Journal of Engineering Issues and Solutions

Towards Standardized Tax Reporting: Leveraging Business Analytics in the Inland Revenue Department

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Submitted: April 13, 2025; Revised: June 15, 2025; Accepted: June 21, 2025

https://doi.org/10.3126/joeis.v4i1.81599

ABSTRACT

The Inland Revenue Department (IRD) of Nepal has been recognized for its leadership in e-governance through the integration of digital technologies into tax administration. While existing systems have successfully transitioned manual processes into electronic formats, the absence of a comprehensive analytical reporting platform limits the ability of decision-makers to independently access and interpret critical data. This research investigates the key management reporting requirements within IRD by conducting a structured survey among senior officials. Priority reports focused on revenue collection, income tax returns, VAT returns, and taxpayer registration were identified and systematically standardized based on parameter prioritization. To address the performance constraints of Online Transaction Processing (OLTP) systems in generating complex reports, an Online Analytical Processing (OLAP) model is suggested. The model supports advanced business analytics operations such as slicing, dicing, aggregation, and dynamic visualization, enabling multidimensional insights for effective policy formulation and operational oversight. Demonstrated use cases highlight the model's capacity to generate actionable intelligence, with potential for further extension into predictive analytics using machine learning and AI. This approach bridges the gap between digital data collection and strategic decision-making, offering a scalable and adaptable solution for tax authorities in similar developing contexts.

Keywords: OLTP, Business Analytics, Tax Administration, E-Governance, Decision Support Systems, ICT for Development

1. Introduction

The Government of Nepal has placed increasing emphasis on e-governance as a national priority, with structured initiatives beginning nearly two decades ago through the formulation of the e-Governance Master Plan (eGMP) in 2006. Building upon this foundation, the Digital Nepal Framework (DNF) has laid out an ambitious

digital transformation roadmap, focusing on one nation, eight sectors, and 80 digital initiatives, with finance identified as one of the key sectors. Within this domain, the Inland Revenue Department (IRD), operating under the Ministry of Finance, plays a pivotal role in administering inland taxes and collecting revenue from millions of individual and institutional taxpayers. Over the years, IRD has adopted a range of technological solutions, evolving from fragmented platforms into a comprehensive, service-oriented web-based Integrated Tax System (ITS) launched in 2013. This system has streamlined taxpayer registration, return filing, payment, and compliance monitoring while supporting tax officials in their administrative and enforcement roles.

Despite receiving national accolades such as the Best ICT User in Public Sector Award (2011) and the Digital Governance ICT Award (2020) for its innovations in digital governance, IRD continues to face critical challenges in one of the most important domains of public sector ICT: management reporting. Currently, all analytical and performance reports are generated directly from the Online Transaction Processing (OLTP) environment of ITS. This has led to two major issues: first, system performance is degraded during peak operations as concurrent queries for analytics overload the transactional infrastructure; second, the reporting outputs are often inconsistent, ambiguous, and time-consuming to generate. This severely limits the institution's capacity for timely, evidence-based policy decisions, especially as tax systems must rapidly respond to dynamic economic and legislative changes. Previous studies have acknowledged these limitations and proposed initial solutions.

An internal assessment report by IRD in 2022 emphasized the urgent need to decouple the reporting mechanisms from the production OLTP system, recommending the development of a separate analytical environment (IRD, 2022a). Another study suggested the establishment of a data warehouse and OLAP-based platform to support business intelligence functions within IRD (IRD, 2022b). However, while these studies highlighted the importance of analytics, they remained generalized and did not explore the specific needs of decision-makers within the organization. They also lacked concrete steps to standardize report structures or validate the effectiveness of the proposed models in practical settings. The technical complexity and confidentiality of tax administration further constrain external researchers from fully engaging with the operational environment, thereby limiting the depth and impact of past research efforts.

This study seeks to address these gaps by designing and testing an OLAP-based analytics model tailored specifically to IRD's requirements. It begins by identifying the key reports sought by middle-level and senior-level management through a structured questionnaire. The study then prioritizes these reports and standardizes their parameters to ensure clarity, consistency, and usability. By applying OLAP techniques such as slicing, dicing, drill-down, and roll-up within a data warehouse framework, the proposed model enables dynamic visualization and interpretation of taxpayer data, significantly improving decision support capabilities of tax administration.

In light of these goals, the study seeks to answer critical research questions, such as: what are the most important reports sought by tax administration decision-makers? How can these reporting requirements be defined in a standardized format to ensure common understanding and interpretation? And how does OLAP-based analytical reporting surpass in efficiency and performance with traditional OLTP-based methods? In alignment with these questions, the core objectives of this research are threefold: first, to identify and prioritize high-value management reports along with their key parameters within the IRD context; second, to design and implement an OLAP-based analytics model capable of supporting those reporting needs; and third, to recommend standardized structures for report visualization and interpretation that enhance clarity, consistency, and decision-making efficiency. Ultimately, this research aims to drive IRD towards a more intelligent, responsive, and technically advanced tax administration system through the strategic application of data analytics and modern ICT practices.

Online Transaction Processing (OLTP) systems manage real-time, day-to-day tax transactions such as registrations and payments, while Online Analytical Processing (OLAP) enables advanced data analysis through aggregation and multidimensional views. Data Warehousing consolidates structured and unstructured data into a central repository for efficient retrieval and analysis, forming the basis for Business Analytics, which applies statistical techniques to identify trends and also supports data-driven decisions. Decision Support Systems (DSS) integrate data, models, and analytical tools to aid tax officers and policymakers in informed decision-making.

