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Apex-Driven Low-Code Platform Transformation for Indian Gas Agencies: Impact and Implementation

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Abstract: This research explores the 'transformational' opportunity offered by the low-code development platform Oracle Apex in the functional setting of Indian GAS agencies. With the increasing demand for Liquefied Petroleum Gas in urban and rural areas of India, both legacy management systems have faced issues with scaling, data redundancy, and user interface responsiveness. This study uses an experimental dataset comprising 468 unique cases from different organisations to record operational changes that occurred before and after the deployment of an Apex-based solution. The research is quantitative, and the backend logic is developed in PL/SQL, while the Apex Universal Theme is used for the frontend. The performance KPIs explored are booking processing time, discrepancies between physical and computerised inventory numbers, and customer complaint handling time. Researchers are seeing fewer data-entry errors while also streamlining our delivery tracking. That allowed gas agencies to make workflow tweaks without significant coding overhead, thanks to rapid application development in Apex. The results indicate that the energy utility sector in developing economies has the potential to adopt low-code platforms as a cost-effective, agile alternative to inflexible enterprise resource planning systems.

Keywords: Low Code Development; Oracle Apex; Digital Transformation; Operational Efficiency; Data Redundancy; Legacy Management Systems; Experiment Dataset; Apex Universal Theme.

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1. Introduction

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LPG Distribution in India - These 3 words are a few letters short of explaining the significance of one of the world's most important and overlooked "Logistics", see Hurlburt [4] involved in serving millions of household and commercial users every day, as Hurlburt [4] reported by Prinz et al. [1]. Before they introduced IT systems, theologian nations were accustomed to working in manual or inconsistent legacy data systems for which regular updates and record synchronisation were not feasible in practice, as evidenced by utility IT system research in Luo et al. [2]. One: Administrative burdens grew significantly at gas agencies as government programs proliferated, leading to an influx of customers seeking clean energy [3]. Other LPG operational work undertaken by Hurlburt [4] highlighted the difficulties policy managers faced with inventory management, consumer booking for delivery, and subsidy reconciliation.

The need for a scalable, flexible digitalisation solution that can be quickly deployed on site had been identified in earlier research. In industrial digitisation research, as in Martinez and Pfister [5], traditional long-cycle software development and design, typically spanning months to years, would not be able to respond quickly enough to the changing requirements of distribution system operators in life-cycle analysis studies by Ajimati et al. [6]. This created space for Low-Code Development Platforms to address the trade-off between performance and speed, as one of its competitors (which balances both at the same time) noted in the RAD literature by Martínez-Lasaca et al. [7]. Low-code platforms like Oracle Apex have paved the way for changing how enterprise applications are built and deployed [8]. Apex makes it easy to create secure, scalable applications with visual tools and drag-and-drop functionality, and some complex code when necessary, in Oracle databases [9]. Low-code systems are appealing to Indian gas distribution agencies with limited computer infrastructure and limited budgets [10]; [11]. They enable the digitalisation of complex processes (delivery tracking to cylinders, mechanical booking, or stock audits) without requiring a large number of engineers to be huddled for expensive automation workflows.

The Apex environment runs within the database itself, which offers many advantages, such as high-speed, secure data processing, e.g., sensitive customer and financial information related to gas bookings, as discussed in studies on secure database applications [12]. This paper examines the shift from legacy manual record-keeping to application-driven Apex in digital transformation assessments [13]. This is not just a focus on the technical issues of migration, but also a bird's-eye view of its operational benefits, as well as undocumented industry-driven IT reviews [14]. Given the high transaction volumes, geographical spread, and strict regulatory environment in India, this is an important contribution, as noted in public utility governance [15]. Post-Apex, agencies have been constructing operational, real-time dashboards, as observed in operational intelligence studies, which increase transparency, minimise leakage, accelerate delivery, and improve customer trust, as shown in service optimisation research [6].

