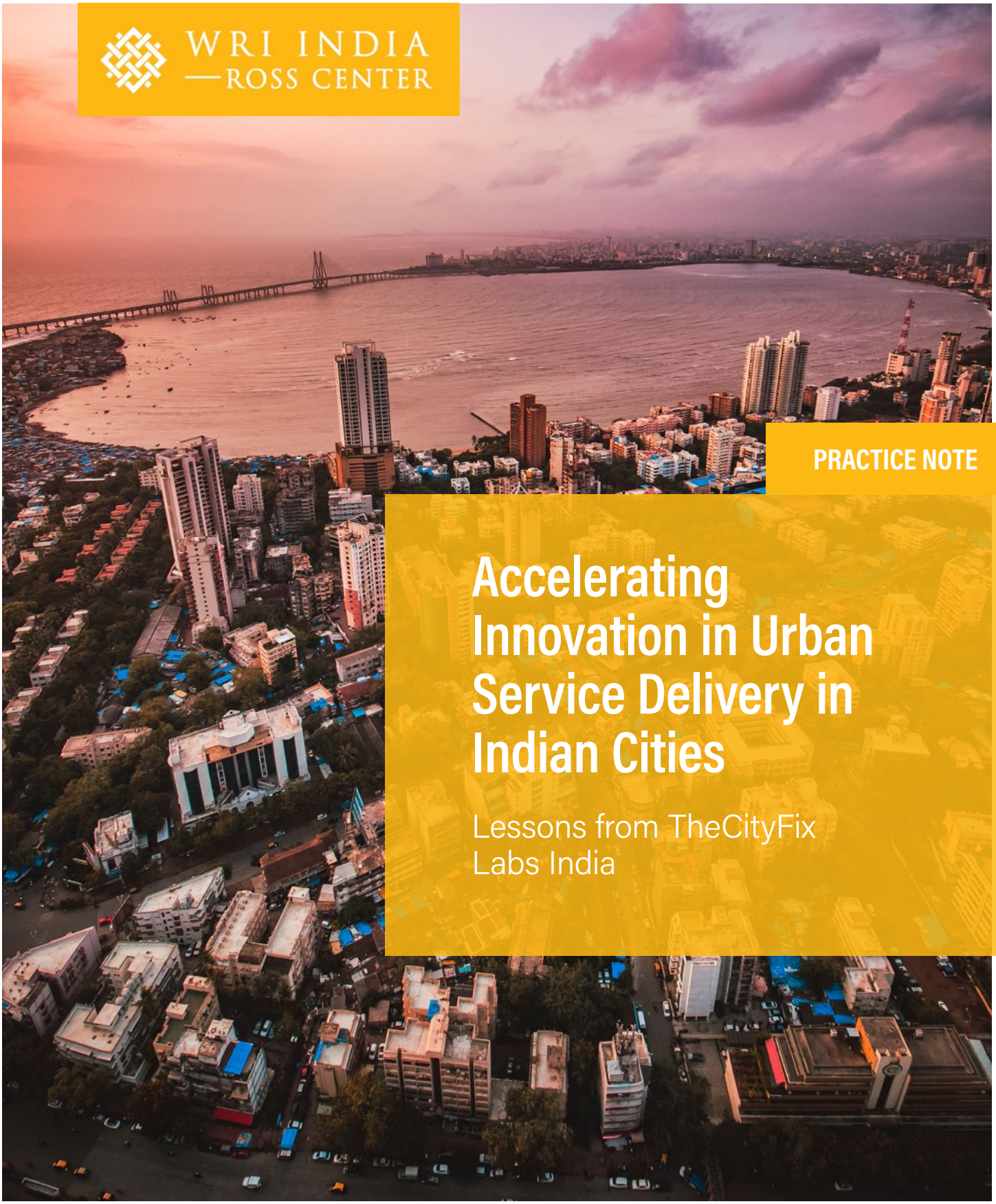

WRI INDIA
—ROSS CENTER

PRACTICE NOTE

Accelerating Innovation in Urban Service Delivery in Indian Cities

Lessons from TheCityFix Labs India

Practice notes provide rapid analysis of experiences related to a particular project. The analysis and recommendations are limited to the specific context presented in the note and should not be construed to apply more broadly.

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CONTENTS

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HIGHLIGHTS

- Urban services delivery in the water, waste, and energy sectors in India struggles due to legacy systems, inadequate funding, and restrictive policy and regulation. Innovation can offer Indian cities an efficient, economical, and sustainable alternative to meet the growing demand for efficient urban services.
- TheCityFix Labs (TCFL) is a multi-stakeholder platform targeting five key gaps in the innovation ecosystem for urban services: lack of investment, insufficient focus on sustainability, inconsistent policy regulation, challenges in public sector engagement, and a geographically skewed support ecosystem.
- The TCFL methodology—Evaluate | Bridge | Accelerate—evaluates the innovation ecosystem and its gaps, identifies solutions to bridge gaps between stakeholders, and helps start-ups accelerate through capacity building, partnerships, and pilots.
- TCFL worked to bridge gaps in access to funding, finance, markets, and government through a customized curriculum for a cohort of 10 companies. Nine pilots are in discussions with multiple state and national-level public agencies. Four companies raised more than US$20 million combined in new private financing. In line with current trends, three of these companies were engaged in the energy sector.
- TCFL learnings focused on creating multi-stakeholder platforms, de-risking pilots, employing new government schemes, and evolving the innovation ecosystem for improved urban services delivery.

EXECUTIVE SUMMARY

Background

Across the world, efficient and equitable urban service delivery is seen as the key to bettering the quality of life. It is also an instrument to direct sustainable and inclusive growth. In India, urban service delivery remains the preserve of largely underfunded and unempowered local governments (Beard et al. 2016; Ahluwalia 2019). This leads to a demonstrable shortfall in the reach and efficacy of urban service delivery:

- Inadequate water supply: Only about 62 percent of India's urban population has access to treated tap water (Wankhede et al. 2014).
- An unmanageable waste crisis: Only 50 to 80 percent of generated waste is collected, of which approximately 40 percent is segregated (Press Information Bureau, Government of India, 2016).
- Unchecked energy consumption: Buildings already consume 34 percent of the country's total electricity, and if no action is taken, this could see an increase in energy consumption and CO2-related emissions of up to 800 percent by 2050 (Global Buildings Performance Network, 2020).

With India's urban population estimated to grow by 416 million by 2050 (United Nations Department of Economic and Social Affairs 2019), the demand for efficient urban service delivery and resources is set to balloon. Over the last decade, cities across the globe have sought and applied different kinds of innovative solutions to meet urban challenges. Innovation has led to the creation of efficient low-cost technologies and business models and helped governments design citizen-centric services. For instance, the city of Barcelona chose to adopt IoT solutions. This innovation-led approach enabled the city to save $58 million a year in water-efficient solutions and a further $37 million annually through lighting technologies, with the additional benefit of also creating 47,000 jobs by engaging the local technology industry to develop these solutions (Adler 2016; Guglielmo 2014). Given that India has the third-largest start-up ecosystem globally (NASSCOM 2019), using innovation offers the country a swift, economical, and sustainable way to tackle urban service delivery challenges, which in turn can enable growth and improve access to better public services.

Current State of the Support Landscape for Innovation in India

At least seven central ministries have launched schemes and policies promoting start-ups. These schemes largely offer financial and procedural support to incentivize the setting up of innovation infrastructure, including incubators, technology, and physical infrastructure (Rajan 2018b). Apart from flagship schemes like Start-up India, there are over 50 government schemes, sector specific as well as sector agnostic, to supplement a supportive ecosystem for innovation in India (Inc42 2018). The Government eMarketplace (GeM) offers an online platform for central government procurement of products and services. Twenty-one of the 29 state governments are also pursuing start-up policies (Poojary 2018). Apart from government schemes and policies, primary institutional support to take start-ups from the ideation stage to commercialization is in the form of incubators, accelerators, challenges, and sandboxes. These are run by state innovation cells, private investors, academic and research institutions, and corporates.

The sustainability and civic-tech space has also seen a growing number of entrepreneurs come forward with unique solutions, with an estimated 450–475 civic-tech start-ups in the country (Village Capital and CIIE.CO 2019). These solutions build on impact with scalable business models and receive philanthropic support and impact investments, but these sectors are still in their nascency. Growing interest from other stakeholder groups, including government and investors, indicate that they may be perfectly positioned for increased engagement and multi-stakeholder collaboration, enabling them to deliver better outcomes for a wider audience. Given

India's high output of scientific publications and the many prominent research institutions present in the country (World Economic Forum 2019), collaboration between businesses and the scientific community can also accelerate the spillover of knowledge and the number of solutions.

About This Practice Note

WRI India partnered with Citi Foundation to launch TCFL to address gaps in service delivery in the sectors of water, waste, and energy. Our goal was to help 10 enterprises overcome the barriers we identified in their access to government, finance, and markets. We used an iterative feedback loop to develop a methodology for identifying solutions and de-risking them to achieve scale. The loop allowed for flexibility in the methodology. We incorporated learnings and stakeholder feedback to build a more nuanced and customized platform for engagement that follows a three-step approach:

- **Evaluate:** We selected a cohort of 10 companies out of 125, through an open call for applications. We based our selection on the following factors: the problem that the solution addressed, the potential of the company to finance pilots, the scalability and replicability of the solutions, and the potential for participation in TCFL to help scale the company's social, economic, and environmental impact.
- **Bridge:** With the cohort selected, we designed a customized accelerator program based on the needs identified by the participants. Our aim was to bridge the gaps between the various stakeholders; that is, the government, the private sector and investors, academia, and community.
- **Accelerate:** We then facilitated the scaling of enterprises through capacity building and pilots.

We analyzed the current state of the innovation ecosystem in India in the sectors of water, waste, and energy, to ascertain the scope of an accelerator platform. On the basis of this analysis, we designed TCFL to offer effective mentorship and access to investors and government stakeholders through a single platform. We brought together 40 mentors to engage and collaborate with the cohort of 10 companies. To assess the impact of TCFL, we collected a combination of qualitative and quantitative (business, operational, and environmental metrics) data from the entrepreneurs before and after the four-month accelerator. Each start-up within the cohort was unique in terms of solutions offered, maturity, and financial profiles. These differences existed not just within the cohort but also relative to shortlisted but non-accelerated start-ups in the control group. Given the diversity of the start-ups and the time constraints, it was not feasible to establish quantitative outcomes from the program or to compare TCFL with other programs or accelerated start-ups. We elected, instead, to measure the impact of the program as key milestones achieved by the cohort. Our learnings from this process are targeted at all participants and stakeholders in the innovation ecosystem for urban service delivery in India and present an understanding of how start-ups can benefit from increased exposure, avenues of engagement, and tailored capacity building. We hope this publication contributes to an emerging body of knowledge on innovation for public service delivery in India that includes research by Nesta (CTIER and Nesta 2019) and the Indian Institute of Technology Madras (Rajan 2018b).

Key Findings

We interviewed key informants from each stakeholder category to understand persisting barriers in the innovation ecosystem for water, waste, and energy. The following insights emerged:

- **In the water sector,** the absence of norms and mandates, at both the national and sub-national levels, has added to a lack of awareness and limited the push for innovative recycling, measurement, and treatment technologies. The challenges of legacy systems such as aging infrastructure and unmapped drain and pipeline networks further compound the problem.

- **In the waste sector,** the problem of waste management is very localized and city specific, with a heavy dependency on local ecosystems, urban local bodies, regulation, and local government.
- **In the energy sector,** existing standards for energy efficiency (EE) are limited and/or voluntary. Consumer confidence in the market remains low, as there are many EE solutions but few standards to help consumers make safe decisions.
- **Across sectors,** the government, investors, enterprises, consumers, and corporates are perceived to have a low priority for sustainability. Engaging with government is still viewed as a daunting task due to long bureaucratic processes requiring approvals at multiple levels.

Learnings and Opportunities

Among the cities and the participant enterprises we worked with, we found the following:

- **Low-risk pilots allow urban local bodies (ULBs) to test and learn** about the product/service while helping entrepreneurs understand ground realities and improve their offerings. TCFL enabled one-on-one discussions between stakeholders, with the result that nine enterprises pursued pilots.
- **Post pilots, the scaling of solutions through government depends on the municipal request for proposal (RFP) process** with its stringent qualification criteria that are difficult for smaller enterprises to meet.
- **A multi-stakeholder intermediary platform** helps break silos to bring together multiple stakeholders, who can pool individual resources and skills toward solving a common problem.
- **The composition of skill sets within the team of founders and their ability** to be coached and absorb inputs is as important as the ability of the incubator/accelerator to offer technical support, sector insight, and advice.

The interviews with stakeholders also highlighted opportunities to address persisting hurdles:

- **Improving procurement processes:** Current procurement processes are too complex to encourage entrepreneurs to participate. The detailed specific solution requirements are also a deterrent. There is a need to reform the process and test alternatives that actively encourage wider participation and innovative solutions.
- **Expanding investment in innovation:** The need for increased investment to support innovation provides an opportunity to widen the net of investors by incentivizing different stakeholders. A potential way to address this could be through a social stock exchange to allow the trading of stock of social impact companies, creating liquidity while removing exit pressure on investors.
- **Leveraging and expanding platforms of engagement:** Platforms for engagement could play a big role in capacity building, creating an environment for collaboration and multi-stakeholder innovation.
- **Creating anchor institutions:** In the present scenario, different agencies at the national, state, and local levels of government work in organizational silos. Fragmented efforts by multiple authorities lead to poor implementation. Setting up anchor institutions can provide leadership, coordination, and a unified approach.

Going forward

TCFL pilots demonstrate the potential for private entrepreneurs to contribute to meeting urban public service needs. Collaboration with city and local governments to actively enable or adopt innovation solutions can increase market size and reduce the cost of delivering these solutions.

The ongoing coronavirus health crisis has focused and redirected government efforts toward containment and management of the pandemic, putting most TCFL pilots on the back

burner. Solutions that the TCFL program supported, however, continue to make critical contributions to urban services. For example, one company from the cohort developed an epidemiological solution for identifying coronavirus outbreaks by testing wastewater. We hope the lessons learned from forming and managing the cohort will continue to contribute to a better understanding—for us at WRI India, for the government participants, and for the other stakeholders.

1. INDIA'S URBANIZATION CHALLENGE: THE INNOVATION POTENTIAL

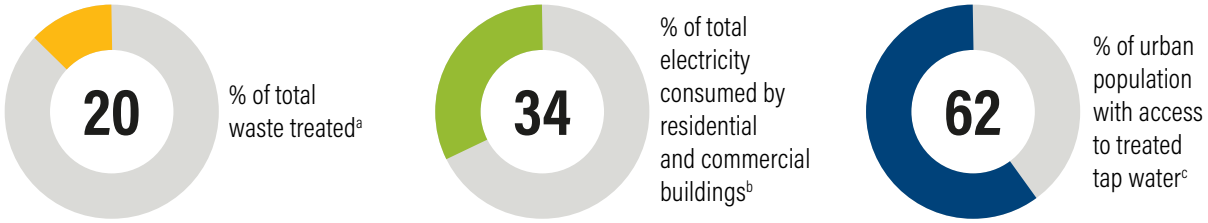
The UN Department of Economic and Social Affair's World Urbanization Prospects (2019) states that India, China, and Nigeria are expected to account for over a third of the urban population added between 2018 and 2050, with India's share being 416 million urban dwellers. Providing equitable access to quality urban services to this growing population is a massive challenge that confronts Indian national, state, and local governments, a problem that is further compounded by inequity and increasing pressure on scarce natural resources.

The gaps in urban service delivery for water, waste, and energy are particularly severe and need immediate attention.

WRI's Aqueduct water risk analysis (Hofste et al. 2019) indicates that India is currently the 13th most water stressed country in the world with only about 62 percent of the urban population having access to treated tap water (Wankhede et al. 2014). Meanwhile, real estate consultants Knight Frank and Royal Institute of Chartered Surveyors (2019) project that current rates of urbanization will create a demand for 25 million affordable housing units by 2030. The water demand for these new properties would be 5 trillion liters annually.[1] A WRI India 10-city study on the impacts of urbanization on natural infrastructure in India affirms that quickly depleting ground water resources are further stressed by deteriorating water quality due to poor sewage and industrial water treatment (Goswami and Basak 2020). This has made water resource management and efficiency a critical issue.

The Ministry of Statistics and Programme Implementation (Central Statistics Office 2018) states that residential and commercial buildings consume 34 percent of the country's total electricity. With India expected to add 35 billion square meters of new buildings by 2050 (Bureau of Energy Efficiency n.d.), managing the total building energy consumption in urban areas will be a crucial step to reducing greenhouse gas (GHG) emissions.[2] It is important to address this too, given the massive environmental and economic cost implications of energy generation.

Figure 1 | India's Urban Challenge

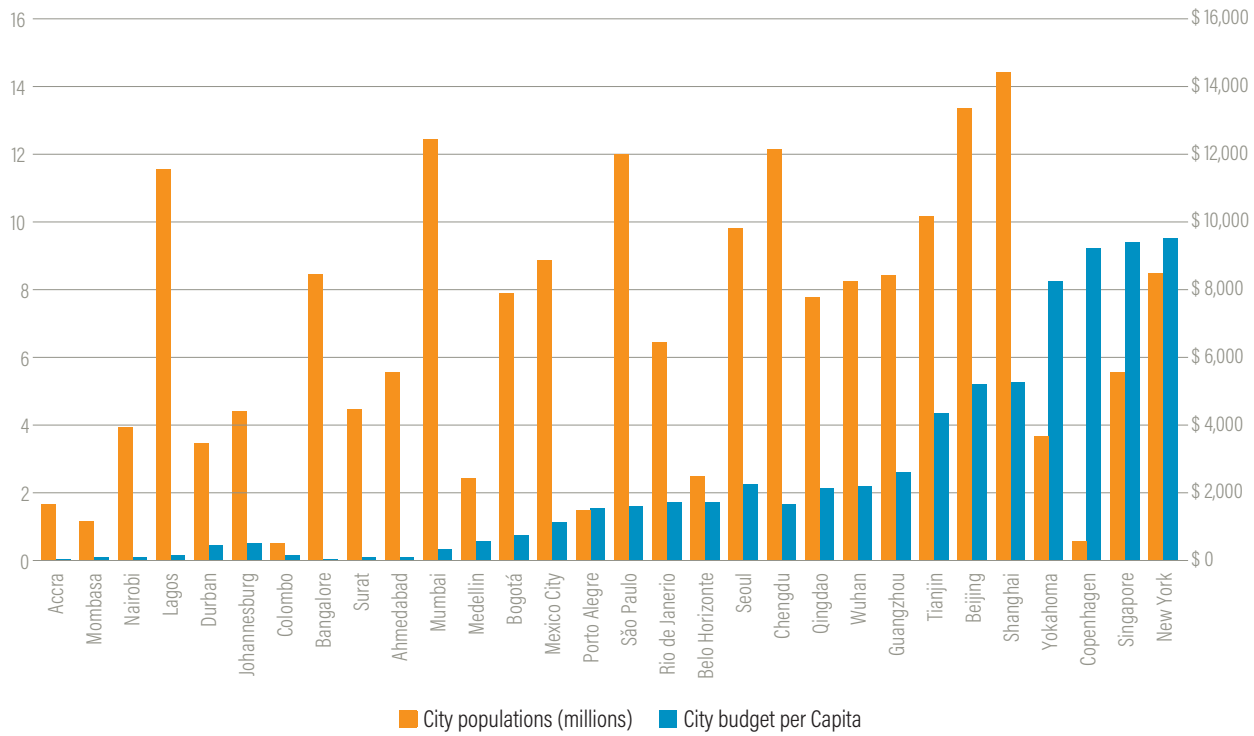


Sources: [a]Press Information Bureau 2016; [b]Bureau of Energy Efficiency n.d.; [c]Wankhede et al. 2014; TheCityFix Labs (TCFL).