Additionally, understanding domain-specific terms is crucial: The Nepali Tax Year follows the fiscal calendar from the month Shrawan (4th) of one year to the month Ashadh (3rd) of next year; Value Added Tax (VAT) is a 13% indirect tax levied on value addition; and Income Tax is imposed on earnings as per the Income Tax Act. Tax Returns must be filed periodically, with filing periods depending on the tax type. Revenue Heads are classification codes for tracking income, and tax regimes define the rules for specific tax types. PAN (Permanent Account Number) uniquely identifies taxpayers, while Taxpayer Category and Status describe taxpayer classifications and activity levels. A Non-filer is one who fails to meet return submission deadlines. Together, these concepts provide the foundation for implementing an effective OLAP-based reporting solution in the tax domain.

The review of the previous reports on the Inland Revenue Department (IRD) systems highlights the evolution of its technology infrastructure and challenges in tax administration. Initially, IRD automated its processes in the late 1990s with the ProTax system based on Oracle replication technology, handling VAT registration and returns (IRD, 1998). Over time, synchronization issues led to inefficiencies, prompting the shift to web-based services and the integration of multiple systems into the current Integrated Tax System (ITS) in 2012, which utilizes Oracle19c and the .Net framework (IRD, 2012). However, ITS faced performance issues, particularly with database connections affecting reporting efficiency (IRD, 2022a). The need for a robust data warehouse system to support evolving reporting and decision-making requirements was recognized (IRD, 2022b). Despite significant reforms, the IRD still lacks comprehensive documentation and follow-up, resulting in underreporting of performance (IRD, 2023). In addition, taxpayer privacy rights are safeguarded by law, restricting access to sensitive information (Income Tax Act, 2002; VAT Act, 1996).

Previous studies have emphasized the role of OLAP systems in improving decision-making through multidimensional data analysis (Kaziyeva et al., 2020; Dahr et al., 2022). Effective management reporting requires structured processes for data integration, retrieval, and visualization (Hristidis et al., 2010; Liu et al., 2023), while data-driven IT governance aids in optimizing business operations (Biagi & Russo, 2022). Studies on decision support systems (DSS) have highlighted the importance of query optimization and multidimensional data for enhancing analytical capabilities (Harinarayan et al., 1996). Data analytics and reporting, supported by business intelligence tools, are crucial for improving compliance and tax administration (Timilsina, 2022; Martikainen, 2012). Furthermore, the use of data mining and artificial intelligence has proven effective in improving taxpayer compliance and detecting tax evasion (Atanasijević et al., 2019). The review suggests that IRD could benefit from a more flexible business intelligence solution to enhance reporting and decision-making (Timilsina, 2022). Additionally, the global Common Reporting Standard (CRS) calls for improved data sharing across jurisdictions to combat tax evasion (OECD, 2017).

Contributions

- **Theoretical and Methodological Advancement**

This study introduces a standardized analytical reporting model using business analytics concepts such as slicing, dicing, aggregation, and OLAP visualization within a public sector context. It contributes to the

academic discourse by providing a proof of concept for applying data analytics in tax administration, an area traditionally lacking in such innovation.

- **Practical and Organizational Impact**

The developed reporting interface enables IRD officials to analyze revenue trends, evaluate office performance, and take timely action through drill-down visualizations. This contributes to transparency, improves taxpayer compliance, and supports evidence-based decision-making at all organizational levels. It also identifies gaps in the current reporting system and offers a scalable solution for enhancement.

- **Foundation for Future Research and Innovation**

As the first structured attempt to develop an analytical reporting system for IRD's key operational areas, this study lays the groundwork for future research in tax data trend analysis, integration of AI/ML for non-compliance detection, and further standardization down to granular and atomic data levels.

