Not a Zero-Sum Game: How to Simultaneously Maximize Efficiency and Privacy in Data-driven Urban Governance

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Abstract

In this paper, we validate the hypothesis that in the context of Indian municipal governance, the trade-off between government efficiency and privacy is not a zero-sum game; rather one can improve these seemingly contrasting forces simultaneously. India is on dual trajectories. On one hand, there is a nationwide push to improve municipal governance through increased transparency and efficiency, especially in the functions that involve citizen interaction. On the other hand, as a country, India must embrace the Supreme Court Bench decision of August, 2017, that privacy is a constitutional right.[9] There are two primary aspects to reaching our conclusion. The first is the addition of a new category of data of significant volume; we have been provided access to 383,959 real citizen transactions across all services for the 112 urban local bodies (ULBs) for one state for all of 2018. The logs include the details of each ULB functionary involved in each stage of responding to a citizen request. This has enabled us to consider our previously defined metrics, the Governance Efficiency Index and Information Privacy Index, at multiple levels of granularity. The second aspect is the government-defined service level agreements that define acceptable completion times. This allows us to evaluate completion times. The further analysis provided in this paper demonstrates that that ULBs from all three size tiers can and do reach our Model ULB designation of performance. We conclude from this analysis that ULBs of all sizes and across all services have the capacity to maximize both efficiency and privacy.

1 Introduction

India, with a population of over 1.2B people [1], three mega-cities with populations over 10M, and another 43 with populations over 1M, finds itself moving forward in two seemingly contrary directions. These two forward thrusts we study here are the move into cyberspace - urban data-driven governance in particular - and the Supreme Court Bench decision [9] in August, 2017, that privacy is a constitutional right. As urban governance becomes increasingly digital, one must consider the possible impact on citizens. An individual citizen may benefit from improved urban services, but possibly at the cost of personal privacy.

India, as is true of much of the world, is moving forward technologically. Especially between the work of the Ministry of Housing and Urban Affairs [5] and the Smart Cities program [6], India has been working toward significantly improved transparency and efficiency in the operations of urban governments. This is a move from a completely paper-based system, to a system that is completely digitized, with electronic citizen interfaces. With the significant growth in availability of cell-phones and in particular, smart phones, phone based interfaces to request government services and interact with governments are becoming increasingly available. One of the lead organizations providing the tools and support to urban governments or urban local bodies (ULBs) is the eGovernment Foundation (eGov), with whom the work reported here is a collaboration.

A second aspect of the thrust to digitize and bring citizen interaction with governments into cyberspace has been the effort to provide a biometrics-based universal identity system, Aadhar [11] to India. Authors Nandan Nilekani and Viral Shah report that between 2009 and 2014, India registered 900M people in the Aadhar system. As the system became more widely available and adopted, however, concerns about privacy grew. It was in that and a wider context that the Indian Supreme Court revisited the question of whether or not

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privacy was a constitutional right, leading to their 2017 decision and the following work to bring the decision into law and regulation.

We began our work in this area shortly before the Supreme Court decision, and that work led to our preliminary report one year ago [13], on which this work builds further. A more comprehensive report of both years of this study - including a more detailed background and further observations and results - has also been compiled[10].

In this new work we report on two major advances. In the preceding year we were able to observe and evaluate the structure of the data collection and usage in ULBs to allow for interesting analysis. This year, however, we have been given an anonymized set of the transaction logs for 112 ULBs in one state of India, allowing us to gain an extremely detailed picture of how the government functions proceed from initial request to completion. An ancillary important component of the data is the service level agreements (SLAs), which specify the acceptable time for completion of each municipal role's task and the total completion time for a service. Equipped with this detailed and broad data set, we can measure efficiency and observe patterns of behavior of ULBs across various government services. This allows us to evaluate one of the two metrics, proposed in our original paper, the Governance Efficiency Index (GEI). In the process we have also gained deeper insights into the application of our Information Privacy Index (IPI).

The second major contribution of this work is the concept of the *Model ULB*. We begin by identifying ULBs with model behavior (i.e., in the 75th percentile or better) in three different Tiers (i.e., population sizes) for offering each of the three candidate services (Water Tap, Property Tax, and Public Grievance Redressal). We then consider consider such model behavior for efficiency index (GEI) and privacy index (IPI) separately. Finally, we identify ULBs that are models simultaneously across both GEI and IPI. This leads to our conclusion that in fact this tradeoff between efficiency and privacy is not a zero-sum game.

The paper proceeds as follows: First, Section 2 begins with a discussion of our research approach and the key questions we answer in this work. Then, in Section 3, we examine in more depth the background to the work, including more information on the privacy question from a legal perspective and a brief overview of our prior work. We then discuss our data collection in Section 4 and in Section 5 examine the two metrics, GEI and IPI in more detail. Section 6 presents our analysis and results in detail, concluding with the application of the Model ULB concept. We review a set of implications for public policy in Section 7 and conclude with final thoughts, observations, and future work in Section 8.

2 Approach and the Research Questions

As we will review below in Section 3.3, in our previous work we proposed a separation of efficiency evaluation from privacy evaluation, although at the time we did not have the data to demonstrate their applicability. The approach we take in this work is to consider three successive questions to ask of the data and analysis.

Q1. *Is it possible to improve government efficiency while keeping the level of privacy constant?*

We study this question by combining the new data we have received on citizen transactions that captures the service commencement and completion times with the understanding of the service levels expected for these transactions. This analysis allows us to study both the actual efficiency for each tasks as well as to compare to the expected efficiency. We observed that all data collected is made available to all functionaries, so all such logging followed a single, consistent, "privacy" policy of exposure of all collected data to all functionaries.

Q2. *Is it possible to improve privacy while keeping efficiency constant?*

Because there is no log data for which the privacy conditions vary, our analysis of this question is hypothetical. Based on the data we collected previously, we have a clear understanding of which data is actually required for each functionary. As a result, we are in a position to hypothesize alternate, more privacy-preserving scenarios, which would improve the information privacy index.

Q3. *Is it possible to improve both efficiency and privacy simultaneously?*

Finally, in light of the analysis we do to address the first two questions, we can then consider the intersection of the two and consider our hypothesis that it is, in fact, possible to improve both efficiency and privacy simultaneously.

3 Background

In 2009, India mandated that every citizen must register their information and certain biometric data under a new unique identification system called Aadhar. The original proposal and design for Aadhar made two assumptions, first, that although it would be made available to all people in India, it would not be required for services, and, second, that it would be used purely for identification, and not for attribute information, such as bank account numbers, addresses, and so forth. [11] However, because Aadhar became so pervasive and readily available there was pressure both to require it for some services and to manage other types of data (attributes) within it. While these pressures did not change the technical architecture of Aadhar to accommodate these demands, both public and private actors began to utilize Aadhar ID as a defailt record-locator in lieu of alternatives that were as pervasive. This led to significant arguments against such practices as well as to the very existence of Aadhar as a potential source of privacy violations. Petitioners questioned the collection of biometric information and the increasing risks of data security and personal privacy violation, leading to the Supreme Court taking up the question of privacy more generally, and its bench decision on the subject. [9] The Supreme Court ruled that in fact, privacy is a fundamental right, and is intrinsic to the values of Article 21 of the Indian Constitution giving citizens the right to life and personal liberty. They noted that the complexity of regulating privacy derives from the context-dependent nature of privacy, and issued a Committee of Experts to deliberate on a data protection framework for the country.

3.1 Supreme Court Decision

On July 18, 2017 the Supreme Court of India set up a nine-judge bench decision to reflect on how the Constitution makers envisioned the nature of privacy:

- Is privacy a guaranteed fundamental right in the Constitution?
- What is privacy defined as?
- Is the right to privacy embedded in the right to liberty and personal dignity, or other guarantees of protected fundamental rights?
- In what parts of a citizen's life is privacy guaranteed?
- How much should the government regulate privacy (nature of regulatory power)?
- What are the different aspects of privacy and does the Constitution cover some but not the others?

On August 24, 2017, the Bench unanimously decided that under the Indian Constitution, privacy is a fundamental right other than for reasons of national security, protection against crime, and protection of revenue. Observing that the Indian Constitution is a dignitarian constitution focused on upholding every citizens personal dignity, the Bench outlined several reasons why privacy is important for ordered liberty: (1) privacy is a form of dignity; (2) privacy provides a limit on the government's power as well as a limit on private sector entities' power; (3) privacy is key for freedom of thought and opinion; (4) it provides the right to control personal information as well as provides incentive for development of personality; (5) a guarantee of privacy prevents unreasonable intrusions by malicious public, private, or individual actors. It was determined that privacy is intrinsic to the values of Article 21 which gives citizens the right to life and personal liberty. Furthermore, privacy should apply to both physical forms and to technological forms of information; rights to enter the home should be up to the individual, excepting security reasons listed in Article 14. Lastly, privacy serves eternal values and guarantees the foundation of ordered liberty. Consequently, the Bench formulated a three-fold requirement for a valid law on privacy:

1. There should exist a law stating that privacy is a fundamental right according to Article 21.
2. To guard against arbitrary state action, the restrictions imposed on the nature and content of the law should abide by Article 14's exceptions to reasonableness.
3. The legislature must be proportional to the object and needs sought to be fulfilled by the law.

The Bench, recognizing that data protection and data privacy are complex issues that require expert opinion and mandated that the government create a Committee of Experts under the Chairmanship of Justice BN Srikrishna, a former judge of the Indian Supreme Court,[9] to deliberate on a data protection framework for the country. While the constitutionality of the right to privacy was decided upon, the complexity of regulating privacy derives from the context-dependent economics of privacy. To better understand existing models of privacy protection and enforcement, an understanding of the transforming definition and value of privacy depending on contexts is important.

3.2 Recommended Model of Privacy

In 2012, an expert group under the then Planning Commission of the Indian Government produced a Report of the Group of Experts on Privacy [8]. Chaired by the former Chief Justice of the Delhi High Court, Justice A.P. Shah, the Expert Group was composed of representatives from industry, civil society, NGOs, voluntary organizations, and government departments. Analytic tools that generate economic value out of data and the ubiquitous transfer of data require an overarching privacy policy to regulate the government and commercial collection of information. Consequently, the Srikrishna Committee drew from the Group of Experts Report, examined international and national privacy principles, and identified a set of recommendations for the Indian Government to consider when formulating a privacy framework for the country. Internationally, the three common models of privacy protection can be described as i) the "Command and Control" Model, ii) the Self-Regulation/Sectoral Model, and iii) the Co-Regulatory Model.[12] The Srikrishna Committee assessed the three models and concluded that the Co-Regulatory Model was appropriate for India as its varying levels of government involvement and industry participation can be molded to the Indian context. The Command and Control Model, also known as the Comprehensive Model,[2] includes a general law that regulates the collection, use and dissemination of personal information in the private and public sectors, governed by an oversight body.

In addition, the White Paper proposed seven salient features for a conceptual foundation for a Privacy Act for India, which the Supreme Court case file reiterates: Technology Agnosticism, Holistic Application, Informed Consent, Data Minimization, Controller Accountability, Structured Enforcement and Deterrent Penalties. The data collectors, holders, and users are responsible for protecting the privacy of data subjects. Drawing from particularly the EUDPD and OECD Guidelines, the Expert Group provides a comprehensive set of principles and foundational elements to construct an exhaustive framework that protects personal privacy especially in the context of government collection of personal data. The principles include guidelines on Notice of Data Use, Choice and Consent, Collection Limitation, Purpose Limitation, Access and Correction, Notice of Disclosure of Information, Security, Openness/Transparency of Data Use, and Accountability.

On July 27, 2018, the Srikrishna Committee submitted a draft Personal Data Protection Bill[7] to the Government of India. We outline some of the Act's key points. The Act gives data principals - citizens who provide personal or sensitive data - control of their own data. Data fiduciaries - the entity who determines the purpose and means of processing data - must be transparent about their data processing methods and must give clear notice to the data principals on how their information is being used. The Act criminalizes the unauthorized use, sale, or transfer of sensitive personal information. In accordance with the co-regulatory privacy model, the Act establishes the Data Protection Authority of India. The Authority will set codes of practice, maintain a database of significant data fiduciaries, and monitor and enforce privacy laws with the power to conduct inquiries.

The Authority will also oversee data impact assessments and data audits. Each data fiduciary must hire a Data Protection Officer (DPO) who is fluent with the data protection policies and can act as an intermediary between data principals and data fiduciaries. A DPO will also carry out data protection impact assessments when its data fiduciary is planning on processing data with new technology or doing large scale profiling using sensitive personal data. Major data fiduciaries must undergo annual data audits by Authority-recognized independent data auditors. The auditors will assign a rating in the form of a data trust score; however, the technical details of how this trust score is derived are not specified. While our study was not designed to develop a methodology for calculating a data trust score, our Information Privacy Index (IPI), discussed in Section 5 presents a possible first approach to that metric.

3.3 Prior Work on Efficiency and Privacy in Data-driven Urban Governance

Our previous paper [13] on this subject set the stage for the work reported here. That paper provided an initial examination of the juxtaposition of two inflection points, the first being to move various aspects of Indian life into the digital age, with a focus on the digitization of urban local body (ULB) governance, and the second being the Supreme Court bench decision that privacy is an Indian constitutional right. In that context, the question addressed in that paper was:

> *How can ULBs (a state actor) use citizen data to maximize governance while protecting the citizens fundamental right to privacy?*

A further extension to this question addressed in the paper was to consider how the limitation of citizen data might affect governance efficiency and privacy. It was this last formulation of the question that led to the data

collection and analysis presented in that paper. An important note here is that in the process of collecting and analyzing data in order to address this question, additional interesting observations emerged. Thus there was value in both the directed results of the data collection and in the ancillary observations, derived from the data.

The context in which we began this study was to work with the eGovernments Foundation, which is providing a large suite of tools for municipal digitization across a number of states in India. Although each ULB decides and operates independently, there are significant state-wide consistencies. We observed that ULBs fall into three population categories, those under 100,000, those up to one million, and those above one million. For this study we consider three ULBs, two in the mid-size and one large, all within one state.

As shown in Figure 18, cities in India offer a number of different citizen services. For this study we focused on three different service modules: Water Tap Charges (WT), Property Tax (PT), and Public Grievance Redressal (PGR). The data that we could collect at the time consisted of the work flow charts our three modules, the division of labor for subtasks within the module among functionaries, the full set of data items collected for each module and the use of particular data fields by individual functionaries in order to complete their tasks.

To a large extent the paper provided a careful analysis of the fragility of data collection in three categories: (1) data minimization and the costs that may incur, (2) the loss of data integrity and its impacts on both individuals personally and the functional and financial implications, (3) data disclosure and the implications for, again, privacy and the functional and social implications. The paper also includes a lengthy discussion of risks to the individual both in the context of a single database and especially cross-database implications.

The aspect of the paper that we build upon in the sections to follow is this: the paper concluded with the definition two indices. The first proposed metric was the Governance Efficiency Index (GEI):

*Governance Efficiency Index (GEI) = Timeliness of Service * Accuracy of Service*

Timeliness must be determined by a combination of the expected service level agreement (SLA) value and actual completion times. Accuracy of Service reflects whether or not a task incurred a resubmission after completion. This is discussed further below in this paper.

The second proposed metric was the Information Privacy Index:

*Information Privacy Index (IPI) = Right Collection * Right Use * Right Disclosure*

In this case, Right Collection reflects the degree to which only needed data is collected, Right Use reflects the degree to which functionaries only see those data fields they need to do their jobs, and Right Disclosure reflects the degree to which individuals privacy is not violated by disclosure of the fields.

In theory, both indices can be applied at different levels of granularity ranging from state-wide, to ULB-wide, to module-wide, to the individual functionary performing specific tasks, although computing them was dependent on having access to data such as the service level agreements (SLAs) that defined for each module and task the expected completion time and logs of task execution. In this succeeding paper, we had access to both of these types of data, as we shall elaborate in Section 5 and beyond.

4 The Data and Data Collection

In this section we review the sources of our data, both in terms of use of the current tools for collecting data, through eGov, and our decisions about both site and data type selection. Our key observations are that not all data collected by ULBs for PT, WT, and PGR are necessary for providing these particular services. This discrepancy suggests room for improvement in access controls and therefore personal privacy.

4.1 Department Hierarchy

Administratively, the position of a ULB within the state administrative hierarchy can be understood as follows. The Director of Municipal Administration (DMA), who provides state level oversight for support services in the municipalities, manages the Additional Director, Joint Directors, and Assistant Directors who oversee various aspects of all municipalities. Then, each municipal corporation houses a commissioner who, with the ULB mayor, provides administration and governance of the operations of each district. Each ULB is assigned a commissioner depending on which district it resides in. The Commissioner defines access controls for employees and can monitor employee performance. Within every ULB, there exist the Administration,

Revenue, Accounts, Public Health and Sanitation, Engineering, Town Planning and Poverty Alleviation departments. Each department is responsible for processing certain modules classified under Expenditure and Revenue. All departments, however, are responsible for the Public Grievance Redressal module depending on factors discussed in the next section below. See Figure 17.

4.2 e-Governments Foundation, Current Installations, Digital Services

The eGovernments Foundation (eGov) develops digital platforms that enable ULB and state governments to improve accountability, transparency, and efficiency for the delivery of citizen services and accounting and organization within the government. The eGov platform is designed to aid in the management of four categories of government information: administration, revenue, expenditure, and citizen services. See Figure 18. While administration and expenditure modules account for employee management, legal case management, payroll and pensions, assets, and so on, revenue and citizen service modules mainly include tax evaluations and registrations filed by citizens. Revenue sources include collection of property tax, water tax, trade licenses, advertisement tax and fees from government land and estates while citizen services include birth and death registrations, marriage registrations, an online citizen portal, public grievance redressals, and building plan approvals.

The platform allows municipal officials to enter information and view individual and cumulative data on quantitative and geo-spatial dashboards. The digital actions of each employee are logged in order to monitor performance and accountability. It also promotes citizen engagement by interfacing with an online citizen portal and mobile app where people can submit and view the status of their applications and registration, improving transparency and accessibility. EGovs clients include but are not limited to the state of Andhra Pradesh, the state of Punjab, the Greater Chennai Corporation, and the state of Maharashtra.

4.3 Functioning of the Selected Service Modules

As mentioned above, the Property Tax Module (PT), Water Tap Charges Module (WT), and Public Grievance Redressal Module (PGR) were chosen for this study based on volume of data, accessibility and prevalence. These modules were among the first to be implemented at our site in 2016. As a result, the volume of transactions for each of the modules exceeds 100,000 in 2018. This combination also lets us consider various different types of potential revelation of citizens personal information. We will examine the nature of this information in further detail in the next few sections.

The Property Tax (PT) and Water Tap Charges (WT)modules offer various services. For example, in the Water Tap Charges Module, citizens can apply for New Connection, Re-Connection, Closure of Connection, and so on. For both modules, the New Property Tax assessment and New Water Tap Connection applications and workflows are fairly representative of, and the most comprehensive in terms of, collected data fields of all of the services in their respective modules. As such, we refer to the new property tax assessment and new water connection workflows as the generalized Property Tax Module and the Water Tap Charges Module, respectively.