Figure 2 | **Annual Waste Management Statistics in India in Metric Tons per Annum (TPA)**

Source: Press Information Bureau, Government of India, 2016

Figure 3 | **Per Capita Municipal Budgets**



Note: Most municipal revenue is spent largely on salaries, pensions, and operational expenses. Cities have been consistently under-investing in core infrastructure.

Source: Beard et al. 2016

Data from the Ministry of Environment show that only 50 to 80 percent of generated waste is collected, of which only about 40 percent is segregated (Figure 2), leading to excessive landfilling and incineration. Gaps in service provisioning for collection are often filled by unauthorized and unregulated waste collectors who improperly dispose of waste through open dumping, dumping in water bodies, and/or burning. This can cause air and water pollution, and increase the likelihood of disease. There is a pressing need to address the negative impact on the environment, public health, and the quality of life of sanitation workers and their families.

Challenges in urban service delivery are exacerbated by weak mandates across resource-strapped and inadequately staffed municipalities. The 74th constitutional amendment recommends devolution of powers to urban local bodies (ULBs) for the planning and implementation of public utilities and infrastructure (Government of India 1992). Yet, they remain poorly funded (see Figure 3) and unempowered (Ahluwalia 2019) to address the pressing issues of basic service provisioning. Investment in urban infrastructure offers a cost-effective way to target beneficiaries due to urban density, but municipal expenditure has remained stagnant at 1 percent of gross domestic product (GDP) for over a decade (Ahluwalia, 2019)

POTENTIAL FOR INNOVATION TO ADDRESS GAPS IN SERVICE DELIVERY

The scale and urgency of India's urban challenge requires solutions that go beyond incremental improvements, and overcome time and resource constraints to tackle urban service delivery effectively and sustainably. Innovation offers the capacity to provide services in a swift, economical, and sustainable manner. Collaboration across the innovation ecosystem of enterprises, investors, academia, and government can break silos, pool resources, and leverage skills across stakeholder groups (Torfing 2018). It can also help governments design and deploy citizen-centered services that are inclusionary (Observatory of Public Sector Innovation 2019).

Globally, there are several examples of how government, private innovation centers, and universities as well as public and private companies have collaborated in developing innovative solutions to long-standing problems in service delivery. One such example is that of Murcia in southern Spain, which set up a desalination and wastewater reuse and reclamation process, through a multi-stakeholder engagement, to address water scarcity (Compagnucci and Spigarelli 2018). Alongside reaching levels of 99.5 percent purification and 97 percent reuse of wastewater, the region now has some of the highest levels of innovation in the water sector globally and has begun exporting the technology (Gil-Meseguer et al. 2019; Rivera et al. 2014). In India, Cygni Energy, a solar inverter-less DC start-up, has supplemented energy utility efforts to provide energy to lower-middle-class and rural households by revolutionizing off-grid and micro-grid solar applications.[3] Working with the Indian Institute of Technology Madras, they have harnessed solar energy to help electrify 40,000 villages in India (Jhunjhunwala and Kaur 2018). Carbon Masters, a waste management company in India, has employed a circular economy PPP business model in partnership with Bengaluru's local government enabled by the local neighborhood community. They were able to convert organic waste into useful asset-light fuel (Carbonlites Bio-CNG) and organic fertilizer that was commercialized and sold to local businesses (Asian Development Bank 2020).[4]

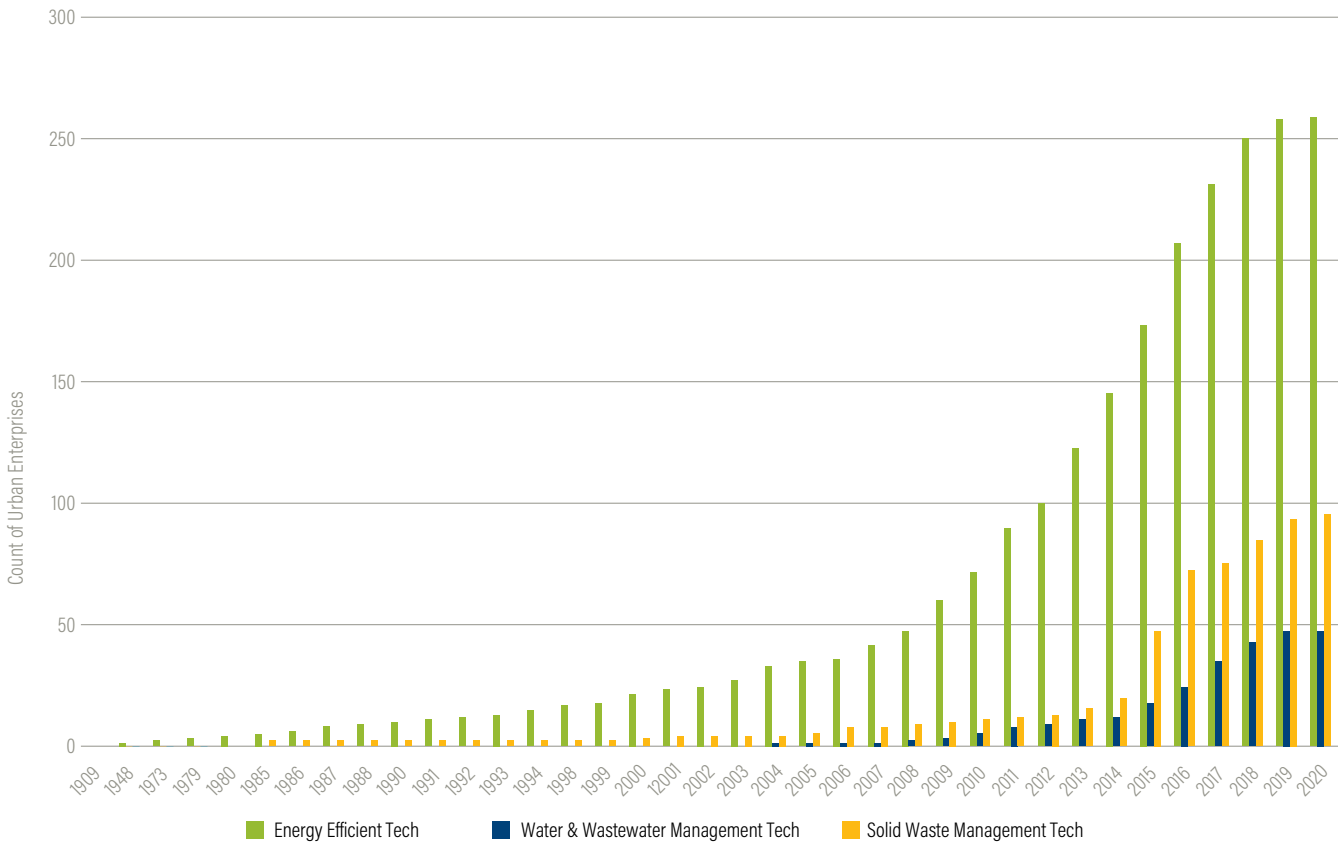
In recent years, India has emerged as the third-largest start-up ecosystem in the world (NASSCOM 2019), while also rising in the World Intellectual Property Organisation's (WIPO) Global Innovation Index, World Bank's Ease of Doing Business, and World Economic Forum's Global Competitiveness Index rankings. The Government of India has adopted several schemes and policies, including flagship programs such as "Startup India," "Make in India," "Digital India," and "Skill India." These programs aim to leverage India's demographic dividend to promote entrepreneurship and employ the potential of innovation to boost economic growth. Growing broadband penetration is a catalyst for innovation as it offers easy access, exchange, and dissemination of information (Shaw and Lanvin 2012).

Although innovation offers many potential benefits, it is not without its own drawbacks:

- Innovation when disruptive can have unintended negative social, economic, or environmental externalities that need to be monitored and addressed.[5]
- Technological and digital innovations may have limited impact due to existing inequalities in access to technology across gender, caste, and region.
- The factors driving innovation for public and private stakeholders can vary and sometimes conflict with each other. Private profit motivations may not always align with public good.

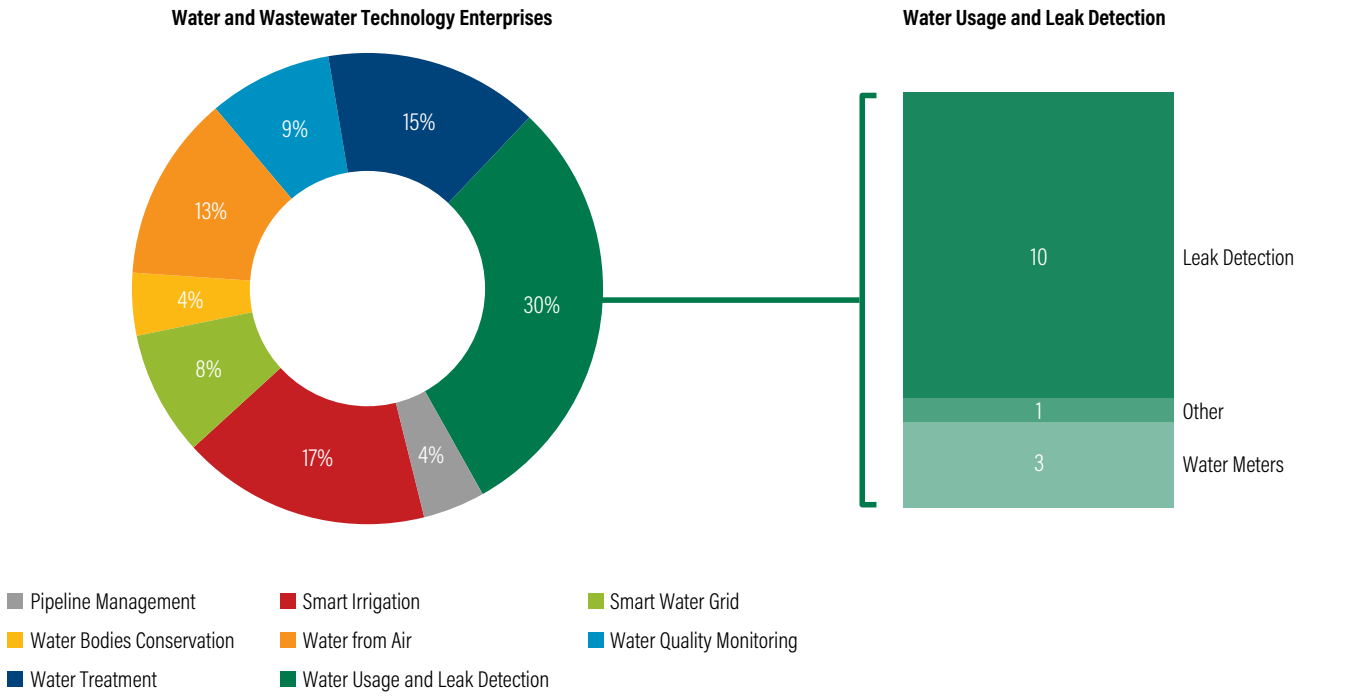
India's booming start-up ecosystem is now seeing a growing pool of domestic start-ups and micro, small, and medium enterprises (MSMEs) working in the sectors of water, waste, and energy (Figure 4). In the water services sector, solution development focuses primarily on demand and use management through smart water meters and leak detection technologies (Figure 5). Waste management start-ups are concentrated in the collection segment of the waste value chain, and they apply technology to improve collection ease and efficiency (Figure 6). Solutions in energy efficiency largely address energy management, from the device level through to building energy management systems (BEMS) (Figure 7). Though there is evidence of the establishment of a growing number of enterprises, there is little documentation of the scale of impact or the support landscape that targets these sectors.

Figure 4 | **Cumulative Count of Urban Service Enterprises in India (2010–2020)**



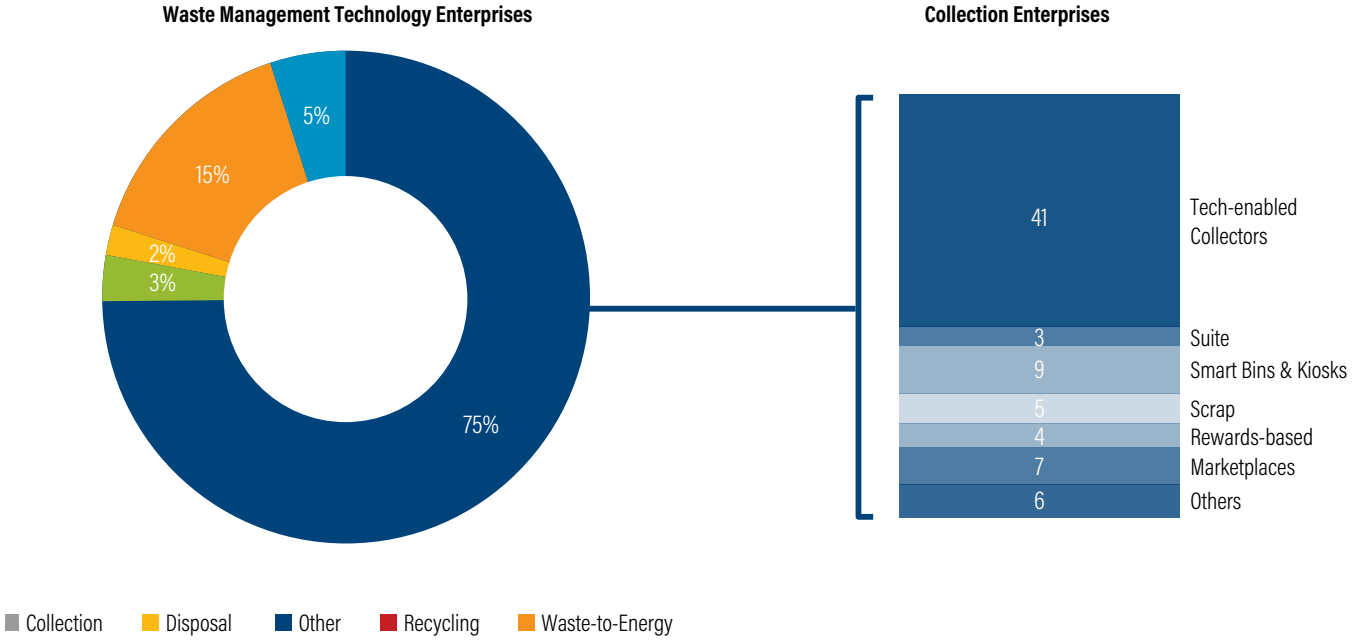
Source: Tracxn 2020b.

Figure 5 | **Innovation in Water and Wastewater in India**



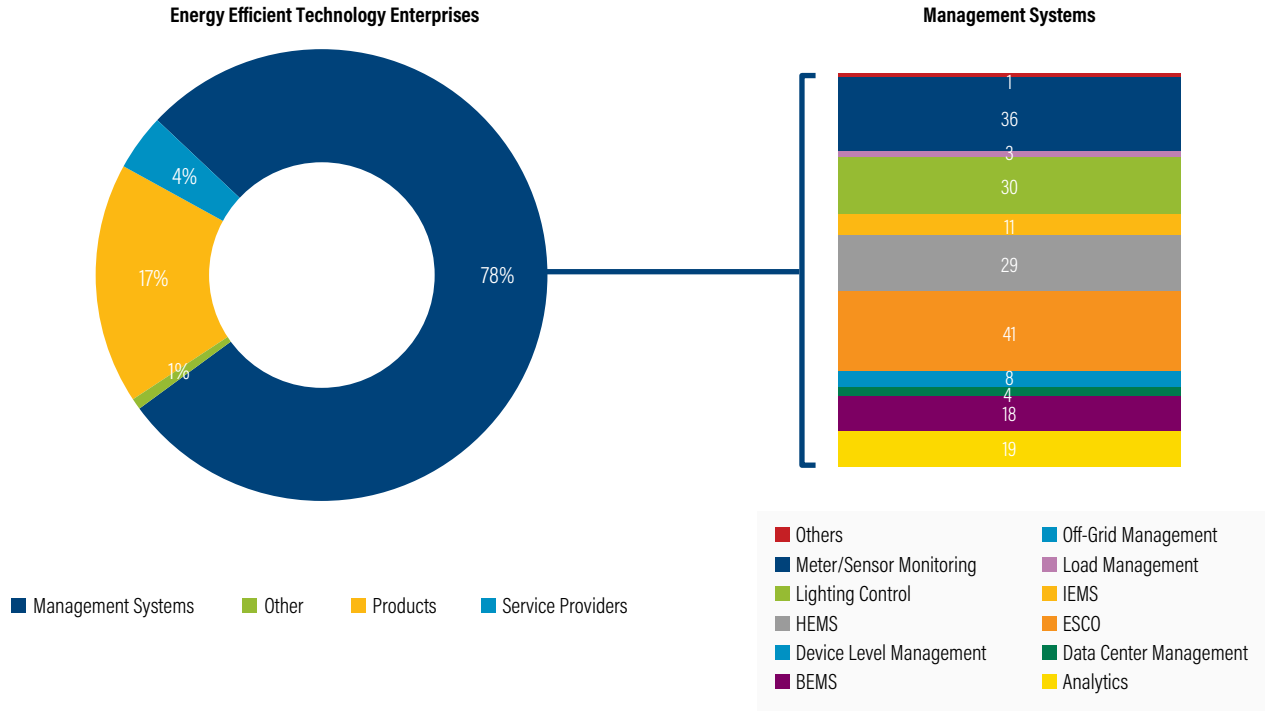
Source: Tracxn 2020b.

Figure 6 | **Innovation in Waste Management in India**



Source: Tracxn 2020b.

Figure 7 | **Innovation in Energy Efficiency in India**



Note: HEMS = home energy management system; BEMS = building energy management system; IEMS = integrated environmental management system; ESCO = energy service company.

Source: Tracxn 2020b.

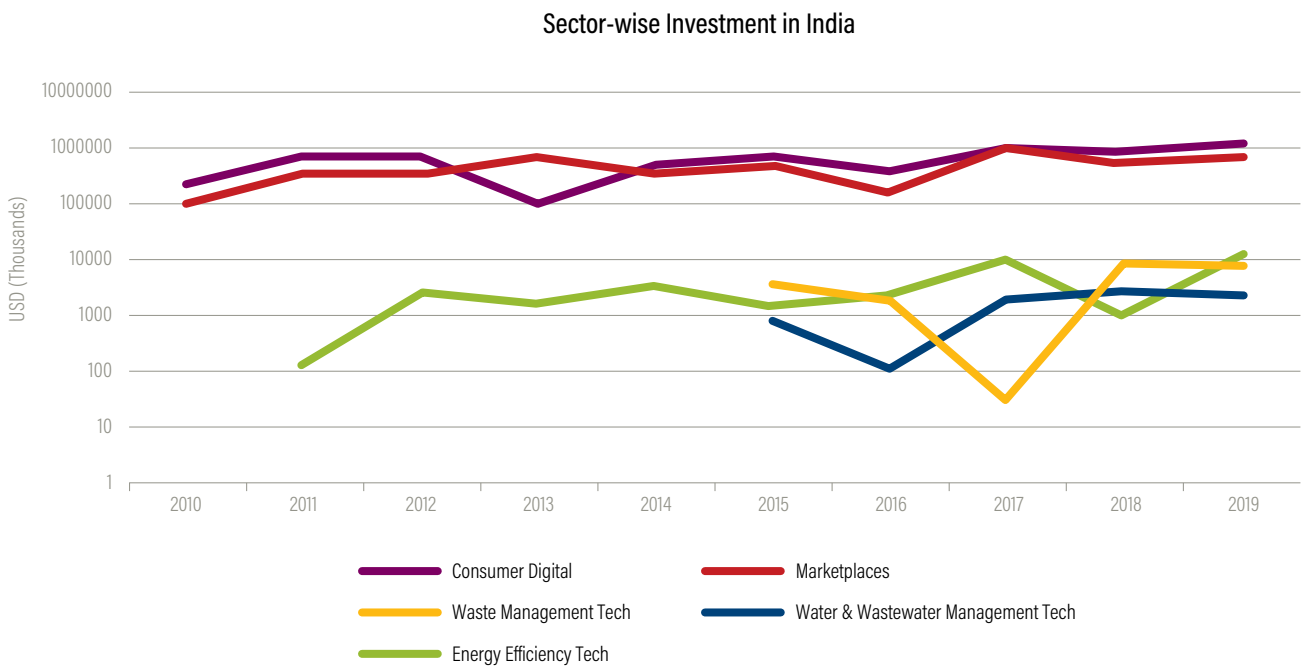
PRESENT SHORTCOMINGS ACROSS THE INNOVATION ECOSYSTEM FOR URBAN SERVICE DELIVERY (WATER, WASTE, AND ENERGY SECTORS)

Through policy dialogues with sector experts and a survey of service delivery enterprises, we identified the following key gaps in the innovation ecosystem for urban service delivery.