2. Methods

2.1 Data Collection

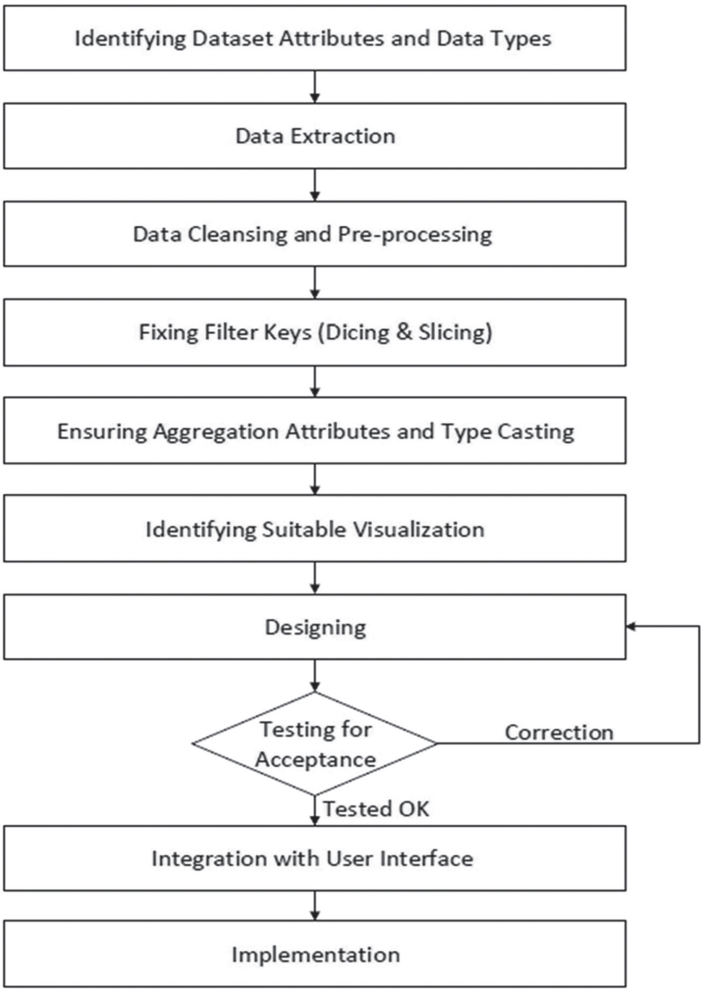

Figure 1 Design Framework for Analytical Report

The research framework, as illustrated in Figure 1, guided the development and implementation of an analytics model for enhancing decision-making at IRD and field offices. The study followed a systematic approach to standardize management reports by identifying modules with consistent and structured data, ensuring data correctness, defining attributes uniformly, and selecting appropriate parameters for filtering, aggregation, and visualization. Key activities included validating atomic datasets, checking for anomalies, selecting relevant chart types, and refining reports through iterative feedback. For analysis, critical modules and parameters were identified via questionnaire responses, and data were extracted using SQL queries from the operational database. Dimensions such as time, office, and tax type were used for filtering and grouping, while revenue figures and counts served as aggregation factors as shown in Table 1. To protect taxpayer confidentiality, data were aggregated monthly, resulting in a dataset of 49.69 million records spanning fiscal years 2073/74 to 2079/80 (BS), as shown in Table 2. A Python-based analytics model with a basic UI was developed to generate multidimensional reports in CSV format with visual outputs in bar, line, and pie charts. The model was validated by comparing generated results with the IRD's official annual reports.

The study adopted a mixed-method research approach, integrating both qualitative and quantitative techniques to ensure comprehensive analysis. Qualitative insights were gathered through discussions and interviews with key personnel to understand existing reports and clarify tax-related terminologies within Nepal's administrative context. Structured datasets from the past five years were selected to guide this process. Concurrently, quantitative data was collected via questionnaires distributed to tax officials, using a priority scale to rank critical reports and reporting parameters. The most significant reports identified through these methods were implemented on an OLAP platform and evaluated based on execution time and accuracy. Their usability was further validated through targeted user presentations and feedback.

Table 1: Dataset Used in Analytics Model

Module Name	Data Collection Parameters	Remarks
Revenue Collection	tax_office, tax_year, month, tax_regime, revenue_head, revenue_amount	The data of revenue deposited by taxpayers under appropriate revenue head as a tax or fee
Income Tax Returns	tax_office, tax_year, return_type, return_category, count	Yearly declaration of income and business transactions for income tax compliance
VAT Returns	tax_office, tax_year, filing_period, return_category, count	Periodic report of sales and purchase together with the VAT collected and paid during the period
Taxpayer Registration	tax_office, tax_year, month, taxpayer_type, count	Registration of different type of taxpayer as per the specific tax regime requirement

Modeling business analytics and generating standardized management reports by utilizing both primary and secondary data sources in a complementary manner was the main purpose of the study. Primary data was obtained through informal discussions and structured questionnaires involving relevant managerial personnel to identify the key reports critical for decision-making. These interactions guided the development of questionnaires that helped determine the most relevant datasets and reporting parameters. For secondary data, taxpayer transaction records maintained by the Inland Revenue Department (IRD) through its Integrated Tax System (ITS) were used. Specifically, data from the past six years were selected to ensure consistency, compatibility, and current relevance. To uphold taxpayer privacy and ensure data confidentiality, all extracted data were aggregated to monthly totals before use in the analytics model.

Table 2: Number of Records Used in Different Modules

Fiscal Year	Revenue Collection	Income Tax Returns	VAT Returns	Registration	All
2073.074	2264924	641104	1608925	204603	4719556
2074.075	2493792	715505	1760640	213041	5182978
2075.076	2761666	807020	2037110	414680	6020476
2076.077	2884208	925702	2493923	1191514	7495347
2077.078	3641522	1039836	2727194	796263	8204815
2078.079	4238439	1042411	2908595	847359	9036804
2079.080	4539805	782593	2917561	795629	9035588
Total	22824356	5954171	16453948	4463089	49695564

3. Results and Discussion

Group discussions, interviews, and questionnaire responses from 67 IRD officials—including senior, middle, and operational-level managers—revealed several key observations regarding the current state of management reporting. Although numerous reports have been developed within IRD, only a few share a standardized interpretation, resulting in inconsistencies due to ad-hoc generation practices and the lack of a defined reporting framework. While most respondents (77.6%) found the ICT-based reporting system satisfactory, 19.4% expressed dissatisfaction, citing performance delays and the need for customization features. A majority (73.1%) highlighted slow report generation as a major concern requiring immediate intervention. In terms of reporting priorities, the revenue collection report was ranked highest by most respondents, followed by income tax and VAT return reports, while the tax assessment report received the lowest priority. These findings underscore the need for standardized, optimized, and user-friendly reporting tools focused on tracking of revenue collection and monitoring of return filing.