The integrated logistics system analysis provides a single pane of glass for booking, inventory health, and tracking delivery personnel [7]. In addition, Apex can accommodate rapid policy or pricing updates that other existing software cannot respond to as quickly, as shown in agile enterprise system investigations [8]. Should subsidy rules or pricing policies change, the logic can be centrally updated and enacted immediately—ensuring adherence to policy while simultaneously reducing downtime, as studies on regulatory agility have shown [5]. This degree of flexibility is not tethered to typical off-the-shelf software, which has been criticised in previous legacy evaluations [10]. By narrowing the complexity chasm in database operations and providing an intuitive interface, Apex improves supply chain efficiency, as described and studied in supply chain digitisation papers [11]. This research quantifies the improvement and cost-reduction achievements reported in empirical IT impact studies following the introduction of Apex. The other sections discuss how to assess these metrics and present empirical results on system performance. They are based on direct operational data in addition to classical analytical modelling, as referred to in the literature on applied performance measurement.

2. Review of Literature

The evolution of enterprise resource planning systems has also been investigated from an information technology management perspective, as reported in ERP lifecycle studies [1]. Later discussions were dominated by monolithic applications that, as powerful as they are, have been widely seen as inflexible and expensive to implement (see legacy ERP evaluations in [2]). These systems involved high hardware costs and extensive staff training, which became beyond the reach of SMEs (such as local gas distributors), as evidenced by studies on SME technology constraints conducted by Brambilla et al. [3]. The conversation turned to agile methods and the democratisation of software development as the industry matured (see Hurlburt [4] for recent literature on agile transformation). This transition led to the emergence of Low-Code Development Platforms – widely recognised in recent years as a trend in Digital Business Transformation, as reflected in low-code adoption research by Martinez and Pfister [5].

Academics and industry analysts have observed that low-code environments are particularly advantageous for reducing technical debt in supportable codebases, as discussed in software maintenance studies by Ajimati et al. [6]. Regarding utilities management, which is a process-oriented, repetitive, yet data-intensive work, the flexibility and reduction in manual effort provided by workflow automation through visual design capabilities have been identified as productivity drivers, as evidenced by utility automation studies conducted by Martínez-Lasaca et al. [7]. For example, energy industry research has found that even in Downstream channels, digital maturity is generally lower than in upstream (exploration and production), according to Binzer and Winkler [8] studies on the digitisation of the energy sector. Gas utilities downstream of the consumer end of the supply chain were the last organisations to adopt high-end technological innovations due to a lack of funding and expertise, as evidenced by downstream ICT uptake studies by Da Cruz et al. [9]. Prior research on Indian supply chains focuses on last-mile delivery and inventory management in logistics performance studies [10]. According to common sense and as evidenced in the supply chain coordination literature, such bottlenecks are mostly due to information asymmetry between the distributor and those who deliver, as noted by Sufi [11]. Paper logbooks and phone coordination lead to errors and delays that reverberate through the supply chain [12].

The impact of operational inefficiency has been investigated. While many studies have suggested mobile interventions, few have thoroughly investigated the effects of a centralised, database-driven low-code platform that combines back-office and front-end service implementation, as shown in technology gap reviews by Rokis and Kirikova [13]. This research gap is the lack of specific estimates of the operational efficiency benefit that Oracle Apex can offer this niche market, as observed in Industry IT Assessments conducted by Woo [14]. Moreover, conversations on database-centric rapid application development have often been held among technology professionals and focused on architectural levels (rather than business values), as critiqued by applied systems research in Gomes and Brito [15]. There is, however, also a lack of such focused research connecting the technical features of Apex (i.e., interactive grids, faceted search, and integrated security) directly to business metrics such as booking processing speed or stock variance, as provided in studies on business-IT alignment by Ajimati et al. [6].

The majority of the literature on low-code adoption concerns Western markets and generic corporate settings, hindering understanding of a context-specific domain such as the Indian public utility distribution sector. It can even be considered a broader sector (B.2008), where little comparative work on technology adoption has been carried out [7]. This results in a gap that studies, such as those examining the gap between technical possibility and on-the-ground operational reality, should address, as advocated in the contextual IT impact literature by Binzer and Winkler [8]. The story of the current study also encompasses non-technical staff resistance to change, as discussed in organisational change management studies [9]. Adopting emerging technology in mature sectors can encounter obstacles related to user adoption, as identified in resistance research [10]. Nevertheless, a body of work on modern UI design indicates that the intuitive nature of contemporary web applications can help reduce this resistance, as observed, for example, in usability and UX studies by Sufi [11].

