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Geographical Data Analysis and Pin Code-Based Clustering for Operational Service Coverage

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Abstract **- Reliable location data enables service teams to allocate work to a vendor that is servicing the correct area. During an internship at the Operations & Data Analyst role, this paper outlines the work conducted in the following areas: Validation of pincode, City mapping, Geographic clustering & Zone classification. On-the-job training (OJT) report indicates that the work was performed in 15+ cities, 1,000+ pincode records reviewed/corrected and 100+ clusters reviewed/corrected. These processes included the use of spread sheet cleaning, matching and geographical checks and the use of standardised cluster and zone fields. The report provides an accuracy estimate of 90-95%, but it does not specify how this percentage was derived or how that percentage was achieved, nor did it have any measured baseline data prior to and after the dispatch time and no verified data were available. The accuracy number is therefore reported as an estimate and the paper does not claim that the work decreased service time or costs. It suggests controlled master data set, frequent data auditing, data ownership and visibility, dashboard data monitoring and progressive automation.**

Keywords—Geographical Data, Vincode Validation, Service Operations, Vendor Management, Clustering, Data Quality, Operational Analytics.

I. INTRODUCTION

Reliable address and location information are vital for service businesses operating in numerous customer locations to book jobs to appropriate vendors. The address, pincode, locality and city and service zone are useful in establishing the address and/or service zone in the context of facility repair and maintenance, where staff can determine where a repair is taking place and what vendor(s) may service it. If fields are incorrect/inconsistent, it may cause additional checking and result in a job being matched to the wrong area.

When assigning a service request, you'll need to verify the customer's location, type of work, vendor coverage and the team to dispatch the work. Where multiple files have multiple spellings and definitions for the same place, staff may need to resolve the mismatch manually. This project was a concentration on the consistency of location records for the purposes of search, comparison and daily use. Data aids the operations team in making decisions, but it is not the operations team's judgment.

Many issues become more difficult to manage if a dataset spans across many cities and localities. A spelling difference can divide one locality into two labels and a pincode may refer to the incorrect city can mean that a location is in the wrong coverage group. The examples listed are indicative of potential data quality issues, and not assertions about specific confidential records. They describe the reasons for mixing the two approaches of standardisation and geographic checks in the project.

Inspacco [1] offer facility services utilizing technology. The OJT report is about a project on the geographic data required to enable a vendor dispatch. It involved reviewing location records, pincode and city links, enhancement of locality-based clusters and creation of directional zones. The reported work in

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this paper is different from recommendations or outcomes that were not measured.

A. Research Problem and Contribution

Location and cluster data was one of the main issues that needed to be addressed to make the data more consistent, traceable and useful for planning. This paper provides a practical workflow which is derived from the internship tasks. It does not make any claim of measured improvements in dispatch time, cost or customer satisfaction, as there is no evidence in the source report to support these claims.

II. BACKGROUND AND CONCEPTUAL FRAMEWORK

A. Data Quality in Service Operations

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There are multiple aspects to data quality. Accuracy: Value equal to the actual place. Completeness: When required fields are completed. Consistency: The same location occurs as the same identifier throughout the file(s). The information must be current, and unique records must be controlled. These checks are complementary. A record might have all the necessary details filled in and still have the wrong city or it could have the correct pincode but an inconsistent cluster name.

Not all postal and operational boundaries coincide. Pincode can be used to identify a postal area [2] but it is not necessarily to be used to specify the best service area. Groups can be based on road access, travel time, locations of customers and vendor coverage. Pincode is thus a good starting point backed by local knowledge and geography checks. There should be clear membership rules for each cluster which staff can understand and can be applied again.

The location records are more valuable if coupled with vendor coverage and availability. If a vendor does not have the required skills, capacity and/or availability, then a nearby vendor may be an unsuitable vendor. This paper concentrates on geographic data and the organisation of geographic data. It does not evaluate all the factors to choose a vendor, and it cannot measure the total service process.

Accuracy, completeness, consistency, timeliness and uniqueness are related for work based on location. The combination of a correct pincode and an incorrect city is an inconsistent record. It is possible that a correct city with an outdated cluster will result in poor groupings. The data, therefore, must be subject to record-level checks and a well-defined procedure for maintaining up-to-date data.

Identify geographic clustering and zone classification. Know the concept of geographic clustering and zone classification.