3.1 Revenue Collection Report

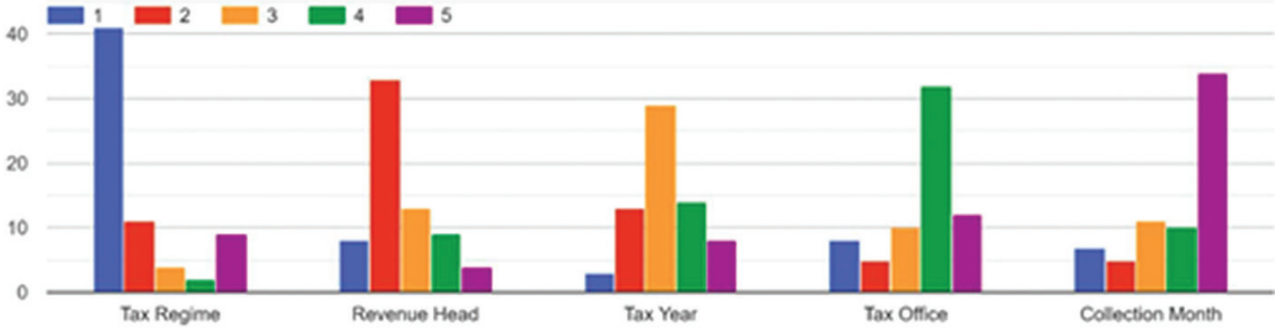

Figure 2: Priority Parameters for Revenue Collection Report

The revenue collection report holds paramount importance for IRD and national leadership, including the Finance Secretary, Finance Minister, and even the Prime Minister, due to its critical role in revenue mobilization. Survey responses revealed that "Tax Regime" is the most prioritized parameter for aggregating revenue data, with 41 officials ranking it highest, followed by "Revenue Head" and "Tax Year." In contrast,

"Tax Office" and "Collection Month" received lower priority. This preference indicates a focus on macro-level tracking of revenue under major tax types like Income Tax, VAT, and Excise, particularly for performance evaluation and meeting fiscal targets. The interpretation of revenue collection reports is essential for strategic monitoring, performance benchmarking, and targeted interventions. Table 3 summarizes representative filter and grouping combinations—such as tax regime, year, office, and revenue head—and their corresponding chart types, aiding in consistent understanding and effective visualization of trends, contributions, and comparisons across different dimensions of tax collection.

Between Tax Years 2074 and 2079, the IRD collected a total of NPR 384.92 billion in 2074, which fluctuated slightly over the years, peaking at NPR 483.52 billion in 2078 before slightly declining to NPR 479.85 billion in 2079. Income Tax (ITX) consistently contributed the largest share, rising from NPR 140.47 billion in 2074 to NPR 229.34 billion in 2078, before dropping to NPR 213.62 billion in 2079—a 6.85% decrease, likely due to the COVID-19 pandemic. VAT collections increased from NPR 76.31 billion in 2074 to NPR 117.54 billion in 2079, with a stable trend during the last three years. Excise Duty (EXC) also showed significant growth, rising from NPR 60.50 billion to NPR 103.96 billion over the same period. Health Service Tax (HST) showed an anomalously high value of NPR 87.22 billion in 2074, dropping sharply in later years. Education Service Fee (ESF), Interest Tax (INT), and Rent Tax (REN) contributed relatively minor shares, with ESF reaching only NPR 2.00 billion in 2079. In 2079, the revenue composition was led by ITX (44.5%) and VAT (24.5%), while ESF accounted for just 0.4%. A drill-down into Office 19 revealed a revenue pattern dominated by excise collections throughout the period.

Table 3: Interpretation of Revenue Collection Reports

Filter	Group1	Group2	Aggregate	Chart	Interpretation
None	Tax Year	Tax Regime	Amount	Bar	Yearly comparative chart of revenue collection under each tax regime
None	Tax Regime		Amount	Pie	Contribution of each tax regime in revenue collection during total time period
Tax Year	Tax Regime		Amount	Pie	Contribution of each tax regime in revenue collection during the given tax year
Tax Year	Tax Regime	Revenue Head	Amount	Bar	Composition of each revenue head in collection of tax under different tax regime on the year
Office	Year	Tax Regime		Bar	Yearly comparative chart of revenue collection by given office under each tax regime
Office	Tax Regime			Pie	Contribution of each tax regime in revenue collection by given office during total time period

Table 4: Yearly Revenue Collection by Tax Regime

Tax Year	ESF	EXC	HST	INT	ITX	REN	VAT	Total
2074	0.91	60.50	87.22	14.98	140.47	4.53	76.31	384.92
2075	1.07	73.61	2.51	18.83	170.69	3.35	88.31	358.37
2076	0.58	64.86	3.46	22.01	193.23	2.65	98.16	384.94
2077	0.37	81.50	5.51	22.32	200.82	2.86	116.53	429.90
2078	1.24	102.94	6.28	24.73	229.34	3.08	115.91	483.52
2079	2.00	103.96	6.76	32.92	213.62	3.04	117.54	479.85