New Property Tax Assessment The Property Tax Module includes services to evaluate property tax or change property tax. While the representative service is New Property Tax Assessment (PT), the module also includes services like Transfer of Title, Bifurcation, Addition/Alterations, Revision Petitions, Demolitions, and so on. The module requires the applicant to give owner details, property address details, assessment details, amenities, construction details, floor details, details of surrounding boundaries of the properties, court documents, and vacant land details if applicable.

*New Water Tap Connection*The Water Tax module, which the Engineering department manages, includes services to evaluate or change water tax payments. In our study, we analyze applications for New Water Tap Connection (WT), as this service fairly representative of, and the most comprehensive in terms of, collected data fields of all of the services in the Water Tap Charges Module. Other services in the module include Change of Usage, Closure of Connection, Re-connection Service, and Additional Water Tap Connection. Similar to the PT module, application particulars are necessary as well for verification.

*Public Grievance Redressal*The Public Grievance Redressal Module allows citizens to submit a complaint to the municipality about sanitation issues, stray animals, illegal businesses, non-functioning of street lights, concerns regarding schools, voter lists, and so on. Each complaint is mapped to an internal department and an official in that department. Once the complaint is submitted and reaches an official in the relevant department, the official has an SLA for that concern by which he must address the issue. If an official does not address

the concern within the given SLA, then the task will be escalated to the next level in the hierarchy. This accountability model promotes transparency and improves efficiency. A comprehensive list of complaint types and corresponding SLAs are outlined by the state, as shown in Figure 19 in the Appendix.

4.4 Three Levels of Data Available for Analysis

Three levels of "data windows" available to us have enabled the construction and application of GEI and IPI in this study. Our previous work presented two of these data windows: *Workflows* that provide the understanding of how a service request flows through the ULB, and *Binary Matrix* that provides the next level of granularity on how functionaries interact with each data element of a service request. In this paper, we add a third, and even more granular, data window of *2018 Citizen Transaction Data*, journaling the actions taken at each step of completing each citizen transaction including timestamps, that has allowed us to take a significant step forward in addressing our core question of improvable performance. We have transaction data for all of the services requested by the citizens of one whole state consisting of 112 ULBS for the year 2018.

4.4.1 Workflows

For each of the modules, we gathered data and information in three parts. To understand the workflow, we first interviewed eGov's team for the state as well as state officials on the workflow of each module. Each of the three selected modules have their own workflow. Once a citizen submits a form or a request, all of the information that they have submitted is passed through various levels of hierarchy in the appropriate department within a certain number of days. These number of days, called Service Level Agreements or SLAs, are unique to the Indian state where we carried out our site visits. If an official does not complete his task within the given SLA, then the task will be escalated to the next level in the hierarchy. This accountability model promotes transparency and improves efficiency. We developed an understanding of how the data collected from a citizen is used and passed through a department to provide a particular service and how long it takes to do so in comparison to the SLA for that service. This information is important in detecting possible efficiency and privacy trade-offs while providing a service.

New Property Tax Assessment The quantitative evaluation of property tax payment depends on Usage, Classification, Zone, Age, and Occupancy Type data fields. Application particulars, such as contact details and address are important in verifying personal identity and assets. Once a citizen submits an evaluation request, the data is verified by a Junior Senior Assistant, then sent to a Bill Collector and Revenue Inspector who verify details and conduct site visits. A revenue officer validates the evaluation, at which point the application must be approved at the Commissioner Level in order to be completed. In smaller ULBs, two or more of these functions may be completed by the same official. In larger ULBs, the process may be less uniform so that work is spread across multiple officials in the same level of hierarchy. The workflow for processing a property tax assessment application is described in Figure 20.[4] All data is first collected from the citizen through an online portal, the Citizen Service Center's (CSC) physical location, or the state's online app. Along the rows we see the various functionaries including Jr./Sr. Assistant, Bill Collector, Revenue Inspector, Revenue Officer, and Commissioner. The green boxes describe the tasks each functionary is responsible for, and the arrows indicate the order of operations.

New Water Tap Assessment The fields that are essential for the evaluation of water tax are Zone, Uses Type, Water Source, Pipe Size and where it is applicable the White Ration Card. If the resident holds a White Ration Card, that means they are eligible for subsidies. In that case, the name and address become important for verification purposes, and that the person holding the white ration card is the one living at the property. The Property Assessment ID must also be provided in the application, where all of the information from that Property Tax (PT) assessment is available to the officials in the Water Tap Charges workflow. The workflow generally looks similar to the PT module, where a Junior/Senior Assistant verifies application details, Assistant Engineer does a field verification and feasibility testing, Deputy Executive Engineer/Executive Engineer/Superintendent Engineer scrutiny the estimation details, and the Commissioner approves the evaluation. Figure 23 reflects this.

Public Grievance Redressal The workflow and escalation of tasks depends on the complaint and the department to which the complaint is assigned. Unlike Property Tax and Water Tap Charges, each PGR complaint can be addressed and completed by one functionary. The module maps to a municipal administration department depending on the type of grievance submitted. This module requires the citizen to input contact details of the citizen and grievance details including the location of the grievance and photos of the complaint if relevant. Depending on the type and geographical area of the complaint, the back-end maps the complaint to

a functionary. If the functionary exceeds the SLA for that complaint, then the complaint will escalate to his superior according to the escalation hierarchy shown in Figure 26.

4.4.2 Binary Matrix

The second type of data we needed was a matrix of how each data field for each service is used. We conducted on-site interviews with service functionaries, the state employees that complete certain tasks in the service workflows. During the interviews, a functionary from each level of the workflow was asked to identify the data fields that they were given access to as well as the data fields that they needed to complete their task in the workflow, and the data fields that were not necessary to complete their task but useful to have access to. During the interviews, we built this Necessary Data Matrix (NDM) to structure this data. The rows contain the data fields collected for a particular service and the columns contain the name of each functionary in the workflow and their tasks. In the NDM, cells are filled with "1" if a particular functionary uses a particular data field to complete his task, or "0" otherwise.

The state has guidelines on how each service is performed or how the outcome of each service is determined. For services like WT and PT, there is a master sheet that is filled with relevant information, which then calculates the respective tax assessment. The data fields collected and service workflows are the same across all ULBs. The master sheet is also identical across all ULBs. In smaller ULBs, one functionary may be responsible for several tasks that are spread out across multiple functionaries in larger ULBs. Although these small variations in responsibilities exists, we assume the tasks performed, data access, and data use are uniform.

See Figures 21, 24, and 27 in the Appendix for the NDMs for the selected service modules.

4.4.3 2018 Citizen Transaction Data

The final source of data includes the 2018 data collected by the state through eGov's modules. With the permission of eGov and our partner state, we were given access to the data collected by all New Water Tap Connection applications, New Property Tax Assessment applications, and Public Grievance Redressals in 2018 for all 112 ULBs. The Data includes all data fields collected by these services as well as details of the workflow transition for each application. The workflow transition documentation includes when a particular application was received by a functionary, the time it took for the functionary to complete his task, the functionary's comments, and the state-mandated completion deadline for the application. Such granular data on the movement of applications through workflows was extremely important for our results and analysis.

New Property Tax Assessment We were given access to all New Property Tax Assessment data from 2018. In 2018, 201,458 applications were processed, which overall went through 931,393 workflow transitions. As of the beginning of 2019, the state has processed 366,711 applications which has undergone 1,986,969 transitions in total. The fields which were collected and their descriptions are shown in Figure 22 in the Appendix.

New Water Tap Connection In 2018, 101,849 New Water Tap Connection applications were processed, which overall went through 747,521 workflow transitions. As of the beginning of 2019, the state has processed 160,809 applications which has undergone 1,192,056 transitions in total.[4] The fields which were collected and their descriptions are shown in Figure 25 in the Appendix.

Public Grievance Redressal In 2018, 135,242 PGR submissions were processed, which overall went through 654,418 workflow transitions. As of the beginning of 2019, the state has processed 265,192 submissions which has undergone 1,307,552 transitions in total.[4] The fields which were collected and their descriptions are shown in Figure 28 in the Appendix. PGR has not yet been implemented for all departments for all ULBs. In the eGov data we received, ULBs had a non-trivial number of transactions for the Revenue Department, Administration Department, Town Planning Department, and Urban Poverty Alleviation Department. In this study we analyze complaints from only these four departments.

5 Formulation of GEI and IPI

In this Section, we define the parameters required to calculate the Government Efficiency Index (GEI) and the Information Privacy Index (IPI). While we discuss calculating GEI and IPI at the level of the service, note that these indices can be calculated at the level of a functionary and at the level of an entity as well. The parameters are constructed such that their definitions are applicable at multiple levels of granularity.

5.1 GEI

The Government Efficiency Index (GEI) is defined as the product of timeliness and accuracy parameters for a give service or entity, as discussed in Section 3.3. GEI is constructed such that it ranges from 0-1, where a value of 1 denotes highest level of governance efficiency.

5.1.1 Timeliness of Service

The definition of *Timeliness of Service* rests upon when a service is considered timely. We consider a service timely when it is delivered on or before the desired Service Level Agreement (SLA). The ULBs in India publish an SLA for each service they offer, as promised by the Citizen's Charter. [3][1] The *Timeliness of Service* component is measured as follows: for a given service, it is the fraction of times the service is delivered on or before the SLA over a given unit of time (i.e., hour, day, month, etc.). For a given group (a division within ULB, the ULB as a whole), Timeliness of Service is measured by averaging the timeliness of the services delivered by the group over a given unit of time.

Timeliness can be computed at the level of a functionary, given service, or for all services offered by an entity (e.g., all services of a division within ULB, all services of the ULB, all services of the ULBs in a given block, all services of ULBs in a given state, etc.) Accordingly, the equations for it come in three flavors.

Each functionary's timeliness can be described by the proportion of tasks that the functionary has completed within the task's SLA as prescribed by the state's SLA guidebook, the Puraseva User Manual. A functionary is usually responsible for one task, although some functionaries are responsible for more depending on the number of steps in the workflow of a service for a particular ULB. Depending on geography, number of human resources, and citizen application, the workflow length may vary. Given the exact workflow of a service for a ULB, the timeliness at the level of the functionary can be calculated.

In this paper, however, we analyze ULBs at the service level, as we do not have complete information on the number of steps for each workflow in each ULB. This level of calculation allows for fairer comparison between ULBs. The timeliness of a service is described by the proportion of instances the service was completed by the SLA for that service. We can calculate this by dividing the number of timely instances divided by the total number of instances for a given service. Suppose set s_i consists of the durations of each instance that the service i was completed:

We can denote the timeliness of a service i with:

$$t_s = \frac{\|\{s_i | s_i \leq SLA_{s_i}\}\|}{\|s_i\|} \tag{1}$$

5.1.2 Accuracy of Service

The definition of *Accuracy of Service* rests upon when a service is considered accurate. We consider a service accurate when right service is delivered to the right person without any rework. The *Accuracy of Service* component is measured as follows: for a given service, it is measured by the fraction of times the service is delivered without rework over a given unit of time (i.e., hour, day, month, etc.). For a given group (a division within ULB, the ULB as a whole), Accuracy of Service is measured by averaging the accuracy of the services delivered by the group over a given unit of time.

Accuracy of a service can be delivered at the level of a service or an entity as previously described.

The accuracy of a service at the service level can be computed by dividing the total number of times the service was accurately comleted divided by the total number of times the service was completed. The number of services completed accurately is equal to the number of times the services was completed n minus the number of times the completed service was petitioned by the citizen and resulted in a change. A proxy for this latter value is the number of Revision Petitions r that resulted in a change in some service. So for a given service s we can calculate the accuracy of the service at the service level as follows:

$$a_s = 1 - \frac{r}{n} \tag{2}$$

[1] Not all ULBs provide such SLAs.

5.2 IPI

IPI is constructed such that it ranges from 0-1, where a value of 1 denotes highest level of information privacy.

We define *Right Collection* as collection of those data fields that are necessary for delivering the service. In other words, without collecting these data fields, the requested service cannot be delivered. *Right Collection* is measured for a given service or for services offered by a given group as *Necessary Data Fields/Total Data Fields Collected*.

We define *Right Use* as access of data fields to only those (in the ULB) who need it for delivering the service. *Right Use* is measured for a given service or for services offered by a given group as *Number of Data Field To Which Access Is Necessary / Number of Data Fields To Which Access Is Granted*.

We define *Right Disclosure* as public disclosure data fields that protects personal identity and undesirable inference. *Right Disclosure* is measured for a given service or for services offered by a given group as *(1 - (Number of Data fields With PII or Undesirable Inference Disclosed / Total Number of Fields with PII or Undesirable Inference))*.

IPI is determined based on the analysis of data collection, use, and disclosure policies of ULBs. The real-time value of IPI will rest upon the frequency and types of service requests a ULB serves.

5.2.1 Right Collection

The extent of right collection is determined by calculating the proportion of the collected data fields that are actually necessary for the completion of the task or service. Since each task has specific data that it requires to be completed, we can compute right collection at the task level as opposed to the functionary level. In this paper, we compute right collection at the service level, though it can be computed at the entity level as well.

5.2.2 Right Use

The right use index measures the extent to which access of data fields is given only to those (in the ULB) who need it for delivering the service. The right use parameter for each task is given by the dividing the number of fields necessary to complete a given task by the total number of fields a functionary completing that task is given access to. The right use parameter for a service is the average right use value across all tasks required to complete that service. Ideally, a functionary should only have access to the fields that are required for him to complete a given task, yielding a right use index of 1.

5.2.3 Right Disclosure

The right disclosure index should describe how protected personal identity and undesirable inferences are against public disclosure. This parameter is defined as the proportion of fields that are considered PII that are not open at each level. In our case study, home address and mobile phone number are considered PII, as defined by eGov.

At the functionary level, right disclosure is calculated by the Proxy: $1 -$ (Data fields With PII or Undesirable Inference Publicly Disclosed/Total Fields with PII or Undesirable Inference). For a given service, the right disclosure parameter will be the same across all functionaries; data fields disclosed publicly are obviously accessible by functionaries as well.

6 Analysis and Results

This section uses GEI and IPI separately as the basis for analysis based on services and ULB Tiers. To that, it considers each element of each of these metrics, before reviewing the composition. of them. It then focuses on the model ULB concept in Section 6.3, using the two indices as the basis for that.[2]

6.1 GEI

In this Section, we explore the distribution of timeliness and accuracy values for New Property Tax Assessment, New Water Tap Connection, and Public Grievance Redressal across all ULBs. We often group ULBs by tier as the varying volume of transactions and resources could affect GEI. We determine top-performing

[2]See [10] for additional details, analyses, and observations.

ULBs according to GEI, and argue that since there are ULBs within each tier that have consistently high GEI, then other ULBs within each tier can also improve their efficiency. We identify these top performers as "Model ULBs."

6.1.1 Timeliness and Adjusted Timeliness

We assess timeliness through several lenses. First, we observe the distribution of timeliness across all ULBs. We calculate adjusted timeliness values and weighted impact of timeliness across all three tiers of ULBs for New Property Tax Assessment (PT), New Water Tap Connection (WT), and Public Grievance Redressal(PGR). For PT and WT, we identify model ULBs by tier based on the adjusted timeliness values and quality workflow transparency. Identifying top-performing ULBs is important in later determining why these ULBs in particular are able to maintain high levels of efficiency and perhaps even privacy. For PGR, we observe timeliness values at various levels. Second, we analyze the distribution of timeliness values across all ULBs by department. Third, we observe which ULBs perform well in which departments. Overall, we determine model ULBs primarily by timeliness values across all departments and secondarily by the average difference between SLA and the days it took to complete the set or subset of requests.

Adjusted timeliness gives a more accurate measure of timeliness as opposed to perceived timeliness. Perceived timeliness is calculated as previously described. Application duration is defined as the difference in timestamps from the application entry until the acceptance/denial of the application. Perceived timeliness is the proportion of applications where the application durations are less than their respective SLAs. However, when observing the distribution of the task durations, we observe that a non-trivial number of applications have unrealistic application durations. Some applications were recorded as having been completed in less than one or two days. Others show entry and approval within seconds. We assume that these applications were received manually, proceeded through the workflow, and were accepted or denied manually. After the completion of the workflow, these applications were likely then entered into the ERP system. Subsequently, technical aids or administrators enter, digitally approve, and pass on the application according to all steps of the workflow within a day. Applications digitally logged to have been completed in less than 1 day are likely to have been recorded in this inaccurate manner. Inaccurate application durations can significantly improve a ULBs timeliness value, leading to incorrect identification of model ULBs.

To normalize for inaccurate recordings, we calculate and compare an adjusted timeliness parameter. For each service, the adjusted timeliness is calculated by ignoring applications that have application durations of less than a day, and re-calculating timeliness as described in Section 5.1.1 with the remaining applications. Adjusted timeliness is calculated as follows:

$$t_{adj} = \frac{\|\{s_i|(s_i \leq SLA_s) \wedge (s_i \geq 1\}\|}{\|\{s_i|s_i \geq 1\}\|} \tag{3}$$

Adjusted timeliness gives a more accurate measure of how timely applications are completed. It also allows for a fairer comparison between ULBs, penalizing ULBs that record large numbers of inaccurate application durations.

6.1.2 Timeliness Results

New Property Tax Assessment Overall, we observe a modal distribution of adjusted timeliness values across all tiers, centered around 0.55 to 0.60. While a 55% timely service rate is not poor, we see examples of ULBs in all tiers that have reached 90% - 100% timely service rates. Consequently, we determine that it is possible to optimize timeliness across all ULBs.

We would expect to see that as the volume of applications that a ULB has to handle increases, that efficiency would be compromised due to limits on resources. However, within each tier of ULBs we observe ULBs with high adjusted timeliness values. We observe no obvious correlation between population or volume of applications and adjusted timeliness, having R^2 coefficient values of 0.0049 and 0.0045 respectively. In Figure 1, we describe the distribution of adjusted timeliness by tiers. Tier 1 ULBs have on average lower timeliness values in comparison to the other tiers, as can be expected. Even if the volume of applications received does not affect timeliness, there could be other factors that lead to more Tier 1 ULBs being less efficient. Human and time resources do not grow proportionately with volume of applications, and the organizational complexity of larger municipalities could further affect timeliness.