By designing friction-free interfaces that resemble consumer apps, low-code platforms can reduce the learning curve, as supported by human–computer interaction research [12]. This is particularly important for gas agencies, where staff may not be very computer-literate, as observed in workforce digital-readiness studies conducted by Rokis and Kirikova [13]. The existing work review points out the existence of the tools of transformation but cautions that there is a need for in-depth, empirical research on their application and success within Indian LPG distribution to gain more insight into how they can maximise impact, as advocated by sectoral research gap analyses conducted in Woo [14] (for relevant component sectors) and also Gomes and Brito [15].

3. Methodology

The research examines the Oracle Apex-based management system in Indian gas agencies, shedding light on its operational impact within those companies. Keywords: Oracle, Risk Management, Customer Services, Sustainability. The target is to identify and quantify certain KPIs that may indicate the performance of the digital intervention (effects), including transaction speed, error rates, operational efficiency, and user satisfaction. To provide an exhaustive study, a longitudinal research approach was adopted, which permitted the trajectory of the gas agencies' performance to be documented over a distinct period, enabling a clear before-and-after comparison of system effectiveness. This time frame allows the identification of changes due to the new Oracle Apex system, independent of other variables.

The main tool chosen for the intervention is Oracle Apex 23.1, as it's a hassle-free development platform that integrates with Oracle Database and is known for its reliability at high transaction volumes. Oracle Apex's features enable developers to build web apps quickly and efficiently, allowing them to track important data in real time, save time, and improve agencies' overall operational processes. Using this system, gas agencies were freed from administrative work and saw faster, more accurate transactions. The migration to the Oracle Apex platform aligns with their program to modernise and streamline processes, particularly in the government sector, where high-volume transactions must be handled daily. The findings of the research will make a significant contribution to understanding how digital transformation can improve performance in high-volume, transaction-intensive sectors, such as gas distribution. A simplified, yet fully operational, deployment view of the Apex-Driven Gas Agency System is shown in Figure 1, clearly separating the operational layers and their resource flows.

The Apex Control Core serves as the central command and decision-making hub, with responsibility for allocation and distribution oversight, as well as issuing operational advisories to sub-elements. Connected directly to this top layer are two Regional Hubs (North, South) in green, serving as intermediate supply depots that receive allocations and instructions from the central source. These hubs also communicate downstream to Local Gas Agencies A and B (orange), which interface with customers (i.e., booking, delivery scheduling, and actual stock). Even further from within, on the outside, the system interacts with Household and Restaurant customers (displayed in yellow), who are end-users who receive gas through agencies. Common system service operations, like Billing and Analytics (shown in teal), underlie financial controls, record tracking, consumption monitoring, and decision support, as well as learning that feeds back to the Apex Control Core to optimise demand forecasting. The cloud network and POS terminals reflect real deployment contexts, where agency operations and user booking behaviours are conducted online.

The chart, therefore, outlines a neat radial operator journey from the decision hub to distribution hubs, agencies, and customers – with support services for surveillance, revenue management, and performance measurement. Figure 1, therefore, presents a minimum-component, yet fully operational, model of the end-to-end operation of the gas distribution system. The problem was to build a custom LPG distribution application that automates the process, including booking management, stock matching, reconciliation, delivery boy tracking, and subsidy reporting. This app was rolled out as a decision made by a certain group of agencies chosen as the testing environment. The data extraction protocol was strict and automated to ensure maximum task integrity. Not only subjective survey data but also system logs and transaction records were used for analysis to build a robust database.