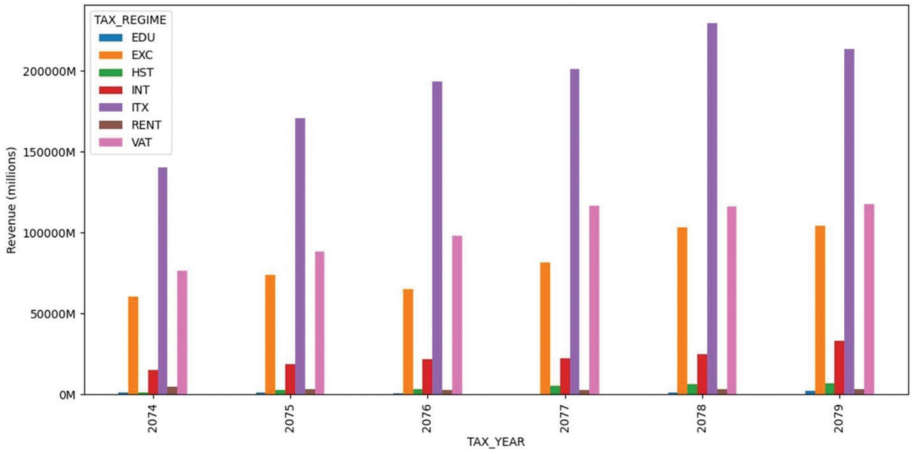

Figure 3: Yearly Revenue Collection by Tax Regime

3.2 Income Tax Returns Report

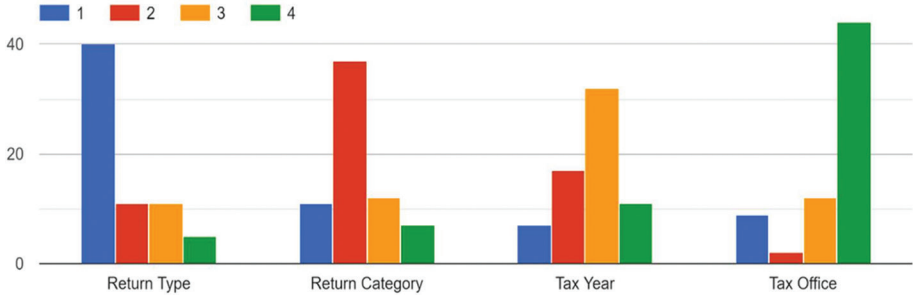

Figure 4: Priority Parameters for Income Tax Returns Report

The Income Tax Returns Report plays a vital role in monitoring taxpayer compliance, as timely submission is mandated by the Income Tax Act, 2002, with penalties for delays. According to survey responses, "Return Type" and "Return Category" are the most critical parameters for aggregating income tax return data, with lower emphasis on "Tax Year" and "Tax Office." These reports help the IRD track taxpayer behavior and identify potential misreporting in business-to-business transactions. The analytics model developed for this study includes combinations of filters and groupings, as illustrated in Table 5, to provide clear visualizations such as bar, pie, and line charts. These facilitate comparative analysis across time, categories, and offices, aiding in more effective monitoring and assessment of income tax return submissions.

Table 5: Interpretation of Income Tax Return Reports

Filter	Group1	Group2	Aggregate	Chart	Interpretation
None	Tax Year	Return Type	Count	Bar	Yearly comparative chart of income tax return under each return type
None	Return Type		Count	Pie	Composition of each return type during total time period
Tax Year	Return Type		Count	Pie	Composition of each return type during the given tax year
Tax Year	Return Type	Return Category	Count	Bar	Composition of each return category under different return type on the given year
Office	Tax Year	Return Type		Line	Yearly comparative chart of different type of income tax return received by given office
Office	Return Type			Pie	Composition of each income tax return type by given office during total time period

Table 6 shows the yearly income tax return filings categorized as D01, D02, and D03 from Tax Year 2074 to 2079. In 2074, the filings were 421,855 (D01), 10,216 (D02), and 283,298 (D03), which increased steadily until 2078, reaching 678,118 (D01), 61,962 (D02), and 299,104 (D03). However, in 2079, all categories saw a significant decline with filings dropping to 501,349 (D01), 44,924 (D02), and 215,375 (D03), resulting in an overall decrease of 26.71% compared to 2078.

Table 6: Income Tax Returns Filing by Tax Year

Tax Year	D01	D02	D03
2074	421855	10216	283298
2075	471327	17734	317628
2076	553822	22341	348955
2077	628195	34594	375733
2078	678118	61962	299104
2079	501349	44924	215375

