paying specific attention to both project and partnership functioning emerged simultaneously with our understanding of the project-partnership cycle. Therefore, these are just the earliest results and examples of how adaptive management within the project-partnership cycle can occur, and have a positive impact on overall CUP functioning, durability, and impact. Continuations of the CUPs described in this study, as well as new CapaCities CUP projects are being adaptively managed and iteratively evaluated using the project-partnership framework, which will provide data for a deeper analysis of the project-partnership cycle framework as a management tool. However, this study clearly shows how thoughtful partnership decisions lead to more meaningful projects, and how projects that are successful reinforce relationships – which are often the foundation of transformative capacity.

Table 6 Chart showing how knowledge of the project-partnership can inform management strategies and produce desirable outcomes across sites

CUP Site	Observation	Adaptive Management Strategy	Outcome
Mexico City & UNAM	Government shift will disrupt partnership	Build relationships outside of current configuration	Partnership survived government upheaval
Luneburg & Leuphana	Uncertainty around city priorities and feelings towards CUP	Conduct reflective interviews with stakeholders	Gamified workshops for partnership development created
Portland & PSU	CUP is durable and attained outcomes enhanced trust and capacity	Formalize partnership with enhanced cross-institutional support and ambitious goals	Assembled new collaborative team of empowered leaders at city and university
Karlsruhe & KIT	University desires and nomenclature are not meeting city needs	Talk about the work in ways that resonate with municipal work-flow	City more receptive to interventions
Tempe & ASU	Partnership is not robust or resilient to change	Involve more participants on city and university side	City and university jointly planning future prolonged engagement

Conclusion

As cities rise to the challenge of attaining urban sustainability and resilience transformations, they will need to co-produce innovative solutions, build their transformative capacity, and undergo massive transitions. No city government can accomplish this magnitude of change on their own. Municipalities face many barriers to solving complex issues; they are often deeply entrenched in the same systems that have created the problems in the first place, and often must make hard trade-offs with limited resources. City-university partnerships (CUPs) have emerged as one strategy for breaking out of old cycles, enhancing learning, and accelerating progress towards solving complex problems. Over the past decade, the number of sustainability and resilience focused CUPs has been increasing rapidly; and while some of these initiatives are successfully enabling cutting-edge transdisciplinary research and transformative change, others fall flat. Research on CUPs has not yet developed a full understanding of what inhibits or propels CUP success, or described how to manage transformative partnerships.

This paper contributes to the understanding of transformative CUP functioning and provides insights for CUP management by closely monitoring five CUPs across three countries, and detailing how actions led to outcomes and impacts over time. Cross-comparison of the sites showed that both the partnership and the project side of CUP initiatives play a critical role in overall CUP success. Additionally, the CUP case studies were related to four types of transformative capacity (stewarding, unlocking, transforming, and orchestrating), in order to explore how different CUP happenings related to the ability to contribute to sustainability and resilience transformations. CUPs were shown to have both positive and negative impacts on inter-institutional transformative capacity, depending on whether or not their partnership and/or project processes or outcomes were being appropriately designed and managed. This highlights that CUPs do not innately increase transformative capacity in cities, but rather CUPs that are specifically designed to be transformative partnerships and function in positively transformative ways are more likely to have the longevity and impacts to create urban sustainability and resilience transformations. Poorly functioning CUPs can potentially reduce overall transformative capacity and reinforce the unhelpful/damaging practices of the status quo.

CUPs are theorized to be useful mechanisms for accelerating innovation and transformative change towards sustainability and resilience outcomes in cities, however, to achieve these aims, CUPs need to challenge existing conditions, overcome structural barriers, and reimagine business as usual. This article primarily documented how five different CUPs were structured and how their internal functioning related to the transformative capacities of the CUPs themselves, rather than transformation in institutions like universities and city governments, or the urban environment itself. However, when CUPs are designed and implemented in innovative ways, and then have the opportunity to function in a way that increases transformative capacity of the partnership itself, the CUP may become a venue for new ways of doing things that can transcend the CUP and become normalized within and across institutions, which has potential to function as a transition area (Rotmans & Loorbach 2009; Wolfram et al. 2019).

Within the transition arena of a transformative CUP the status quo may be challenged in multiple ways that are essential to overall institutional and physical sustainability/

resilience transformation in cities. At universities this may look like including community-embedded and socially engaged/problem based & values driven research. For city governments the changes allowed by CUPs may be increasingly flexible and less engrained and narrow disciplinary ways of doing things. Overall, the goal would be transformation both within and outside of each CUP, where the CUP become greater than the sum of its parts. A few examples of this are seen in the CUP case studies depicted in this article. For instance, in Tempe the CUP produced new ways of doing research that can be iteratively integrated in climate action planning processes at the municipal level. Additionally, the Portland CUP created new governance venues i.e. DRAGG with ongoing mutual collaboration between city administrators and university researchers. Finally, the Mexico City CUP actually institutionalized changes in city government by solidifying the role of a resilience office through a massive governmental shift.

The relationship between partnership development and project outcomes (and vice-versa) was explored in-depth, and culminated in the articulation of the project-partnership positive-feedback cycle. The functioning of this cycle was seen across all five case study sites, as it amplified mishaps and reinforced positive changes. Additionally, the progression of the cycle may lead CUPs towards improved or diminished transformative capacity, impacting their ability to tackle complex problems and implement impactful solutions. Therefore, it is recommended that CUPs managers practice adaptive management techniques that utilize the project-partnership cycle framework and engage in iterative reflection activities that illuminate places where partnership or project interventions will amplify their CUP's longevity and impact. The findings stated in this paper can be immediately used to better CUPs design and management, and advance the fruitful co-production of knowledge, collaborative research, and cross-institutional coalition-building for transformation.

Future research should attempt to directly measure transformative change in each partner institution outside of the CUP itself, and also quantify transformative impacts. It would also be useful to explore how the project-partnership cycle functions in larger and more complex collaborations, or those working between universities and community-based organizations.

Abbreviations
CUPS City University Partnerships

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Authors' contributions
The authors confirm contribution to the paper as follows: LC, LWK, and FB contributed to study conception and design. LC did the data collection. LC and FB completed the analysis and interpretation of results. LC wrote and prepared the draft manuscript. All authors reviewed the results and approved the final version of the manuscript.

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