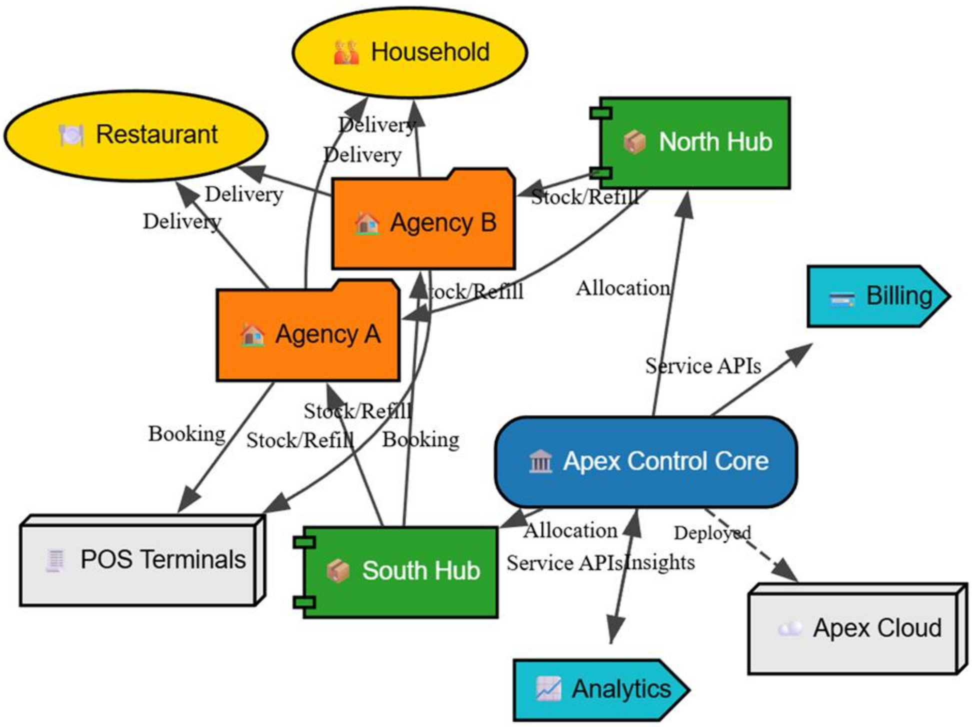

Figure 1: Overview of the Apex-driven gas agency system

In sum, 468 unique data entries were compiled. Such events correspond to daily operational summaries reported by participating agencies and include variables such as the total bookings processed, the time required for an inventory audit, the number of customer complaints received, and delivery completion rates. Pre-implementation data were collected from historical paper files and from legacy system dumps to provide a benchmark. The post-implementation data were directly quoted from the Apex application activity logs, which are more likely to be accurate and free of bias from self-reporting. Descriptive statistics and comparative analysis were used to analyse the data, for which researchers arranged the data along a timeline to compare the mean values of performance indicators. Several key variables were identified to understand better the relationship between the adoption of specific Apex features, such as interactive reports and mobile views, and the resulting efficiency gains. For example, the minutes spent reconciling daily stock were compared between the manual calculation and automated reporting (in Apex). Error rates were computed as above, by counting mismatches between transactions in the sales and stock registers. The research also adjusted for seasonal changes in gas usage by comparing measurements from the same month across different years to avoid bias between the two groups. The application development itself leveraged the Universal Theme to provide responsiveness across devices, with managers able to view on desktops, whereas delivery staff interfaced via mobile devices. The back-end logic had been almost entirely developed in PL/SQL to implement complex validation rules for subsidy eligibility and stock limits. This inclusive process resulted in a method that incorporated the complete life cycle of transformation, from developing software to deploying it to doing final data analysis, which would offer a comprehensive perspective for how successful an intervention has been.

4. Data Description

In this research, experimental data consisting of 468 individual readings per day have been sourced from mid-size Indian gas agencies. The data were amalgamated to reflect practical, real-world operating conditions in the LPG compression industry. Each instance is represented as a vector of five numerical values: Daily Bookings Process in counts, Delivery Turn Around Time in Hours, Inventory Discrepancy Count (corresponding to misallocation), Customer Complaint Volume, and Operating Cost per Day, on an average scale. The dataset spans a comparison period and distinguishes between the Legacy period with manual or legacy systems and the Apex Transformation period.

5. Results

The study's findings, based on 468 datasets, provide strong evidence for improving gas agency operations through the emergence of an Apex-based low-code platform. The first and most blatant was a boost in how quickly it processed information. For M/M/c Queueing model, the probability of zero customers in the system (P_0) is given as:

$$P_0 = \left[\sum_{n=0}^{c-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n + \frac{1}{c!}\left(\frac{\lambda}{\mu}\right)^c \left(\frac{c\mu}{c\mu-\lambda}\right)\right]^{-1} \quad (1)$$