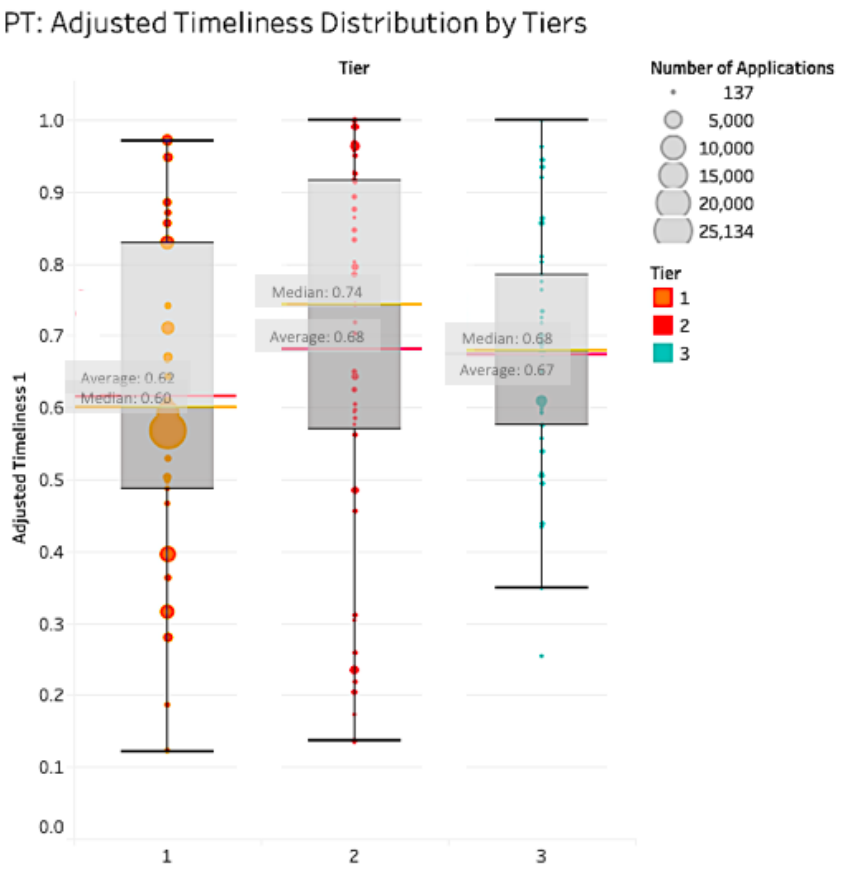


Figure 1: Distribution of Adjusted Timeliness for PT by Tier: These boxplots separated by tier describe the distribution of adjusted timeliness values. Each marker, representing a ULB, has size proportional to the volume of applications received by that ULB. The pink reference lines indicate the average t_{adj} for the corresponding tiers. The yellow line indicates the median t_{adj} for the corresponding tiers

New Water Tap Connection We would expect to see that as the volume of applications that a ULB has to handle increases, that efficiency would be compromised due to limits on resources. However, within each tier of ULBs we observe ULBs with high adjusted timeliness values. We observe no obvious correlation between population or volume of applications and adjusted timeliness, both having R^2 coefficient values of 0. There is a very slight negative correlation between volume and adjusted timeliness for Tier 1. As volume increases, timeliness has a very slight decrease. Overall however, there are ULBs that are able to perform well despite volume. In Figure **??**, we describe the distribution of adjusted timeliness by tiers. Tier 3 timeliness values are shifted slightly to the right, but in general, all tiers have a spread of timeliness. The histogram is unimodal, with the peak at the 0.65 to 0.70 bin. In comparison to PT, WT has higher timeliness in general.

Tiers 1, 2, and 3 have an average timeliness of 0.517, 0.508, and 0.559 respectively. All tiers have similar timeliness, where the Tier 3 average and median are slightly higher than those for Tier 1 and Tier 2. Tier 3 has a maximum spread of timeliness values, ranging from 0 to 1.0. ULBs in Tier 3 receive fairly small volumes of applications and yet have a wide range of timeliness. Workflows are likely not different, but further studies should be completed to understand what differences with municipalities leads to the spread of timeliness. Additionally, we can see here that large Tier 1 ULBs with large volumes of applications seem to have lower timeliness.

PGR We analyze PGR timeliness from a couple of different dimensions.

- Which departments of which ULBs consistently provide timely service?

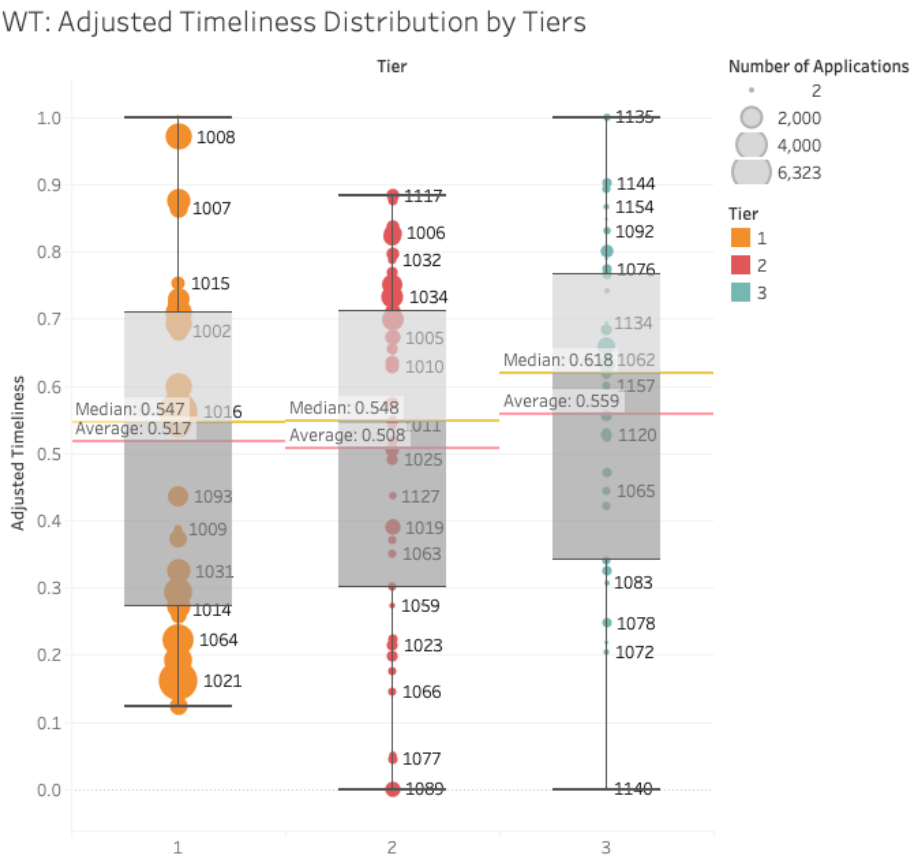


Figure 2: Distribution of Adjusted Timeliness for WT by Tier: These boxplots separated by tier describe the distribution of adjusted timeliness values. Each marker, representing a ULB, has size proportional to the volume of applications received by that ULB. The pink reference lines indicate the average t_{adj} for the corresponding tiers. The yellow line indicates the median t_{adj} for the corresponding tiers.

- Which complaints consistently require more time than the given SLA across all ULBs?

Unlike PT and WT, public grievances can only be submitted digitally. As soon as a complaint is submitted by the citizen, it enters into the workflow and all its information, including time of submission, is recorded. As a result, we do not need to normalize the data for inaccurate application durations. Timeliness at the ULB level or department level can be computed directly. See Figures 3 and 29 in the Appendix for a full table of results.

We observe distribution of timeliness by Tier as well (Figure 4). It is easy to identify the top performing ULBs in each tier for each department. As can be expected, Tier 1 ULBs process significantly more requests than Tier 2 or Tier 3 ULBs. Tier 1 ULBs perform much worse when it comes to complaints in the administration department. By breaking down the department timeliness by complaint, one can detect exactly which complaints are leading the drop in timeliness by Tier 1 ULBs. As seen in Figure 15b, Tier 1 ULBs are particularly less timely regarding "Complaints regarding schools" and "Inclusion, Detection of Correction in Voter List" than the average Tier 2 or Tier 3 ULB. As in Figure 15c one can then further break down the complaints by ULB to determine which ULBs in Tier 1 are able to redress the specific complaint in a timely manner.

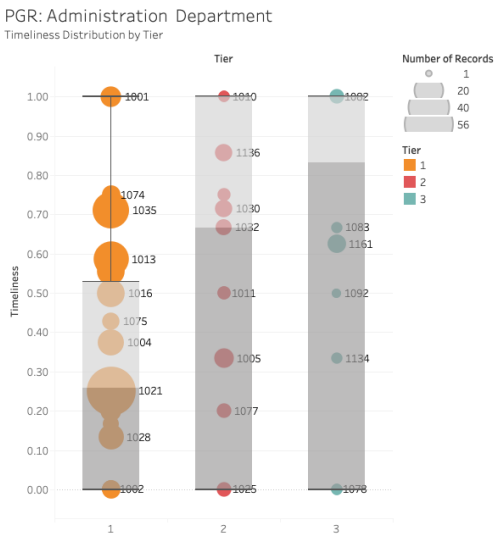
6.1.3 Accuracy

Currently there is no easy way to determine how accurately a PT or WT application or a public grievance has been processed in the ERP system. A citizen can re-open a previous complaint if he is not satisfied with the redressal. However, it is difficult to automate the process of determining whether the complaint is subsequently closed due to the ULB not properly addressing the complaint or determined to be an unreasonable request. Similarly, citizens can file a revision petition for WT and PT if they believe that their property tax

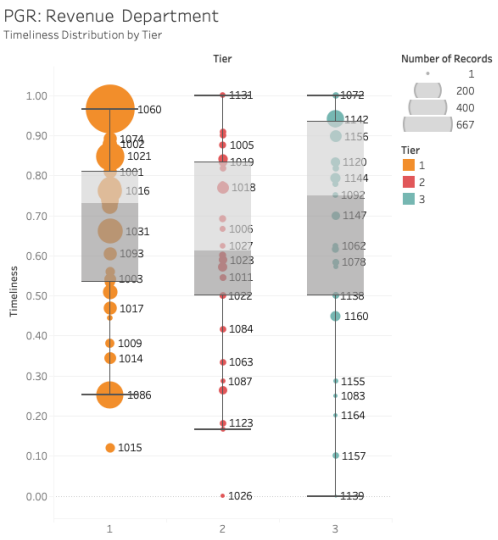
PGR: Timeliness by Tier and Complaint

Department	Complaint	Tier 1	Tier 2	Tier 3
Administration	Complaints regarding Schools	0.28	0.39	0.60
	Complaints regarding Voter list	0.46	0.52	0.62
	Inclusion, delection of correction in the Voter list	0.48	0.71	0.62
	pay fixation promotion scale	0.50		
	RTI act	0.00		
Revenue	Complaints related to issue of all types of license	0.72	0.70	0.70
	Complaints related to property tax	0.75	0.58	0.70
	Demand Extract	1.00		
	Double Assessments	0.69	0.59	0.68
	Errors in demand Notice	0.78	0.79	0.86
	Improper Sweeping	0.80		
	Issues relating to Vacant lands	0.50		
	New Property Tax Fixation	0.68	0.76	0.85
	New Vacant Land tax Fixation	0.57	0.80	0.83
	Property Tax Bifurcation	0.60	0.67	0.80
	Revision Petition on Property Tax	0.89	0.78	0.91
	solvency	0.00		
	Transfer of Title of property	0.59	0.59	0.87
	Vacancy Remission	0.92	0.00	
Town Planning	Encroachment on the public property	0.40	0.23	0.36
	Issues relating to Advertisement Boards	0.54	0.37	0.83
	Misuse of Community Hall	0.23	0.44	0.00
	Over head cable Wires running in Hapazard manner	0.16	0.33	0.00
	Parking Issue	0.32	0.16	0.38
	property survey	0.00		
	Removal of Debris	0.00		
	Removal of shops in the footpath	0.50	0.39	0.25
	Unauthorised / Illegal construction	0.63	0.61	0.65
	Unauthorised Advt. Boards	0.43	0.45	0.75
	Violation of DCR/Building bye laws	0.63	0.70	0.66
UPA	Complaints regarding all Sanctioned loans	0.59	0.61	0.68
	Disputes in SSG / SLF / TLF	0.54	0.82	0.57
	Non Receipt of Pensions (Disabled/ Old age/ Wido..	0.55	0.30	0.23
	Non Sanction of Bank Linkage to the group	0.54	0.50	0.00
	Provision of Placement after Training under ESTP	0.30	1.00	1.00
	Sanction of Gas Connection Under Deepam Scheme	0.69	0.60	0.55
	Vaddi Leni Runalu	0.17	0.50	

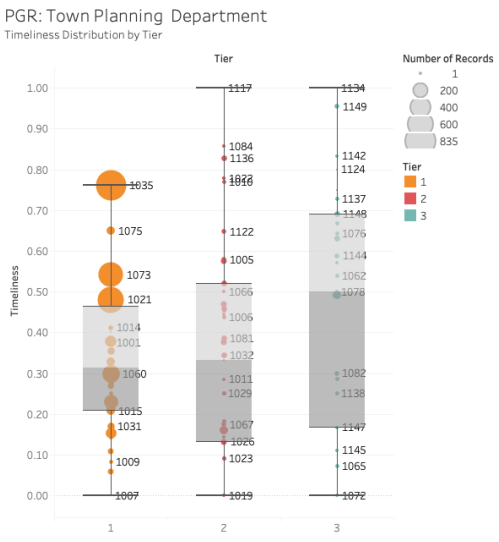
Figure 3: Average Timeliness across Tiers by PGR Department



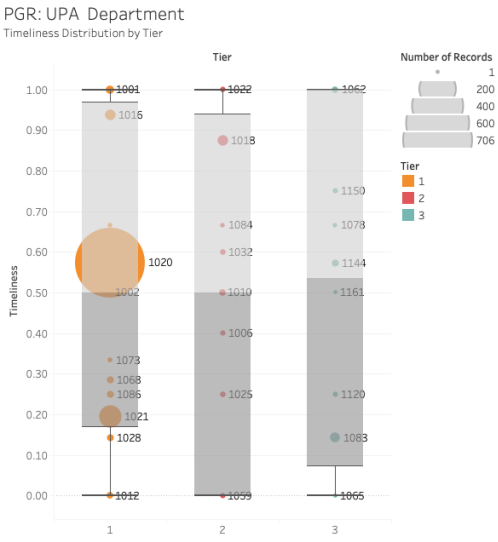
(a) Administration



(b) Revenue



(c) Town Planning



(d) UPA

Figure 4: PGR Timeliness by Department of Complaint and Tier

of water charges determination is incorrect. The assessment may initially be wrong due to a mistake on the part of the ULB for multiple reasons. Functionaries could have inputted wrong values in the master sheet that calculates charges. If the municipality accepts the revision petition, the citizen's property assessment or water charges tax may be affected. Even after approval however, the revision petition can be withdrawn.

An accuracy range for each service can be calculated. The minimum accuracy of a service is the proportion of applications that were either never challenged or if challenged were not approved by the municipality. It is technically possible that all applications were assessed or addressed accurately, making the maximum accuracy parameter 1.0. However, a range of possible values is not necessarily helpful in comparing GEI between ULBs.

Due to the complexity of accurately evaluating accuracy, this study did not account for accurate accuracy values to compare GEI between ULBS. We assigned the accuracy parameter a value of 1 for all ULBs and services. Further work and on-site visits should be completed to understand how to go about calculating this parameter.

6.1.4 Maximization of GEI

As seen in Figure 1, Figure 2, and Figure 4, there exist high-performing ULBs across all tiers. Despite similar volumes of applications, these model ULBs are able to maintain high timeliness values. The methodology for identifying model ULBs is detailed in Section 6.3.1. Factors affecting GEI may include the number of functionaries allotted to each municipal department, zoning patterns, adoption rate of use of the citizen portal, demographics, and so on. By studying the top-performing ULBs, one can dissect the causes of high timelines. Policymakers or municipal administrators can make the necessary changes to policy, organizational structures, or workflows accordingly to maximize GEI. While ULBs may never reach a GEI of 1.0, the average timeliness of all ULBs for each service can improve.

6.2 IPI

Using the workflows and NDM matrices, we calculated the right use, right collection, and right disclosure parameters at the level of the functionary, service, and ULB. In this section, we will explain how each parameter was calculated and discuss the resulting values. A point to note about these parameters is that at the ULB level, they are the same across all ULBs. In the state we studied, every ULB collected the same data for each service. All ULBs follow similar workflows and evaluate each application or complaint using the same criteria outlined by the state government.

6.2.1 Right Collection

The right collection index at the functionary level is calculated by understanding what data is necessary for a given task to be completed and the data collected for that service. Each of the service forms include mandatory data fields and optional data fields. For the purpose of this study, we consider "collected fields" as all of the fields that are requested by a particular service. This includes the mandatory and non-mandatory fields, as the government has the ability to observe all fields.

The right collection parameter at a functionary level by dividing necessary fields by all collected fields for a particular functionary. The number of necessary fields is found by summing the corresponding column of a functionary where a cell is denoted "1" if the field is necessary for completion of a task. All collected fields is the number of fields given in the service form. At the service level, the parameter is found by dividing all fields that are needed by one or more functionary by all collected fields. To calculate the numerator, we run a row-wise "OR" function and sum the resulting values. The denominator remains the same. Accordingly, the results for each of the services are shown in Figure 5, Figure 6, and Figure 7.

As all ULBs have the parameter values, the Right Collection parameter at the ULB level across all three services we analyzed is 0.436.

6.2.2 Right Use

Like the right collection index, the right use index is calculated from the NDM matrix. At a functionary level, the right use parameter is calculated by dividing the necessary data fields by all data fields that the functionary is given access to. In this particular state, all functionaries are given access to all data that is collected. As a result, the right collection and right use parameters at the functionary level are all the same across all services.

	Junior Asst./Senior Asst.	Bill Collector	Revenue Inspector	Revenue Officer	Asst Comm, Zonal Comm, Additional Comm, Deputy Comm, Commissioner	
	Validate the application details and correct if any; Check for the rejection comments and provide the relevant info; Available for notice print	Field verification - mainly floor details + construction type	Gather the application details and proceed for field verification; Conduct the field verification inline with the application particulars; Validation of BPA documents with the document details uploaded; Approve (DECISION) verifies everything	Validate the RI Comments with the application particulars; Approve (DECISION)	Scrutiny the RI and RO comments with the application details; Approve (DECISION); Approve and digitally sign - check at random, sign all, whoever has approving authority	Across all Functionaries
Necessary Fields	10	10	10	10	10	10
Total Collected	25	25	25	25	25	25
Right Collection Index	0.4	0.4	0.4	0.4	0.4	0.4

Figure 5: New Water Tap Connection Right Collection Parameters: The functionary level parameters are displayed under the columns of each functionary, while the parameter at the service level is displayed in the right most column.

	Junior Asst./Senior Asst.	Bill Collector	Revenue Inspector	Revenue Officer	Asst Comm, Zonal Comm, Additional Comm, Deputy Comm, Commissioner	
	Validate the application details and correct if any; Check for the rejection comments and provide the relevant info; Available for notice print	Field verification - mainly floor details + construction type	Gather the application details and proceed for field verification; Conduct the field verification inline with the application particulars; Validation of BPA documents with the document details uploaded; Approve (DECISION) verifies everything	Validate the RI Comments with the application particulars; Approve (DECISION)	Scrutiny the RI and RO comments with the application details; Approve (DECISION); Approve and digitally sign - check at random, sign all, whoever has approving authority	Across all Functionaries
Necessary Fields	42	44	44	44	44	44
Total Collected	83	83	83	83	83	83
Right Collection Parameter	0.506024096	0.530120482	0.530120482	0.530120482	0.530120482	0.530120482

Figure 6: New Property Tax Assessment Right Collection Parameters: The functionary level parameters are displayed under the columns of each functionary, while the parameter at the service level is displayed in the right most column.