B. Geographic Clustering and Zone Classification

Grouping together locations that are geographically close or are grouped due to some logical reason. Pincodes can be used to help divide up the groups but cannot fully capture the coordinates or road distance/travel time. Clusters should not be based solely on similar text but should be developed around the actual locality and service needs. Clear and consistent city boundaries can make it easier to provide a summary of each zone: North, South, East and West.

C. Vendor Management and Decision Support

Vendor management involves managing information on the vendor and matching requests with appropriate vendors. Both vendor directory and location data impact assignment decisions. While cluster information is important to be transparent, service performance is also dependent on the ability, skills, availability, and type of job and service level requirements of the vendors. Geographic information is useful in this process, but it does not ensure faster service.

D. Analytical Framework

The study is descriptive in nature using a case-study approach. It examines the source records, ensures that the fields are standardised, verifies geographic relationships, corrects cluster assignments, categorises zones and provides notes related to the record. Use of spreadsheet tools is useful when matching and summarizing, and map checks are useful to determine if a grouping makes geographic sense. These data checks would have to be correlated with dispatch and service data in a future evaluation. Table I shows how each concept is applied and what it is limited to.

TABLE I CONCEPT MAPPING

Concept	Application in this project	Boundary / caution
Data cleaning	Standardise fields and find inconsistencies	Requires clear rules for ambiguous records
Pincode-city validation	Check the recorded location link	Postal boundaries and service areas may not match perfectly
Geographic clustering	Group localities into useful service clusters	Proximity alone may not capture traffic or vendor capacity
Zone classification	Summarise locations by direction	Reference point and boundaries must be documented
Vendor data management	Organise coverage information for team use	Detailed vendor performance was outside the core scope

III. RESEARCH OBJECTIVES AND QUESTIONS

The primary goal was to review and amend pincode-based geographic clusters across multiple cities, for better vendor coverage. Specific objectives included identifying the pincode and city connections, verifying inconsistent locality or cluster labels, adding meaningful geographic zone designations and providing suggestions for checks that can be repeated for vendor management use.

The focus was on improving the use of location records. Pincode, city and state fields needed to agree with each other. Clusters of labels were required to designate the areas that they covered. Directional zones provided teams with a wider perspective of coverage, and vendor related information was grouped together for reference. The project also included recommendations on how the data could be kept afterward with the initial clean-up.

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These goals are not a controlled experiment but are rather a practical data-cleaning exercise. No comparison group has been provided, or total operational records are not provided in the source report. The study thus not only outlines what work has been done and what kind of work, but what further evidence is required to assess business results.

(RQ1) How can we integrate and use spreadsheet checks and geographic references to validate location records? (RQ2) What factors maintain consistency of clusters over time? In order to determine if improved location records will lead to improved performance in dispatching, what data would be required?

IV. MATERIALS AND METHODS

A. Research Design and Scope

This case study looks at a specific group of operational data tasks as outlined in the OJT report [5]. All the evidence in this report includes the description of the work, tools and estimated project scope. Confidential row level records are not reproduced. The process can be shown with aggregated data, without identifying vendors, internal contacts, etc.

The initial step was to look at the sheets available and finalize which fields are required for matching, e.g., City, State, pincode, locality, cluster and vendor coverage. You can use sorting and filtering to show empty cells and/or unusual values. Lookup functions are used to compare records from tables, and Pivot Tables are used to summarise groups of records. Validation of data can ensure that only approved formats are added to the data. The methods are effective if the data type is the same for all the fields in the field. For instance, if the pincode is stored as Text Data in one file and as a Number Data in another, there will be a mismatch for them.

Geographic review is a review that a spreadsheet alone would not be able to provide. Having a code or city label does not mean that the locality is in the right service cluster. Local context and maps can be used to find confused records. If there is evidence that is not clear, the record should be flagged for review rather than changed without supporting evidence. The OJT report mentions that some geographic relationships had to be checked further.

The work went through a cycle of review that was repeatable. As a result of cleaning, records that needed attention were identified. Assessments of possible corrections were made using spreadsheet matching and geographic checks. The updated clusters were then reviewed for consistency and unresolved cases sent for further review. When a value changes, it was easier to record why; this will help the process to be easier to audit and repeat if new locations are added.