Government

- *Limited linkages*: Very few states, such as Kerala and Telangana, have adopted measures like entrepreneurship cells, challenges, and rewards, and developed links to institutions and the industry to reinforce their start-up policies and boost the success of their incubators.
- *Poor scheme implementation*: Stringent qualifying criteria and poor implementation of schemes, coupled with uncertainty and delays around disbursement of funds, limit the participation of cash-strapped start-ups.
- *Procedural hurdles*: The tendering process within government institutions has historically remained restrictive. Often, the only way smaller players like MSMEs and start-ups can participate is by being a sub-contractor to larger private enterprises. The qualification criteria are difficult for MSMEs to meet. The typically long procurement cycles (Hazarika and Jena 2017) and delays in contract payments are a hindrance for smaller enterprises with limited resources.

Figure 8 | **Sector-wise Investment in India Comparing Urban Service against Other Industries**



Source: Tracxn 2020b.

Investors

- *Limited engagement with business-to-government (B2G) models*: Private investment in innovation is still focused on profit-making sectors such as digital, food, payments, ecommerce, and online marketplaces (see Figure 8). The sectors of water, waste, and energy efficiency, where the government is largely responsible for providing services, are not lucrative for private investors. Most of them do not understand this space and are reluctant to engage with and commit to long investment cycles, which may yield little returns.

Consumers

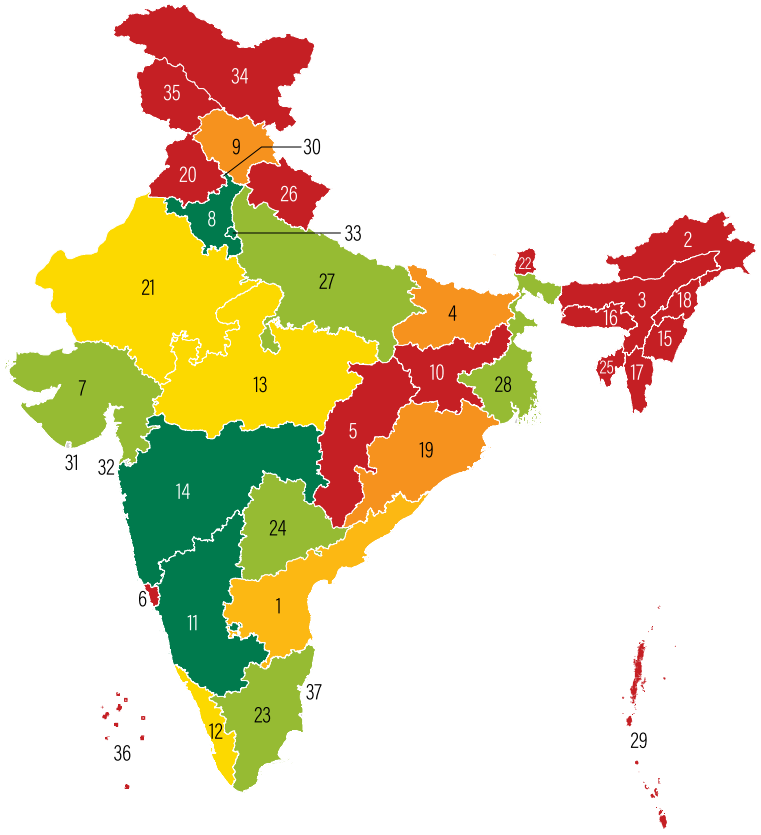
- *Low priority for environmental sustainability:* Despite some awareness of sustainability, sustainable solutions are viewed as having a green premium. As decision-making in residential markets remains price led, there is little demand for urban service innovations.

Research

- *Insufficient commercialization of research:* The ecosystem has not been able to leverage the strong research and publication experience of Indian academic institutions (World Economic Forum 2019), because insufficient support and attention are given to market research and commercialization.

Across stakeholder groups, there is a geographic skew in terms of innovation support (see Figure 9). Tracxn, one of the largest platforms for tracking innovation internationally, shows that over 50 percent of India's incubation cells/centers are concentrated in just three states: Maharashtra (68), Karnataka (65), and New Delhi (46). There is also limited focus on environmental sustainability and government engagement in the incubator and accelerator support offered. The nature of urban service innovation requires sector-specific support and sandboxes to test and pilot solutions with government bodies in order to achieve scale. This customized support environment is largely unavailable.

Figure 9 | **State-wise Concentration of Accelerators**



Lowest — Highest

1 - Andhra Pradesh
2 - Arunachal Pradesh
3 - Assam
4 - Bihar
5 - Chhattisgarh
6 - Goa
7 - Gujarat
8 - Haryana
9 - Himachal Pradesh
10 - Jharkhand
11 - Karnataka
12 - Kerala
13 - Madhya Pradesh
14 - Maharashtra
15 - Manipur
16 - Meghalaya
17 - Mizoram
18 - Nagaland
19 - Odisha
20 - Punjab
21 - Rajasthan
22 - Sikkim
23 - Tamil Nadu
24 - Telangana
25 - Tripura
26 - Uttarakhand
27 - Uttar Pradesh
28 - West Bengal
29 - Andaman and Nicobar Islands
30 - Chandigarh
31 - Dadra and Nagar Haveli and
32 - Daman & Diu
33 - Delhi
34 - Jammu & Kashmir
35 - Ladakh
36 - Lakshadweep
37 - Puducherry

Source: Tracxn 2020a.

2. SCOPE, METHODOLOGY, AND LIMITATIONS

SCOPE

Our focus was to understand three key points:

1. What is the state of the innovation ecosystem for urban service delivery in India, particularly in the sectors of water, waste, and energy management?
2. How was the format for TheCityFix Labs (TCFL) designed and applied to a cohort of 10 companies and what impact did it have?

What did TCFL do well and what steps will need to be taken to address the barriers that persist?

METHODOLOGY

We used a combination of the available literature, policy dialogues, and qualitative interviews with experts to understand the Indian innovation ecosystem for urban service delivery.

- **Scaling:** Evaluating the success milestones of the companies that are part of the accelerator program in receiving follow-on funding, acquisition of customers, expansion to new geographies, and government engagement.
- **Counterfactual:** Comparing the trajectory of the companies against a counterfactual group of start-ups not selected for TCFL.

- **Impact:** Evaluating the outcomes of the accelerator program against our objectives of breaking silos by aggregating networks, enabling effective engagement for enterprises, and improving government engagement with innovators.

We realized that measuring the success of an accelerator platform through a comparative analysis is a challenging process given the varied nature of support that different accelerators provide, as most if not all the participants have gone through diverse accelerator/incubator programs. The start-ups in the TCFL cohort differed from fellow members within the cohort as well as from the counterfactual group in terms maturity, problem-solution fit, and motivations. It was difficult to control for this variance when measuring quantitative outcomes. We chose instead to present the trajectory of the accelerator program in terms of comparable milestones achieved by the companies within both groups.

We had to assess the ecosystem linkages created in order to understand the efficacy of a multi-stakeholder approach. Finally, to measure the environmental and social objectives of focusing on water, waste, and energy, we had to assess the environmental and social impact of the start-ups.

We obtained primary data through the following exercises:

1. We collected a combination of qualitative and quantitative data (Appendix F) on business, administration, social, and environmental metrics from the entrepreneurs (Table B5) before and after the four-month accelerator. We also tracked the following milestones achieved by the enterprises: government engagement, expansion of geography, business model changes, and follow-on funding.

2. We administered a questionnaire to a counterfactual group of shortlisted applicants not selected to participate in TCFL, to compare their achievements for the same period during which TCFL was conducted. We matched the counterfactual group as closely as possible to the cohort with three working in waste management, four in energy, and three in water management.

3. Finally, we conducted a series of semi-structured, qualitative interviews (Appendix F) with different stakeholder participants such as investors (Table B1), mentors (Table B4), customers (Table B2), and institutions (Table B3). This was done to better understand stakeholder engagement with TCFL and the cohort, their insight into persisting barriers, and how TCFL impacted their engagement with innovation.

LIMITATIONS OF THE STUDY

- It was difficult to isolate the influence of a single accelerator program on funding raised subsequently, because many start-ups, even within the TCFL cohort, had engaged with multiple accelerator programs prior to, during, and after the program.
- Given that follow-on funding or government pilots and contracts often involve lengthy due diligence and approval processes, a longitudinal study of these metrics would be better suited to identifying the impact of the acceleration process. However, time constraints limited our assessment period to a year.
- Due to the COVID-19 pandemic, delays affected government pilots, preventing the inclusion of their outcomes for the time being. This limited our understanding of the impact of pilots on government engagement with innovation.
- One member of the cohort, Sanshodan E-waste Exchange, was not included in this assessment due to their limited participation and the inadequacy of data they provided.

3. TCFL APPROACH AND COHORT

The Financing Sustainable Cities Initiative and TCFL

In 2015, Citi committed $100 billion globally toward environmental finance to accelerate the transition to low-carbon economies (Citi 2015). As part of this push toward achieving sustainable development goals, Citi Foundation initiated the Financing Sustainable Cities Initiative (FSCI), in partnership with WRI Ross Center for Sustainable Cities and C40 Cities Climate Leadership Group, to leverage the expertise and long-term engagement of the three organizations with cities, so as to scale sustainable urban solutions.

Given WRI India's extensive experience in executing mobility accelerators in partnership with local government, FSCI's TCFL chose to focus on the previously unexplored area of efficient new and retrofit solutions for buildings in the domain of waste, water, and energy.

THE APPROACH

We used a three-step approach of Evaluate, Bridge, Accelerate to achieve the following:

Table 1 | **TCFL Landscape Assessment**

	BARRIERS	OPPORTUNITIES
Access to government	Barriers to government-supported schemes include limited awareness and information, qualification criteria, etc.	**Water & Waste:** A clear need for urban service delivery technologies with environmental and climate benefits and solutions—if a successful pilot can be implemented, it can help build traction with government. Entrepreneurs are also keen to engage with government **Energy:** There is an encouraging policy environment, with both regulatory and funding support offered through a variety of schemes at both the central and state levels
	Little coordination between central and state agencies, banks, etc.	
	Decentralization of responsibility not always accompanied by decentralization of funds or decision-making power	
	Rigid and tough-to-meet criteria in the procurement process, particularly for smaller organizations	
Access to finance	A risk-averse investment market, particularly in these sectors	**Waste and Water**: A supportive environment for entrepreneurs in the form of public and private accelerators and incubators, with a limited but growing focus on the water and waste sectors. India is also a growing investment destination for waste and water management **Energy**: India remains a huge investment destination for energy, with solar alone receiving a cumulative $4.6 billion as of September 2019 (Tracxn 2019)
	Not much awareness among financial institutions about government policies/schemes	
	Lack of investment and high cost of borrowing, restricting most start-ups to self-financing or bootstrapping, particularly at the early stages	
Access to markets	A residential market disinclined to incur capital expenses, with customers in this segment unaware of the potential future savings	A need for innovative solutions, and the accompanying cost and resource-saving benefits in the residential market
	Entrepreneurs forced to self-finance research and development to create low-cost products	Start-ups displaying the willingness and ability to adapt a single physical product to the demands of multiple markets using diverse business models

Source: TheCityFix Labs.

1. **Break silos by aggregating networks:** We wanted to bring a wide variety of actors to a common platform. Increased engagement and exposure would help participants leverage the advantages of the different stakeholder groups.
2. **Enable effective engagement for enterprises:** We wanted to maximize the impact and outcomes of engagement. We decided to capacity-build enterprises and give them access to mentors and networks to help them overcome barriers to scale.
3. **Improve government engagement with innovation:** We wanted to build trust across the government-enterprise relationship by increasing exposure and avenues for engagement, and facilitating pilots.

Evaluate

We assessed the ecosystem to determine the key challenges faced in each sector, the main stakeholders involved, and the avenues of innovation currently available (Table 1). We spoke with enterprises across the three sectors to determine the barriers to scale and the nature of support required.

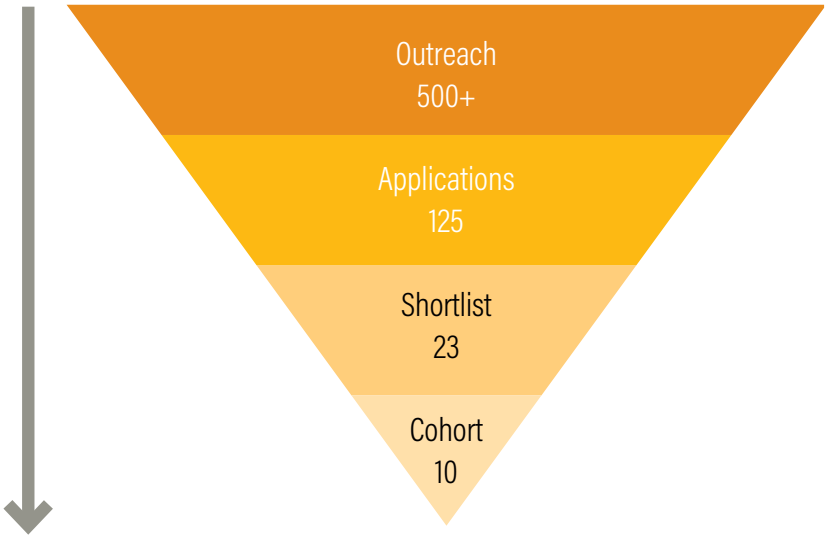
Bridge

We determined that the key hurdles for enterprises were access to government, finance, and markets. To address these hurdles, we onboarded a wide spectrum of mentors including decision-making and technical representatives from city, state, and central government, impact investors, and technical mentors with extensive sector experience (see Figures 11 and 12).

To select a cohort, we held a six-week call for applications. We conducted policy dialogues in four cities and partnered with local academic institutions for outreach across the country to ensure participation from multiple geographies and city scales.

We received 125 applications and internally evaluated them, creating a shortlist of 23 companies (Figure 10). These companies were invited to pitch their solutions to a jury of external technical experts, who evaluated them on the criteria listed in Table 2.

Figure 10 | TCFL Cohort Selection Process



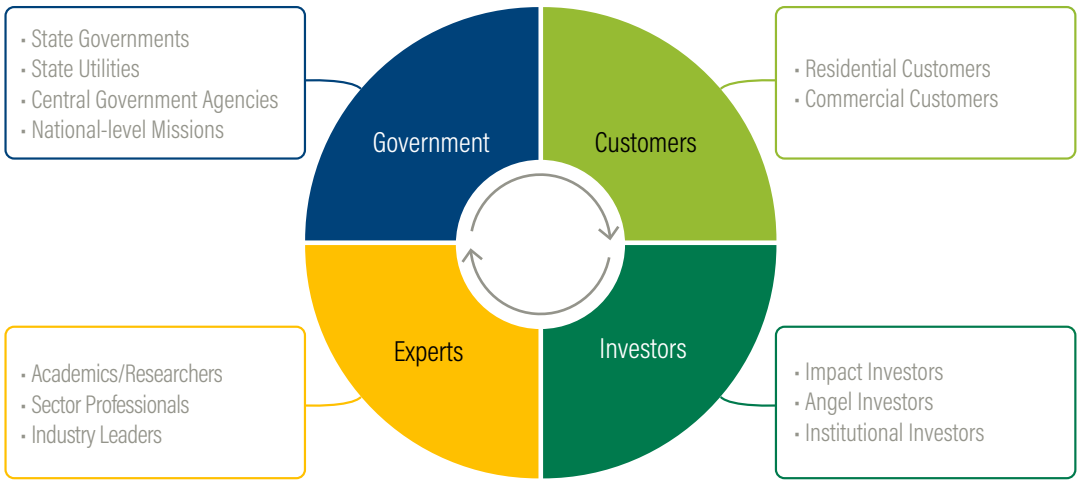
Source: Tracxn 2020a.

Table 2 | **TCFL Cohort Selection Criteria**

Problem addressed	Does the solution address a real problem?
	What specific city need is being addressed?
	Is the innovation unique, demonstrable, and potentially disruptive?
Potential financing	Is there a clear and feasible vision on how they want to move forward?
	Are there major hurdles arising from the business model framework (funding, financing, legal, contracting) that cannot be overcome?
	Does the team have the resources (human + finances) and skills to develop/deliver the pilot/project?
Scalability and replicability	Is it scalable to other cities?
Impact	Does the intervention or solution have a discernible socioeconomic and environmental impact dimension?
	How significant would participation in TCFL be to scaling the solution?

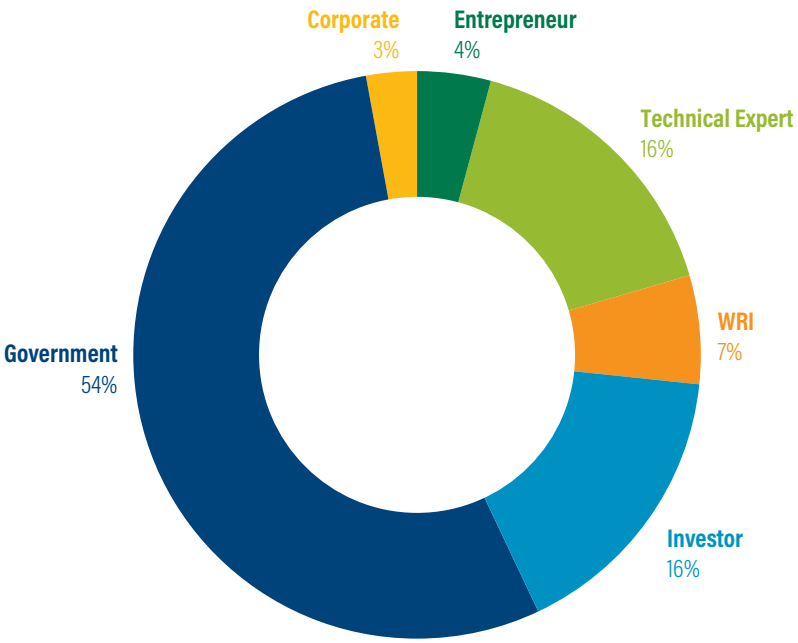
Source: TheCityFix Labs.

Figure 11 | **Multi-stakeholder Participation in TCFL**



Source: TheCityFix Labs.

Figure 12 | **TCFL Mentor Distribution across Stakeholder Groups**



Source: TheCityFix Labs.

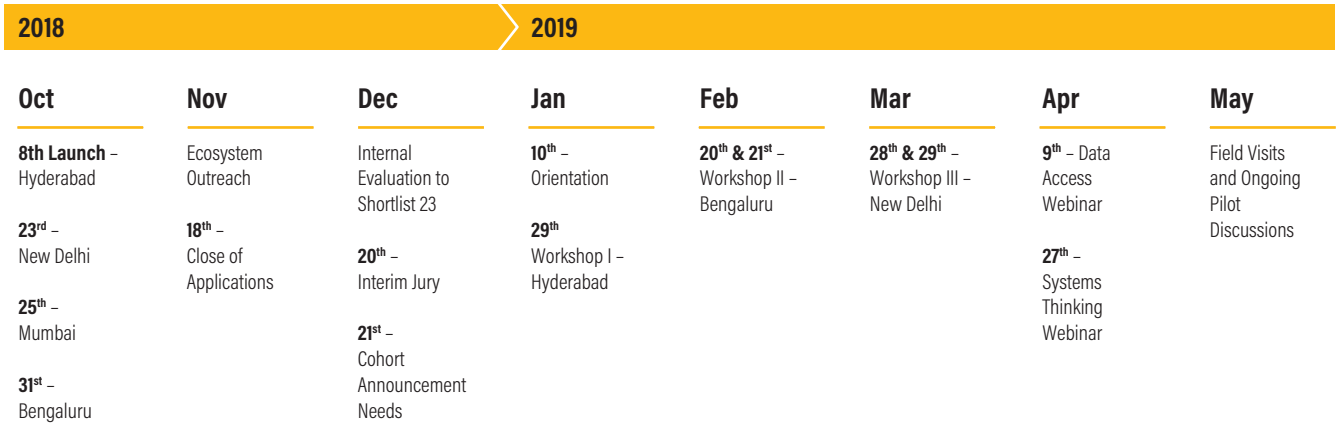
Accelerate

Our research revealed the need for a customized curriculum. We carried out a needs assessment exercise to ascertain the exact support required by each enterprise. Most entrepreneurs asked for access to stakeholders instead of traditional accelerator training sessions.