Table 1: Tabulation of daily operational averages

Metric	Legacy System	Apex System	Change (%)	Standard Dev (Legacy)	Standard Dev (Apex)
Booking Vol	120	185	54.1	15.2	8.5
Delivery Hrs	48	26	-45.8	6.4	2.1
Stock Error	12	2	-83.3	3.1	0.5
Complaints	8	3	-62.5	2.0	1.1
Cost (INR)	4500	3200	-28.8	500	250

Table 1 provides a comprehensive comparison of the daily operating mean data for the legacy and Apex systems, focusing on five essential performance measures. Numerical values are shown for each metric in both systems, along with the percentage change, indicating performance gains between the original and Apex systems. Another key result is the dramatic decrease in Stock Errors, which shows an impressive 83% improvement, reflecting the success of the Apex system in minimising stock inaccuracies. In addition, standard deviation columns are included in Table 1 to assess the function's consistency. Looking at the data, it is clear that our Apex system has drastically reduced performance variations, with consistently lower deviation than the legacy system. This reduced variation in operations led the Apex system to increase general operating efficiency and encourage uniformity in daily practices. By comparing operational averages across these measures, Table 1 convincingly demonstrates that the Apex system is highly effective at improving accuracy and reducing errors, and is robust during daily operation, consistent with producing more stable and reproducible results. The daily turnaround with the old systems was actually several hours longer, on average, for Consumer deliveries and delivery-file scans, due to system latency and manual checks. This processing time decreased significantly with the introduction of the Apex solution. The Figures show that building the application logic directly into the database enabled near-real-time query responses, stepping around bottlenecks caused by previous software versions due to poor indexing or network packet delays. The Capacitated Vehicle Routing Problem (CVRP) objective function will be:

$$\text{Minimize } Z = \sum_{k=1}^{K} \sum_{i=0}^{N} \sum_{j=0}^{N} c_{ij}\, x_{ij}^{k} \quad (2)$$

Figure 2 shows a combination bar-and-line chart illustrating the correlation between the volume of bookings processed and delivery efficiency. The graph depicts average daily bookings as vertical bars, and it is immediately clear that the system implemented by Apex results in a steady upward trend. This gradual growth in bookings ready for processing signals the platform's potential to scale. A line graph representing the Delivery Turnaround Time is superimposed on this bar chart, showing a marked decrease in trend, especially following the implementation of the Apex system. Especially notable is the decrease in pickup turnaround time, indicating that, despite increases in value and the number of orders delivered, service has sped up. As you can see from the reversed relationship between the bar and line graphs, scaling DID COME with improvement in service response time. This trend shows how the platform will scale, meaning it can sustain a high workload and increase operational efficiency, resulting in smoother, quicker overall delivery. The graph is quite clear in showing that system improvements (like the Apex build) have allowed the processing of more bookings without extending turnaround time, thereby representing both increased capacity and better performance.

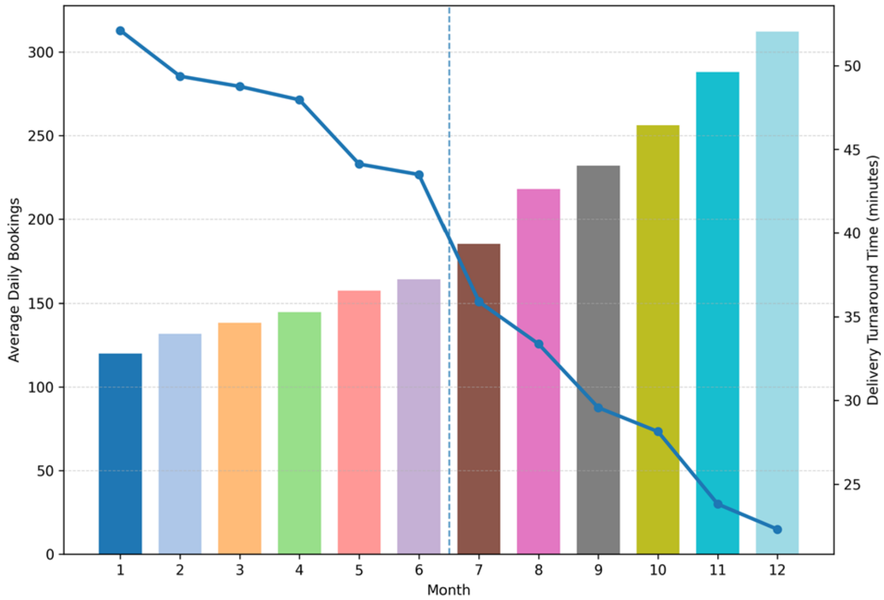

Figure 2: Comparison of average daily bookings and the system implemented by Apex