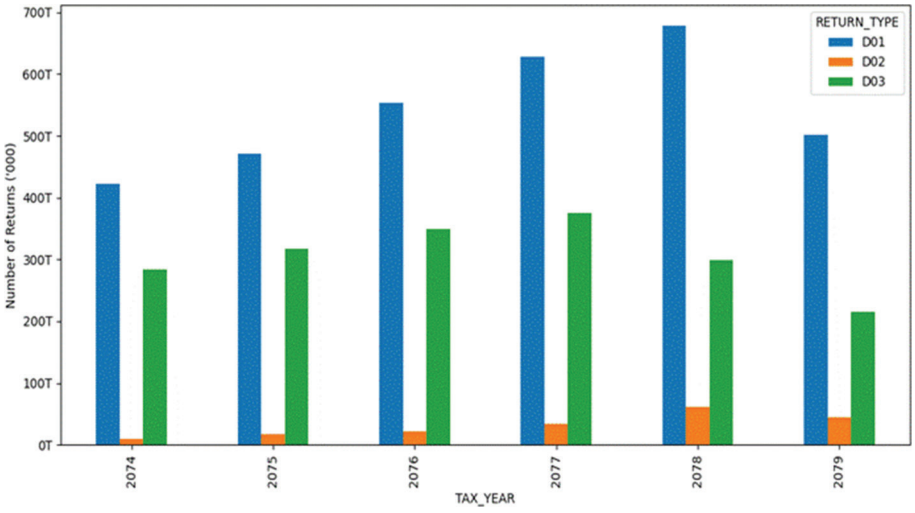

Figure 5: Yearly Income Tax Return Filing by Return Type

3.3 VAT Returns Report

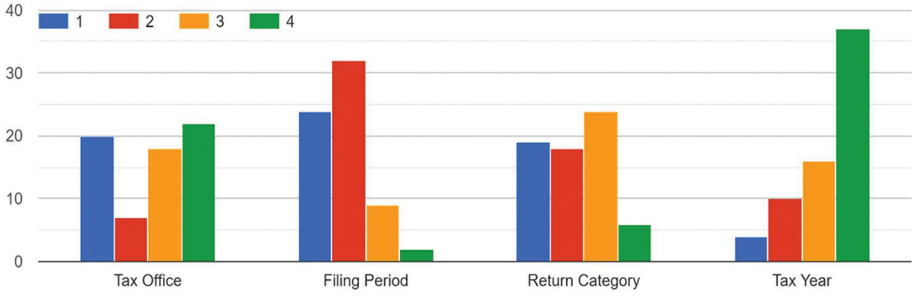

Figure 6: Priority Parameters for VAT Returns Report

VAT returns are submitted by traders whose transactions exceed a set threshold, with historical return periods including monthly, bimonthly, and trimester—though the bimonthly option has since been discontinued. Figure 6 shows that filing period, tax office, and return category are the most prioritized parameters for reporting, with filing period receiving the highest first-priority responses. Table 7 outlines key combinations of filters and grouping parameters used in VAT return reports, presenting insights through bar and pie charts to aid interpretation across tax years, offices, and filing periods. A major analytical consideration is the treatment of credit carry-forward across periods, which influences the classification of return types. For accuracy and period-specific analysis, this study excludes carried-forward credits and determines return types by calculating the net difference between reported debit and credit within each period—where a positive value indicates a debit return, a negative value denotes a credit return, and zero indicates a zero return. This method provides a clearer reflection of real transactional activity and supports effective performance monitoring and policy decisions.

Table 7: Interpretation of VAT Return Report

Filter	Group1	Group2	Aggregated	Chart	Interpretation
None	Tax Year	Return Category	Count	Bar	Yearly comparative chart of VAT return under each category
None	Return Category		Count	Pie	Composition of each return category during total time period
Tax Year	Return Category		Count	Pie	Composition of each return category in the given tax year
Tax Year	Filing Period	Return Category	Count	Bar	Comparative chart of each return category as per different filing period during the year
Office	Tax Year	Return Category		Bar	Chart of yearly VAT returns received by given office by category
Tax Year	Return Category			Pie	Composition of each VAT return category in particular tax year

From Tax Year 2074 to 2079, VAT return filings steadily increased across all categories: Credit returns rose from 834,701 to 1,650,574, Debit returns from 221,433 to 320,336, and Zero returns from 511,089 to 796,487. In 2079, Credit returns accounted for 59.6% of total filings, followed by Zero (28.8%) and Debit (11.6%). Taxpayer registrations also showed notable trends: PPAN registrations peaked at 1,021,747 in 2076 due to mandated salary PAN requirements, then fluctuated, reaching 607,629 in 2079. BPAN registrations peaked in 2077 (221,362) but declined to 136,888 in 2079, reflecting reduced business activity. VAT registrations rose to 43,252 in 2076 before dropping to 23,187 by 2079, while WPAN registrations steadily increased from 29 in 2074 to 9,692 in 2079, indicating enhanced TDS compliance enforcement.

Table 8: VAT Returns by Return Category

Tax Year	Return Category		
	Credit	Debit	Zero
2074	834701	221433	511089
2075	1001257	246406	598534
2076	1240727	278282	737856
2077	1442931	290358	765292
2078	1638697	305093	790038
2079	1650574	320336	796487

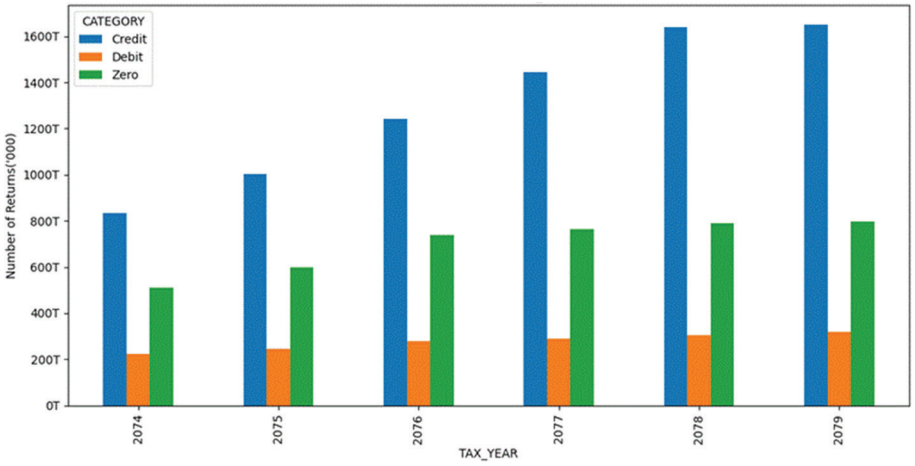

Figure 7: VAT Returns by Tax Year

3.4 Registration and Assessment Report

Taxpayer registration plays a crucial role in determining tax liability, with the Permanent Account Number (PAN) serving as the unique identifier for both individuals and entities. Responses indicate that taxpayer type is the most prioritized parameter for registration reporting, followed by tax year and tax office, while the month holds the least priority. Registration patterns guide Inland Revenue Offices (IROs) and Taxpayer Service Offices (TSOs) in planning registration drives and education campaigns. The analytics model interprets various combinations of parameters, such as yearly comparative trends by taxpayer type or composition of taxpayer categories within a given year, aiding strategic planning.