We designed a curriculum focusing on engagement with government and investors through in-person workshops, field visits, and webinars over four months, followed by a piloting period. By enabling conversations with government in particular (see Table 2), we hoped to help the enterprises find and develop pilot interest, while simultaneously building government confidence in new and innovative solutions.

Each enterprise was paired with a primary mentor who was able to offer targeted advice and guidance over the course of the accelerator program. To a more limited extent, they had access to secondary mentors and sector experts to support them around specific, identified challenges. They also engaged with legal, marketing and storytelling, systems thinking, and data experts. Finally, alongside a session focused on sustainability and impact, the enterprises also visited a successful local circular economy enterprise. We arranged this to encourage thinking across sectors to the up-and-down-the-river inputs and outcomes of their businesses. We also provided the cohort nationwide exposure through WRI India's social media platforms and individual articles published through the Indian entrepreneurship media platform, YourStory.

Figure 13 | TCFL Timeline of Events



Source: TheCityFix Labs.

THE COHORT

The cohort was distributed across the three sectors, with three each in water and waste, and four in energy (For more detailed company profiles see Appendix E).

The Solutions

Water

Boson White Water: An on-site water treatment solution that can recover potable quality water from partially treated wastewater. IoT sensors help customers monitor the quality and quantity of water remotely. Fluid Robotics: Multi-sensor robots and machine learning models to map pipes and identify their health. This helps combat water leakages, flooding, and pollution through India's 500,000 km+ long underground pipeline infrastructure, which is often unmapped and damaged.

WEGot Utilities: An IoT solution with low-cost, high-precision sensors that track the flow, pressure, and quality of water. This previously unavailable granular consumption data can be used to reduce water consumption by up to 50 percent as well as lower maintenance and electricity costs, while improving efficiency of water assets like pumps and treatment plants.

Waste

Hasiru Dala Innovations (HDI): A total waste management solution with a decentralized franchisee model that empowers waste-picker entrepreneurs by creating predictable livelihoods for them. This helps increase segregation at source and improves material recovery rates, with at least 90 percent of the waste generated being diverted away from landfills.

RaddiConnect: A door-to-door waste management service that employs an aggregated network of waste pickers, supplying the waste to authorized recycling centers. The company also partners with local municipalities to manage dry waste and with plastic manufacturers to set up recovery channels for the plastic they introduce into the environment.

Sanshodan E-waste Exchange: An online platform helping users directly transfer their e-waste to government-authorized, technically competent e-waste recyclers. They also offer capacity building and an extended producer responsibility (EPR) compliance assessment system designed especially for state governments.

Energy

75F: This is a full-stack IoT solution consisting of hardware, software, and services to predict, monitor, and proactively manage various elements in a building including temperature, lighting, air quality, and energy. This can help increase employee productivity, reduce energy usage, and increase profits.

Energos: It offers artificial intelligence (AI)-based services that address demand- and supply-side management of energy. The cloud technology connects heating, ventilation, and air conditioning (HVAC) to the Internet, builds machine learning, and focuses on reducing energy cost by decreasing energy from all cooling and heating loads for enterprise customers by 20 to 30 percent. They also offer solutions for decentralized generation of energy.

MinionLabs: Its product is an easily installed, non-intrusive, hand-sized energy auditing device called "The Minion" that can record and analyze device-level electricity consumption. By providing valuable real-time, actionable insights, this enables energy transparency, achieves up to 30 percent in energy savings, and helps in the predictive maintenance of appliances.

The Solar Labs (TSL): It offers a software solution for solar companies and utilities to analyze sites remotely using satellite imagery/video to design an optimized solar photovoltaic (PV) system. This helps maximize solar energy generation for a site.

TCFL COHORT AT A GLANCE

Location

The TCFL companies are all located in metropolitan areas (Figure 14), with four located in Bangalore alone.

MinionLabs: Its product is an easily installed, non-intrusive, hand-sized energy auditing device called "The Minion" that can record and analyze device-level electricity consumption. By providing valuable real-time, actionable insights, this enables energy transparency, achieves up to 30 percent in energy savings, and helps in the predictive maintenance of appliances.

Age of Organization

Across sectors, the cohort primarily consisted of young companies in existence for less than five years (see Figure 15).

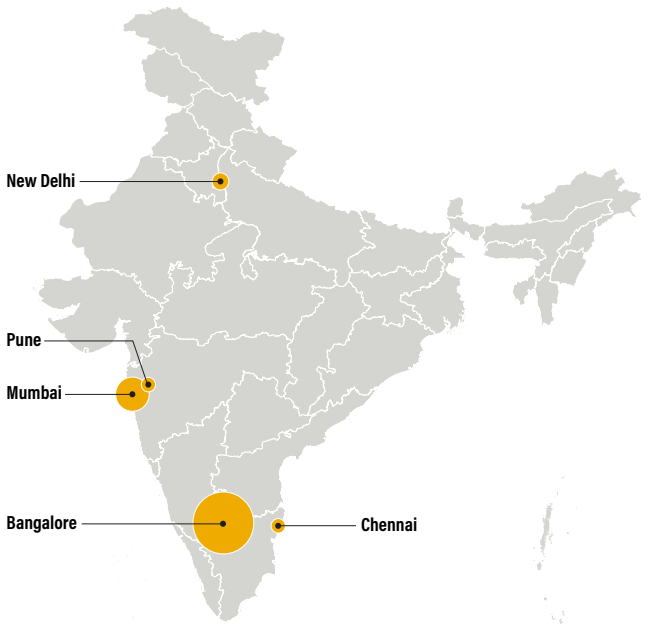
Founder Experience and Background

The cohort company founders had some prior work experience, though only two had any prior entrepreneurship experience. Less than half the companies had prior experience engaging with government (Figure 16).

Customers

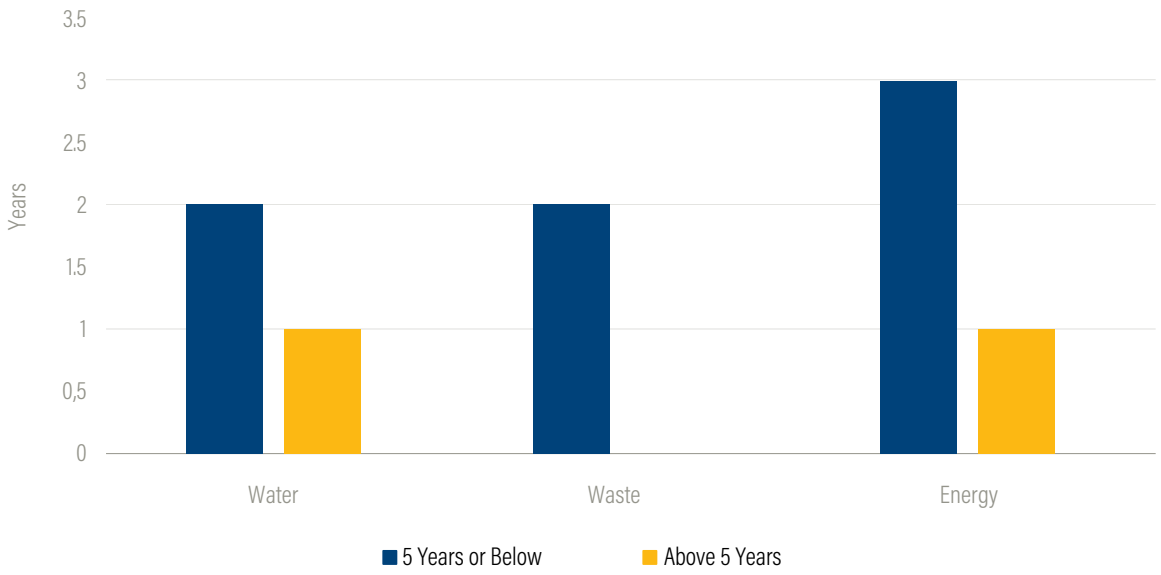
All companies had paying customers. The target segment was primarily nonresidential customers including businesses, utilities, industry, and commercial real estate like IT parks, retail, hospitals, and malls. They targeted individual and bulk residential consumers to a lesser degree and had little experience selling to government.

Figure 14 | **Geographic Spread of Companies' Headquarters**



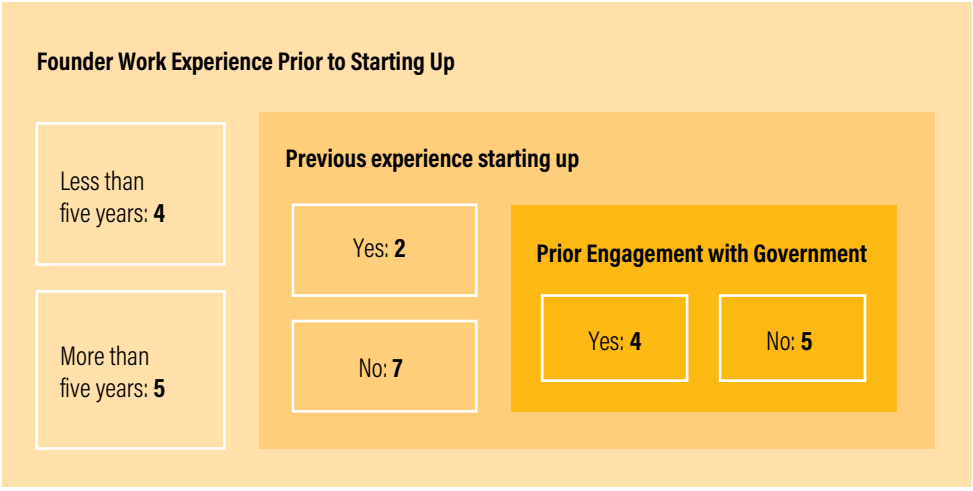
Source: TheCityFix Labs.

Figure 15 | **Age of Organization by Sector**



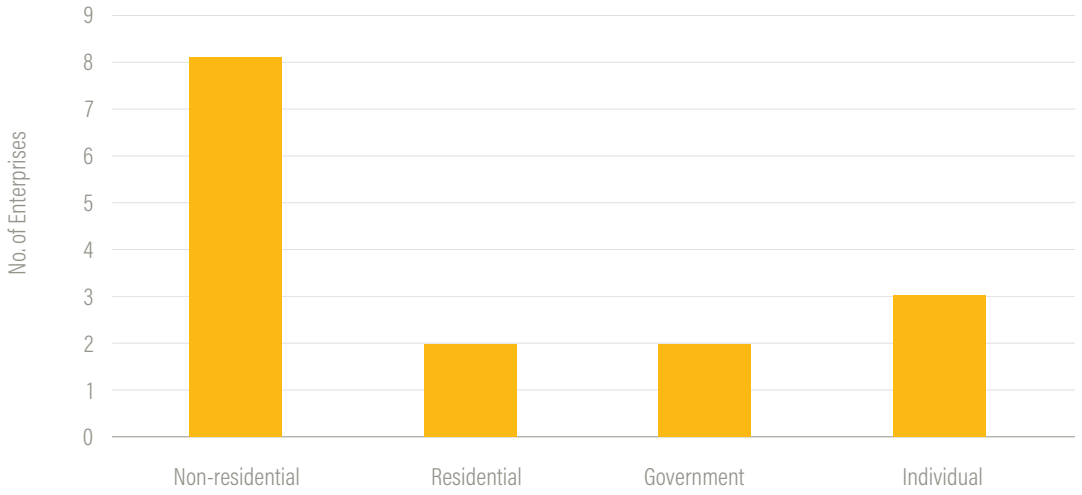
Source: TheCityFix Labs.

Figure 16 | **Variation across the TCFL Cohort Experience**



Source: TheCityFix Labs.

Figure 17 | **Target Customer Segments**



Source: TheCityFix Labs.

Business Model

Each company adopted one of the following three for-profit business models:

- Capital expenditure (CAPEX): Charging customers mainly for the capital expense of the solution with some recurring revenues through value-added services
- Operational expenditure (OPEX): Charging customers primarily for the operating expenses of the solution with a fixed service fee[6]
- Both: A combination of both CAPEX and OPEX models

Figure 18 | **Business Models of TCFL Cohort**

	CAPEX	OPEX	Both
Water		3	
Waste		2	
Energy	1	1	2

Source: TheCityFix Labs.

4. TCFL OUTCOMES

The cohort participated in TCFL accelerator workshops from January 2018 to April 2018. During this period, mentors helped the cohort to structure solutions that would appeal to government programs while also evolving business models that could gain private financing access and support. These companies also had one-on-one interactions with local and central government officials at each of the accelerator workshops in Hyderabad, Bengaluru, and Delhi. This helped them better understand government priorities and expectations. Conversely, it also served to expose government officials to innovative solutions in sustainability and their adoption in the context of local challenges and resources. The TCFL program also enabled a peer-to-peer learning community through which cohort enterprises exchanged experiences on developing joint projects and engagements.

The cohort engaged with officials from the states of Karnataka and Telangana. At the national level, they networked with officials from the central government ministries of Housing and Urban Affairs (MoHUA) and Power (MoP), the Indian Railways Station Development

Corporation (IRSDC), and wider networks including the 100 cities under MoHUA's Smart City Mission. These agencies have expansive reach and can offer easy opportunities to scale solutions. WEGot were able to interact with the Prime Minister at MoHUA's Global Housing Technology Challenge. The cohort also engaged with private customers including developers, facilities managers, and apartment owners' associations like the Bangalore Apartment Federation (BAF).

We present the outcomes of TCFL as follows:

- Primary outcomes (direct impact): These are presented by the mentorship, investment, and pilot opportunities offered and utilized by the companies, against each need identified before the accelerator program (Table 3).
- Secondary outcomes (indirect impact): The business and environmental metrics of the start-ups are presented to assess their performance after the accelerator program.
- Milestone outcomes: The start-ups journeys are traced through the key milestones of fundraising, pilots, market expansion, and business model pivots (Table 4).

PRIMARY OUTCOMES

Table 3 | TCFL Primary Outcomes

Water

COMPANY	NEED IDENTIFIED	OPPORTUNITIES OFFERED AND UTILIZED AT WORKSHOPS
Boson White Water	Business model mentorship	Primary and secondary mentors with extensive investment and business development expertise
	Connections with investors	Discussions are underway with one of the TCFL mentors for a potential round of funding
		Pursued pilot opportunities with Government of Telangana to treat water from one of Hyderabad city's sewage treatment plants
Fluid Robotics	Raise funds to accelerate product development	Primary and secondary mentors with extensive investment and business development expertise. Workshop engagement with technical experts in the water sector
	Mentorship and guidance around business model (tech product + service)	
		Completed a pilot with Government of Telangana to map a section of the sewerage network and a drone-based lake survey
WeGot	Access to markets	Successfully completed a pilot with the software company VMWare for their Internet of Things (IoT) device management platform
	Assistance in business development: (a) Private customers in Mumbai, Pune, Confederation of Real Estate Developers' Associations of India (CREDAI), and International Finance Corporation (IFC); (b) Government customers such as Prime Minister Awas Yojana (PMAY), housing sector of banking financial companies, railways stations, airports, and Smart Cities (e.g., Amravati)	Pitched to Indian Railway Stations Development Corporation (IRSDC). Pursuing pilot opportunity with Bangalore International Airport Ltd. Engagement with Prime Minister and officials at Ministry of Housing and Urban Affairs (MoHUA)

Waste

COMPANY	NEED IDENTIFIED	OPPORTUNITIES OFFERED AND UTILIZED AT WORKSHOPS
Hasiru Dala	Marketing and branding	Participation in a customized marketing and branding workshop with a marketing expert mentor
	Business model	Primary and secondary mentors with extensive sectoral, investment, and business development expertise
	Legal and compliance	One-on-one access to a legal expert
RaddiConnect	Networking with policymakers	Engagement with over 70 government officials, 31 of them at state and central levels including representatives from the MoHUA
	Contacts with corporates (fast-moving consumer goods [FMCG] companies) for plastic waste management. Higher-level management, to accelerate business development	Contract with Coca-Cola through the TCFL network
		Pilot agreement entered into with Government of Telangana to set up a dry waste collection and segregation center in Hyderabad

Energy

COMPANY	NEED IDENTIFIED	OPPORTUNITIES OFFERED AND UTILIZED AT WORKSHOPS
75F	Interest in working in Smart Cities	Pitch made to four Smart Cities
	Opportunities to engage through pilots, etc.	Pilot opportunity is being pursued with Bangalore International Airport (BIAL) to test their energy management solution
Energos	Technical skills/business modeling around micro-grids	Primary and secondary mentors with extensive sectoral, investment, and business development expertise
	Business model expertise plus interaction with utilities and micro-grid owners	Extensive engagement with government, including Secretary of Energy Department for Telangana State
		Pilot agreement entered into with Government of Telangana to implement their energy efficiency solution at the Department of Town and Country Planning offices
MinionLabs	Fundraising and marketing	Engagement with a marketing expert
	Business development and sales	Primary and secondary mentors with extensive investment and business development expertise
	–	Pilot opportunity with IRSDC pursued but did not materialize
The Solar Labs	Networking with government customers	Engagement with over 70 government officials, 31 of them at the state and central levels including representatives from the MoHUA and Telangana State Energy Department
	Assistance with piloting (either in terms of a grant or assistance in accessing data)	Pilot opportunity pursued with Government of Telangana but did not materialize

Source: TheCityFix Labs.

SECONDARY OUTCOMES

Business Metrics

Water: Among the water enterprises, two companies managed to raise funding. Collectively, the enterprises achieved 21 new deployments during 2018–19. Water enterprises onboarded 6 new employees.

Waste: None of the waste start-ups raised funding during 2018–19. Waste enterprises collectively onboarded 10 new employees.

Energy: Two of the energy companies raised funding during 2018–19. They also collectively achieved 266 new deployments. Energy enterprises onboarded 4 new employees.

Environmental Metrics

Water: Water companies (excluding Fluid Robotics) collectively increased water savings from ~15.3 million liters to 28.2 million liters per month in the period 2018-19.

Fluid Robotics managed to divert 400 million liters per day (MLD) of wastewater from Powai Lake and Mithi River.

Waste: Waste companies collectively diverted about 139.15 tons per month from landfills during the period 2018–19.[7]

Energy: Energy efficiency start-ups (except MinionLabs) collectively saved about 0.457 gigawatt hours (GWh) per month during 2018–19. MinionLabs saved about 5.2 GWh since their inception in 2017. TSL completed analysis of 125 megawatt hour (MWh) of installed solar power capacity.

MILESTONE OUTCOMES

Table 4 | TCFL Milestone Outcomes

START-UP MILESTONES	COHORT COMPANIES
Fundraising (in the pipeline and fully disbursed)	4 (WEGot, 75F, Minion, Fluid Robotics)
Pilot projects with government customers (underway and completed)	6 (WEGot, Fluid, Energos, RaddiConnect, 75F, Boson)
Expanded to a new geography	2 (Fluid, The Solar Labs)
Business model pivot	1 (MinionLabs)

Source: TheCityFix Labs.