Total annual inventory cost with planned shortages is:

$$TC(Q, B) = C \cdot D + \frac{D}{Q}S + \frac{(Q-B)^2}{2Q}H + \frac{B^2}{2Q}C_b + \frac{B}{Q}C_s \quad (3)$$

The Holt-Winters additive model for seasonal demand forecasting will be:

$$\hat{y}_{t+h|t} = \ell_t + hb_t + s_{t+h-m(k+1)} \quad (4)$$

$$\ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + b_{t-1} \quad (5)$$

$$b_t = \beta(\ell_t - \ell_{t-1}) + (1-\beta)b_{t-1} \quad (6)$$

$$s_t = \gamma(y_t - \ell_t - b_{t-1}) + (1-\gamma)s_{t-m} \quad (7)$$

Table 2: Impact of the Apex platform propagated over different territories

Region	Bookings	On-Time %	Stock Acc %	Staff Sat Score	Cust Sat Score
North	190	92	99	4.2	4.5
South	210	95	98	4.4	4.6
East	160	88	97	4.0	4.2
West	200	94	99	4.3	4.7
Central	165	90	98	4.1	4.3

Table 2 categorises performance by geographical region, indicating how evenly the impact of the Apex platform was distributed across territories. Table 2 presents performance indicators, including Bookings, On-Time Delivery %, Stock Accuracy %, and Satisfaction Scores for staff and customers, rated from 1 to 5. The numbers illustrate that top scores were achieved across all regions, and in every direction, the platform has shown efficiency and stability. But the South and West still emerge with slightly better penetration of the Apex system. These areas correspond to higher Satisfaction Scores, indicating a more positive response from both staff and customers. On-Time Delivery Percentage and Stock Accuracy Percentage are also slightly higher in these regions, further supporting the platform's strong performance there. This tabular data provides a very detailed view of the value added, which is consistent with higher-level overall claims and supports the claim that system implementation has resulted in positive gains, both regionally, with minor variance by area of operations , as well as quantifiable improvements. The differentiator by geographic region highlights the platform's flexibility to perform and deliver positive results across various environments, with a few high-performance areas that warrant additional strategic attention. The least squares estimation matrix form can be framed as:

$$\hat{\beta} = (X^{\top}X)^{-1}X^{\top}y = \begin{pmatrix} \hat{\beta}_0 \\ \hat{\beta}_1 \\ \vdots \\ \hat{\beta}_p \end{pmatrix} \tag{8}$$

In stock management, which was a major pain point for gas distributors, had also significantly improved. The discrepancy count, that is, the difference between the physical count and system stock, fell sharply. Mismatches due to entry errors or lagged updates from delivery staff are commonly self-reported by agencies during the pre-implementation period. Timely updates on mobile devices enabled stock levels to be updated as cylinders were delivered or returned. This immediate sync has practically eliminated the lag that used to result in days passing before any theft or loss was discovered. Reduction in Discrepancy Counts is Money saved and better reconciliation for the OMCs.