The OJT report details work done in 15+ cities, with 1,000+ pincode records reviewed or corrected, and 100+ clusters. The other sites included Nashik, Kanpur, Bhopal, Ludhiana, Agra, Meerut, Rajkot, Thane, Vasai, Varanasi, Srinagar, Amritsar, Moradabad and Jammu and were used as reference models. The internship period is indicated as June-August 2026. This paper does not contain confidential information about the company.

B. Tools and Analytical Techniques

Tools used are listed in Table II. The primary environment was Microsoft Excel [4] and Google maps [3] were used to aid geographic plausibility checks.

TABLE II TOOLS AND TECHNIQUES

Tool / technique	Role in the workflow
Microsoft Excel	Cleaning, sorting, filtering, structured reporting
VLOOKUP / INDEX-MATCH	Matching location fields across datasets
Pivot Tables / SUMIFS	Summarising records and reviewing groupings
Power Query (where used in the project workflow)	Supporting repeatable data preparation
Google Maps	Geographic plausibility and proximity checks
Manual review notes	Recording correction decisions and exceptions

C. Procedure

The reported workflow (Fig.1) consisted of the following steps:

1) Gather as much operational information as possible and keep original fields for comparison.

2) Normalize pincode, city, state, locality and cluster columns; detect empty, duplicate names, and inconsistent names.

3)Match pincode-city relationships and evaluate locality and proximity using geographical references.

4) Check clusters and zone assignments; make corrections if there is adequate supporting evidence.

5) Keep notes of observations/reviews for revisiting exceptions and judgement-based changes.

6)Describe the corrected structure for operational and vendor-management reference.

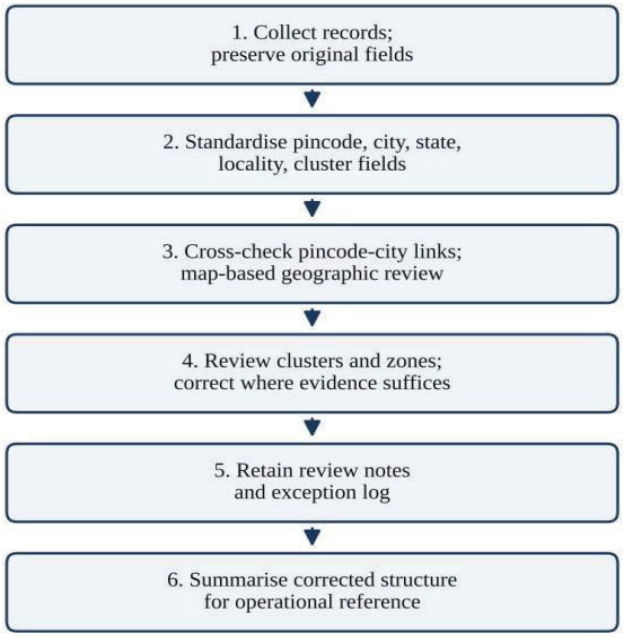


Fig. 1. Proposed representation of the reported workflow; it is a process illustration, not a time-series or performance chart.

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D. Measures and Interpretation

OJT report provides the approximate number of cities, pincode records / cluster and reports post correction accuracy of approximately 90-95%. It does not report the number of records that were checked, the method for calculating it, or whether it was done by an independent audit. The paper does not calculate an improvement against a non-documented baseline but rather reports this as an estimate from the project.

V. RESULTS AND ANALYSIS

A. Project Coverage

The report features work done in 15+ cities, 1,000+ pincode records reviewed/corrected, etc. There were thus local lists involved in the task that spanned more than one list. When data is put in many different cities, then it is essential to have consistent naming and repeatable checks, as it's possible that it adds up small differences between the files. Figures are approximate; the report does not have an audited total of all rows. They discussed the project scope that was reported, not a statistical sample.

There are multiple categories of location data problems that are addressed in the report: duplicate, inconsistent names, missing, incorrect mapping. The checks are different for each. Duplicate detection is dependent upon what field(s) are used to define the duplicate. Unless there is a reliable source for the missing information, it should not be added to the answer. Name differences require a standard format; Incorrect Pincode / city links should be matched with a trusted geographical reference.

The project also examined geographic clusters and refined the labels to be more specific to localities. Adjacent pincodes were evaluated for geographical and operational matches. Names based on locality may facilitate the clarity of coverage for staff. The source report does not provide cluster by cluster counts or demand; this paper does not assume that each cluster has the same size or same demand.