5. OBSERVATIONS FROM TCFL

Through interviews with TCFL participants and their associated networks, we were able to identify persisting barriers in the innovation ecosystem for urban service delivery in India. We interviewed the companies in the cohort; consumers with experience of engaging with their water, waste, and energy solutions; external sector experts with extensive research experience; investors; and government sector mentors (see Appendix B). Given their experience in the urban services delivery sector and with the TCFL cohort, these interviewees were best positioned to identify the hurdles that affect entrepreneurs looking to scale innovative solutions in urban service delivery. We were able to distill insights obtained through the interviews into two key types:

1. Persisting sector barriers unique to the sectors of water, waste, and energy (for a sectoral comparison, see Appendix C)
2. Persisting stakeholder barriers relating to the roles, responsibilities, and capacities of different stakeholder groups (for a stakeholder comparison, see Appendix D)

PERSISTING SECTOR BARRIERS

The sector barriers broadly related to policy and regulations, awareness and capacity, data and implementation, and financial sustainability.

Water

Policy and Regulation

The government is mandated to provide clean drinking water, but policy and implementation rest with multiple agencies. This means that there is no cohesion across agencies on water resource management.[8] For example, although a ULB is mandated to provide water for a city, infrastructure projects are often planned at the state level and may be dependent on the Center for funds. This multiplicity of authority often deters the participation of private players.

Awareness and Capacity

- There is a growing awareness around issues of water stress, but there is limited awareness of the solutions available in the market. Without norms and mandates to measure water consumption, encourage the use of recycling/conservation technologies, or minimize water pollution, solutions in the market are seen as "good-to-have" rather than "must-haves."
- Constrained by a lack of human resources and financial constraints, parastatals lack the empowerment and authority to guarantee water rights. Ms. Veena Srinivasan, Director at the Centre for Social and Environmental Innovation, ATREE, notes government's limited willingness to undertake risk. "The real innovation of trying something drastic does not come easily to government. With many incentives tied to legacy systems there is a tendency to get stuck in large infrastructure."

Financial Sustainability

Pricing is an effective mechanism to regulate water resource allocation and use efficiency, but the government remains reluctant to implement water-pricing solutions. Increasing the price of water is considered politically unfavorable. This politicization of water has discouraged the participation of private investors in the space (Shen and Reddy 2016). The low price point combined with the issue of non-revenue water of over 40 percent (Press Information Bureau, Government of India 2019) also affects the economic viability of many solutions.

Waste

Policy and Regulation

The Solid Waste Management (SWM) Rules 2016 has expanded the scope of solid waste management, yet massive gaps in enforcement remain for both residential and industrial waste. Poor enforcement, particularly in the matter of segregation and user fees, can impact the viability of business models.

Awareness and Capacity

- Waste management requires high levels of segregation for innovation and technology to be effective. It is dependent on the awareness of communities and individuals, capacity, and behavioral change. Effective implementation of solutions requires advocacy and evangelization of communities, which are time-consuming exercises that slow down efforts to scale.
- The problem of waste management is very city specific, with a heavy dependency on local ecosystems, ULBs, regulation, and local government. There is also a lack of peer-to-peer learning across geographies.

Data and Implementation

There is limited research on the viability of solutions for urban India, leading decision-makers to implement technologies and solutions that might not be well suited to the Indian context. Often, where research is available, engagement gaps across the ecosystem lead to relevant information not being communicated to decision-makers.

Financial Sustainability

The new SWM regulation allows for collection of user fees from waste generators. But there is reluctance on the part of waste generators to move to a fee-paying model. Mr. Rahul Nainani, Co-founder of RaddiConnect, points out: "The concept of wealth out of waste has been blown out of proportion—both government and private waste generators often fail to see waste management as a service with attached costs that have to be borne by someone." Private investment in waste remains limited and leaves very little room for experimentation and innovation.

Energy

Policy and Regulation

Despite plans to reduce the carbon intensity of the economy, energy efficiency (EE) and renewable energy (RE) are not prioritized. Mr. Tanmay Tathagat, Director at Environmental Design Solutions explains: "The challenge is that EE and RE are seen as private solutions for private interest, and not as an integrated part of better service or better energy productivity by utilities." A few states, despite making a commitment to ease the transition to RE, have been inconsistent about choosing between net or gross metering, which creates an unstable policy environment for consumers considering solar.[9]

Awareness and Capacity

Consumer confidence in the market remains low as there are many solutions but few standards to help consumers make safe decisions. Mr. Gaurav Burman, Vice President for Asia-Pacific Operations at 75F, adds: "There is a need for mandates for energy usage and management and compliance standards around energy efficiency. These efforts will add much needed credibility to the efforts of EE players."

Data and Implementation

The existing design of warranties and service contracts across the industry lacks the transparency required for easy interoperability of solutions. This slows down decision-making and deters new users.

Financial Sustainability

- As there are many similar solutions in the EE space with little differentiation, investor interest remains low. The lack of standards and compliance relating to EE solutions creates a higher perceived risk for investors.
- Traditional sources of finance tend to be risk averse. Lenders like banks or creditors offer fixed rates of interest and often require collateral. This has led to the entry of nontraditional sources of finance such as project financing or venture capital. However, project financing models in India are still in their infancy, with few banks and non-banking financial institutions offering them. These nontraditional sources of finance may impose prohibitively rigid and excessive terms and conditions to offset the perceived risk.

PERSISTING STAKEHOLDER BARRIERS

The stakeholder barriers that emerged from our interviews broadly related to process, risk-taking ability, low priorities for sustainability, and limited ownership and agency associated with different stakeholder groups.

Government

Process

- Different aspects of each sector fall under the purview of multiple ministries and departments. Planning that is divided over too many institutions results in very disconnected policy. There follows disjointed and conflicted implementation that occurs in silos and is often project centric. With rotation of bureaucrats and limited institutional learning, this scenario can deter nongovernment and private stakeholders from seeking to engage with government.
- The existing processes of procurement are still too complex to encourage entrepreneurs to participate.

Despite recent reforms, RFPs often have very rigid criteria such as earnest money deposits and years of experience or profitability, eliminating most MSMEs. RFPs also detail specific solution requirements rather than offering problems for open solutioning. This limits participation to providers of solutions that the government is aware of, thus closing the door to other solutions.

Risk-Taking Ability

Government lacks the funds to provide services, let alone absorb the risk of innovation. Ms. Harichandana Dasari, former Additional Commissioner of Greater Hyderabad Municipal Corporation (GHMC), states: '"The challenge is finding ways to work with systems we already have, to build on them and optimize for cost-effectiveness. If the technology is too expensive, then we have to reevaluate our priorities. It can also be challenging to work with start-ups that are absolutely green and have no experience in implementing a solution on the ground."

Low Priority for Sustainability

To push for sustainable methods and mechanisms, investors, entrepreneurs, and customers all require strong signaling from the government, which is currently lacking. Government needs to prescribe and enforce norms and standards to influence consumer and investor behavior.

Long Cycles

- Government's long payment cycles adversely affect MSMEs, who have limited resources. The Confederation of Indian Industry (2020) stated that over 94 percent of the dues payable to its MSME members are from the government or public sector undertakings.
- The long bureaucratic process of government engagement requires approvals at multiple levels. With little role clarity within various government organizations, this process can be even longer for entrepreneurs seeking to engage with the government. At a local level, leadership dictates how a ULB engages with innovation. Rotation of bureaucrats across positions with limited institutional learning leads to MSMEs being discouraged by finding they have to repeat the entire cycle of pitching and implementing their new solution.

Lack of Ownership and Agency

The multiplicity of authority in dealing with urban services can result in a tendency to pass the buck. With no clarity regarding roles and responsibilities, stakeholders like entrepreneurs, corporates, and academia struggle to engage with government or determine their own role within the ecosystem.

Investors

Risk-Taking Ability

Investors remain cautious, particularly when it comes to the extent of investment required for scale. They are also reluctant to engage in business-to-government (B2G) business models in the space of urban service delivery as they worry about poor enforcement, delays, and lack of sanctity of contracts (Upadhyay and Trivedi 2017; World Economic Forum 2019). Investors are also unwilling to invest in the sectors of water, waste, and energy without the necessary in-house technical expertise. Many still lack the research and foresight to see the potential for returns and scale.

Low Priority for Sustainability

- Mr. Girish Agarwal, Director of Incubation at UnLtd India, notes: "There has been an inherent shift of mindset from not-for-profit to either dual-model[10] or for-profit because sustainability is being seen increasingly as for-profit." This has also reduced the funding available to incubators and accelerators supporting non-profit organizations working in the space.

- Investors have also been increasing pressure on Indian entrepreneurs for accelerated exits (Rajan 2018a). The sustainability sector by its nature lacks digitally scalable business models. It requires more patient capital that allows experimentation and validation of new innovations. Patient capital also has a higher tolerance for risk, giving businesses sufficient time to grow sustainably.

Enterprises

Process

Enterprises seem to lack awareness of the exact problem and context. Many are building solutions that are futuristic and fail to address the current Indian context. Ms. Srinivasan remarks: "Enterprises tend to work in silos with the belief that if they work on one part of the system, the whole system will move from one equilibrium to another. Historically however, this rarely happens."

Corporates

Low Priority to Sustainability

- The private sector does not pay adequate attention to sustainability, restricting their sustainability engagement to corporate social responsibility (CSR). Despite narratives around sustainability and climate change, price remains the key factor in corporate decision-making. Companies lack clear and actionable sustainability goals, particularly in matters of resource efficiency, waste, and producer responsibility.
- Corporate participation in the innovation ecosystem for urban service delivery remains passive. Unlike for entrepreneurs, innovation is not key to corporate survival. It must be a deliberate choice made by corporates. Yet, expenditure in research and development in India is predominantly led by the central government and public sector enterprises (Economic Advisory Council to the Prime Minister 2019).

Consumers

Long Cycles and Capital Intensiveness

Mr. Mohammed Asif, Facilities Manager at RMZ Corp., points out: "Whether with corporate customers or residential associations, solutions in water, waste, and energy go through long approval processes. This is because they are often capital intensive and impact operations and maintenance (O&M) expenditure." This impacts cash flows and slows down expansion for enterprises working in this space.

Lack of Ownership and Agency

There is a lack of ownership and agency in tackling most sustainability issues. The diffusion of responsibility across large groups results in inaction. Despite awareness about sustainability, communities display a resistance to changing behavior patterns. This is evident in low levels of segregation of waste and the reluctance to pay for water or waste management services.

Researchers

Process

- Academia needs to bring greater focus to their research and engage better with the rest of the innovation ecosystem, so that their research can feed into more evidence-based policymaking and decision-making. Speaking about the gaps in waste management, Ms. Revathy Ashok, Managing Trustee of Bangalore Political Action Committee, adds: "India has not seriously evaluated available solutions and technologies and determined the ideal waste management solutions for different use cases relevant to our context." By addressing knowledge gaps across the ecosystem about the appropriateness of solutions for the Indian context, academia can help de-risk government engagement with innovation.
- There is also little commercialization of research (World Economic Forum 2019) as insufficient attention is given to market research. Academia needs to build stronger industry ties to be able to benefit from the high output of scientific publication

and the many prominent research institutions present in the country (World Economic Forum 2019)

6. LEARNINGS

We present our learnings as follows:

1. ACCELERATOR FORMAT LEARNINGS

These can help stakeholders better design accelerator platforms in the future.

Enterprises

- **Outreach** — We received 66 percent of our applications from the four cities of Bangalore (43), Hyderabad (15), Mumbai (14), and New Delhi (10), where we conducted in-person outreach events. We will need to conduct more active outreach events if we are to expand to peri-urban, tier-II & III cities, and regions apart from the south and west.
- **Cohort collaboration** — Considering the energy, water, and waste sectors together encouraged the cohort to consider the perspectives and challenges of faced by the other sectors. For example, the impact measurement session during the Bangalore workshop encouraged energy start-ups to track their water consumption and waste generation as well, and vice versa. This also encouraged companies to pitch a combined package of solutions to the consumer. In the long run, creating an alumni group or a start-up association for cohort members can help maintain long-term engagement with current and future cohorts and mentors.
- **Engagement and initiative** — Although we helped initiate pilot discussions with government agencies, some of these failed to materialize into actual pilots in the months following the accelerator. Although introductions by a credible intermediary like WRI is a good first step, enterprises need to show persistence in maintaining these relationships and translating them into pilots or contracts. Mentor feedback also indicated that outside of the workshop interactions, engagement with the enterprises was poor and follow-up from cohort enterprises was inadequate. Accelerators require a more structured engagement design tied to specific milestones to enable continued communication and help build lasting mutually beneficial relationships. With entrepreneurs often able to devote only limited time to accelerators, a system of incentives and rewards might also be needed to ensure active participation.
- **Team composition** — The composition of skill sets within the team of founders, their consistent engagement, and ability and willingness to be coached is crucial in realizing the outcomes of the support offered by the incubator/accelerator. This is particularly relevant when designing an accelerator curriculum that focuses on one-on-one engagement and access to wide networks of actors.

Government

- **Engaging with the government** — Given our track record of working with public agencies, the government stakeholders were more comfortable engaging with the enterprises that we had vetted. Having us conduct the initial due diligence and determining suitability made the process of selection less time consuming for them. It is important to build and maintain strong relationships with government.
- **Exposure and pilots at different scales** — Engaging with city and state governments as well as national-level ministries and programs like the Smart City Mission offered different scope and scales of government engagement. Although national-level programs were better for increased exposure for the enterprises, it was easier to structure pilots at city-level engagements, which then showed potential for scaling through the state government.
- **Involvement and perspectiv**e — Although the awareness and engagement of government stakeholders with innovation had been low, they were enthusiastic participants at workshops, showing interest in solutions and offering valuable

feedback to enterprises. They were also willing to engage in pilots with solutions that were low risk and required minimal disruption/retrofits and investment. Using pilots, ULBs were able to test and learn about the product or service while helping entrepreneurs understand ground realities and improve their offerings. Over time, accelerators like TCFL can support the transition of government from service provider to facilitator and regulator and enable trust building between government and innovators.

The Counterfactual Group of Enterprises

- **Value of accelerator programs** — All start-ups in the counterfactual group of unsuccessful shortlisted applicants to TCFL participated in one or more incubators/accelerators parallel to the TCFL program. Within the counterfactual group:
  - six companies have either raised funds or are in the process of raising funds,
  - five having expanded to a new city as a result of their pilot, and
  - three companies have pivoted their business model based on feedback received by mentors in an accelerator program and/or by advisors.
- **Alternate avenues for government engagement** — Although the counterfactual group was able to engage with government, they did this through partnerships with master system integrators,[11] or by applying to become empanelled vendors with the government. They sought business and investment assistance from other accelerators supporting entrepreneurs.

2. ECOSYSTEM LEARNINGS

These describe the strengths and scope of different stakeholders in helping better position future accelerator platforms within the ecosystem.

Government

- Government, as the stakeholder with the widest reach and capacity to determine the rules of engagement, has a massive role to play in breaking silos and building ecosystem linkages. Clear signaling from the government can
  - build investor confidence,
  - increase the scale of adoption and acceptance of solutions, and
  - direct research to help build an evidence base to frame policy.
- Government could increase cohesion across their efforts to improve urban service delivery. Greater clarity regarding the roles that different arms and agencies of the government play in determining and implementing policy can help reduce multiplicity of authority. Incentives and punitive measures can help structure implementation by departments and agencies to act in accordance with larger policy aims informed by local experience, instead of by departmental agendas.
- Until process and policy reform offer a structured way for government to procure innovative solutions, pilots will remain an efficient way to validate and scale solutions. They increase the chances of securing government tenders, while also building confidence for investors.
- There is a need for clear and well-publicized norms and standards to help direct innovation, build consumer confidence and awareness, and scale acceptance of new solutions. This could include mandatory green building guidelines, standards for building EE solutions, and norms and mandates for water and wastewater efficiency solutions. However, to prevent these from becoming additional hurdles to innovation, there is a need for simultaneous reforms to the certification process to make it easier and more accessible.

Investors

There is a need for hybrid financial instruments and patient capital. As a multiplier effect, this can de-risk investments and help them attract funding from mainstream commercial investors. Impact investors also need to redefine impact to provide more targeted investment. They should also create a sustainable investment framework that enhances adoption while driving both commercial and environmental viability.

Researchers

Academia and researchers need to conduct a more detailed study of the economics and political economy of urban services to plug the current gaps in knowledge and help find better ways to leverage finance. For example, most ULB funds for waste management are spent in transportation. Allocating funds toward upgrading local collection centers with the capability to clean, sort, and compress waste with increased automation would have a two-pronged impact. ULBs could improve health, hygiene, and working conditions at the centers while simultaneously reducing the costs of transportation.

Consumers

- Businesses and government can help educate consumers and build awareness to drive behavior change and improve capacities. Local government and civil society in Bengaluru used extensive education and outreach programs to improve segregation behavior in the city.
- Decentralization of solutioning, particularly in waste management, can help build ownership and agency into the problem and increase accountability. Decentralized solutions in water and wastewater management are already being developed through private players, but they need wider adoption and scale.

Although all stakeholders, whether government, investors, entrepreneurs, or academia, are engaged in innovation, these efforts are confined to individual silos. We need to build stronger linkages and trust across the ecosystem to coordinate these efforts, especially when there is resistance on account of disruption of existing practices.[12] Finally, will, trust, and leadership are vital across stakeholders if the sustainability narrative is to move from "good-to-have" to "must-have." Visionary thought leadership can elicit sufficient buy-in by stakeholders like government or the community. It also has the capacity to overcome existing inertia in shifting to more resource-efficient and sustainable water, waste, and energy management.

7. OPPORTUNITIES AND THE WAY FORWARD

OPPORTUNITIES

Interviews with TCFL participants and mentors revealed the following avenues and opportunities to address identified barriers:

- **Improving procurement processes:** Although pilots offered low-risk ways for government to test solutions, scaling these through the procurement process was a huge hurdle for the enterprises. Tenders proved too prescriptive for easy incorporation of the innovative technologies offered by the enterprises. There is a need to reform and test alternatives to traditional procurement.
  - The Smart Cities Promoting Innovation Research and Incubation in Technology (SPIRIT) program, collaboratively proposed by the Smart Cities Mission, Atal Innovation Mission, and Startup India, is an evolving concept that offers an alternative to the traditional RFP procurement method, in leveraging innovation to seek solutions for cities. Some of the proposed improvements include
    - seeking innovative solutions to problem statements rather than prescribing solutions,
    - increasing transparency and aligning incentives across stakeholder groups in the innovation ecosystem, and
    - strengthening engagement between innovators and Smart Cities.
- **Expanding investment in innovation:** Three of the four cohort enterprises who raised funds were from the energy sector. Finance remains a bigger hurdle for water and waste, which are perceived to be riskier sectors. There is scope to help spread this risk by widening the net of investors and incentivizing different stakeholders.

- Developers are beginning to direct funds toward supporting innovative enterprises (Inc42 2019). The Real Estate Regulation and Development Act (RERA) 2016 is forcing developers to be more organized, efficient, and cost-effective. This has created an urgent need to speed up the pace of adoption of technology to create significant efficiencies in every aspect of the business. As a result, developers are investing in solutions that improve resource efficiency and increase measurability and accountability.
- There is a need for the development of a stock exchange specifically for social impact organizations. Impact ventures need more patient capital, which requires a different model than the current venture capital model. A social stock exchange will create liquidity and remove exit pressure on investors by widening the participation of smaller investors and trading of stock of social impact companies. As mentioned by the Finance Minister in the 2019 Budget, a working committee at the Securities and Exchange Board of India is currently determining the necessary structures and regulations required to operationalize the SSE.