Similarly, in tax assessment, the self-assessment system entrusts taxpayers with the responsibility to determine and report their payable taxes, while tax officials selectively audit returns to detect discrepancies. Tax regime, tax year, and tax office are identified as the key parameters for reporting assessments, reflecting their significance in monitoring compliance of taxpayers and performance of the tax officials. In addition, data sourced from other agencies has emerged as a vital tool for identifying high-risk taxpayers through discrepancies in reported transactions in other agencies. Tax regime, tax year, and month are prioritized parameters for utilizing such third-party data. Although structured data from external agencies is not yet readily accessible for integration, there is strong support for further research into leveraging this information for compliance monitoring and enforcement of tax rules.

3.5 Analytics Model for Management Reporting

A robust analytics model for management reporting has been developed based on principles of clarity, ease of use, and standardization. The model is designed to facilitate report generation through a user-friendly interface that requires only a basic understanding of business modules and operational parameters. As illustrated in Figure 8, users can dynamically select filter keys, primary and secondary grouping fields to customize report views for specific modules. For example, the registration module includes separate grouping sets for Income Tax and Other Taxes to enhance comparability. This modular design ensures flexibility and adaptability across diverse reporting needs within the Inland Revenue Department (IRD).

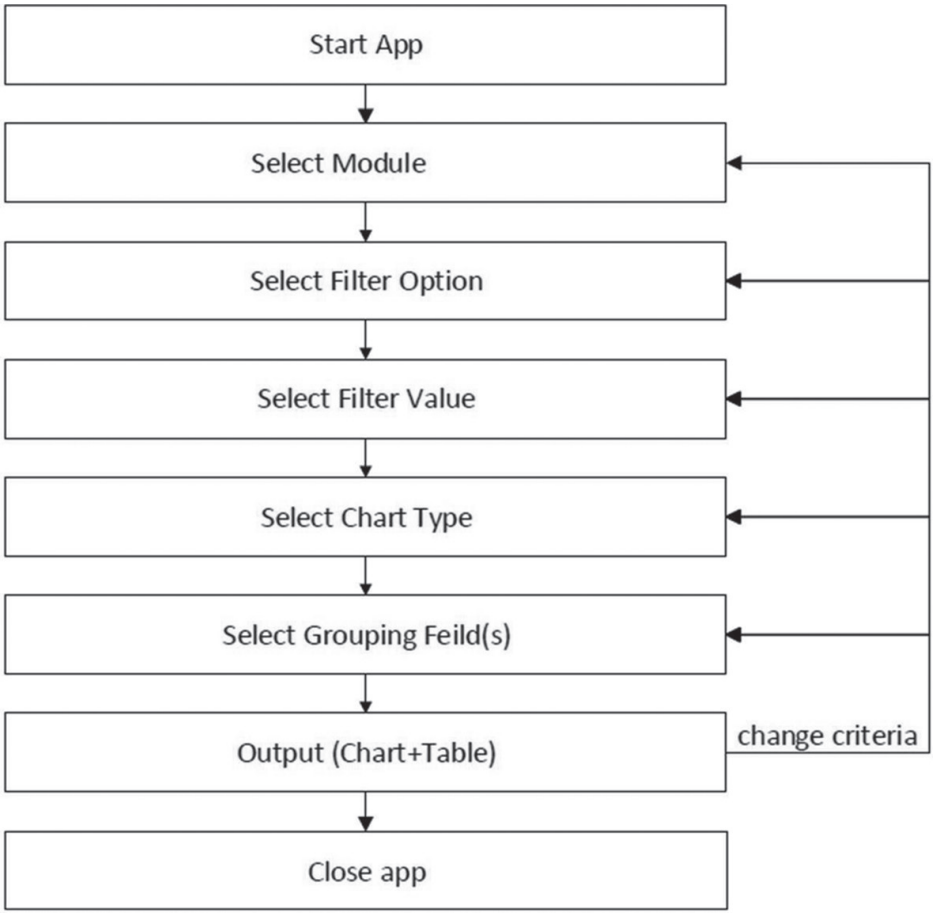

Figure 8: Analytics Model for Management Reporting

3.6 Comparison of Model-Based and Existing Reporting

A comparative analysis between the existing reporting system and the proposed analytics model (Table 9) highlights several advantages of the new approach. The existing system is dependent on technical staff for each report, with separate data preparation and visualization processes for every analytical requirement. In contrast, the model centralizes data extraction, cleansing, and preprocessing, enabling end-users to generate customized reports without additional technical intervention. Visualization and charting are integrated within the model, enhancing speed and reducing the risk of inconsistency. Moreover, user-level access control ensures confidentiality and secures sensitive taxpayer data during report generation.