	Help Desk Officer (ULB Official)	GO	ULB Official First Level Escalation	
	Files complaint on behalf of official; Is routing for the complaint filed defined in the system (DECISION)	Receives complaint for which routing is not defined; forwards complaint to the concerned official	Receives the compaint in the inbox; Is the complaint attended within the stipulated time (DECISION); Complaint automatically escalated to the next official; Complaint closed with action taken	Across all Functionaries
Necessary Fields	6	4	6	7
Total Collected	9	9	9	9
Right Collection Parameter	0.666666667	0.444444444	0.666666667	0.777777778

Figure 7: PGR Right Collection Parameters: The functionary level parameters are displayed under the columns of each functionary, while the parameter at the service level is displayed in the right most column.

	New Property Tax Assessment	New Water Tap Connection	Public Grievance Redressal
Right Collection	0.53	0.4	0.778
Right Use	0.525301205	0.4	0.592592593
Right Disclosure	1	1	0.5
IPI	0.278409639	0.16	0.230518519

Figure 8: IPI Calculation for All ULBs

Right use at the service level, however, is calculated by taking the average of the right use indices across all functionaries (See Figure 8). The ULB level right use parameter is similarly the average across all services.

6.2.3 Right Disclosure

The right disclosure values at the functionary level will be the same as that at the service level, as described in 5.2.3. Across all information collected across all services, we consider Mobile Phone number and home address as PII. We chose these specifically because our collaborators specified these as the targets for anonymization in the provided data. Accordingly, the right disclosure parameter has been calculated. At the ULB level, the right disclosure value is the average of the right disclosure values across all services.

6.2.4 Maximization of IPI

None of the ULBs we analyzed currently had an IPI value of 1. However, the three parameters that determine IPI - Right Use, Right Collection, and Right Disclosure - can be theoretically maximized with minimal affects on efficiency. Consequently, we argue that ULBs can attain the maximal IPI value of 1.

Right Collection Maximization
The Right Collection of a service is the number of data fields that are required by a ULB to provide a service divided by the total number of fields. From Figures 5, 6, and 7, we observe that there is room for improvement. Before e-governance systems were installed, paper forms collected extra information to enable quicker processing in edge cases where that extra information was necessary. When the forms were transcribed to digital systems, the unnecessary data fields were also transcribed. While there may be variations in the necessary data fields between ULBs, each ULB can theoretically collect only the information it deems necessary with modified data entry forms for each service. As a result, each service can achieve a right collection value of 1.

Right Use Maximization
The Right Use for a service is the average proportion of data fields each municipal actor needs to complete his role for all actors in a given service. Currently, all municipal actors have access to all data fields. Instead, a ULB can theoretically impose restricted access controls where an actor is only given access to the data fields he needs to complete his task. In certain edge cases, he may also request access to additional data fields. Further study on such edge edge cases, including the frequency, kinds of edge cases, and additional necessary data fields, should be completed. Restricted access control may also improve timeliness of a service. Instead of having to sort through all data fields to find the relevant information for their task, restricted access provides officials with the necessary subset of data. Consequently, right use may be maximized while having a positive affect on efficiency.

Right Disclosure Maximization
While New Property Tax Assessment and New Water Connection have maximum Right Disclosure parameters. PGR, however, discloses phone number of the citizen filing the complaint to the public. As we discussed during on-site interviews, disclosure of phone number had no apparent purpose other than for the functionary to contact the grievant. If this is the only use case, then it need not be publicly disclosed and instead can just be accessed by the attending functionary. With no obvious affects on timeliness or accuracy of service, right disclosure for PGR can also be maximized.

6.3 The Model ULB Concept Based on GEI and IPI

In this section we introduce and discuss the *Model ULB* concept. We begin by describing how it is calculated in general for both IPI and GEI. In general, we consider values in the 75th percentile or higher as model. We treat IPI and GEI slightly differently as discussed here. We then consider each of the three services, WT, PT,

and PGR, independently and the final consider the composition of all three services, This analysis leads to the conclusion that it is possible for a ULB to be a model ULB with respect to both efficiency and privacy; **it is not a zero-sum game.**

6.3.1 Methodology for Determining Model ULBs

Determination of top-performing ULBs informs on the limitations of GEI and IPI for a given service and the resources or workflows conducive to improved efficiency and privacy. ULBs above the 75th percentile in GEI and IPI for their given tier should be considered model ULBs.

Due to the simplifications of the IPI calculation and lack of information on accuracy, we identify model ULBs with a slightly different method. Only timeliness can be accurately calculated, and IPI can reasonably be assumed to be similar, if not identical, within tiers. Thus we use timeliness as the primary factor in determining model ULBs given our current data.

Determining the top-performing ULBs for PT and WT takes into account two factors: adjusted timeliness and the difference between perceived and adjusted timeliness (δ_t). First, we consider ULBs with adjusted timeliness greater than the 75 percentile and δ_t values above the median as model ULBs. We identify model ULBs for each tier to normalize for factors related to the volume of applications, amount of resources, and population size.

While ultimately adjusted timeliness values are most important in determining model ULBs within each tier, we use the difference between perceived and adjusted timeliness (δ_t) as a secondary factor. A smaller difference does not necessarily indicate a lower percentage of recording inaccurate application durations. However, we use it as a secondary factor for two reasons. First, when comparing ULBs handling similar volumes of applications, a smaller δ_t indicates a smaller proportion of applications had inaccurate application durations. The adjusted timeliness values for ULBs processing similar volumes are similarly sensitive to the number of applications that were inaccurately recorded. As a result, a slight preference can be given to the ULB with a smaller δ_t. Second, when comparing ULBs with highly varying volumes of applications even with the same tier, comparing δ_t values gives more leeway for ULBs processing large application volumes. Suppose we have a ULB α that handles twice the volume of applications as ULB β. The adjusted timeliness of α is less sensitive to a larger percentage of inaccurate application durations. ULB α can have a higher percentage than β while δ_t for both will remain similar. This leeway partially accounts for the fact that the amount of resources or SLAs for a ULB do not grow proportionally with the volume of applications received. The ULBs are in a way given credit for having high timeliness despite large application volumes.

For PGR, we identify ULBs that provide consistent timely redressal for each department. We assume that departments within ULBs function independently of each other. As a result, identifying model ULBs for all PGR is not necessarily the most informative. Therefore a study of model ULBs for each department and tiers together can provide the most information on why certain departments, with respect to specific volumes of complaints, are still able to provide efficient service.

6.3.2 Property Tax: Model ULBs

Figures 9, 10, and 11 provide a table of the model ULBs for each tier and their relative performance to other ULBs. Each marker in the plots indicates a ULB in the appropriate tier. The size of the indicator is proportional to the volume of applications received. The blue and gray shaded areas show the range of the 25th and 75th percentiles for each axis. ULBs exceeding the 75th percentile in adjusted timeliness and 50th percentile in the difference between adjusted and perceived timeliness are indicated in red. These are the model ULBs.

In Tier 1, we identify 3 model ULBs: 1013, 1068, and 1075. While adjusted timeliness values are high, note that 1013 and 1068 also have high proportions of applications that digitally were recorded to have undergone the PT workflow in less than a day. Both ULBs have nearly 50% of inaccurate application durations. The average application durations for both ULBs is seemingly low for such high volumes of applications. It is possible that the calculated adjusted timeliness values include applications that were manually processed but digitally recorded after one day. Although it is not as timely as the other two ULBs, 1075 seems to be using the ERP system as designed: 1075 has an extremely low percentage of inaccurate application durations and high average application duration. Perhaps 1075 should be the first ULB to be further analyzed on its high timeliness and proper adoption of the e-governance system.

Tier 2 has 10 model ULBs, all of which have timeliness ranging from 0.914 to 1.0. Unlike Tier 1, the general trends seems to be that as the application volume increases, the percentage of inaccurate application duration decreases. Perhaps Tier 2 ULBs are finding the ERP system more helpful in monitoring applications and are better trained in using the system. ULB 1013 in particular stands out as exemplary, having high adjusted timeliness and much lower percentage of inaccurate application recording. All other model ULBs have rather high percentages of inaccurate recordings, having as high as 81%. Particularly in Tier 2 ULBs, the rate of adoption of the digital systems should be addressed.

As seen in Figure 11, Tier 3 model ULBs include 1062, 1135, 1120, 1165, and so on . We expect IPI to be fairly identical to the calculations explained in Section 6.2, as they use the most basic workflow. In terms of GEI, the model ULBs have high timeliness values, ranging from 0.80 to 1.0. One would expect that the ERP system in small towns in general is not used as intended; smaller towns may not have as many computer-literate officials as corporations might. However, the model ULBs - except for 1135 - have fairly low percentages of inaccurate recordings. ULB 1120 in fact has the lowest percentage out of all model ULBs across all tiers. The method of training government officials on using the ERP system can be further studied in 1120.

6.3.3 Water Tax: Model ULBs

Figures 12, 13, and 14 provide a table of the model ULBs for each tier and their relative performance to other ULBs. As described in 6.3.2, each marker in the plots indicates a ULB in the appropriate tier. The size of the indicator is proportional to the volume of applications received, and the model ULBs are marked in red. The blue and gray shaded areas show the range of the 25th and 75th percentiles for each axis.

The seven Tier 1 model ULBs have adjusted timeliness values ranging from 0.71 to 1.0. Surprisingly, the overall percentage of inaccurate application recordings in generally much lower than those for new property tax assessment even while handling similar volumes of applications. One possible explanation for this difference is that the New Water Tap Connection is processed by the Engineering Department while the New Property Tax Assessment applications are processed by the Revenue department. Perhaps the officials in the Engineering department are better trained in using computer systems. 1007 in particular is exemplary as a result.

Tier 2 model ULBs also have lower inaccurate recording percentages in comparison to Property Tax, similar to Tier 1. 1006 in particular is an exemplary Tier 2 ULB - while handling a relatively large volume of applications, it maintains 0.84 timeliness with an inaccurate application rate of 0.051%. It is interesting to note that the interquartile range of the y-axis is much larger than the that of all other tiers as well as New Property Tax Assessment.

Lastly, Tier 3 model ULBs range in timeliness from 0.76 to 1.0, including 1135, 1154, 1137, and 1149. ULB 1135 and 1156 have high adjusted timeliness but also high percentages of inaccurate recordings. Adjusted timeliness overall vary greatly within Tier 3. Of note is ULB 1076, as it has high timeliness with extremely low percentage of inaccurate application duration. ULB 1135 does perform the best with respect to timeliness but also has an extremely high percentage of inaccurate application recordings.

6.3.4 PGR: Model ULBs

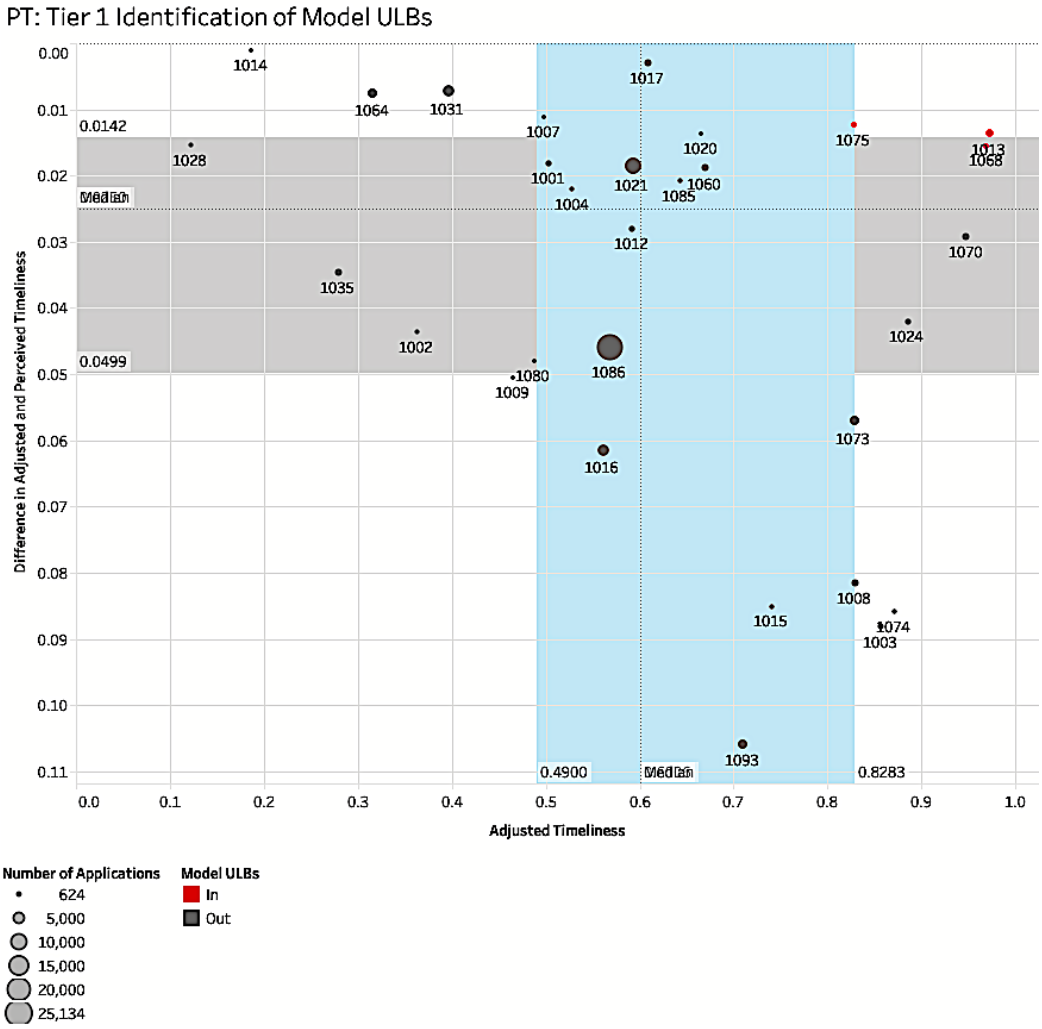
One method of identifying model ULBs is looking at the ULBs that are in the top 5 percentile for each complaint across each tier. This process can be repeated across all departments and complaints to identify model ULBs. These ULBs can be studied further to inform the observer on how possible differences in workflow, amount of staff, and other factors can improve timeliness of service.

In general, we identify ULBs that provide consistent timely redressal for each department. Again, we assume that departments within ULBs function independently of each other. As a result, identifying model ULBs for all PGR is not necessarily the most informative. Given that the current SLAs are uniform for each complaint across ULBs, we would expect that Tier 1 ULBs on average would provide less timely service than smaller ULBs due to a larger volume of complaints or other such population-related factors. As seen in Figure 15, this is not always the case. Surprisingly, in the Revenue Department Tier 1 ULBs overall perform the best regardless of application volume. Therefore a study of model ULBs for each department and tiers together could provide the most information on why certain departments, with respect to specific volumes of complaints, are still able to provide efficient service.

PT: Tier 1 Model ULBs

ULB Code	Tier	Population	Number of Applications	Adjusted Timeliness	Difference in Adjusted and Perceived Timeliness	Average Application Duration	% of Inaccurate Appplication Durations	Weighted Impact
1013	1	343054	2379	0.972062449	0.013645832	2.72803699	48.844052123	2,312.53
1068	1	118167	985	0.969262295	0.015509279	3.366497462	50.456852792	954.72
1075	1	203780	820	0.827858081	0.012385821	9.482926829	7.195121951	678.84

(a) Top-performing ULBs for New Property Tax Assessment timeliness of service in Tier 1 according to criteria described in 6.3.1



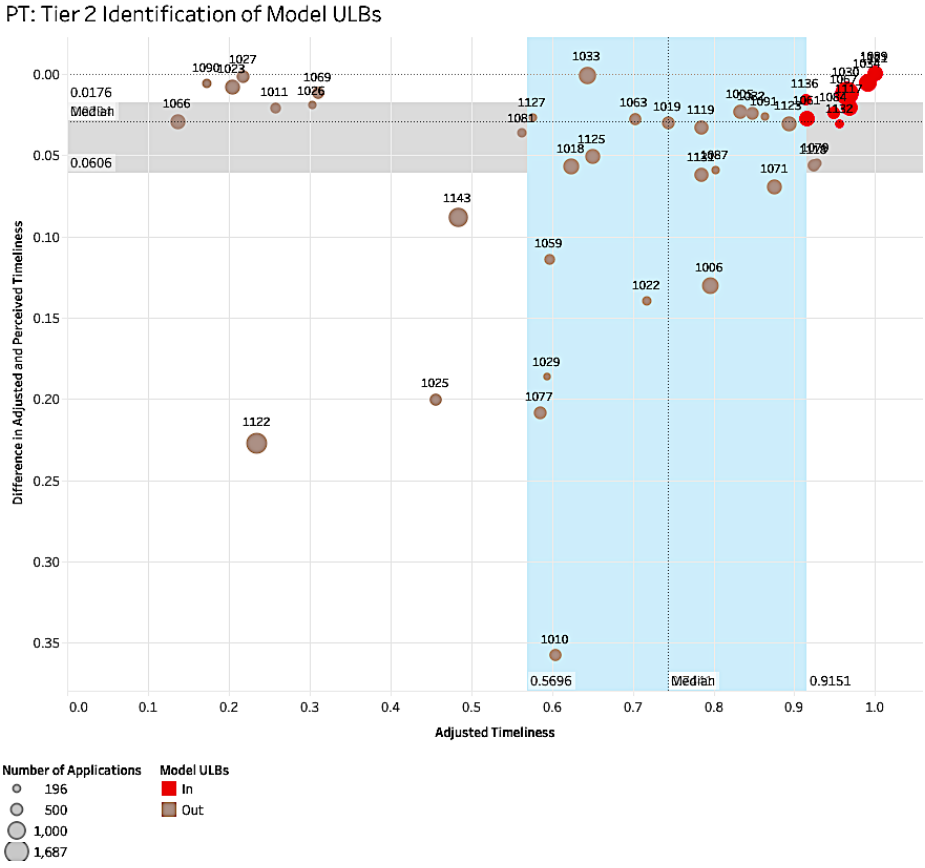
(b) Identification of Model ULBs in Tier 1: We plot t_{adj} against δ_t and choose top-performing ULBs according to the criteria outlined in Section 6.3.1. The blue region shows the interquartile range of t_{adj} for Tier 1 ULBs. the grey region shows the interquartile range for δ_t. Each marker corresponds to a ULB in Tier 1 where the size of the marker is proportional to the number of applications received by that ULB.