- **Leveraging and expanding platforms of engagement:** The reach of TCFL was limited to governments and regions where WRI India had previous working relationships and experience. The success of the platform format in engaging different stakeholders, however, demonstrated the scope for similar platforms to offer capacity building toward creating an environment for collaboration and multi-stakeholder innovation.
  - Building over or expanding existing platforms such as Startup India, or GeM, can help include other stakeholders such as local and state government, academia, and the private sector. This expanded platform can offer channels of communication and engagement, and increase awareness by publishing research, guidelines, best practices, and lessons learned.
- **Creating anchor institutions:** TCFL applied WRI India's positioning within the innovation ecosystem to help enterprises navigate different levels of government. Anchor institutions can provide similar leadership to help coordinate the efforts of different agencies at the national, state, and local levels, and address issues of conflict and multiplicity of authority and implementation.
  - The Draft National Resource Efficiency Policy offers an avenue for increased coordination across government. The policy proposes the creation of a National Resource Efficiency Authority (NREA) that will coordinate resource efficiency efforts across the Center and states. The NREA will include members representing different states and union territories, ministries, departments, and agencies, and act as a regulating authority. It will also facilitate cross-sector collaboration, collate data on resource efficiency, and offer capacity building for stakeholders.

GOING FORWARD: GOVERNMENT ENGAGEMENT AND INNOVATION IN THE POST-COVID WORLD

Outside of TCFL, our engagement with the Smart City Mission helped us collaboratively draft a guide to encourage and facilitate innovation in Smart Cities. The guide helps cities create Innovation Zones, build partnerships, develop test-beds, build the capacity of city officials, organize innovation events, and use an Open Innovation Framework to measure and improve social, infrastructural, and regulatory readiness for innovation. Though the Innovation Zones program has yet to be approved, elements of the framework have been incorporated into two recently launched programs under the Smart Cities Mission: City Innovation Exchange (CiX) and ClimateSmart Cities (CSC).

Meanwhile, the coronavirus health crisis has redirected government efforts toward containment and management, putting most TCFL pilots on the back burner. The pandemic and accompanying health risks have made clear the need for reliable, safe, and accessible urban services. However, the initial lockdown, followed by social distancing and the need to

safeguard both employees and customers from health risks, is posing a new challenge to the innovation ecosystem for urban service delivery. The TCFL cohort has been forced to reevaluate their operations and strategies. They are displaying some hesitation in strongly pursuing government as a customer given persistent delayed payments and worries that these will be further impacted by the economic slowdown.

Since the health crisis hit, the TCFL cohort adopted different approaches to ensure their continued operations. Hasiru Dala Innovations and RaddiConnect, as essential service providers, continued offering waste management services. After overcoming the initial hurdles of acquiring permits for their employees to work and travel and providing them with personal protective equipment, these companies now face financial challenges. The new social distancing requirements limit public events and constrain institutions to operate at reduced capacities. This has impacted the revenue streams associated with event waste management and managing waste for commercial institutions. With the rest of the recycling value chain still not operational, they were running out of storage space and seeing reduced recycling revenues.

Organizations like WEGot Utilities, Boson White Water, and TSL, which offer non-essential services, are looking instead to prolong their operational runways by either cutting costs or adding services to their existing solutions. They have been addressing technical and product glitches and improvements. They continue to receive enquiries for their solutions, and are working on sales and customer engagement, to better capitalize in the future. They have cut down on unnecessary travel, rental, and advertising expenses to maintain operations without having to retrench employees.

Some organizations like Fluid Robotics and MinionLabs are repurposing their skills and solutions toward tackling the pandemic and associated health risks. Fluid Robotics has incorporated a wastewater-based epidemiological approach to their robotics solution. This is helping local municipalities' efforts to locate and contain coronavirus outbreaks. By collecting a wastewater sample and mapping the pipelines that feed that sample, they hope to be able to narrow down an outbreak to a neighborhood, and possibly a building, level. This solution is currently being piloted in Mumbai.

MinionLabs has applied its considerable in-house engineering and technological abilities toward developing an ultraviolet (UV) sterilization device. This device can help sterilize delivered packages in the time it takes to wash your hands. Leveraging TCFL networks, they are currently piloting this product at BAF housing complexes across Bangalore, while also seeking funding to help scale production of the device swiftly.

As public procurement of innovation helps overcome market failures by building a critical mass of demand (Uyarra et al. 2014), TCFL could potentially achieve larger equity gains by enabling entrepreneurs to viably serve a public market. It has enabled the broader public service delivery system to gain more from the innovation ecosystem, thus fostering access to urban service solutions across a wider audience, and with increased efficiency. This, in turn, has allowed WRI India to make a social impact beyond what it can do directly, by identifying and nurturing opportunities with government leadership and local entrepreneurs. The lessons from creating and managing a cohort with individual as well as common needs have been used in the ongoing implementation and design of WRI programs in air quality and natural infrastructure.

APPENDIX A: PILOTS

Energos

Energos and the Department of Town & Country Planning of the state of Telangana entered into a Memorandum of Understanding (MoU) to pilot their energy efficiency solution at the DT&CP office to save energy costs and monitor the health of air-conditioning units. Energos will implement its proprietary machine learning (ML) model and automation program after initial assessment, and subsequently train DT&CP employees to use the platform dashboard and access reports. Energos will be responsible for calculating energy savings and submit monthly savings and asset health reports to DT&CP. If the pilot is successful, DT&CP will consider a bigger contract to implement the solution in 180 government buildings. This pilot is ongoing, though outcomes are expected to be skewed, with offices functioning at reduced capacity due to the COVID-19 health crisis.

RaddiConnect

RaddiConnect and the Greater Hyderabad Municipal Corporation (GHMC) of the state of Telangana entered into an MoU to set up a dry waste collection and segregation center in Serilingampally zone of GHMC. GHMC will provide the necessary infrastructure, including land (up to 1,000 m^2) to set up the center with a covered shed and gate. RaddiConnect will be responsible for conducting the day-to-day operations of the center, maintaining data, and raising awareness by issuing letters to nearby schools and other institutions. They will also hire local workers and partner with other local institutions in Hyderabad. The pilot was set to begin in April and continue for 12 months, but due to the ongoing COVID-19 health crisis, it has been postponed to when normal operations of the GHMC resume.

Fluid Robotics

1. Fluid Robotics entered into an agreement with GHMC to perform a Remote Sensing Survey & Wastewater Pipeline Monitoring of Khajaguda Lake. The scope of the project included a drone-based lake survey, flow monitoring of storm water outfalls, and GIS mapping of the sewer network near the lake. An engineer from GHMC coordinated the project, and additional labor was provided by GHMC to open the manhole chambers. The pilot is complete; two discharge points were identified, and 1.3 MLD (million liters a day) of raw sewage was monitored over a period of three days in December 2019.
2. Fluid Robotics has also begun discussions with BIAL to conduct a pipeline examination pilot for a 3 km stretch of a buried water pipeline from a reservoir to the airport. Due to the current COVID-19 crisis, discussions are on hold as they have been unable to get a team to travel to Bangalore to conduct the feasibility study.

WEGot Utilities

WEGot Utilities completed a pilot of their Aqua smart water meter solution for the software company VMWare, successfully converting it into a partnership where their solution has been integrated into VMWare's IoT device management platform, Pulse. They are also in discussion with BIAL to conduct a pilot on vendor consumption of water at the airport by measuring demand and billing them on the basis of usage.

75F

75F is in discussion with BIAL to conduct a pilot of their energy management solution at their innovation lab.

Boson White Water

Boson White Water is pursuing a pilot with the Hyderabad Metropolitan Water Supply and Sewerage Board of the State of Telangana. The pilot aims to treat water from one of Hyderabad city's sewage treatment plants and selling the treated water to nearby industries in a revenue-sharing model with the ULB.

APPENDIX B: LIST OF INTERVIEWEES

Table B1 – Investors

NAME	ORGANIZATION	DESIGNATION
Mr. Girish Agarwal	UnLtd India	Director, Incubation
Mr. Rajeev Nair	Brigade REAP	Head, Operations
Mr. Srikanth Prabhu	Social Alpha	Portfolio Manager
Mr. Sachin Unni	Zeroth.AI	Partner
Mr. Amit Chauhan	Angel Investor/Merchant Navy	NA
Mr. Matt Eggers	Breakthrough Energy Ventures	Investor and Company Builder
Mr. Madhusudhan Kela	MK Ventures	Founder

Source: WRI India Authors

Table B2 – Customers

NAME	ORGANIZATION	DESIGNATION
Mr. Mohammed Asif	RMZ Corp	Facility Manager
Mr. Pradeep P.	Ahad Apartments	Head of RWA
Ms. Rama N. S.	ELCITA (Electronic City Industrial Township Authority)	Executive Head
Mr. Prathamesh Ekawde	Xynteo	Insights Advisor
Mr. Glenn Noronha	WeWork	Regional Energy Manager
Mr. Krishnamurthy Venkatesh	Axis Bank Limited	Deputy Manager
Mr. Mabin J.	Orion Mall	Facility Manager
Mr. Shakti Madan	Synergy Wave System LLP	Business Development

Source: WRI India Authors

Table B3 – Government

NAME	ORGANIZATION	DESIGNATION
Ms. Harichandana Dasari	Greater Hyderabad Municipal Corporation (GHMC), Government of Telangana	Former Additional Commissioner, GHMC and Zonal Commissioner (GHMC Zone–West),
Mr. VijayKumar Reddy	Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB), Government of Telangana	Director (Revenue)

Source: WRI India Authors

Table B4 – Mentors

NAME	ORGANIZATION	DESIGNATION
Mr. Vignesh Nandakumar	Lightstone Aspada	Former Partner
Ms. Revathy Ashok	India Angels Network, Bangalore Political Action Committee	Angel Investor
Mr. Tanmay Tathagath	Environmental Design Solutions	Director
Ms. Veena Srinivasan	Ashoka Trust for Research in Ecology and the Environment (ATREE)	Senior Fellow, Centre for Environment and Development,
Mr. Navratan Katariya	Nasscom Pvt. Ltd	Director, Innovation and Entrepreneurship
Mr. C. M. Patil	Sandbox Startups	CEO

Source: WRI India Authors

Table B5 – Cohort

NAME	ORGANIZATION	DESIGNATION
Mr. Vikas Brahmavar	Boson White Water	Founder
Mr. Asim Bhalerao	Fluid Robotics	Founder
Mr. Abilash Haridass	WEGot Utilities	Founder and CEO
Mr. Shekar Prabhakar	Hasiru Dala Innovation	Co-founder
Mr. Rahul Nainani	RaddiConnect	Co-founder
Mr. Gaurav Burman	75F	Vice President for Asia-Pacific Operations
Mr. Anees Mir	Energos	Executive Director and CTO
Mr. Gokul Shrinivas	MinionLabs	Founder and CEO
Mr. Siddharth Gangal	The Solar Labs	Founder and CEO

Source: WRI India Authors

APPENDIX C: PERSISTING SECTOR BARRIERS

Table C1 – Persisting Barriers across Water, Waste, and Energy

BARRIER	WATER	WASTE	ENERGY
Policy and regulation	The government is mandated to provide clean drinking water, but policy and implementation involve multiple agencies. This means that there is no cohesion across agencies on water resource management. This multiplicity of authority often deters the participation of private players.	The Solid Waste Management (SWM) Rules 2016 has expanded the scope of solid waste management, yet massive gaps in enforcement remain for both residential and industrial waste. Poor enforcement, particularly with segregation and user fees, can impact the viability of business models.	Despite plans to reduce the carbon intensity of the economy, energy efficiency (EE) and renewable energy (RE) are not prioritized. A few states, despite making a commitment to ease the transition to RE, have returned to gross metering and created an unstable policy environment for consumers considering solar.
Awareness and capacity	There is a growing awareness within the market of the issues around water stress, but there is limited awareness of the solutions available in the market. Further, without norms and mandates to measure water consumption, or encourage the use of recycling/conservation technologies, or minimization of water pollution, solutions in the market are seen as "good-to-have" rather than as "must-have" solutions. Compounded by a lack of human resources and financial constraints, parastatals lack the empowerment and authority to guarantee water rights. Governments display limited willingness to undertake risk; with many incentives tied to legacy systems, there is a tendency to get stuck in large infrastructure.	Waste management requires high levels of segregation for innovation and technology to be effective. It is dependent on communities' and individuals' awareness, capacity, and behavioral change. As a result, implementation of solutions requires advocacy and evangelization of communities, which are time-consuming activities that slow down efforts to scale. In India, the problem of waste management is very localized and city specific, with a heavy dependency on local ecosystems, urban local bodies (ULBs), regulation, and local government. There is also a lack of peer-to-peer learning across geographies.	Consumer confidence in the market remains low as there are many solutions but few standards to help consumers make safe decisions. There is a need for mandates governing energy usage and management, and compliance standards around energy efficiency.
Financial sustainability	Finally, although pricing is an effective mechanism to regulate water resource allocation and water-use efficiency, government remains reluctant to implement water-pricing solutions. This is because increasing the price of water is considered politically unfavorable. This politicization of water has discouraged participation of private investors in the space (Shen and Reddy 2016). The low price point also affects the economic viability of many solutions.	The new Solid Waste Management (SWM) regulation allows for collection of user fees from waste generators. But there is reluctance on the part of waste generators to move to a fee-paying model. Both government and private waste generators often fail to see waste management as a service with attached costs that have to be borne by someone. Further, private investment in waste remains limited and leaves very little room for experimentation and innovation.	As there are many similar solutions in the energy efficiency space with little differentiation, investor interest remains low. Further, the lack of standards and compliance relating to EE solutions creates a higher perceived risk for investors. Traditional sources of finance from lenders like banks or creditors, with fixed rates of interest and often requiring collateral, tend to be risk averse. This has led to the entry of nontraditional sources of finance such as project financing or venture capital. However, project financing models in India are still in their infancy, with few banks and non-banking financial institutions offering them. Further, nontraditional sources of finance may impose prohibitively rigid and excessive terms and conditions to offset the perceived risk.
Data and implementation	Hasiru Dala Innovation	There is limited research on the viability of solutions for urban India, leading decision-makers to implement technologies and solutions that might not be suited to the Indian context. On the other hand, when research is available, engagement gaps across the ecosystem means that these may not be communicated to decision-makers.	Existing design of warranties and service contracts across the industry lacks the transparency required for easy interoperability of solutions. This slows down decision-making and deters new users.

Source: TheCityFix Labs.

APPENDIX D: PERSISTING STAKEHOLDER BARRIERS

Table D1 – Persisting Barrier of Process

BARRIER	GOVERNMENT	ENTERPRISES	ACADEMIA
Policy and regulation	Different aspects of each sector fall under the purview of multiple ministries and departments. Planning with too many institutions results in disconnected policies. This results in disjointed and conflicted implementation that takes place in silos and is often project centric. With rotation of bureaucrats and limited institutional learning, this projects confusion to nongovernment players. This can deter private stakeholders that seek to engage with government. The existing processes of procurement are still too complex to encourage participation of entrepreneurs. Despite recent reforms, requests for proposals (RFPs) often have very rigid criteria such as earnest money deposits or years of experience or profitability, eliminating most micro, small, and medium enterprises (MSMEs). RFPs also detail specific solution requirements rather than offering problems for open solutioning. This limits participation to providers of solutions that the government is aware of, thus closing the door to other solutions.	Enterprises seem to lack awareness of the exact problem and context. Many are building solutions that are futuristic and fail to address the current Indian context. They also tend to work in silos with the belief that if they work on one part of the system, the whole system will move from one equilibrium to another. Historically, however, this rarely happens.	Academia needs to bring more focus to their research and engage better with the rest of the innovation ecosystem, so that their research can feed into more evidence-based policy and decision-making. By addressing knowledge gaps across the ecosystem about the appropriateness of solutions for the Indian context, academia can help de-risk government engagement with innovation. There is also little commercialization of research (World Economic Forum 2019) as insufficient attention is given to market research. Academia needs to build stronger ties with industry to be able to benefit from the high output of scientific publication and the many prominent research institutions in the country (World Economic Forum 2019.

Source: TheCityFix Labs.

Table D2 – Persisting Barrier of Process

BARRIER	GOVERNMENT	INVESTORS	
Risk-taking ability	Government lacks the funds to provide services, let alone absorb the risk of innovation. It is challenging for governments to find innovations that work with existing systems, build on them, and optimize them for cost-effectiveness. It can also be challenging to work with start-ups that have no experience in implementing a solution on the ground.	Investors remain cautious, particularly when it comes to the extent of investment required for scale. They are also reluctant to engage in business-to-government (B2G) business models in the space of urban service delivery as they worry about poor enforcement, delays, and lack of sanctity of contracts (Upadhyay and Trivedi 2017; World Economic Forum 2019). Investors are also unwilling to invest in the sectors of water, waste, and energy without the necessary in-house technical expertise. Many still lack the research and foresight to see the potential for returns and scale.	

Source: TheCityFix Labs.

Table D3 – Persisting Barrier of Low Priority for Sustainability

BARRIER	GOVERNMENT	ENTERPRISES	ACADEMIA
Low priority for sustainability	Investors, entrepreneurs, and customers all require strong signaling from the government, which is currently lacking. Government needs to prescribe and enforce norms and standards to influence consumer and investor behavior.	There has been a shift of mindset from not-for-profit to either dual-model or for-profit because sustainability is being increasingly seen as for-profit, reducing the funding available to incubators and accelerators supporting non-profit organizations working in the space. Investors have also been increasing pressure on Indian entrepreneurs for accelerated exits (Rajan 2018a). The sustainability sector by its nature lacks digitally scalable business models. It requires more patient capital that allows experimentation and validation of new innovations. Patient capital also has a higher tolerance for risk, giving businesses sufficient time to grow sustainably.	The private sector does not pay adequate attention to sustainability, restricting their sustainability engagement to corporate social responsibility (CSR). Despite narratives around sustainability and climate change, price remains the key factor in corporate decision-making. Companies lack clear and actionable sustainability goals, particularly around resource efficiency, waste, and producer responsibility. Corporate participation in the innovation ecosystem for urban service delivery remains passive. Unlike for entrepreneurs, innovation is not key to corporate survival. It must be a deliberate choice made by corporates. Yet, expenditure in research and development in India is predominantly led by the central government and public sector enterprises (Economic Advisory Council to The Prime Minister 2019).

Source: TheCityFix Labs.

Table D4 – Persisting Barrier of Long Cycles

BARRIER	GOVERNMENT	CONSUMERS	
Risk-taking ability	Government's long payment cycles adversely affects MSMEs, who have limited resources. The Confederation of Indian Industry (2020) stated that over 94% of the dues payable to its MSME members are from the government or public sector undertakings. The long bureaucratic process of government engagement requires approvals at multiple levels. With little role clarity, this process can be even longer for entrepreneurs seeking to engage with government. At a local level, leadership dictates how an urban local body (ULB) engages with innovation. Rotation of bureaucrats across positions with limited institutional learning means MSMEs might find they have to repeat the entire cycle of pitching and implementing their new solution. This further discourages small private players from engaging with government.	Whether with corporate customers or residential associations, solutions in water, waste, and energy go through long approval processes as they are often capital intensive and impact operations and maintenance (O&M) expenditure. This impacts cash flows and slows down expansion for enterprises working in this space.	
Lack of ownership and agency	The multiplicity of authority in dealing with urban services can result in a tendency to pass the buck. With no clarity regarding roles and responsibilities, stakeholders such as entrepreneurs, corporates, and academia struggle to engage with government or to determine their own role within the ecosystem.	There is a lack of ownership and agency in tackling most sustainability issues. The diffusion of responsibility across large groups results in inaction. Despite awareness about sustainability, communities have shown reluctance in changing behavior patterns. This is evident in low levels of segregation of waste and the reluctance to pay for water or waste management services.	

Source: TheCityFix Labs.

APPENDIX E: TCFL COMPANY PROFILES

Energy

75F

Solution

TEAM	GAURAV BURMAN, VICE PRESIDENT FOR ASIA PACIFIC OPERATIONS
Location	Bengaluru, India
Founded	December 2012
Maturity	Paying Users

75F is an award-winning, IoT, and machine learning company that is taking a fresh approach to heating, ventilation, and air conditioning (HVAC), lighting, air quality, and controls in commercial buildings. Founded in 2012, 75F offers a vertically integrated suite of wireless sensors, equipment controllers, and cloud-based software delivering data-driven, proactive, predictive building intelligence and controls. The solution predicts, monitors, and proactively manages various elements in a building including its temperature, lighting, air quality, and energy management needs. The company also claims that its solution contributes to increased employee productivity (social), reduced energy usage (environment), and increased profit (economic), thus helping companies achieve their triple bottom line in a smarter and a more intuitive and cost-effective way.