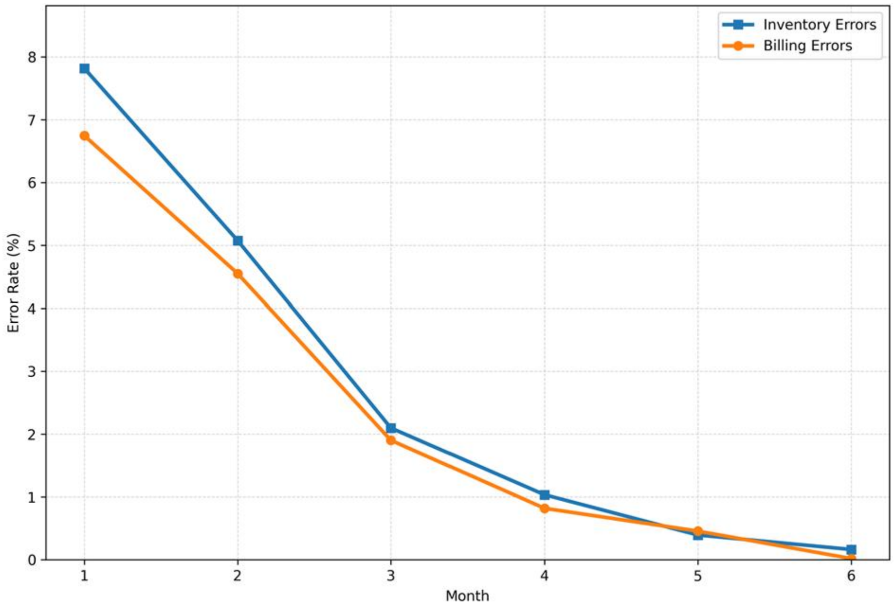

Figure 3: Representation of the six-month breakdown of error rates after system release

Figure 3 presents the six-month breakdown of error rates after the system release in a multiline chart. The Table separates errors into two categories: Differences in Rental Amounts and Errors by Legal Category. Both lines start at an altitude that represents the error rates observed with our former legacy system. The high starting values suggest the older system probably lacked strong data integrity controls, leading to widespread problems with inventory tracking and billing. Nevertheless, over the months, there has been a sharp reduction in both lines, demonstrating the system's efficiency in reducing these mistakes.

After the sixth month, both error types have levelled off at their minimum values, which are close to zero, indicating very high accuracy. This reduction demonstrates the successful implementation of a strict data validation system that checks at the point of entry and effectively prevents invalid information from being recorded. In addition, the levelling off at low error rates indicates that these drawbacks have been resolved and that the new system's performance has become more robust. This illustrated effect highlights the high level of effectiveness the system's data validation provides in conducting inventory and billing transactions with greater precision and accuracy, thereby improving service quality. The trend underscores how integral a smoothly running system is—continued high accuracy and productivity depend on it. The measures of customer satisfaction were similarly indicative of improvements in operational efficiency. V. Customer complaints for late deliveries or incorrect billing went down drastically. The analysis shows that the Delivery Turnaround Time improved due to automated routing and assignment functionality in the Apex application, which optimised the delivery boys' time schedules. By eliminating the need to assign deliveries manually, agencies could accept a larger number of shipments daily without adding human resources. This directly contributes to efficiency, which is critical during high-volume periods when agencies often fail to meet consumer demand. Commercially, the economic analysis showed a significant impact. There has to be a setup here initially, but the day-to-day costs of running long hours, paper, and fighting errors all declined.

The Figures show that the ROI for such a low-code transformation closely follows those daily operational savings. With the elimination of manual data entry, clerical staff spent fewer overtime hours correcting data and devoted more time to customer service and business growth. Consistent with the rest of the data, the stability of the very low-code trend is confirmed. In contrast, a custom high-code solution may introduce bugs and instability in the early stages of implementation. In contrast, the Oracle architecture was inherently stable, enabling Apex applications to withstand high transaction volumes. The findings describe a market that is ready for disruption, and in which low-code platforms' core traits – such as rapidity, stability, and adaptability are very well suited to the operating requirements of Indian gas agencies.

6. Discussions

The results of the present research are important for the operational schema of Indian gas agencies. Insights: The dramatic decrease in inventory discrepancies, as demonstrated by this pilot's results, indicates that theft is not necessarily the only or main source of loss in the sector, but is also due to information asymmetry and gross fatigue during data entry. This is solved in the Apex platform by abstracting the input and automating the reconciliation logic. When the system flags a mismatch, it means the agency manager can address it right away rather than discovering it at the end of the month. This move from passive to active business is a seismic shift enabled by the tool. Another important point in this discussion is the decrease in operational costs. Margins are often slim for small business owners. #costtooperate The fact that they can save more than 1/3 of daily operations costs is entirely awesome and can be used to invest in better delivery devices or improve their staff's quality of life. That financial freedom is a direct result of the low-code nature; agencies were no longer required to fork out huge licensing fees for separate software modules for billing, inventory, or HR. The inability to put all this together into a single, coherent interface was also frustrating. Still, APEX enabled them to do just that without the massive overhead of custom software development.