Figure 9: Tier 1 Model ULBs with respect to Timeliness of Service for New Property Tax Assessment

PT: Tier 2 Model ULBs

ULB Code	Tier	Population	Number of Applications	Adjusted Timeliness	Difference in Adjusted and Perceived Timeliness	Average Application Duration	% of Inaccurate Appplication Durations	Weighted Impact
1030	2	97053	1687	0.964448496	0.012433543	3.739774748	18.604651163	349.00
1034	2	71092	1065	0.990430622	0.005813509	1.994366197	32.653061224	668.00
1061	2	53633	708	0.915966387	0.027536438	4.276836158	32.768361582	1054.81
1067	2	53425	196	0.962121212	0.012368584	4.770408163	34.973325430	727.44
1084	2	57507	452	0.949152542	0.024298785	3.528761062	47.787610619	1627.02
1089	2	55082	668	1	0	0.616766467	60.751173709	188.58
1117	2	51163	751	0.968627451	0.020720086	2.760319574	66.045272969	226.70
1121	2	91234	349	1	0	0.776504298	70.886075949	429.02
1132	2	63103	237	0.956521739	0.030820033	2.097046414	81.586826347	648.50
1136	2	61540	387	0.914285714	0.015946844	6.271317829	85.386819484	353.83

(a) Top-performing ULBs for New Property Tax Assessment timeliness of service in Tier 2 according to criteria described in 6.3.1



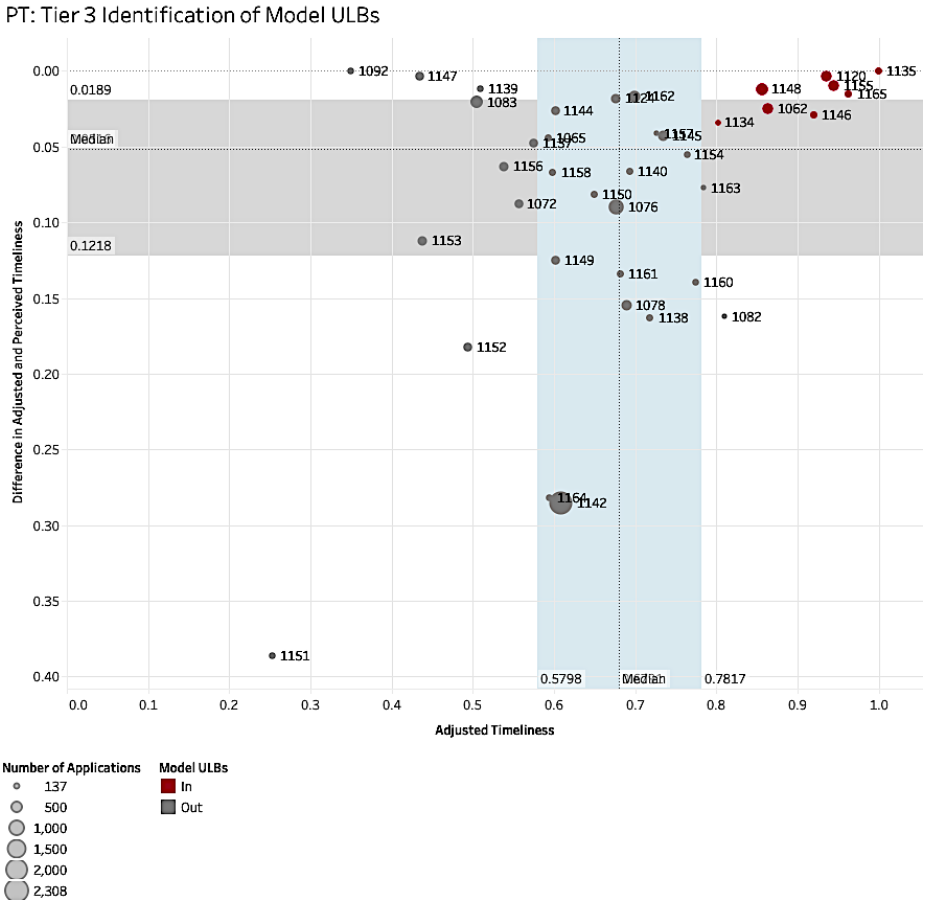
(b) Identification of Model ULBs in Tier 2: We plot t_{adj} against δ_t and choose top-performing ULBs according to the criteria outlined in Section 6.3.1. The blue region shows the interquartile range of t_{adj} for Tier 2 ULBs. the grey region shows the interquartile range for δ_t. Each marker corresponds to a ULB in Tier 2 where the size of the marker is proportional to the number of applications received by that ULB.

Figure 10: Tier 2 Model ULBs with respect to Timeliness of Service for New Property Tax Assessment

PT: Tier 3 Model ULBs

ULB Code	Tier	Population	Number of Applications	Adjusted Timeliness	Difference in Adjusted and Perceived Timeliness	Average Application Duration	% of Inaccurate Appplication Durations	Weighted Impact
1062	3	49477	510	0.863309353	0.024925942	9.288235294	18.235294118	440.29
1120	3	47220	507	0.935550936	0.00330508	6.055226824	5.128205128	474.32
1134	3	31572	140	0.801724138	0.033990148	8.371428571	17.142857143	112.24
1135	3	26259	208	1	0	0.504807692	91.346153846	208.00
1146	3	34623	272	0.91954023	0.028989182	5.213235294	36.029411765	250.11
1148	3	35150	546	0.856	0.012131868	9.076923077	8.424908425	467.38
1155	3	30782	506	0.944444444	0.01010101	5.982213439	18.181818182	477.89
1165	3	32574	271	0.962732919	0.015126859	3.874538745	40.590405904	260.90

(a) Top-performing ULBs for New Property Tax Assessment timeliness of service in Tier 3 according to criteria described in 6.3.1



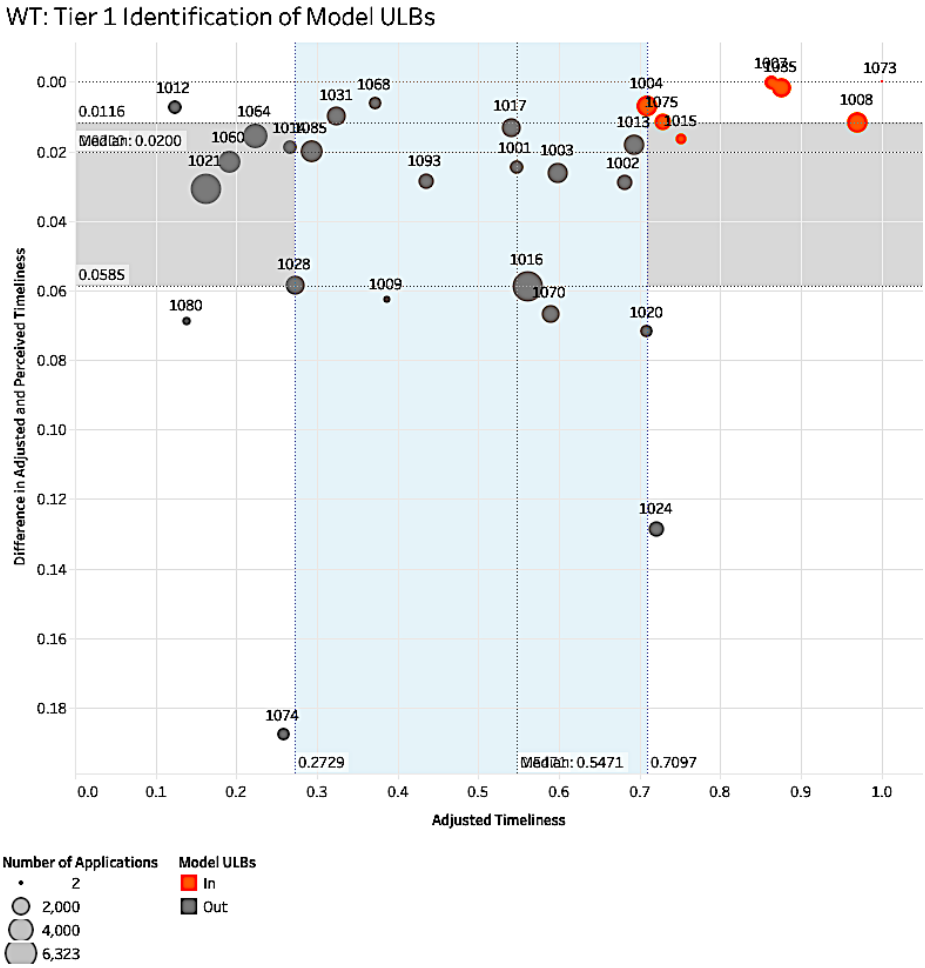
(b) Identification of Model ULBs in Tier 3: We plot t_{adj} against δ_t and choose top-performing ULBs according to the criteria outlined in Section 6.3.1. The blue region shows the interquartile range of t_{adj} for Tier 3 ULBs. the grey region shows the interquartile range for δ_t. Each marker corresponds to a ULB in Tier 3 where the size of the marker is proportional to the number of applications received by that ULB.

Figure 11: Tier 3 Model ULBs with respect to Timeliness of Service for New Property Tax Assessment

WT: Tier 1 Model ULBs

ULB Code	Tier	Population	Number of Applications	Adjusted Timeliness	Difference in Adjusted and Perceived Timeliness	Average Application Duration	% of Inaccurate Application Durations	Weighted Impact
1073	1	1,034,358	2	1	0	6.50	0.00	2.00
1008	1	196,601	2,886	0.970336566	0.011645416	4.48	39.26	2,800.39
1035	1	251,175	2,316	0.875547765	0.001827019	9.78	1.47	2,027.77
1007	1	108,171	1,439	0.863604732	0.00018957	10.59	0.14	1,242.73
1015	1	166,344	810	0.751651255	0.01624998	12.44	6.54	608.84
1075	1	203,780	1,867	0.729155008	0.01160557	12.64	4.28	1,361.33
1004	1	151,677	3,112	0.709677419	0.006903558	13.00	2.38	2,208.52

(a) Top-performing ULBs for New Water Tap Connection timeliness of service in Tier 1 according to criteria described in 6.3.1



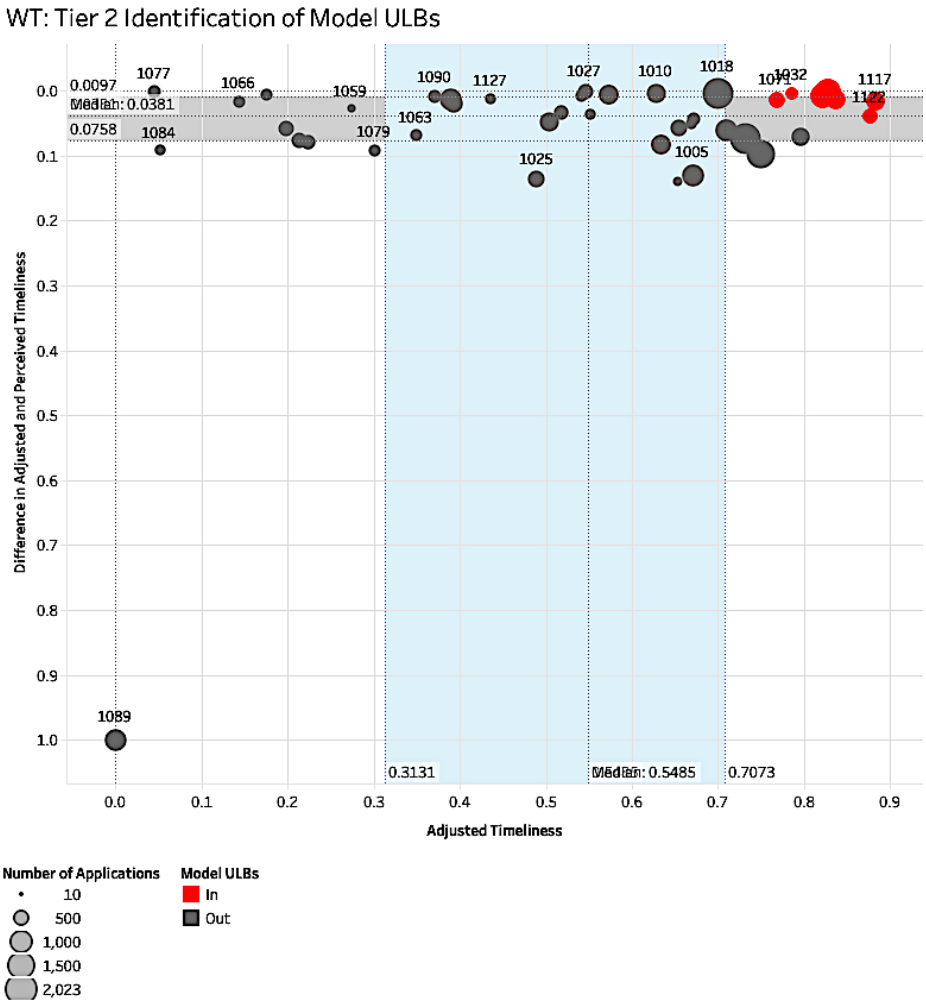
(b) Identification of Model ULBs in Tier 1: We plot t_{adj} against δ_t and choose top-performing ULBs according to the criteria outlined in Section 6.3.1. The blue region shows the interquartile range of t_{adj} for Tier 1 ULBs. The grey region shows the interquartile range for δ_t. Each marker corresponds to a ULB in Tier 1 where the size of the marker is proportional to the number of applications received by that ULB.

Figure 12: Tier 1 Model ULBs with respect to Timeliness of Service for New Water Tap Connection

WT: Tier 2 Model ULBs

ULB Code	Tier	Population	Number of Applications	Adjusted Timeliness	Difference in Adjusted and Perceived Timeliness	Average Application Duration	% of Inaccurate Application Durations	Weighted Impact
1117	2	51,163	715	0.883116883	0.016183816	7.73	13.85	631.43
1122	2	65,706	440	0.876254181	0.03965491	6.05	32.05	385.55
1118	2	62,253	738	0.836795252	0.014153257	9.36	8.67	617.55
1006	2	61,749	1,367	0.827205882	0.000884828	12.39	0.51	1,130.79
1033	2	57,246	1,237	0.821489002	0.007937029	9.60	4.45	1,016.18
1032	2	87,200	295	0.786206897	0.003623611	11.89	1.69	231.93
1071	2	58,590	549	0.767891683	0.013529082	11.43	5.83	421.57

(a) Top-performing ULBs for New Water Tap Connection timeliness of service in Tier 2 according to criteria described in 6.3.1



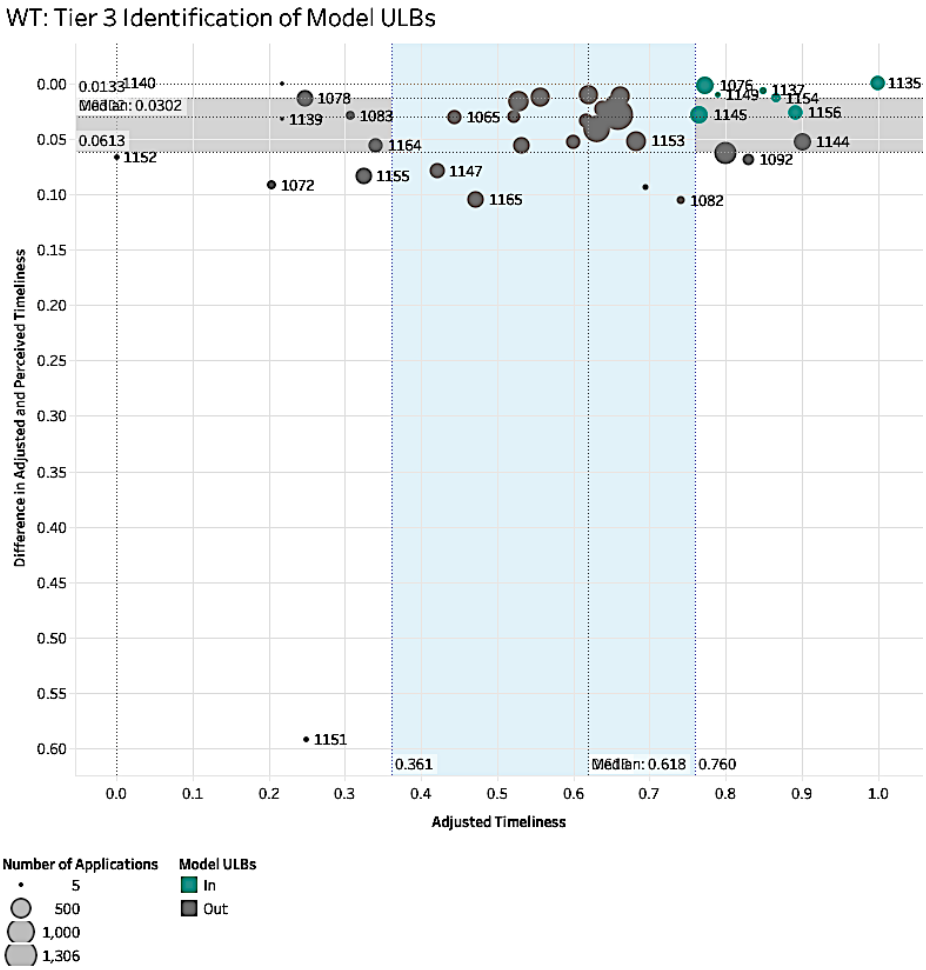
(b) Identification of Model ULBs in Tier 2: We plot t_{adj} against δ_t and choose top-performing ULBs according to the criteria outlined in Section 6.3.1. The blue region shows the interquartile range of t_{adj} for Tier 2 ULBs. The grey region shows the interquartile range for δ_t. Each marker corresponds to a ULB in Tier 2 where the size of the marker is proportional to the number of applications received by that ULB.

Figure 13: Tier 2 Model ULBs with respect to Timeliness of Service for New Water Tap Connection

WT: Tier 3 Model ULBs

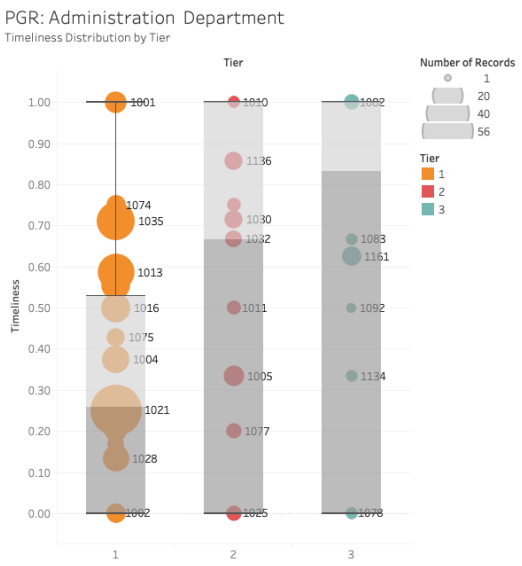
ULB Code	Tier	Population	Number of Applications	Adjusted Timeliness	Difference in Adjusted and Perceived Timeliness	Average Application Duration	% of Inaccurate Application Durations	Weighted Impact
1135	3	26,259	267	1	0	1.92	75.66	267.00
1156	3	48,838	306	0.892241379	0.026059275	6.93	24.18	273.03
1154	3	21,464	141	0.866141732	0.013290892	10.38	9.93	122.13
1137	3	46,159	69	0.848484848	0.006587616	8.80	4.35	58.55
1149	3	30,279	40	0.789473684	0.010526316	13.45	5.00	31.58
1076	3	39,667	471	0.773019272	0.001927649	10.11	0.85	364.09
1145	3	44,359	456	0.765586035	0.028273614	8.62	12.06	349.11

(a) Top-performing ULBs for New Water Tap Connection timeliness of service in Tier 3 according to criteria described in 6.3.1

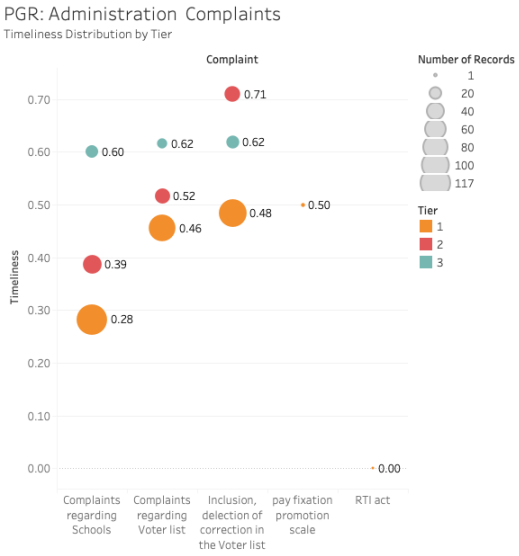


(b) Identification of Model ULBs in Tier 3: We plot t_{adj} against δ_t and choose top-performing ULBs according to the criteria outlined in Section 6.3.1. The blue region shows the interquartile range of t_{adj} for Tier 3 ULBs. The grey region shows the interquartile range for δ_t. Each marker corresponds to a ULB in Tier 3 where the size of the marker is proportional to the number of applications received by that ULB.