Business Model

75F provides customers a full-stack solution consisting of hardware, software, and services, as a one-time project to both greenfield and brownfield projects. Subsequent recurring revenues could be in the form of maintenance contracts and value-added services.

Customer Segment

The customer segment includes commercial buildings, primarily IT/ITES, co-working, healthcare, and hospitality sectors.

Priorities and Motivations

As a pioneer in this space, 75F sees itself as the advanced guard, capable of making more of a difference than larger organizations. Through TCFL, they were looking for technical advice, financial contacts, and collaborative partners. A key motivation was also the introduction to government as both potential clients as well as avenues toward creating increased awareness about energy efficiency and the need for better standards.

Mentors

Primary: Mr. Sudhir Krishna, Chairman of the Committee on Standards for Smart Cities at the Bureau of Indian Standards

Secondary: Pawan Mulukutla, Head of City Development at Bosch; Revathy Ashok, Managing Trustee and CEO at the Bangalore Political Action Committee (BPAC)

MinionLabs

Solution

TEAM	GOKUL SHRINIVAS, FOUNDER AND CEO
Location	Bengaluru, India
Founded	July 2017
Maturity	Paying Users

MinionLabs' product, the Minion, is an easily installed, non-intrusive, hand-sized energy auditing device that can record and analyze device-level electricity consumption, providing valuable real-time, actionable insights. The solution is based on a machine learning approach that uses automation to train its state-of-the-art algorithm to capture voltage and energy signatures at microsecond speed, identifying the individual assets used and studying their consumption patterns. This enables energy transparency, energy efficiency up to 30 percent savings, predictive maintenance, and asset health monitoring.

Business Model

MinionLabs uses a subscription model, with the subscription including both the rental cost of the Minion and the energy auditing services.

Customer Segment

MinionLabs' customer segment primarily consists of commercial buildings such as retail facilities and malls, hotels and restaurants, hospitals, and offices. The solution is also applicable to small and medium enterprises (SMEs), automobile and logistics, energy utilities, individual homes and housing communities, or any other industry where machinery needs to be monitored.

Priorities and Motivations

Passionate about sustainability and problem solving, Gokul quit his job at Amazon and worked with a professor at Indian Institute of Technology (IIT) Madras to narrow down a problem statement. Seeking consistent growth and scale, MinionLabs' main motivations in joining TCFL were access to funding and technical assistance around product development and user interface (UI/UX) design. Gokul was also keen to understand how government engages with the energy sector and entrepreneurs like himself.

Mentors

Primary: Aditya Dev Sood, Chief Mentor and General Partner at Startup Tunnel

Secondary: Anju Gupta, Co-founder and President at IvyCamp; Nagaraja Prakasam, Partner at Acumen Fund

Energos

Solution

TEAM	RAJESH SOLANKI, FOUNDER & CEO
Location	Mumbai, India
Founded	September 2008
Maturity	Paying Users

Energos cloud technology connects heating, ventilation, and air conditioning (HVAC) to the Internet, builds machine learning, and focuses on reducing energy cost. Energos reduces energy from all cooling and heating loads for their enterprise customers by 20 to 30 percent. Thirty to 40 percent of the world's electricity need comes from cooling and heating loads. HVAC is needed for all built spaces, but it consumes a lot of electricity, sheds heat outdoors that makes the outdoors warmer, and often uses coolant gases that deplete the ozone layer. Adding machine learning to these loads can improve efficiency and reduce the energy needed by 20 to 30 percent, which can go a long way toward energy sustainability.

Business Model

Energos uses two business models: (1) pay-as-you-save and (2) one-time investment and licenses for analytics. The company initially began licensing the product to large corporates, but realized there was more scope in energy efficiency and management as a service because ownership and responsibility is clear, and it is easier to ensure energy savings for the customer and reduce carbon footprints.

Customer Segment

Energos has installed this solution in over 1,000 locations in India. Customers include large enterprises like banks, food chains, manufacturing, and pharma. It has pan-India operations deployed in 75 cities in India, and active users include 12 Commercial & Industrial (C&I) customers.

Priorities and Motivations

Combating climate change was the key motivation for both Rajesh and Anees, who wanted to innovate specifically in energy given their professional background in energy management. Energos began as a demand-side management company for decentralized air-conditioners (ACs). Subsequently, they diversified to centralized heating, ventilation, and air-conditioning (HVAC), then customer-side generation (solar, RE), and now they are also expanding into storage and electric vehicles (EVs) and connecting to different distributors/plants. Energos aimed to participate in TCFL to acquire government and private customers and simultaneously secure investor interest.

Mentors

Primary mentor: Amber Maheshwari, Principal at Bharat Innovation Fund

Secondary mentors: Navratan Katariya, Director of IoT and Innovation at NASSCOM; Nagaraja Prakasam, Partner at Acumen Fund

The Solar Labs

Solution

TEAM	SIDDHARTH GANGAL, FOUNDER AND CEO
Location	Delhi, India
Founded	December 2017
Maturity	Paying Users

The Solar Labs helps solar companies and utilities analyze sites remotely using satellite imagery/video to design an optimized solar photovoltaic (PV) system that generates the maximum solar energy for that site. Solar engineering, procurement, and construction (EPC) companies that use their SaaS software are able to cut down on design time and increase their revenue.

Business Model

It operates a monthly software subscription service for solar companies, charging $40/user/month for preliminary analysis and $120/user/month for advanced designs. The cost to utilities/government per sq. km area is INR 50,000 to INR 100,000 depending on the total area analyzed.

Customer Segment

The Solar Labs caters to solar EPCs (B2B). SaaS software takes 5 percent more time to make designs that generate up to 10 percent more energy on average than manual solar software tools on the market. The Solar Labs also caters to utilities and government (B2G). SaaS software can analyze satellite imagery/drone video and identify individual rooftops in a large area (e.g., a city) and suggest system size, generation, and financials for each individual building on a citywide scale.

Priorities and Motivations

Inspired by his father to do social good, Siddharth wanted to solve the access-to-electricity problem and simultaneously work toward sustainability. He conducted a survey and found that most people were unaware of the benefits of rooftop solar. The Solar Labs began as a consumer awareness platform and then pivoted to SaaS. In his current role as CEO, he finds hiring good talent to be a major priority, and fundraising is also important in the medium term. Through TCFL, the company aimed to leverage the expertise of mentors, establish government connections, and acquire government customers.

Mentors

Primary mentor: Navratan Katariya, Director of IoT and innovation at NASSCOM

Secondary mentors: Bhaskar Deol, founder of Mynergy; Aakarsh Naidu: Founder of Startupreneur

Water

Boson White Water

Solution

TEAM	VIKAS BRAHMAVAR, FOUNDER
Location	Bengaluru, India
Founded	2011
Maturity	Paying Users

Boson White Water's water treatment solution can recover potable-quality water from partially treated wastewater, integrating Internet of Things (IoT) sensors to help customers monitor the quality and quantity of water remotely.

Business Model

Through a unique operations expense (OPEX)-based model, Boson White Water is able to provide their wastewater treatment solution by supplying the equipment and charging the customer for only the treated water.

Customer Segment

Boson White Water's customer base consists primarily of commercial buildings such as IT parks, malls, and apartment complexes, with plans to eventually expand to industries.

Priorities and Motivations

Passionate about finding a solution to India's water scarcity, Vikas returned from a five-year stint as a software engineer in London. Working on water treatment, he recently expanded to wastewater treatment, with a focus on reducing wastage of treated water. The key motivation for participating in TCFL was assistance with business modeling and strategy, engagement with other stakeholders in the water sector, and access to investors. As he had never sought external funding before, he was also looking for assistance in pitching and building a narrative that would appeal to investors.

Mentors

Primary: Vignesh Nandakumar, Partner at Lightstone Aspada

Secondary: Rajeev Nair, Head of Operations at Brigade Real Estate Accelerator Program (Brigade REAP); Nagaraja Prakasam: Partner at Acumen Fund

WEGoT Utility Solutions

Solution

TEAM	ABILASH, FOUNDER AND CEO
Location	Chennai, India
Founded	April 2015
Maturity	Paying Users

WEGoT helps manage the entire water infrastructure in a property. It acquires granular consumption data that was previously unavailable, by using low-cost and high-precision sensors that track the flow, pressure, and quality of water and then applies the obtained data to various water-related applications on the property. It catalyzes a reduction in water consumption by up to 50 percent, enables cost savings in maintenance and electricity, and improves the efficiency of water assets like pumps and treatment plants.

Business Model

In order to reduce upfront CAPEX, the product is provided for free and the client is charged a monthly subscription fee.

Customer Segment

Residential and commercial; ~20,000 apartments, ~20 million sq. ft, and 30,000+ sensors. During 2018–19, the company also witnessed a jump in the number of new users by 22.5 percent.

Priorities and Motivations

Having seen the catastrophic effects of Chennai's water crisis, Abilash's foremost motivation in starting WEGot was to do something actionable by reducing demand. He was previously working with his family business, in industrial and electronic security, which involved partnering with large corporates selling their devices, and WEGoT's co-founders were developing products and solutions for other companies. All the co-founders wanted to build and sell their own product. Hence, they began developing a product that could change behavior, ultimately making people accountable for their water habits. Although funding and operational issues keep coming to the forefront from time to time, his biggest priority is to transform conservation awareness to scale and deliver at that scale. Through TCFL, the company aimed to leverage the expertise and networks of mentors based in cities other than Chennai, establish government connections, and acquire private customers.

Mentors

Primary mentor: Tanmay Tathagath, Founder of Environmental Design Solutions (EDS)

Secondary mentor: Revathy Ashok, Managing Trustee and CEO at the Bangalore Political Action Committee (BPAC); Sudhir Krishna, Chairman of the Committee on Standards for Smart Cities at the Bureau of Indian Standards

Fluid Robotics

Solution

TEAM	ASIM BHALERAO, FOUNDER
Location	Pune, India
Founded	August 2016
Maturity	Paying Users

Fluid Robotics builds multi-sensor robots and machine learning models to map pipes and identify their health in order to combat water leakages, flooding, and pollution through India's 500,000-km-long underground pipeline infrastructure, which is unmapped and damaged. The company's robots are designed to crawl, float, and swim through pipelines, and work in dry as well as submerged conditions. Their solutions have also been used to take a data-driven approach toward river and lake rejuvenation projects.

Business Model

Fluid Robotics relies on the Robot-as-a-Service business model, in which the company charges based on project scope or through subscriptions. This is similar to the Software-as-a-Service (SaaS) model, but robots (hardware + software) are offered as a service/subscription to customers on an annual basis.

Customer Segment

Fluid Robotics started out as a business-to-government (B2G) start-up, but is currently working on expanding to B2B, including pipelines that supply to power plants.

Priorities and Motivations

Having worked in surgical robotics and become interested in developing both hardware and software, Asim was inclined to dive deep into a single specialization. The problem he decided to focus on was water loss and water pollution in India. Research pinpointed pipelines as the root cause of many problems, and hence Asim decided to concentrate on introducing automation to pipeline mapping and diagnosis, which would also help alleviate the risky business of manual intervention that involves human contact with hazardous waste. His second priority was also to address the need to conserve water. His biggest priority currently is to find alternate avenues, including diversifying and finding private clients, to combat the long procurement cycles of the government. Through TCFL, the company aimed to establish government connections and acquire government customers.

Mentors

Primary mentor: CM Patil, CEO of Sandbox Startups

Secondary mentors: Vignesh Nandakumar, Partner at Lightstone Aspada; Tanmay Tathagath, Founder of Environmental Design Solutions (EDS)

Waste

Hasiru Dala Innovations (HDI)

Solution

TEAM	SHEKAR PRABHAKAR, CO-FOUNDER
Location	Bengaluru, India
Founded	November 2015
Maturity	Paying Users

Hasiru Dala Innovations' decentralized franchisee model seeks to empower waste-picker entrepreneurs by creating predictable livelihoods for them. HDI offers a total waste management solution that has resulted in increased segregation at source and improved material recovery rates, with at least 90 percent of the waste generated diverted away from landfills. HDI has also pioneered event waste management solutions for near-zero waste events.

Business Model

HDI's business model works on the premise that waste generators should pay for waste management. They enter into annual to three-year contracts with bulk waste generators, offering services such as primary collection and transport, secondary transportation, and further segregation of dry waste into marketable categories. The pricing model includes a fixed service charge plus a differentially priced variable component for different kinds of waste. Dry waste incurs the lowest cost, followed by wet, and then mixed waste, to incentivize segregation at source.

Customer Segment

HDI operates on a business-to-business (B2B) model, with apartment owners associations, facility management companies, restaurant owners, and corporate administration departments.

Priorities and Motivations

Having worked alongside his wife on waste-picker rights through sister organization Hasiru Dala, Shekar realized that India's waste management problem could be transformed by running it as a professional business. Through TCFL, HDI hope to access finance to help scale their operations. Working capital was a struggle, and the enterprise sought investor connects for pre-series A funding. In addition, they were also looking for assistance with marketing and branding, business modeling, and compliance.

Mentors

Primary: Surojit Bose, Associate Vice President of Sustainability Legal at Coca-Cola India

Secondary: Amber Maheshwari, Principal at the Bharat Innovation Fund; Bharath Visweswariah, Director at Omidyar Network

RaddiConnect

Solution

TEAM	RAHUL NAINANI, CO-FOUNDER
Location	Mumbai, India
Founded	August 2015
Maturity	Paying Users

RaddiConnect is a waste management service that provides a free doorstep pick-up service through an aggregated network of raddiwallas (waste pickers)for housing societies and commercial establishments to dispose of their raddi (i.e., scrap) and recyclable waste, and then supply the waste to authorized recycling centers, ensuring safety and sustainability. RaddiConnect also partners with the local municipalities to manage dry waste at the ward level for the city. The company is also working with plastic manufacturers and brand owners (fast-moving consumer goods [FMCG] companies) to set up recovery channels for the plastic they introduce into the environment.

Business Model

RaddiConnect has a business-to-consumers (B2C) subscription model; that is, it charges subscription fees to collect waste from waste generators and charges FMCG companies to become plastic neutral and meet extended producer responsibility (EPR) compliance.

Customer Segment

RaddiConnect began with a B2C model; it then evolved to work with governments and then corporates. The evolution ensured business sustainability: waste being a volume business, B2B and business-to-government (B2G) give larger orders and bring in larger revenues.

Priorities and Motivations

A fire incident at Deonar in Mumbai caught Rahul's attention. He realized that waste management was being overlooked. Upon further research, he discovered that in terms of market size, potential, and waste generated, a start-up in waste management was the need of the hour. Although Rahul dove deep into every aspect of the business, from fundraising to government liaising, in the beginning, today he is more focused on setting up infrastructure for managing waste. RaddiConnect aspired to be mentored by investors and gain government and private customers, particularly in the FMCG space, through TCFL.

Mentors

Primary mentor: Anju Gupta, Partner at IvyCamp ventures

Secondary mentors: Surojit Bose, Associate Vice President of Sustainability Legal at Coca Cola India; CM Patil, CEO of Sandbox Startups

Sanshodan E-Waste Exchange

Solution

TEAM	DR. SHALINI SHARMA, FOUNDER & CEO
Location	Hyderabad, India
Founded	November 2017
Maturity	Users

E-Waste Exchange is the world's first circular economy platform for e-waste management sector, providing a digital infrastructure for citizens and businesses in India to directly transfer their e-waste to government-authorized, technically competent e-waste recyclers and safeguard the environment from e-pollution.

Business Model

Sanshodan's E-Waste Exchange offers an online platform and collection services for e-waste, as well as consultancy services for producer responsibility organizations (PROs). They also offer capacity building and an extended producer responsibility (EPR) compliance assessment system designed especially for state governments.

Customer Segment

The three key customer segments for Sanshodan include individuals in the residential segment, small and medium businesses and educational institutions, and bulk generators such as large-scale businesses.

Priorities and Motivations

Through TCFL, Sanshodan sought mentorship from sectoral experts, access to a collaborative network to further their plans for a green supply chain and circular economy, and funding.

Mentors

Primary: Revathy Ashok, Managing Trustee and CEO at the Bangalore Political Action Committee (BPAC)

Secondary: Pawan Mulukutla, Head of City Development at Bosch; Bharath Visweswariah, Director at Omidyar Network

APPENDIX F: SURVEYS AND QUESTIONNAIRES

Data Collected from TCFL Cohort

1. **General**
   - Year of Incorporation
   - Number of employees (Male/Female)
   - Location of Head Office
   - Customer segment
2. **Business Metrics**
   - Total funds raised, by source (debt, equity) in INR
   - Funds in Pipeline, by status in INR
   - Monthly Revenue, by sector (residential, commercial, industrial, municipal) in INR
   - Monthly Expenses (Personnel, Other Operating Expenses) in INR
3. **Operational Metrics**
   - Cities of Operation
   - No. of New Users/Deployments
   - No. of Active Users/Deployments
4. **Impact Metrics – Water**
   - No. of litres saved
   - No. of litres of potable water generated
   - No. of litres of waste-water treated
   - No. of people impacted
   - Money leveraged (in INR)
   - Environmental benefits
5. **Impact Metrics – Energy**
   - KWH saved (by sector)
   - % increase in energy efficiency
   - CO_2 emissions avoided (if available)
   - No. of people impacted
   - Money leveraged (in INR)
   - Environmental benefits
6. **Impact Metrics – Waste**
   - Amount of Dry Waste Processed (in tons)
   - Amount of Wet Waste processed (in tons)
   - Amount of waste diverted from landfills (in tons)
   - Amount of waste recycled (in tons)
   - Amount of waste converted to energy (in tons)
   - Amount of waste converted to compost (in tons)
   - Awareness raised/Capacity built
   - Livelihoods generated
   - No. of people impacted
   - Money leveraged (in INR)
   - Environmental benefits

Survey Questionnaires

Investor

The attached questionnaire has 4 sections.

Section 1 is on personal and professional details to better understand your professional experience in the sector.

Section 2 looks at your understanding of the sector, and the role investors and other stakeholders play in this ecosystem. We are looking for some insight into how investors identify entrepreneurs and solutions, what drives your investment decisions, what gaps need to be addressed that would make this ecosystem function better.

Section 3 focuses more on the company and their solution, and your engagement with them.

And lastly, Section 4 aims to understand the wider ecosystem, and changes you anticipate impacting the scaling of innovation. Given your experience working in this sector, we would like to know what changes you have seen in terms of people, policy, process, available resources, etc. that have influenced how the sector currently works, and how you view the future of this space.

All interview data will be strictly confidential, and any quotes used will be attributed only with your explicit permission.

*Date:*_____

*Name:*_____

*Company/Firm:*_____

Designation: _____

*Start Year:*_____ | *End Year:*_____

*City/State:*_____ / _____

1. **Personal/Professional details**
   - How long have you been working in this space?
   - Where were you working prior to this?
   - What are your main focus areas of investment?
   - What are your priorities/motivations when it comes to working in these focus areas and what challenges do you encounter in accomplishing these priorities?
   - What specific challenges do you encounter while investing in water/waste/energy? Please elaborate.

2. **Problem/Sector**
   - In your opinion, what is the state of innovation in water/waste/energy?
   - In your opinion, who are the other stakeholders that should be/are involved in the problem-solving process and what (if applicable) is the role of other stakeholders in solving these problems?

i. Government
ii. Corporates
iii. Entrepreneurs
iv. Community
v. Research/academia
vi. Others: Elaborate

- Are there interactions between different stakeholders? Is there a healthy level of trust to collaborate and collectively solve the issue at hand?
- What kinds of solutions are gaining traction with investors like yourself? Are there unique products with differentiated value propositions or do you see a number of similar products in this space?
- What are the fund's priorities/portfolio when it comes to selecting companies to invest in? (For example: Sector, returns, the stage of the companies to invest in? (early stage, product stage)).
- How do you find out about companies to invest in? Please elaborate on the process.
  i. Through challenges
  ii. Through partnerships with accelerators/incubators/academic institutions
  iii. Use an external online database (Tracxn, AngelList, Crunchbase, etc.)
  iv. Use an internal online database
  v. Through professional recommendations
  vi. Others: Elaborate
- What, if any, are the benefits or challenges with this process?