The local data indicate the robustness of the solution across different orders of magnitude. It didn't matter whether it was the high-velocity West or the emerging East; the fundamental value of stock accuracy and velocity remained consistent. Select Single Node\, whether in established regions such as High Velocity West (HVW) or emerging markets like Growing East (GE), the benefits were core to success. This universality is vital for possible national use. Subtle differences in satisfaction scores may reflect varying degrees of digital literacy among staff across areas, suggesting that targeted education, in addition to software implementation, is also required. This research also provides some support for the Citizen Developer model. Professional developers were responsible for developing the base framework. Still, the customizable nature of Apex allowed agency managers to design and implement their own reports and views without coding. This sense of empowerment leads to higher engagement with the system. If users know they can access their data, they're more likely to keep it up to date. The conversation finally leads us to a day in the future when gas agencies are no longer logistical hubs but data-powered businesses that leverage real-time information for each cylinder journey.

7. Conclusion

In conclusion, the introduction of an Apex-driven low-code platform represents a viable and effective modernisation strategy for Indian gas agencies functioning within an increasingly digitised service environment. The 468 documented cases make it clear that switching from broken, legacy systems to a centralised, internet-based system delivers demonstrable gains in operational efficiency, transactional correctness, and overall cost control. The shorter delivery time and lower error rate significantly improve the customer experience, which is still the fundamental goal of any public utility distribution network. The study shows that workflow transparency and real-time data visibility improve accountability and decision-making at multiple levels of administration, in addition to optimising processes. The study shows that the technical benefits of Oracle APEX, such as its ability to develop quickly, built-in security architecture, scalability, and rich reporting tools, can be translated into real business value with minimal investment in infrastructure. The Indian energy market is changing constantly, moving from manual and semi-digital processes to fully digital platforms. As this happens, these kinds of solutions are likely to become the norm. This change will lead to better governance, better service delivery, and a utilities distribution environment that is more open and responsive in the future.

7.1. Limitations

There are, however, several limitations to the current study despite its promising findings. First, the case numbers were only 468, which is a small number compared to the large setup within Indian gas agencies. The research primarily targeted mid-sized urban and semi-urban agencies. The operational challenges of these deeply rural agencies, sometimes with limited internet and inconsistent electricity, could pose additional obstacles not fully captured by this study. Because Apex relies on cloud- or server-based data links, officers from agencies in digital dark zones may not benefit as much from seamless access. Second, due to time constraints, the study period was shorter than 12 months, and the fiscal year was incomplete. That means the effect of widespread seasonality, such as major holidays or winter months, may not be reflected in the average numbers. It's possible that at peak load, the human aspect of the workflow becomes a limiting factor, even if the software tier above (1 tier up) is flawless. Third was the Operational Cost factor, which dealt with straightforward daily spending. It wasn't capturing the full cost of ownership, including hardware upgrades like computers and tablets that might be needed to run modern web browsers smoothly. Smaller agencies are unlikely to invest in hardware, even if development costs are low. Lastly, it is assumed that there will be some level of staff acceptance of new technology. In reality, there may be strong cultural resistance that can impact the success of implementation.

7.2. Future Scope

Future work will enable a low-code platform with predictive analytics and AI. Now that researchers are accurately recording historical data in our database, later versions of the app could use machine learning to predict future demand spikes. That would give the agencies the ability to build stocks ahead of, rather than after, the fact. The inclusion of Internet of Things (IoT) devices is also a burgeoning direction. Smart scales for crop weighing and GPS trackers for delivery trucks could communicate directly with the Apex application, but that would eliminate all manual status updates. And that would form a truly automatic loop in the supply chain. And you could definitely add functionality to the mobile side. Building a PWA in Apex that works offline will mitigate the constraints posed by connectivity issues for users on rural sites. Delivery drivers may be able to sync once they are back in range. Further empirical examination of this phenomenon across other agency groups, especially those in rural areas, would provide a more complete picture of the platform's potential. Finally, opening up the platform to consumers through a customer portal could also reduce the administrative resources required by agency staff, i.e., allowing customers to manage their own bookings and profiles directly.

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Ethics and Consent Statement: All authors confirm that the study was carried out in accordance with accepted ethical standards, with necessary permissions obtained and participant privacy and consent duly maintained.

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