North, South, East and West zones are convenient ways of summarizing coverage. They are only useful as long as the same reference point and boundaries are used within each city. If the rules of the boundary are not written down, it may be difficult to interpret the directional label. Zones should be used in conjunction with detailed locations and not in place of these fields.

Also included in the report was vendor-related information that was made more geographically accessible and convenient for review of availability. Vendor performance scores, cost comparisons or detailed coverage counts are not included in the source material. The following outcomes are not presented here. After the fields are standardised and approved for use, the next step may be to connect the vendor information with location records which have been cleaned.

Table III and Fig. 2 summarise the scope reported in the OJT report. These are not audited operational totals and are approximate.

TABLE III REPORTED PROJECT SCOPE

Indicator	Reported scope	Interpretation
Cities covered	15+	Several city datasets needed the same field rules
Pincode records	Approx. 1,000+	Checking and matching individual records was central
Clusters reviewed / corrected	100+	Cluster names and group membership needed review
Post-correction accuracy	Approx. 90–95% reported	Reported estimate; calculation method needs documenting

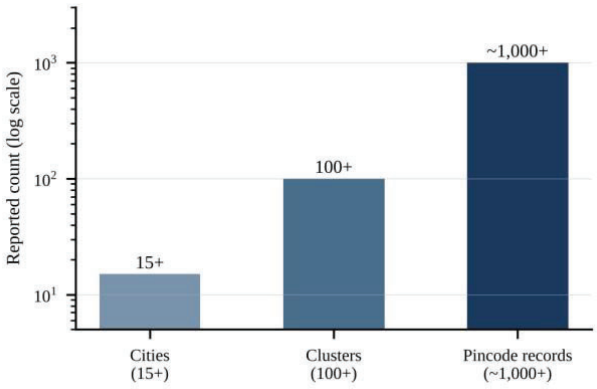


Fig. 2. Approximate reported scope. A logarithmic scale is used because the three counts differ substantially in magnitude.

B. Data-Quality Changes

The report is a comparison of the original records and the corrected structure. The major working areas were pincode mapping, cluster names and area coverage and geographic grouping (Table IV). Consistent fields help to filter, summaries, check and share records between teams.

TABLE IV
DATA-QUALITY ISSUES AND CORRECTIONS

Data element	Issue described in report	Correction approach
Pincode mapping	Some inconsistencies	Validate pincode against city/state reference
Cluster names	Not always localityspecific	Use clear labels based on localities
Area coverage	Required improvement	Check that the area belongs in the cluster
Geographic grouping	Inconsistent in some cases	Check geography and apply the same cluster/zone rules
Vendor reference data	Needed organisation for operational use	Organise coverage fields and protect confidential details

C. Zone Classification

North, South, East and West were general geographical terms used in the project. Although these labels help the reports to be readable, each city must have a document-based reference point and boundary rules including what is considered central and outlying areas. Directional zones should not take the place of more detailed locality clusters but should complement them in cities with irregular layouts.

VI. DISCUSSION

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A. What the Findings Suggest

There is a possibility of using spreadsheet functions to find mismatches and to perform repeated checks more quickly, but the analyst must still have an understanding of how each field is used in the organisation. Match can be correct but the cluster rules not. Good data work requires the selection of appropriate data tools, understanding how data tools work, and documenting decisions.

Once the data is corrected, it won't be accurate forever. Locations shift, vendors come and go and local data becomes current. If not properly maintained, the same mistakes will occur again. The process must have a named owner, a standard method of adding records, periodic reviews, and a location to record pending cases.

One of the direct products of the project is A corrected cluster list. It may be possible to achieve faster assignments, but this may depend on vendor availability, the types of assignments, scheduling/dispatching and location data. If no time stamps are included and a comparison to an appropriate level of difficulty, the paper cannot claim that the work saved time on the assignment. The practical outcome is a more structured collection of location records that provides the operations team with a more uniform foundation to compare locations, the source material doesn't mean service turnaround time was improved.

There is a difference between spreadsheet matching and map checks. Large lists can be summarised and mismatches can be highlighted using spreadsheets. Maps can be used to identify supposed records that appear valid in a table but seem incorrect on the map. Automated checks may reapply a wrong rule when the reference is incorrect, and manual checks of maps may be inconsistent from one checker to another. Both risks are minimized by recording rules.