3. **Company engagement**
   - How did you find out about this company?
   - What are the top 3 factors that influenced your decision to invest in this company?

     i. Company History
     ii. Product strength/suitability
     iii. Cost of the product/service
     iv. Business Model
     v. Exit/Return potential
     vi. Favorable Terms
     vii. Uniqueness of the technology/solution
     viii. Background of Founders/Promoters
     ix. Existing and Future demand
     x. Impact (social, environmental)
     xi. Other: Elaborate (operational, financial and technological).
   - What is the time frame within which the investment decision was made?
   - Are you aware of other similar products? What, in your opinion, differentiates said company from competitors?
   - What were your key learnings whilst working with this company?
   - Do you believe this company has transformed or showed potential to transform the energy management space?

4. **Sector/Ecosystem**
   - Have there been any changes (process, policy, technology, motivations, leadership) recently that have made the investment process easier for you? Do you anticipate any changes in the future that might make investment in water/waste/energy easier?

Customer

The attached questionnaire has 3 sections.

Section 1 is on personal and professional details to better understand your experience in the sector of water/waste/energy.

Section 2 focuses on the solution itself to determine how and why it was selected, how it performed, and what lessons were learnt from the implementation. We are looking to gain insights into the market appeal of the company and its solution, whether it has potential for scale, and what steps would need to be taken to help this happen.

And lastly, Section 3 aims to understand the wider ecosystem, and changes that might impact the scaling of innovation. We would like to know what changes you have seen in terms of people, policy, process, available resources, etc. that have influenced how the sector currently works, and how you view the future of this space.

All interview data will be strictly confidential, and any quotes used will be attributed only with your explicit permission.

*Date:*_____

*Name:*_____

*Organisatio/Association:*_____

Designation: _____

*Start Year:*_____ | *End Year:*_____

*City/State:*_____ / _____

1. **Personal/Professional details**
   - How long have you been part of this organisation/association?
   - What is the main focus of your work at your organisation/association?
   - In your opinion, what are the most pressing problems faced by a customer in this sector in the city? Has this changed over the last 5-10 years?
   - What are your organisation/association's priorities when it comes to addressing the water management?
   - What are your personal priorities/motivations when it comes to tackling the same issue?
   - Do you face any challenges in addressing water/waste/energy management?

2. **Solution**

- How did you find out about this company?
- Why did you choose this particular product/service?
- What is the problem this solution is addressing?
- How effective is the solution in addressing the identified problem?
- Are there ways in which the product/service could be improved? If you could change anything about the product/service, what would it be and why?
- What is the cost of the product/service? (per unit)
- On a scale of 1-5, 5 being the best score, please rate the product service in the following categories:

	1	2	3	4	5	REMARKS
Performance:						
Ease of Use: Did it require training, if yes, how long?						
Ease of adoption						
Affordability of the product/service						
Reliability						
Environmental Impact (Water saved): How much were the savings?						
Social Impact						
After sales service						
Likely to recommend to others; Why?						
Likely to re-purchase products/services from this company; Why?						
Overall satisfaction						

- What is the time frame within which the company deployed their product/service? Were there any delays? If yes, why?
- Are you aware of other offerings in the market? Have you experimented with any of them? Y/N
- What differentiates the product/service from these alternatives?
- What were your key learnings whilst working with this company? Did they meet your expectations?
- How has using the said product transformed or showed potential to transform the service delivery in your city?

3. **Sector/Ecosystem Changes that have been taking place—process, policy, technology, leadership, motivations, priorities**

- Have you noticed any changes in the ecosystem or sector at large that have encouraged your use or acquisition of innovation?
- What kind of solutions have you noticed gaining traction with other organisations/associations? Would you consider adopting these solutions?
- Is there possibility of the current solution becoming obsolete?
- Other than the water management solution deployed, how do you deal with the other two problems of water/waste/energy management in your organisation/association? Does your organisation employ a circular model?

Government

The attached questionnaire has 3 sections.

Section 1 is on personal and professional details to better understand your professional experience in the sector. Based on your experience working in water/waste/energy, we would like to understand where you identify challenges, and how you accordingly find solutions. The aim is to gain insight into what challenges local Indian governments face in this sector, where these challenges come from, and what steps are involved in addressing them.
Section 2 focuses on the solution offered by the company, to determine why it was selected, and how it performed, and what lessons were learnt from the implementation. This is to better understand whether the solution properly addresses the problem and to what extent, and the potential of this solution or similar solutions to find use with other public utilities, as well as the steps that need to be taken to help this happen.

And lastly, Section 3 aims to understand the wider national/state level ecosystem, and changes that might impact the scaling of innovation. We would like to know your expert opinion on what changes you have seen in terms of people, policy, process, available resources, etc. that have influenced how the sector currently works, and how you view the future of this space.

All interview data will be strictly confidential and anonymised, and we will only quote you in the paper if you are comfortable with us doing so.

*Date:*_____

*Name:*_____

*Organisation:*_____

Designation: _____

*Start Year:*_____ | *End Year:*_____

*City/State:*_____ / _____

1. **Personal/Professional details and State of the sector**
   - What is your educational/professional background?
   - Where did you work prior to this? For how long? What were your responsibilities? Please elaborate.
   - What is the main focus of your work at the department? Can you briefly explain.
   - What are the problems in the sector of renewable energy/energy management that need attention?
   - Who are the other stakeholders that should be/are involved in the problem-solving process? What in your view is the role of other stakeholders in solving these problems?
     - Investors
     - Corporates
     - Entrepreneurs
     - Community
     - Research/academia
     - Others: Elaborate
   - What are the department priorities when it comes to addressing the issue at hand?
   - What are your priorities/motivations when it comes to tackling the issue of renewable energy/energy management?
   - Do you face any challenges in addressing this issue? If so, what?
   - How do you source solutions to address the issues? Please elaborate on the process.
     - Pre-existing vendor list
     - Through challenges/competitions
     - Through partnerships with accelerators/incubators/ academic institutions
     - Use an external database (Tracxn, AngelList, Crunchbase, etc.). If so, is the database online?
     - Use an internal database. If so, is the database shared?
     - Through professional recommendations
     - Others: Elaborate
   - What criteria do you apply to assess the viability of these solutions?
   - What kind of solutions do you typically deploy? Could you provide an example/scenario?
   - What are the benefits of the current process? What are the challenges?
   - Is it different from how you used to source solutions previously? If yes, how?
   - Have you previously sourced solutions from SMEs? If yes, how?
   - Have the solutions sourced from the existing process worked well?
     - If yes, why? What were the benefits? What were the challenges, if any?
     - If no, why not?
   - Does the department have a Research and Development (R&D) and/ or innovation division/function? Y/N
     - If yes, how many people are employed in this division/ function? And what is their focus of work?
     - If no, why not?

2. **Solution**
   - How did you find out about this company?
   - What is the problem this solution is addressing? Why was this problem chosen?
   - How effective is the solution in addressing the identified problem?
   - Why were you interested in this particular product/service?
   - Are you aware of other offerings in the market? If yes, what differentiates the product/service from these alternates?
   - If you could change anything about the product/service, what would it be and why?
   - Was this a pilot or direct acquisition? If there was a pilot, who financed the pilot? What is the typical methodology for financing solutions that are not acquired through the RFP process?

- If there wasn't a pilot, what was the main reason the pilot didn't happen?
- What were your key learnings from this experience?
- Has this experience in any way impacted your perception on working with new technologies? If yes, how?
- Do you think the product shows potential to transform the service delivery in your city/state? If yes, how? If no, why not?

3. **Sector/Ecosystem**

- Have there been any changes recently that have made the process of sourcing solutions easier for you?
- Do you anticipate any changes that might make this process easier?
- Are you aware of central/state government schemes/policies/ platforms that are enabling the use of innovation for service delivery (GeM, Startup-India, etc.)? Please check the appropriate box for the following schemes/policies?

NATIONAL	AWARE	EXPLORED/RESEARCHED	APPLIED/ACCESSED
Digital India			
Make in India			
Start-up India			
Niti Aayog			
Atal Innovation Mission			
Invest India/ GeM			
Smart Cities Mission			
Swachh Bharat			
Global Innovation & Technology Alliance (GITA)			
IUDX			
SmartNet			

MAHARASHTRA STATE POLICIES	AWARE	EXPLORED/RESEARCHED	APPLIED/ACCESSED
IT/ITES Policy			
Industrial Policy 2013			
Innovation and Start-up Policy 2017			
Women Entrepreneur Policy 2017			

Mentor

The attached questionnaire has 3 sections.

Section 1 is on personal and professional details to better understand your professional experience in the sector.

Section 2 looks at your understanding of the sector, and the role different stakeholders play in this ecosystem. We are looking for some insight into the kinds of solutions currently finding traction and what gaps need to be addressed to make this ecosystem function better. Given your experience working in this sector, we would also like to know what changes you have

seen in terms of people, policy, process, available resources, etc., that have influenced how the sector currently works, and how you view the future of this space.

And lastly, Section 3 focuses more on the company and their solution, and your engagement with them.

All interview data will be strictly confidential, and any quotes used will be attributed only with your explicit permission.

*Date:*_____

*Name:*_____

*Organisation:*_____

Designation: _____

*Start Year:*_____ | *End Year:*_____

*City/State:*_____ / _____

1. **Personal/Professional details**

- What is your background?
- What is the main focus of your work?
- What are your priorities/motivations when it comes to working in this sector/space? Do you face any challenges in accomplishing these?

2. **Problem/Sector**

- According to you, what problems in this sector need attention?
- What is your assessment about the products/services you have encountered in the space of sustainability technologies?
- Are there more duct-tape solutions being implemented or do the solutions address systemic changes and/or issues that the public sector is disinclined/unable to solve in a timely manner?
- What criteria do you apply to assess potential solutions for their viability?
- Who are the other stakeholders that should be/are involved in the problem-solving process? What (if applicable) in your view is the role of other stakeholders in solving this problem?
    - Government
    - Investors
    - Entrepreneurs
    - Corporates
    - Community
    - Research/Academia
    - Others
- What do you believe are the major challenges or hurdles facing this ecosystem and these players?

Has anything changed in the space that might impact the use of innovation to address these problems? Do you anticipate any changes in the future?

3. **Solution**

- Which company(ies) did you mentor during TCFL? For how long?
- Had you heard of this(these) company(ies) prior to TCFL?
- What problem does the company's offering address?
- How well does the company's offering address the identified problem?
- What particular features of the offering were unique? How were they unique?
- On a scale of 0-5, 5 being the best score, please rate the product/service in the following categories:
    - Perception of ease of use:
        i. Did it require training; if yes, how long?
    - Ease of adoption
    - Relevance at the macro/city scale
    - Affordability of the product/service
    - Environmental impact (Water/Energy savings, Waste diverted):
        i. How much were the savings?
    - Likely to implement/use: Why/Why not?
    - Likely to recommend to others: Why/Why not?
- Are you aware of other offerings in the market?
    - What differentiates the product/service from these alternates?
- Can the solution be easily adopted? Is it scalable to other cities? If so, under what conditions?
- Are there ways in which the product/service could be improved? If you could change anything about the product/service, what would it be and why?
- How would using the said product transform or show potential to transform urban service delivery?
- Does the solution show potential for sustained impact?
- What were your key learnings whilst working with this company? Did they meet your expectations?

Cohort

The attached questionnaire has 4 sections.

Section 1 is on personal and professional details to better understand your educational background and professional experience in the sector.

Section 2 looks at your understanding of the sector, and the role other stakeholders play in this ecosystem. We are looking for some insight into what drives your decision to work in this sector, the hurdles faced, and how they can be addressed to make this ecosystem function better.

Section 3 aims to understand the wider ecosystem, and changes you anticipate impacting the scaling of innovation. Given your experience working in this sector, we would like to know what changes you have

seen in terms of people, policy, process, available resources, etc., that have influenced how the sector currently works, and how you view the future of this space.

And lastly, Section 4 looks at your engagement with the TCFL Accelerator program. We would like to understand whether TCFL was able to help you, how your pilot engagements worked out, and what scope you see for accelerators in this space.

All interview data will be strictly confidential, and any quotes used will be attributed only with your explicit permission.

*Date:*_____

*Name:*_____

*Company:*_____

Designation: _____

*Start Year:*_____ | *End Year:*_____

*City/State:*_____ / _____

1. **Personal/Professional details**
   - What is your educational background?
   - What were you engaged in prior to this?
   - What motivated you to engage on this/change track/start a start up?
   - What is the main focus of your work in the organisation?
   - What are your priorities/motivations when it comes to working in this sector/space?
   - Do you face any challenges in accomplishing these?

2. **Problem/Sector**
   - According to you, what problems in this sector need attention?
   - How do you prioritise problems for solving? Why did you pick this particular problem (need, marketability, tech background to produce solution, etc.)?
   - Who are the other stakeholders that should be/are involved in the problem-solving process? What (if applicable) in your view is the role of other stakeholders in solving these problems?
     - Government
     - Investors
     - Entrepreneurs
     - Corporates
     - Community
     - Research/Academia
     - Others
   - What do you believe are the major challenges or hurdles facing this ecosystem and these players?
   - Do you anticipate any changes in the above space that might impact the use of innovation to address these problems? If so, what types of changes?

3. **Ecosystem/Sector**
   - Has anything changed in the space that might impact the use of innovation to address these problems?
   - Have there been any changes recently that have made this process easier for you? Do you anticipate any in the future?
   - Have you accessed any government schemes/policies/platforms? Y/N.
   - If yes, which ones and can you elaborate on the process?
   - If no, why not?

4. **Accelerator Design and Mentorship**
   - Have you worked with an accelerator/incubator platform before? When? Which ones (names and dates) and why?
   - What are your views on the efficacy of accelerator platforms to address the challenges within the urban ecosystem? In your experience, what are accelerators useful for?
   - What were your motivations in choosing to participate in TCFL? Please elaborate.
   - What particular features of TCFL were unique?
   - Did you receive any pilot interest for your solution? From whom?
   - Were you able to convert this interest into a pilot project? Who was the client? If yes, elaborate on the process. If no, why not?
   - Do you think a WRI accelerator alumni setup would be useful to you? How/what would you like to see this setup offer to you and other enterprises?

Would you be interested in being part of the alumni association and receive educational materials/workshops and e-mail updates about WRI's innovation work going forward?

GLOSSARY

Accelerator: Though similar to incubators in many ways, accelerators focus on more advanced enterprises, typically offering support to take them from the post-prototype stage to scale. Accelerators are often sector specific.

Business model: A business model is a company's core strategy for doing business profitably.

Challenges: A challenge is a tool that supports innovation by means of a monetary prize to the winners of the challenge. The prize may be an award in recognition of past work, or as an incentive to trigger future innovation. These may happen on either a recurring or a one-time basis, and are usually used to target specific problem statements.

Counterfactual: Counterfactual analysis is used to measure the effect of an intervention through comparison of beneficiaries against a counterfactual group without the intervention.

Curriculum: A curriculum is a collection of lessons, assessments, and other academic content that is taught in a program.

Enterprise: This term is another word for a business or company, but it is most often associated with entrepreneurial ventures.

Impact investment: Impact investment aims to generate specific beneficial social or environmental effects in addition to financial gains.

Incubator: An incubator is an institution that nurtures idea-stage enterprises, hand-holds entrepreneurs, and often offers pre-seed funding, use of proprietary software and tools, or free office space/infrastructure, technical and business mentorship, and networking opportunities. Many incubators take an equity stake in the enterprise in exchange for their investment as well as mentorship services provided, though some non-profit programs eschew the equity stake. Incubators are usually sector agnostic.

Innovation ecosystem: The innovation ecosystem is the synergistic association of people, institutions, processes, and place that facilitates idea generation, commercialization, and scale.

Innovation: Innovation is the implementation of a new or significantly improved process, product (good or service), organizational practice, business model, or promotional method. In essence, innovation comprises three core dimensions: novelty in approaches and application to new situations, implementability in some form, and ability to achieve impact.

Internet of Things (IoT): Cisco defines the IoT as a system where items in the physical world, and sensors within or attached to these items, are connected to the Internet via wireless and wired Internet connections.

Mentorship: The guidance provided by a mentor, especially an experienced person in a company or educational institution.

Pilots: A pilot is an initial rollout of a solution or product used to demonstrate the suitability and viability of a solution in a new environment. It usually targets a limited-scope implementation of the planned final solution.

(Stakeholder) Platform: A network in which actors from business, civil society, and governmental or private institutions come together in order to find a common approach to solve a complex issue.

Procurement: Procurement is the act of sourcing, negotiation, and selection of goods or services.

Sandbox: Sandboxes offer a physical environment within which to test the robustness of solutions and assist in their refinement. They are often used by governments to spread the risk between public and private stakeholders.

Start-ups: A start-up is a young company founded by one or more entrepreneurs to develop a unique product or service and bring it to market.

Sustainability: Environmental sustainability; it is the meeting of needs through responsible interaction with the environment, which helps maintain natural resources while also not jeopardizing the ability of future generations to meet their needs.

Urban services: This term refers to services provided by a city municipality, such as water, sewer, energy, and transit.

ENDNOTES

1. Assuming a household size of four and the norm of 135 liters per capita per day (lpcd) as prescribed by the Central Public Health and Environmental Engineering Organisation (CPHEEO), 5 trillion litres would be 3.75 times the current annual domestic water demand of India's most populous city of New Delhi (Planning Department, Government of NCT of Delhi, 2020).

2. Under the Paris Agreement, India committed to reduce greenhouse gas (GHG) emission intensity of its gross domestic product (GDP) by 33 to 35 percent below 2005 levels by 2030.

3. Many lower-middle-class and rural households lack access to power from public distribution companies for many reasons, including affordability. Cygni Energy, incubated at the Indian Institute of Technology Madras, attempted to close this gap by introducing Solar-DC technology. The Solar-DC inverter-less technology, conceptualized and ideated by IIT Madras, uses complete DC solutions to eliminate AC-to-DC and DC-to-AC conversions. Eliminating the need for conversion helps save energy and power costs.

4. A conventional model for managing municipal wet waste involves the transport of the waste over long distances to a biogas plant located outside the city, whereas Carbon Masters has illustrated the benefits of decentralized plants. They won the tender put out by BBMP (Bruhat Bengaluru Mahanagara Palike), Bengaluru's local government, and the Koramangala residential association for the 50TPD project in Koramangala ward in Bangalore and have highlighted the potential of innovative public-private partnerships (https://carbonlites.com/projects.html).

5. For example, although reverse osmosis (RO) was a game changer in water treatment, it can waste large quantities of water. The extent of waste pushed the National Green Tribunal to instruct the Ministry of Environment, Forest and Climate Change to mandate a minimum 60 percent recovery of treated water from RO systems manufacturers (Kaur 2019).

6. Using an OPEX model requires a company to bear the capital expenses—the cost of the physical product—which can often be quite expensive for new technologies. Transferring the burden of capital expenses to the customer can offer more financial security for smaller enterprises, but can also result in longer sales cycles, as decision-making and approval processes also tend be longer for large, lump sum capital expenses.

7. Hasiru Dala actually saw a slight decrease in total waste diverted in April 2019 as compared to December 2018; this was due to customer preference leading them to being billed in March instead of in April.

8. The creation of the Ministry of Jal Shakti at the Center by merging the central ministries of Water Resources, River Development & Ganga Rejuvenation, and Drinking Water and Sanitation is only the first step in addressing the larger reform required for more integrated management of water resources.

9. With gross metering, distribution companies are guaranteed higher revenues as the compensation paid to individual rooftop generators is usually lower than the tariff charged to consumers.

10. Operating two entities: for-profit and non-profit.

11. Master system integrators are companies that offer widespread optimization solutions including data management, security, traffic management, G2C, and G2B services.

12. Water shortage in Bangalore has created water tanker networks and players. When one of our start-ups tried to employ water recycling, they had to face the wrath of existing water tanker players.

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Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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