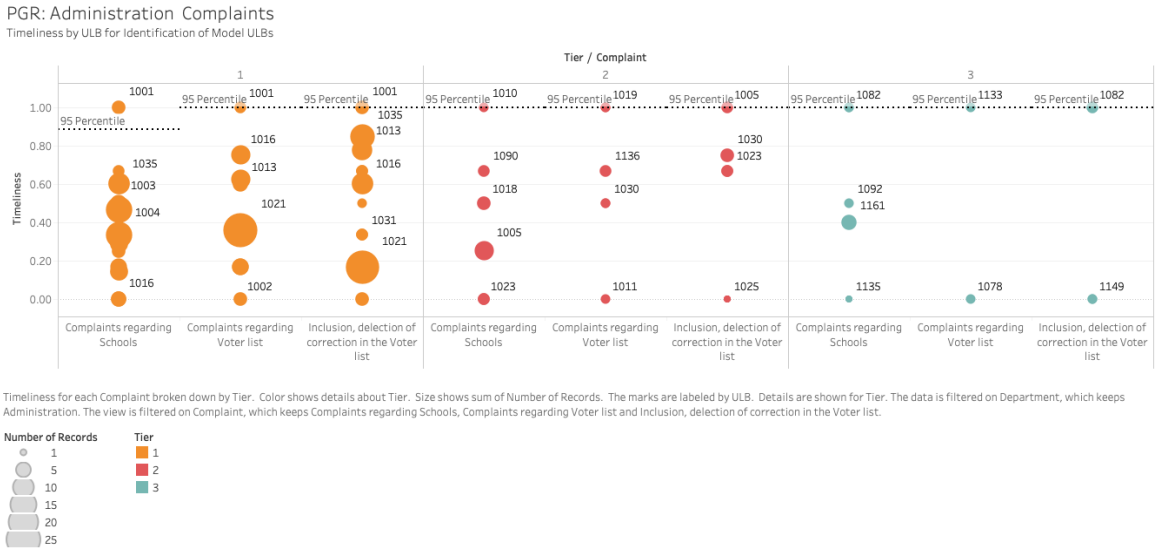
Figure 14: Tier 3 Model ULBs with respect to Timeliness of Service for New Water Tap Connection



(a) Distribution of Timeliness for Administration Complaints by Tier



(b) Average Timeliness by Administration Complaints and Tier



(c) ULB Timeliness by Administration Complaint

Figure 15: Process for Identifying Model ULBs for a Complaint

6.3.5 All Services: Model ULBs

Considering just PT and WT, we observe a couple ULBs of note. First, we identify 1073 as a model ULB in Tier 1 (see Figure 12) but only 2 applications were received. We can disregard this ULB due to the trivial volume of applications. Second, 1075 is classified as a model ULB for both new property tax assessment and new water tap connection. It receives a significant volume of applications (1,867) but maintains high timeliness, where $t_{adj}^{(PT)} = 0.83$ and $t_{adj}^{(WT)} = 0.73$. Additionally, only about 7.2% of PT applications and 4.3% of WT applications are incorrectly recorded. Such low numbers imply that the ERP system is being utilized as intended during the application workflow as opposed to after the processing is manually completed.

In Tier 2, 1117 and 1032 are model ULBs for both WT and PT. For 1117,the percent of inaccurate application durations for WT is 14% while it is 66% for PT. Such a large difference within one ULB is surprising. However, the PT module falls under the the Revenue Department and the WT module falls under the Engineering Department. It's possible that officials in the Engineering Department were more skilled with computers such that adoption of the ERP system did not require a high activation energy.

Although 1135 is classified as a model ULB for both PT and WT, the data indicates that 1135 may not necessarily be a timely and transparent ULB. When calculating adjusted timeliness, we disregarded applications that were processed in less than a day. The one day threshold is a lower bound, as applications with durations of less than 2-3 days are likely also inaccurately recorded. 91% of PT applications and 75% of WT applications were recorded to have been completed in less than a day. It is possible that if the threshold for being considered inaccurately recorded is increased to 2 days from 1 day, the majority of the remaining PT and WT applications would be considered ignored as well in the timeliness calculation. Further work is required to determine if 1135 is in fact providing services in a timely manner or recording inaccurate application durations with a higher time threshold.

In Figure 16, we identify model ULBs across all services. In this analysis, identification of model ULBs boils down to timeliness values if ULBs within the same tier are being compared. As such, for each tier we plot timeliness of PT on the x-axis and WT on the y-axis. Then we color the ULB markers on a scale of red to green correlating with the ULB's overall timeliness for PGR. ULBs performing above the 75th percentile for PT and WT and above the 50th percentile for PGR are considered overall model ULBs. We give more leeway to PGR as performance can vary widely across departments. In Tier 1, 1073,1008, 1075, and 1024 are considered model ULBs. Tier 2 model ULBs include 1117, 1118, and 1034. Tier 3 has only one model ULB: 1135. The size of the markers in Figure 16 indicate the volume of applications or requests received. Model ULBs handling large volumes in particular should be further studied.

7 Implications on Public Policy

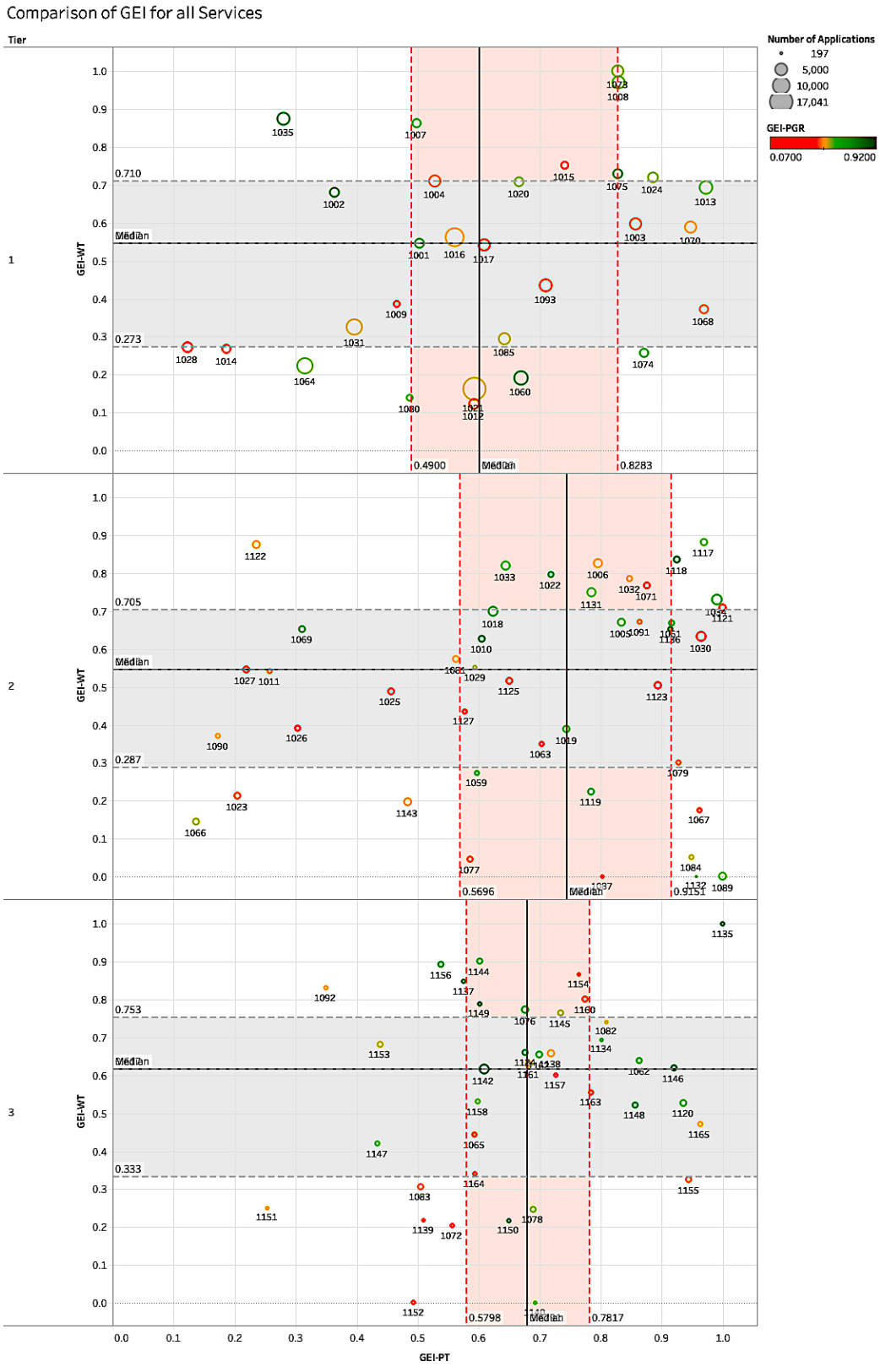
A methodology for comparing efficiency and privacy of various entities provides a structure to understanding, evaluating, and comparing governmental processes. The process for evaluating GEI and IPI as well as the resulting values provide multiple lenses through which the workflows of a state, ULB, or department can be analyzed, as discussed in Section 6. In particular, we highlight a couple use cases for GEI and IPI.

7.1 Evaluating the Trade-Offs Between Efficiency and Privacy

From Section 6.2, it is clear that there is reasonable room for improvement in privacy standards at the service and functionary level. The most obvious optimization is tightening access controls for functionaries in terms of the citizen information they have access to. When a citizen files a new water tap connection application or new property tax assessment application, a Jr./Sr. Assistant first views the application to verify contact and personal details. However, he/she does not need access to details about the building, construction type, occupation, and so on, as can be seen in Figures 21 and 24 in the Appendix. If he/she were not given immediate access to these fields, then the right use parameter would increase, leading to an increase in IPI. Access controls that are too strict, however, could lead to decreases in efficiency. Consequently, the structured methodology we provide to evaluate both efficiency and privacy in tandem is informative.

7.2 Learning from Model ULBs

Across all services, top-performing ULBs within each tier are identified according to certain criteria outlined in Section 6. As all ULBs currently have the same IPI and the accuracy parameter has been set to 1, the model ULBs identified according to timeliness can be considered top-performing with respect to both IPI and GEI.



Sum of GEI-PT vs. sum of GEI-WT broken down by Tier. Color shows sum of GEI-PGR. Size shows sum of total_apps. The marks are labeled by ULB. Details are shown for ULB.

Figure 16: GEI Comparison for All Services by Tier

These ULBs can be studied more in depth to understand why they are able to provide timely services. Each ULB, even within tiers, might have slight variations in their workflow. Consolidation or separation of certain tasks or roles may lead to an improved workflow. Such kind of specific optimizations can be detected and implemented in other places through analyzing model ULBs.

Conversely, comparison of GEI and IPI can identify ULBs that consistently perform poorly for a given service or redressal for specific complaints. One can use a methodology similar that described in Section 6.3.1. ULBs within each tier performing under the 25th percentile can be targeted for improvement. By comparing to the respective model ULBs for each service or complaint, ULBs marked for improvement can compare staffing models, workflow modifications, and other such ULB dependent factors.

Furthermore, parameters for GEI can be calculated at the functionary level as well, as described in Section 5. Calculating timeliness for each functionary along the service workflows can inform on where the bottleneck for a particular ULB may be. Once this is identified, the ULB can act accordingly, possibly by increasing resources for that particular task. Making the functionary timeliness values public for ULBs of similar size to view can give a basis for comparison as to what can be reasonably expected of each functionary.

7.3 Reviewing Fairness of SLAs

GEI analysis for PGR across all departments and complaints could be used to identify complaints for which the SLAs may need to be reviewed or possibly differentiated by tier. SLAs are uniform for each service and PGR complaint across all ULBs regardless of the volume of applications or complaints received. While shorter SLAs push ULBs to complete tasks in a timely manner, SLAs that are consistently not being met may do more harm than good. SLAs consistently not being met could impact citizens' trust in the municipality. Furthermore, funtionaries, particularly in PGR, are being evaluated by the number of times they have met or not met the SLA. For PGR, this value is public. However, it cannot be reasonably expected that functionaries performing the same role in a village versus a corporation will be able to complete their jobs in the same way for some complaints due to the sheer difference in volume of complaints, population, and physical constraints of being in a large ULB. Since SLAs do affect a functionary's performance metric, it is interesting to investigate first by tier, for which complaints the SLAs are consistently not being met.

A modified version of timeliness can be used identify the subset of complaints whose SLAs may need to be re-evaluated, in general or by tier. While timeliness measures the proportion of complaints addressed by the SLA, it does not provide information on how close or far from the SLA complaints are being addressed. Timeliness is calculated under the assumption that the SLAs are fair and correct. If timeliness values across ULBs are low, then either the SLA is too low, or it is low for a reason and ULBs need to improve their workflow process, staffing model, or other such organizational factors. Using a threshold or a percentile threshold for timeliness, one can determine what is considered a low timeliness for a given complaint for a particular tier of ULBs. If the state expects a timeliness of service rate of 50%, then one can expect the distribution of timeliness values for a given complaint to be normally distributed with a mean of 0.50. If the probability of sampling the relevant subset of ULBs' timeliness from this distribution is below a certain threshold, then one may need to re-evaluate the SLA itself. [3]

If the complaint is time-sensitive, however, then the pros and cons of increasing the SLA time should be weighed. For example, "Electric Shock due to Street Lights" or "Illegal Draining of Sewerage to Open Site" are complaints that regardless of timeliness values across tiers, should have low SLAs. In general, complaints regarding Public Health and Sanitation are time sensitive.

8 Conclusions, Limitations and Further Work

In this section we highlight the conclusions we draw from this work, consider the possibility that such measurement and evaluation may distort behaviors, and then look forward to further work we foresee for this effort.

[3] In a recent workshop run by the authors, the participants suggested variable SLAs. The idea was to have a standard SLA available to all citizens, but an expedited one for those wishing to pay extra for the privilege. This would put some of the SLA requirement into an economic regime and allow ULBs both to perhaps hire additional staff to meet the increased demands, as well as reduce some of the routine load on the existing functionaries. We expect possible extensions such as this to be later developments.

8.1 Conclusions

This study lays out and applies a methodology to analyze how ULBs perform on the axes of government efficiency (GEI) and informational privacy (IPI). Using real data from eGovernments Foundation for three government services - New Property Tax Assessment, New Water Tap Connection, and Public Grievance Redressal - we demonstrate that both efficiency and privacy are measurable concepts in the context of urban governance. The model of identifying top-performing ULBs allows us to conclude that there are exemplar cases of ULBs that need to be studied further. These model ULBs demonstrate that ULBs can have high GEImpact and IPImpact, and that there is room for improvement for model ULBs as well.

We analyze the performance of ULBs by tier, as the volume of applications received and the resources available to each ULB affects the timeliness parameter of GEI. We also discover that certain New Property Tax Assessment and New Water Tap Connection applications in some ULBs have gone through the digital workflow in the ERP system in a suspiciously small amount of time. We identify applications that have inaccurate application durations, and ignore those during the calculation of adjusted timeliness. As only online complaints can be filed, the Public Grievance Redressal module does not have applications with inaccurate application durations. In addition to grouping and analyzing ULBs by tiers, we identify top-performing ULBs in each department independently. There exist ULBs that are generally top-performing as well across all PGR. As IPI is the same for each service across all ULBs and accuracy could not be calculated with the collected data, ULBs with high timeliness within each tier are considered model ULBs, regardless of the volume of applications received. We identify ULBs that have high timeliness across all services, demonstrating that it is possible to maximize efficiency irrespective of population or the resulting volume of transactions.

Finally, we calculate and compare $GEImpact_{total}$ and $IPImpact_{total}$ across all ULBs. While ULBs with low impact are not necessarily less efficient or private, ULBs with high impact on both axes should be further studied to understand what specifics about their workflow, organizational structure, or resource structure leads to high efficiency and privacy impact even with a high volume of applications.

8.2 Limitation: Metric-driven Behavior Distortion

It is valuable to note here that our metrics, GEI and IPI, are valuable for evaluation of an individual organization or as the basis for comparison. The concept of a model ULB was devised in order that a ULB might compare itself to some ideal. In addition, ULBs, especially in the same Tier might be compared with each other. In that context, we observe that it is human nature to try to improve oneself with respect to metrics being applied.

We recently learned that when a ULB is setting up its system, it is provided with a minimum set of required fields for each module and function, but it can choose additional fields to be required. For example, some ULBs may require additional documentation on the ownership or physical details of a piece of property, where other ULBs may choose not to, leaving those additional pieces of data as optional.

Now, if we return to the IPI evaluation, we note that it is based in part on the number of fields required divided by the number of fields collected. Thus, we hypothesize that there is motivation for ULBs to increase the number of required fields, in order to improve their privacy evaluation, if they think they will ever collect the information that may otherwise be optional. What is perhaps even more important here is that it may motivate ULBs to require collection of information that may provide a privacy risk to the citizen and is in fact not necessary.

We have not observed this sort of distortion of behavior, but recognize that it may happen. We note here that this example demonstrates an interesting tradeoff in the design and use of these metrics. There is not likely to be a perfect answer to the dilemma, and we note that it is better to have evaluation than not, but one needs to be careful and thoughtful about the application of it and the consequences of it.

8.3 Further Work

A methodology to calculate efficiency and privacy is helpful in determining top-performing ULBs within an entity, in this case our study state; however, further work can be done to improve the indices to make them more accurate, informative, and comprehensive.