B. Interpreting the Reported Accuracy

The OJT report provides a post-correction estimate of accuracy of approximately 90-95% but the material supplied doesn't specify the reference standard, sample or calculation, therefore the accuracy cannot be determined independently from the OJT report. For it to be assessed correctly, there must be a definition of accuracy. A possibility is to calculate the proportion of records sampled for which the pincode, city and cluster are all equal to a reference that has been approved. For future audits: A representative sample should be selected, fields should be compared to approved samples and cases of uncertainty should be listed separately. The same method should be employed prior to and post correction, otherwise it would be impossible to calculate percentage-point improvement

C. Relationship to Operational Performance

Better clusters could reduce location-related reassignment, manual clarification and unsuitable vendor matches. The current report does not measure these outcomes. Dispatch time also depends on vendor availability, required skills, traffic, customer scheduling, parts and job complexity. A future study should track service measures alongside data-quality checks before claiming a link between them (Table V).

TABLE V POTENTIAL PATHWAYS TO OPERATIONAL BENEFIT

Potential pathway	Suggested measure	Evidence needed
Fewer location mismatches	Mismatch rate per 100 records	Consistent audit sample before and after correction
Less manual rework	Correction/review minutes per batch	Time logs or workflow timestamps
Better vendor matching	Eligible-vendor match rate	Job and vendor assignment records
Faster dispatch	Request-to-assignment time	Timestamped service requests and assignments
More stable data	Records passing periodic checks	Scheduled quality audits over time

D. Practical Contribution

The project provides a process others may want to follow for their multi-location service teams: Normalize fields, preserve original values, validate geographic relationships, document exceptions, and refresh data on a regular basis. A different organisation would have to tweak the rules to fit their properties, vendor and service needs.

VII. RECOMMENDATIONS AND IMPLEMENTATION ROADMAP

The suggestions are made in practical order. The first is to finalize the master data structure and correction rules. With consistent fields and a person in charge of the field maintenance, dashboards and automation will be more useful.

Establish one approved master data set, or designate one data system as the official source, if any. Use a common identifier and definitions in the same fields if teams will require their own sheets. Include the original value next to each correction, so changes can be identified. Marks for queries that have not been answered so that users do not incorrectly interpret the queries as being answered.

Develop a basic validation sheet for pincode, city, state, locality, cluster, zone and vendor-coverage. It should establish reasonable formats, label the trusted source for each component, and discuss what to do when there are discrepancies. The rules should be easily located and readily followed by the staff who add and update records.

Establish exception log for dubious records. Assign each case a status (e.g., new, under review, corrected or unresolved). Document the person who reviewed it, when it was reviewed and why the change was made. This helps to ensure that decisions are documented and that the team can focus on documents that could impact assignments.

Wait until you know the rules before automating checks. Standard cleaning steps, identifying duplicates, comparing reference lists and generating exception reports can be repeated via Power Query or scripts. Compare the automated test results with a sample that was checked manually before relying on the results. A dashboard then would indicate missing fields, records that need to be reviewed, failed checks, and last refresh date.

To determine if cleaner data makes a difference in operations, begin to record a baseline. The mismatch rate, time spent making the mismatch, request-to-assignment time, reassignments as a result of location errors are all useful

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measures. Monitor these for a specified time and take into account fluctuations of demand, vendor availability/service mix when analyzing the results.

TABLE VI PRIORITISED RECOMMENDATIONS

Rank	Action	Implementation detail	Proposed success indicator
1 – High	Controlled master dataset	One approved source, unique ID, original plus corrected values	Share of records with required fields completed
2 – High	Standardise field definitions	Document rules for pincode, locality, cluster, zone and vendor coverage	Share of records passing validation
3 – High	Periodic validation	Monthly or quarterly reviews; track exceptions	Age of unresolved exceptions
4 – High	Assign data ownership	Owner for updates, approvals and change records	Share of changes with owner and timestamp
5 – Med.	Operational dashboard	City, zone and cluster counts, missing fields, exceptions	Dashboard freshness; active exception count
6 – Med.	Automate repeatable checks	Power Query or scripts for duplicates and reference matching	Manual processing time per batch
7 – Med.	Link data quality to service KPIs	Track assignment time and rework linked to mismatches	Median request-toassignment time; mismatch rate