There are a couple of more specific questions we may ask with regards to this study. First, in this study we only calculate GEI and IPI at the service level for each ULB. An interesting direction for further work includes implementing the methods laid out in Section 5 to calculate GEI and IPI at the functionary level.

In particular, observing and analyzing timeliness at the functionary level across ULBs can provide a wealth of information on exactly which task or functionary in the workflow for each service is the bottleneck for improving timeliness. Once the bottleneck is identified, municipalities can have individualized solutions for addressing the issue. ULBs with high timeliness across all functionaries can serve as case studies for those unable to consistently maintain high efficiency. In general, on-site studies and interviews can be completed at the model ULBs identified in this document to pinpoint exactly what factors lead to high timeliness. Further investigation can be done on why ULBs with high impacts and high timeliness are able to maintain efficiency while handling large volumes of applications.

Second, further work is required to develop a methodology to calculate accuracy or develop a proxy for accuracy. Accuracy is an important component of GEI, and while we currently assume that accuracy values are largely close to 1, research confirming that assumption needs to completed. Calculation of accuracy may require designing and implementing a way of logging accuracy in the ERP system with eGov.

Third, for complaints in PGR that have been marked as possibly requiring review, a process for determining any change in SLA can be developed. While we calculate GEI based on the assumption that SLAs are fair and correct, we recognize that this may not necessarily be the case. This process would take into account the urgency of the complaint as well as timeliness information. Based on the resulting analysis, it may also be argued that some SLAs should be dependent on the tier of a ULB so that functionaries in corporations are not penalized for urban mobility or resource issues that are out of their control.

Fourth, a more rigorous approach to identifying ULBs that are not properly documenting application workflows in the ERP system can be developed. In this study, we classify applications that have an application duration of less than a day as incorrectly recorded transactions. It is reasonable to assume, however, that most applications completed in less than a couple days may have also been incorrectly recorded, particularly if the applications were from Tier 1 ULBs. In general, it would be interesting if we could train a machine learning model that could predict timeliness of a ULB based on a range of socio-economic or organization factors, including population, volume of transactions, amount of resources, geographic location, and so on. Depending on the model, we could gain valuable information regarding the importance of each of these factors in determining the performance of a ULB.

Most importantly, now that there exists a methodology to measure and analyze government efficiency and informational privacy, the general direction of further research should be to understand any causal affects between GEI and IPI. Do implementing changes to access controls or data disclosure affect government efficiency? More excitingly, can we innovate upon existing procedures to improve both efficiency and privacy in a sustainable manner? Answering this question will require further field work, experiments with changes to the workflows or ERP system for particular services, and so on. Equipped with the lessons from our current study, we hope to expand upon this line of research in the future.

Acknowledgements

This work would not have been possible without the work and contributions of Gautham Ravichander, Ranjeet Vimal, Rishi Katara, Krishnakumar Thiagarajan and his colleagues at the eGovernments Foundation. In addition, we wish to acknowledge research funding as well as many probing questions from the MIT Internet Policy Research Initiative.

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Appendix: Figures

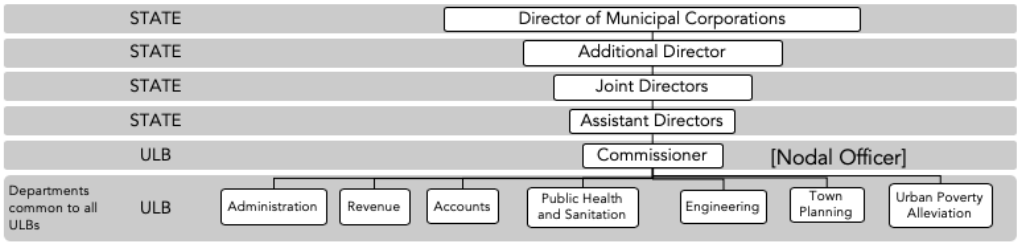

Figure 17: Department Hierarchy

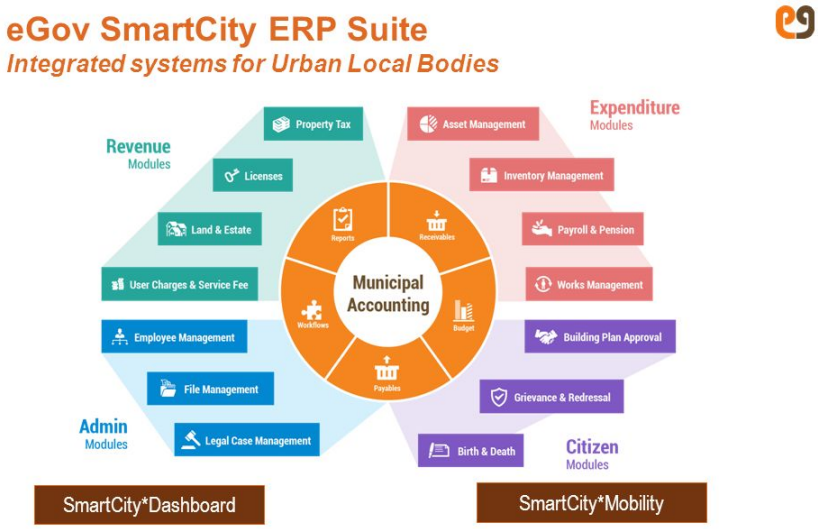

Figure 18: eGovernments Foundation ERP Suite[4]

Complaint Categorisation and SLAs in days			
Sl No	Grievance Type *	Category	SLA
1	Complaints regarding Schools	Administration	3
2	Complaints regarding Voter list	Election	6
3	Inclusion, delection of correction in the Voter list	Election	6
1	Pot hole fill up/Repairs to the damage surface	Engineering	7
2	Repairs to existing footpath	Engineering	7
3	Repairs to the SWD	Engineering	7
4	Obstruction of water flow	Engineering	1
5	Replacement of Cover for Manholes	Engineering	7
6	Maintenance of Parks	Engineering	7
7	Maintenance of Playground	Engineering	7
8	Repairs to Flyovers/ bridges/ Culverts	Engineering	7
9	Repairs to Centre Median	Engineering	7
10	Repairs to Traffic Island	Engineering	7
11	Stoppage of Civil Works	Engineering	2
12	Poor quality of work	Engineering	1
13	UGD Over Flow	Engineering	1
14	Unauthorised Road cutting	Engineering	1
1	Desilting of Drain	Public Health and Sanitation	1
2	Stagnation of water	Public Health and Sanitation	1
3	Disposal of removed silt on the Road	Public Health and Sanitation	1
4	Removal of fallen trees	Public Health and Sanitation	1
5	Illegal draining of sewage to SWD/Open site	Public Health and Sanitation	2
6	Unauthorised tree Cutting	Public Health and Sanitation	1
7	Removal of garbage	Public Health and Sanitation	1
8	Over flowing of garbage bins	Public Health and Sanitation	1
9	Shifting of garbage bin	Public Health and Sanitation	1
10	Provision of garbage bin	Public Health and Sanitation	1
11	Absenteesim of sweepers	Public Health and Sanitation	1
12	Absenteesim of door to door garbage collector	Public Health and Sanitation	1
13	Removal of Debris	Public Health and Sanitation	3
14	Bio Medical waste/Health hazard waste removal	Public Health and Sanitation	1
15	Obstruction of road by Trees branches	Public Health and Sanitation	1
16	Complaints regarding burial ground	Public Health and Sanitation	1
17	Complaints regarding public toilets	Public Health and Sanitation	1
18	Complaints regarding restaurants / Function halls	Public Health and Sanitation	1
19	Complaints regarding Dispensary	Public Health and Sanitation	1
20	Request for Anti Larval operations - to prevent Dengue /Malaria etc	Public Health and Sanitation	2
21	Mosquito menace	Public Health and Sanitation	2
22	Dog menace	Public Health and Sanitation	1
23	Burning of garbage	Public Health and Sanitation	1
24	Unsanitary conditions on the road	Public Health and Sanitation	1
25	Unhygeinic conditions because of Slaughter House	Public Health and Sanitation	1

26	Unauthorised sale of meat and meat product	Public Health and Sanitation	1
27	Stray cattle	Public Health and Sanitation	1
28	Illegal slaughtering	Public Health and Sanitation	1
29	Stray Pigs	Public Health and Sanitation	1
30	Death of Stray Animals	Public Health and Sanitation	0.5
31	Unhygienic and improper transport of meat and livestock	Public Health and Sanitation	0.5
32	Improper Sweeping	Public Health and Sanitation	1
33	Broken Bin	Public Health and Sanitation	1
34	Garbage lorry with out Net	Public Health and Sanitation	1
35	Transfer Station Smell	Public Health and Sanitation	1
36	Spilling of Garbage from lorry	Public Health and Sanitation	1
37	Fevers - Dengue/Malaria/ Gastro-enteritis	Public Health and Sanitation	2
38	Food adulteration: Road Side Eateries	Public Health and Sanitation	1
39	Issues relating to Vacant lands	Public Health and Sanitation	3
40	Complaints regarding function Halls	Public Health and Sanitation	1
41	Unclaimed Dead Bodies	Public Health and Sanitation	0.5
42	Complaint Regarding School Toilets	Public Health and Sanitation	1
43	Open defecation- free (ODF)	Public Health and Sanitation	1
44	Community Toilets	Public Health and Sanitation	1
45	Silt by the side of dividers	Public Health and Sanitation	1
1	Complaints related to property tax	Revenue	5
2	Complaints related to issue of Trade License	Revenue	5
3	New Property Tax Fixation	Revenue	5
4	New Vacant Land tax Fixation	Revenue	5
5	Property Tax Bifurcation	Revenue	5
6	Revision Petition on Property Tax	Revenue	30
7	Transfer of Title of property	Revenue	7
8	Vacancy Remission	Revenue	30
9	Errors in demand Notice	Revenue	7
10	Double Assessments	Revenue	7
1	Non Burning of Street Lights	Street Lighting	1
2	Electric Shock due to street light	Street Lighting	1
3	Hanging of Streetlight Wires	Street Lighting	1
1	Removal of shops in the footpath	Town Planning	3
2	Unauthorised / Illegal construction	Town Planning	15
3	Violation of DCR/Building bye laws	Town Planning	15
4	Encroachment on the public property	Town Planning	2
5	Misuse of Community Hall	Town Planning	1
6	Parking Issue	Town Planning	1
7	Over head cable Wires running in Hapazard manner	Town Planning	1
8	Unauthorised Advt. Boards	Town Planning	3
9	Issues relating to Advertisement Boards	Town Planning	7
1	Vaddi Leni Runalu	UPA	3

2	Non Receipt of Pensions (Disabled/ Old age/ Widow)	UPA	3
3	Sanction of Gas Connection Under Deepam Scheme	UPA	7
4	Complaints regarding all Sanctioned loans	UPA	7
5	Non Sanction of Bank Linkage to the group	UPA	7
6	Provision of Placement after Training under ESTP	UPA	7
7	Disputes in SSG / SLF / TLF	UPA	7
1	Contamination of Water	Water Supply	1
2	Issues Related to Drinking Water Supply	Water Supply	2
3	Repair Bore wells	Water Supply	2
4	Water pipe leakage	Water Supply	2

Figure 19: Service Level Agreements for PGR

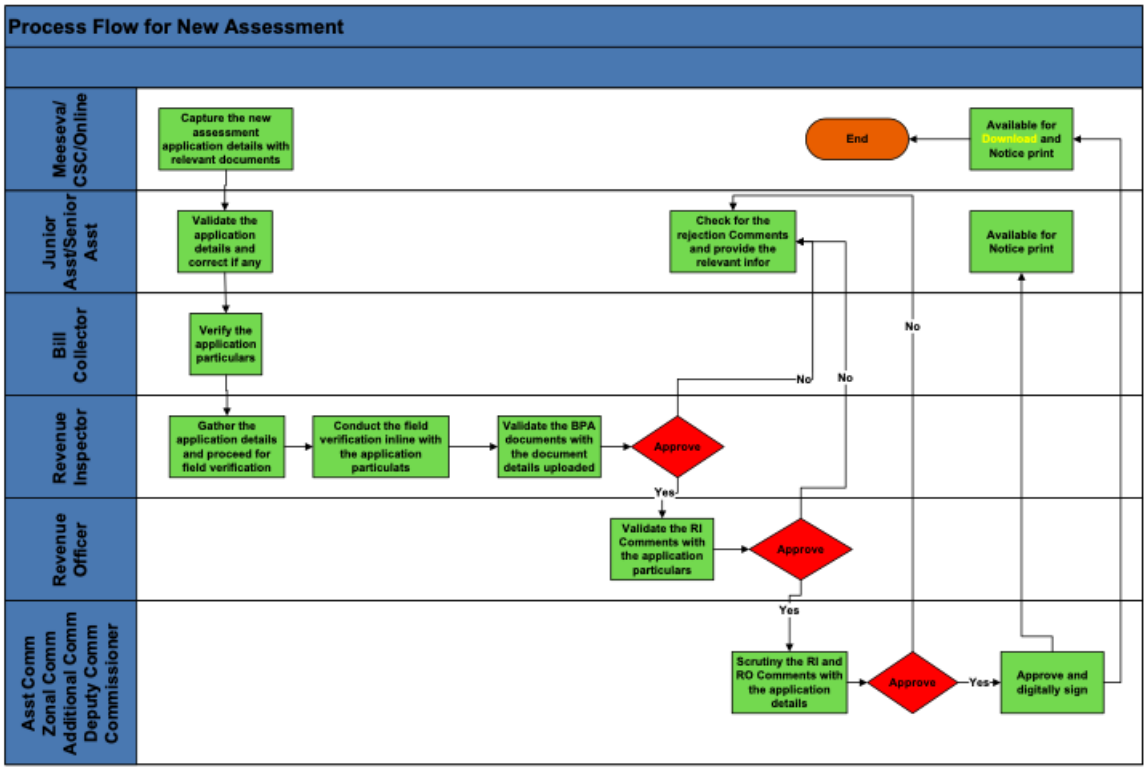

Figure 20: New Property Tax Assessment Workflow[4]

	End Point/Officials (->)	MeeSeva/CSC/Online	Junior Asst./Senior Asst.	Bill Collator	Revenue Inspator	Revenue Officer	Asst. Comm., Zonal Comm., Additional Comm., Deputy Comm., Commissioner
	Function (+)	Capture the new assessment application details with relevant documents. Available for download and notice print	Validate the application details and correct if any; Check for the rejection comments and provide the relevant info; Available for notice print	Field verification - mainly floor details + construction type	Gather the application details and proceed for field verification; Conduct the field verification inline with the application particulars; Validation of BPA documents with the document details uploaded; Approve (DECISION) verifies everything	Validate the RI Comments with the application particulars; Approve (DECISION)	Scrutiny the RI and RO comments with the application details; Approve (DECISION); Approve and digitally sign - check at random., sign all., whoever has approving authority
Module	**Fields**						
PROPERTY TAX	Category of Ownership*	1	1	1	1	1	1
	Apartment/Complex Name	0	0	0	0	0	0
	Property Department	0	0	0	0	0	0
	Property Type*	1	1	1	1	1	1
Owner Detail	Aadhar No	0	0	0	0	0	0
	Mobile No*	1	1	1	1	1	1
	Owner Name*	1	1	1	1	1	1
	Gender*	1	1	1	1	1	1
	Email Address	0	0	0	0	0	0
	Guardian Relation*	1	1	1	1	1	1
	Guardian*	1	1	1	1	1	1
Property Address	Locality*	1	1	1	1	1	1
	Zone No*	1	1	1	1	1	1
	Block No*	1	1	1	1	1	1
	Election Ward*	1	1	1	1	1	1
	Enumeration Block	0	0	0	0	0	0
	Ward No*	1	1	1	1	1	1
	Street	0	0	0	0	0	0
	Door No	0	0	0	0	0	0
	Pin Code*	1	1	1	1	1	1
	Is correspondace address different from property address ?	0	0	0	0	0	0
Assessment Details	Reason for Creation*	1	1	1	1	1	1
	Occupation Certificate No	0	0	0	0	0	0
	Extent of Site (Sq. Mtrs)*	1	1	1	1	1	1
	Occupancy Certificate Date	0	0	0	0	0	0
Amenities	Lift	0	0	0	0	0	0
	Electricity	0	0	0	0	0	0
	Toilets	0	0	0	0	0	0
	Attached Bathrooms	0	0	0	0	0	0
	Water Tap	0	0	0	0	0	0
	Water Harvesting	0	0	0	0	0	0
	Cable Connection	0	0	0	0	0	0
Construction Type	Floor Type	0	0	0	0	0	0
	Wall Type	0	0	0	0	0	0
	Roof Type	0	0	0	0	0	0
	Wood Type	0	0	0	0	0	0
Floor Details	Floor No*	1	1	1	1	1	1
	Classification of Usage*	1	1	1	1	1	1
	Number of Usage*	1		1	1	1	1
	Firm Name*	1	1	1	1	1	1
	Occupancy*	1		1	1	1	1
	Occupant Name	0	0	0	0	0	0
	Construction Date*	1	1	1	1	1	1
	Effective from Date*	1	1	1	1	1	1
	Unstructural Land*	1	1	1	1	1	1
	Length*	1	1	1	1	1	1
Vacant Land Details	Survey Number*	1	1	1	1	1	1
	Patta Number*	1	1	1	1	1	1
	Vacant Land Area (in Sq. Mtrs.)*	1	1	1	1	1	1
	Market Value (As per Registered Document)*	1	1	1	1	1	1
	Effective Date*	1	1	1	1	1	1
	Vacant Land Plot Area*	1	1	1	1	1	1

	Layout Approval Authority*	1	1	1	1	1	1
	Layout Permit Number*	1	1	1	1	1	1
	Layout Permit Date*	1	1	1	1	1	1
Details of Surrounding Boundaries of the Property	North*	1	1	1	1	1	1
	East*	1	1	1	1	1	1
	West*	1	1	1	1	1	1
	South*	1	1	1	1	1	1
Documents	Document Type*	1	1	1	1	1	1
	No*	1	1	1	1	1	1
	MRO Proceeding Number*	1	1	1	1	1	1
	Court Name*	1	1	1	1	1	1
	Date*	1	1	1	1	1	1
	MRO Proceeding Date*	1	1	1	1	1	1
	Testator and Two Witnesses Signed	0	0	0	0	0	0
Document Enclosed Details	Building Permission Copy	0	0	0	0	0	0
	Attested Copy of Property Document	0	0	0	0	0	0
	Two Non-Judicial Stamp Paper of Rs. 10	0	0	0	0	0	0
	Notarized Affidavit Cum Indemnity Bond on Rs. 100 Stamp Paper	0	0	0	0	0	0
	Photo of Assessment*	1	1	1	1	1	1
	Copy of Death Certificate/Succession Certificate/Legal Heir Certificate	0	0	0	0	0	0
	Pata Certificate	0	0	0	0	0	0
	MRO Proceedings	0	0	0	0	0	0
	Will Deed	0	0	0	0	0	0
	Decree Document	0	0	0	0	0	0
	Registration Document	0	0	0	0	0	0
	Photo of Property with Holder	0	0	0	0	0	0
	I here by declare I have checked all application details and documents uploaded.	0	0	0	0	0	0