A. Suggested Phased Rollout

TABLE VII PROPOSED PHASED ROLLOUT

Phase	Timing	Deliverable
1: Stabilise	Weeks 1–2	Approved data structure, field definitions and owner
2: Validate	Weeks 3–4	Exception log, quality checklist and sample audit
3: Visualise	Weeks 5–6	Dashboard for coverage and data quality
4: Automate & evaluate	Weeks 7–10	Repeatable validation checks and KPI baseline

The timeline is a suggested plan and is not an actual list of work accomplished. The operations team should review each of the phases. Academic reports and shared dashboards should never reveal information about vendors such as contact information or other commercially sensitive data.

B. Minimum Data-Governance Controls

Never overwrite the only copy of a source field: Always leave original values along with corrected values.

•Establish field validation rules and authoritative source for each field.

•Record review date, reason for change, status for review.

•Avoid sharing information or outputs that are sensitive to vendors, except when it is about aggregated outputs.

•Re-check records, after city expansion, vendor onboarding or changes to service coverage.

VIII. LIMITATIONS AND FUTURE RESEARCH

A. Limitations

The OJT report shows the work and provides an approximate count, but not the entire data set, nor a full audit trail. Therefore, it is not possible for an external reviewer to make all corrections. However, the report does not provide any details on how the accuracy figure was determined. The purpose of this paper is to describe an applied project rather than a statistical business impact test.

The quality of the clusters is also dependent upon the detail in the source data. A pincode may not be able to identify all locations that are important for the planning of services and geographic proximity does not necessarily imply proximity for journeys. Not all vendor-selection factors have been evaluated in this study—service skills, availability or performance, for example. All of those would have to be incorporated into the model for assignment to follow.

The study excludes and does not include period outside of the internship and data not provided by the intern to the operational data. No service data with a time stamp has been provided in it to test changes in dispatch speed, cost or customer satisfaction and confidential company information has been deleted.

B. Future Research Design

A more robust follow-up would establish a reference sample and recheck and review the same records before and after the correction. It might be able to perform accuracy, completeness and mismatch analysis, correlate the corrected data with service requests, vendor assignments and ensure the privacy and commercial sensitivity of the data. When making comparisons, service type, city, vendor availability, demand and job complexity (where available) should be taken into consideration. Table VIII presents some suggestions for directions.

TABLE VIII FUTURE RESEARCH DIRECTIONS

Direction	Method	Possible output
Accuracy audit	Blind sample review against a documented reference	Baseline and final accuracy with confidence limits
Dispatch impact	Compare request-toassignment time before/after	Median and percentile change, with limitations
Geospatial optimisation	Use coordinates, travel-time estimates and service demand	Candidate cluster design for operational review
Vendor coverage	Join coverage data with job demand and availability	Coverage gaps and over/underserved zones
Automation assessment	Compare manual and automated validation batches	Processing time, exception rate and auditability

IX. CONCLUSION

This case study outlines the work done on mapping Pincodes, Cluster analysis of localities, Zone classification and Vendor Reference data during an internship at Inspacco. The OJT report provides information on the number of cities covered, the number of pincode records reviewed/corrected and the number of clusters reviewed/corrected and also gives the accuracy post correction at approximately 90–95%. The accuracy figure listed in the report is a project estimate and no operational improvement can be made without a baseline or dispatch-performance data.

It's an ongoing process to maintain location data accuracy. While analysts can make corrections to a data record, there should be rules for adding new data, approving corrections,

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reviewing exceptions, and changing old data. If not, errors may creep back in and future analysis may be affected.

The primary recommendation is to keep an approved master dataset, apply common validation rules, conduct audits on a regular basis, record exceptions, and monitor data quality on a dashboard. Once reliable baseline data is obtained, measures like assignment time, rework and service quality should be tested separately.

APPENDIX A. PROPOSED VALIDATION CHECKLIST

TABLE A-I VALIDATION CHECKLIST

Check	Pass condition	Action if failed
Required fields	City, state, pin code and cluster are populated	Place record in exception queue
Pin code-city consistency	Reference check supports recorded city/state	Verify source and retain correction note
Cluster relevance	Locality fits documented cluster rule	Review with geographic reference
Zone assignment	Zone follows approved city specific rule	Reassign only after review
Audit trail	Change has owner, date and reason	Do not close record until documented

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