Figure 21: New Property Tax Assessment: Necessary Data Matrix

Property Tax		
Field Name	DataType	Description
arrearBalance	double	Arrear Balance amount
isExempted	boolean	Flag whether the property is exempted
mobileNumber	string	Property Owners mobile number
revenueBlock	string	Revenue Block Name
isUnderCourtcase	boolean	Flag whether the property is under court case
currentInterestCollection	double	Current Financial Year Interest Collection
isActive	boolean	Flag whether the property is active
advance	double	Advance amount if any
cityGrade	string	Grade of the city
secondInstallmentCollection	double	Current Financial Year Second Installment Collection
currentyearcoll	double	Current Financial Year Collection
totalDemand	double	Total Demand of the Property
duePeriod	string	Due Period
propertyCategory	string	Property Category
annualDemand	double	Annual Demand
propertyAddress	string	Address of the Property
totalBalance	double	Total Balance Amount
boundaryGeolon	double	Boundary Geo Longitude
boundaryGeolat	double	Boundary Geo Latitude
arrearInterestDemand	double	Arrear Interest Demand Amount
consumerType	string	Consumer Type
sitalArea	string	Sital Area of the property
builtupArea	double	Built Up Area of the property
adjustment	double	Adjustment
currentInterestDemand	double	Current Interest Demand
cityWard	string	City Ward
annualBalance	double	Annual Balance
cityCode	string	City Code
regionName	string	Region Name
revenueWard	string	Revenue Ward Name
totalCollection	double	Total Collection Amount
arrearCollection	double	Arrear Collection Amount
annualCollection	double	Annual Collection Amount
cityName	string	City Name
propertyGeolon	double	Property Geo Longitude
propertyGeolat	double	Property Geo Latitude
revZoneName	string	Revenue Zone Name
consumerCode	string	Consumer Code is the unique identifier of the property'
locationName	string	Location Name
districtName	string	District Name
secondInstallmentDemand	double	Second Installment Demand
rebate	double	Rebate
arrearInterestCollection	double	Arrear Interest Collection Amount
arvAmount	double	ARV Amount
ptAssesmentNo	string	Property Tax Assessment Number
adminWardName	string	Administration Ward Name

billCollector	string	Bill Collector
firstInstallmentDemand	double	Current Financial Year First Installment Demand
propertyUsage	string	Property Usage
firstInstallmentCollection	double	Current Financial Year First Installment Collection
arrearDemand	double	Arrear Demand
consumerName	string	Consumer Name is Property Owners Name

Figure 22: New Property Tax Assessment: 2018 Data Fields

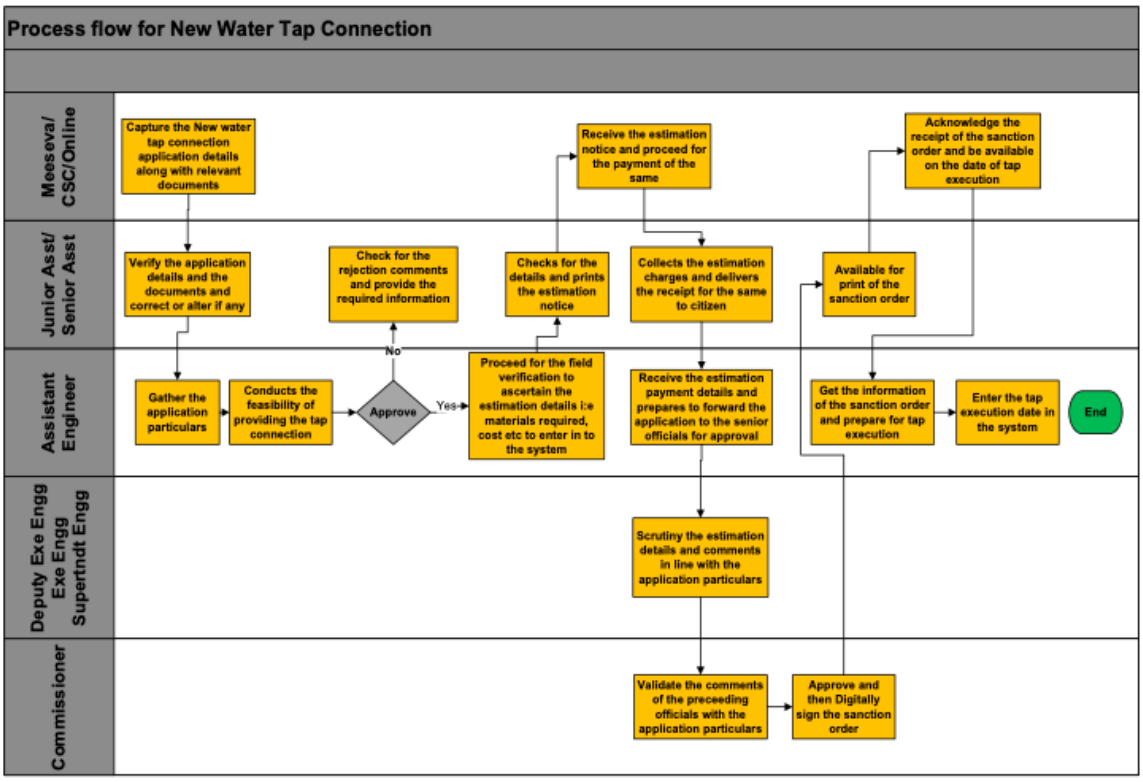

Figure 23: New Water Tap Connection Workflow[4]

	End Point/Officials (->)	MeeSeva/ CSC/Online	Junior Asst./Senior Asst.	Assistant Engineer	Deputy Exe Engg, Exe Engg, Supertndt Engg	Commissioner
	Function (->)	Capture the additional water tap connection with relevant documents; receive estimation notice and proceed for payment of the same; acknowledge the receipt of the sanction order and be available on the date of tap execution	Verify the application details and the documents and correcr or alter if any; Check for the rejection comments and provide the required info; checks for the details and prints the estimation notice; collects the estimation charges and delivers the receipt for the same to citizen; availabel for print of sanction order	Gather the application particulars; Conducts the feasibilty of providing the tap connection; approves or disapproves; proceed for the field verification to ascertain the estimation details i.e. materials required, cost, etc, to enter into system; receiev the estimation payment details and prepares to forward the application to the senior officials for approval; get the information of the sanction order and prepare for tap execution ; enter the tap execution date in the system	Scrutiny the estimation details and comments in line with the application particulars	Validate the comments of the preceeding officials with the application particulars; approved and then digitally sign the sanction order
NEW WATER CONNECTION						
Application Particulars	PT Assessment Number*	1	1	1	1	1
	Name of Applicant	0	0	0	0	0
	Mobile No	0	0	0	0	0
	Email	0	0	0	0	0
	Aadhar No	0	0	0	0	0
	Locality	0	0	0	0	0
	Address	0	0	0	0	0
	Zone/Ward/Block	0	0	0	0	0
	No of Floors	0	0	0	0	0
	Property Tax	0	0	0	0	0
Connection Details	Connection Type*	1	1	1	1	1
	Water Source Type*	1	1	1	1	1
	Property Type*	1	1	1	1	1
	Category*	1	1	1	1	1
	Usage Type*	1	1	1	1	1
	H.S.C Pipe Size (Inches)*	1	1	1	1	1
	Sump Capacity (Litres)	0	0	0	0	0
	No. of Persons	0	0	0	0	0
Enclosed Documents - Check List	P. Tax Receipt	0	0	0	0	0
	Distribution Line Location Map	0	0	0	0	0
	White Ration Card	0	0	0	0	0
	20Rs Court Fee Stamp	0	0	0	0	0
Approval Details	Approver Department*	1	1	1	1	1
	Approver Designation*	1	1	1	1	1
	Approver*	1	1	1	1	1

Figure 24: New Water Tap Connection: Necessary Data Matrix

Water Charges Consumer		
Field Name	Data Type	Description
createdDate	date	Record Creation Date.
wardlocation	geo_point	Lat, Long of Ward/property belongs to) Location.
propertylocation	geo_point	Lat, Long of Property Location.
closureType	string	If the connection is closed, possible values : 1. Temporary and 2. Permanent
waterSource	string	Source from where the water is supplied to connection.
legacy	boolean	Is it a migrated connection from old system.
sumpCapacity	long	Sump capacity at the consumer end(if any).
mobileNumber	string	Mobile Number of the consumer.
numberOfPerson	long	Number of person in the family of consumer.
totalDue	long	Total Property Tax Due, including current charges, penalty(if any) and arrear(if any).
usage	string	Usage Type of the connection.
propertyType	string	Property Type of the connection.
consumerCode	string	Unique consumer code.
revenueWard	string	Revenue Ward to which the connection belongs.
applicationCode	string	Type of Application
districtName	string	Name of district.
zone	string	Name of zone.
adminWard	string	Admin ward to which the connection belongs.
cityGrade	string	Grade of city.
cityName	string	Name of city.
cityCode	string	Code of city.
regionName	string	Name of Region.
pipeSize	string	Pipe size of connection provided to consumer.
doorNo	string	Door Number of the connection.
category	string	Category of Connection.
connectionType	string	Type of connection: Metered OR Non Metered.
propertyId	string	Property Identifier of the connection.
status	string	Status of connection.
monthlyRate	long	Monthly rate for non metered connection.
waterTaxDue	long	Total Water Charges due for the connection.
locality	string	Locality of the consumer.
arrearsDue	long	Total arrears due for the connection.
consumerName	string	Name of the consumer.
currentDue	long	Total current year due for the connection.
arrearsDemand	long	Total arrears demand for the connection at the time of rollover.
currentDemand	long	Total current demand for the connection at the time of rollover.
bpaId	string	Building Plan Approval Identifier of the property where connection is provided.
totalDemand	long	Total demand, included current and arrear due at the time of rollover.
oldConsumerCode	string	Applicable for legacy connections.
billCollector	string	Name of the bill collector who has generated current year demand.
duePeriod	string	Period for which the current demand is generated.

Figure 25: New Water Tap Connection: 2018 Data Fields

Figure 26: PGR Escalation Hierarchy[4]

		Citizen (Call/Website/Mobile App)	Help Desk Officer (ULB Official)	GO	ULB Official First Level Escalation
		File complaint; View the complaint with the action taken against it; Complaint reopened (DECISION); Citizen submits ratings with comments	Files complaint on behalf of official; Is routing for the complaint filed defined in the system (DECISION)	Receives complaint for which routing is not defined; forwards complaint to the concerned official	Receives the compaint in the inbox; Is the complaint attended within the stipulated time (DECISION); Complaint automatically escalated to the next official; Complaint closed with action taken
GRIEVANCE REGISTRATION	Fields				
Contact Information	Name*	1	1	0	1
	Mobile No*	1	1	0	1
	Email	0	0	0	0
	Address	0	0	0	0
Grievance Information	Select from top grievance type	0	1	1	0
	Grievance Type*	1	1	1	1
More Details	Grievance Details*	1	1	1	1
	Grievance Location*	1	1	1	1
	Landmark (if any)	0	0	0	1

Figure 27: Public Grievance Redressal: Necessary Data Matrix

Complaint Index	
Field Name	**Type**
escalation1FunctionaryAssigneddate	date
escalation1FunctionaryIfSLA	integer
departmentCode	string
registered	integer
receivingMode	string
complaintPeriod	double
currentFunctionaryIsSLA	string
inProcess	integer
localityName	string
initialFunctionaryAssigneddate	date
initialFunctionaryMobileNumber	string
complaintAgeingFromDue	double
complaintGeo	geo_point
id	string
currentFunctionaryIfSLA	integer
currentFunctionaryAssigneddate	date
escalation1FunctionaryAgeingFromDue	double
complainantName	string
complaintDuration	double
escalationLevel	integer
cityRegionName	string
wardName	string
currentFunctionarySLADays	long
wardGeo	geo_point
reOpened	integer
complaintAgeingdaysFromDue	long
ifSLA	integer
escalation1FunctionaryIsSLA	string
complainantEmail	string
durationrange	string
escalationDate	date
complaintReOpenedDate	date
complaintTypeName	string
assigneeName	string
initialFunctionaryName	string
escalation3FunctionaryAssigneddate	date
escalation3FunctionarySLADays	long
cityDistrictCode	string
escalation2FunctionaryIfSLA	integer
isSLA	string
initialFunctionaryAgeingFromDue	double
currentFunctionaryAgeingFromDue	double

escalation2FunctionaryIsSLA	string
noOfFeedbackReviews	integer
assigneeId	long
feedbackInWords	string
satisfactionIndex	double
escalation2FunctionaryAgeingFromDue	double
createdDate	date
closedByFunctionaryName	string
complaintIsClosed	string
escalation1FunctionarySLADays	long
reasonForRejection	string
ifClosed	integer
closed	boolean
escalation2FunctionaryAssigneddate	date
escalation2FunctionaryName	string
escalation3FunctionaryAgeingFromDue	double
complaintStatusName	string
escalation3FunctionaryIsSLA	string
rating	integer
source	string
cityGrade	string
initialFunctionaryIfSLA	integer
details	string
departmentName	string
complainantMobile	string
feedbackReason	string
durationRange	string
initialFunctionarySLADays	long
addressed	integer
currentFunctionaryMobileNumber	string
cityDistrictName	string
escalation3FunctionaryIfSLA	integer
noOfFeedbackTaken	integer
initialFunctionaryIsSLA	string
wardNo	string
landmarkDetails	string
rejected	integer
cityCode	string
localityNo	string
feedbackDate	date
escalation3FunctionaryName	string
categoryName	string
complaintTypeCode	string
currentFunctionaryName	string
feedbackRating	integer
cityName	string
cityDomainUrl	string

crn	string
feedbackCallStatus	string
initialFunctionarySLADays	long
localityGeo	geo_point
escalation2FunctionarySLADays	long
escalation1FunctionaryName	string
complaintSLADays	long
completionDate	date
categoryId	long

Figure 28: Public Grievance Redressal: 2018 Data Fields

PGR: Timeliness Results by ULB and Department

	Department			
ULB	Administration	Revenue	Town Planning	UPA
1001	1.00	0.81	0.38	1.00
1002	0.00	0.88	0.40	0.50
1003	0.38	0.54	0.28	
1004	0.38	0.53	0.25	1.00
1005	0.33	0.88	0.58	
1006		0.67	0.44	0.40
1007		0.67	0.00	1.00
1008	0.25	0.65	0.55	0.50
1009	0.00	0.38	0.08	
1010	1.00	0.91	0.77	0.50
1011	0.50	0.55	0.29	0.50
1012		0.51	0.27	0.00
1013	0.59	0.75	0.46	0.50
1014	0.00	0.34	0.41	0.00
1015	0.00	0.12	0.21	0.00
1016	0.50	0.76	0.23	0.94
1017	0.56	0.47	0.21	0.00
1018	0.50	0.77	0.58	0.88
1019	1.00	0.83	0.00	
1020	0.00	0.44	0.14	0.57
1021	0.25	0.85	0.48	0.19
1022	1.00	0.50	0.78	1.00
1023	0.50	0.59	0.09	
1024	0.00	0.83	0.47	
1025	0.00	0.55	0.00	0.25
1026		0.00	0.13	
1027	0.00	0.63	0.09	
1028	0.13	0.56	0.06	0.14
1029	0.00	0.83	0.25	
1030	0.71	0.57	0.16	0.50
1031	0.20	0.66	0.17	0.00
1032	0.67	0.69	0.34	0.60
1033	0.50	0.77	0.25	
1034	1.00	0.83	0.00	0.60

	Department			
ULB	Administration	Revenue	Town Planning	UPA
1035	0.71	0.77	0.76	1.00
1059	1.00	0.60	0.78	0.00
1060	0.75	0.97	0.30	0.50
1061		0.90	0.45	
1062		0.63	0.54	1.00
1063	0.00	0.33	0.14	0.50
1064	0.17	0.74	0.35	0.00
1065		0.62	0.07	0.00
1066	1.00		0.50	
1067	1.00	0.57	0.17	0.00
1068	0.38	0.74	0.38	0.29
1069	1.00	0.78	0.00	
1070	1.00	0.74	0.33	1.00
1071		0.67	0.00	0.00
1072		1.00	0.00	
1073	0.00	0.72	0.54	0.33
1074	0.75	0.89	0.50	0.50
1075	0.43	0.86	0.65	0.33
1076		1.00	0.64	1.00
1077	0.20	0.83	0.25	0.50
1078	0.00	0.58	0.50	0.67
1079		0.60	0.38	
1080	0.50	0.82	0.33	1.00
1081	1.00	0.82	0.38	0.00
1082	1.00	1.00	0.30	
1083	0.67	0.25	0.63	0.14
1084	0.00	0.42	0.86	0.67
1085	0.00	0.74	0.11	0.67
1086	0.00	0.25	0.15	0.25
1087	1.00	0.29		1.00
1089	1.00	0.50		0.50
1090	0.67	0.50	0.44	
1091	0.00	0.50	0.47	1.00
1092	0.50	0.75	0.49	1.00
1093	0.27	0.60	0.22	1.00
1117	0.00	0.50	1.00	
1118	1.00	0.84	1.00	1.00

	Department			
ULB	Administration	Revenue	Town Planning	UPA
1119	1.00	0.67	0.33	
1120		0.83	0.50	0.25
1121	0.00	0.26	0.00	
1122	0.00	0.50	0.65	0.25
1123	0.00	0.18	0.00	0.00
1124		0.78	0.80	
1125	0.00	0.67	0.00	0.00
1127		0.17	0.25	
1131	0.00	1.00	0.52	0.00
1132	1.00	0.88	0.18	1.00
1133	1.00	1.00	0.63	1.00
1134	0.33	0.93	1.00	0.14
1135	0.00	1.00	1.00	1.00
1136	0.86	1.00	0.83	1.00
1137	1.00	0.82	0.73	1.00
1138	1.00	0.50	0.25	1.00
1139		0.00	0.25	0.00
1140	1.00	0.57	0.57	
1142		0.94	0.83	0.00
1143	0.75	0.57	0.46	0.00
1144	0.50	0.79	0.59	0.57
1145	1.00	0.75	0.11	
1146		1.00	0.67	
1147	1.00	0.70	0.17	
1148	1.00	0.83	0.69	
1149	0.00	1.00	0.95	
1150	0.00	0.94	0.30	0.75
1151	1.00	1.00	0.00	0.00
1152	0.00	0.50	0.00	
1153		0.78	0.00	
1154		0.50	0.00	
1155	0.00	0.29	0.75	
1156	0.00	0.90	0.29	
1157		0.10	0.00	0.00
1158	1.00	0.50	1.00	
1160	0.00	0.45	0.25	
1161	0.63	0.50	0.50	0.50

	Department			
ULB	Administration	Revenue	Town Planning	UPA
1162	1.00	0.58	0.67	
1163	1.00	0.00	0.00	0.50
1164	1.00	0.20		
1165		0.00	1.00	

Figure 29: Public Grievance Redressal Timeliness by ULB across Departments