Table 9: Comparison between Existing and Model-based Reporting

Aspects	Existing Reporting	Model Based Reporting
Data set identification	Unclear, just a few parameters known	Clear identification of data sets caters all analysis perspectives
Data extraction frequency	Needs technical staff for each report	Technical staff extracts data once covering identified combinations
Data extraction time	Multiplies the time for each report need	One time extraction and hence no additional time needed
Data preparation	Separate for each perspective	One time cleansing and preprocessing
Parameter change	Needs new dataset extraction/ preparation	Just filter option and group are selected by the user oneself
Visualization	Needs data feeding to a separate charting tool	Model generates output data and chart at once
Changing chart type	Input data might not fit, dataset may change	User selects suitable parameters and chart type, model fits it
Data inconsistency	May occur during each extraction	Once preprocessed and cleansed there arises no inconsistency
Confidentiality and Secrecy	Confidentiality can be compromised by the helping hands	User access control maintains confidentiality and secrecy

3.7 User Interface Prototype

A prototype of the user interface (UI) has been developed as a proof of concept, integrating key components of the analytics model as shown in Figure 9The UI allows decision-makers to select filters, grouping parameters, and chart types through a sequential and intuitive workflow. No advanced technical knowledge is required, enabling easy adoption by non-technical personnel. This interface exemplifies the role of user-centric design in decision support systems (DSS), where data management, model logic, UI interaction, and domain knowledge collectively contribute to the generation of standardized and interpretable management reports.

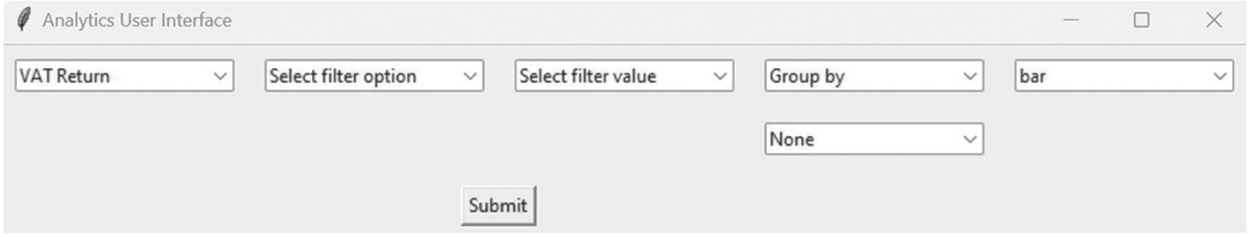

Figure 9: Analytics User Interface

Validation of the model was carried out using publicly disclosed annual revenue collection data from IRD, deemed reliable and consistent across years. Table 10 presents the yearly revenue figures generated by the model, which were compared against the officially published data in Table 11. The results show high accuracy, with overall revenue figures exceeding 99% alignment across all tax years. Minor discrepancies, such as those

in ESF and HST for 2077, are attributed to post-publication adjustments between revenue heads. Table 12 summarizes the model's accuracy, confirming its reliability for decision-making. Verification involved comprehensive unit testing, performance evaluation, and iterative code reviews during model development and integration. Usability validation was conducted through feedback sessions with IRD stakeholders including Deputy Director Generals, Directors, and Officers. While initial expectations leaned towards real-time reporting, users acknowledged the model's strength in historical analysis and strategic performance monitoring. The analytics model is thus validated as an efficient, scalable, and standardized tool, ready for deployment and further enhancement to support IRD's data-driven governance initiatives.

Table 10: Yearly Revenue Collection (Computed by Analytics Model)

Tax Year	ESF	EXC	HST/ HHT	INT	ITX	REN	VAT	Total
2074	0.91	60.48	1.15	14.97	140.38	4.54	76.22	298.65
2075	1.07	73.61	2.51	18.82	170.70	3.35	88.29	358.30
2076	0.58	64.84	3.45	22.00	192.85	2.64	98.14	384.53
2077	0.36	81.51	5.02	22.31	200.80	2.86	116.40	429.30
2078	1.24	103.02	6.28	24.72	229.28	3.08	115.86	483.48
2079	2.00	103.96	6.76	32.92	213.60	3.03	117.52	479.80

Table 11: Yearly Revenue Collection (Published in Annual Report of IRD)

Tax Year	ESF	EXC	HST/HHT	INT	ITX	REN	VAT	Total
2074	0.91	60.48	1.15	14.97	140.38	4.54	76.22	298.65
2075	1.07	73.61	2.51	18.82	170.70	3.35	88.29	358.30
2076	0.58	64.84	3.45	22.00	192.85	2.64	98.14	384.53
2077	0.36	81.51	5.02	22.31	200.80	2.86	116.40	429.30
2078	1.24	103.02	6.28	24.72	229.28	3.08	115.86	483.48
2079	2.00	103.96	6.76	32.92	213.60	3.03	117.52	479.80

Source: Annual Reports, Inland Revenue Department

Table 12: Accuracy of the Model (%)

Tax Year	ESF	EXC	HST	INT	ITX	REN	VAT	Total
2074	99.97	99.96	99.99	99.91	99.94	99.69	99.88	99.93
2075	99.59	100.00	99.85	99.95	99.99	99.97	99.98	99.98
2076	99.48	99.97	99.85	99.96	99.80	99.72	99.98	99.89
2077	98.19	99.99	90.33	99.95	99.99	99.92	99.89	99.86
2078	99.83	99.93	99.96	99.98	99.97	99.96	99.96	99.99
2079	99.88	100.00	100.00	99.99	99.99	99.65	99.98	99.99

4. Conclusion

The research concludes that standardized analytical management reporting using OLAP and data warehouse platforms significantly enhances decision-making processes at the Inland Revenue Department (IRD). High-priority reports such as revenue collection, income tax returns, VAT returns, and taxpayer registration were identified and modeled using multi-dimensional analysis techniques to improve interpretability and reduce ambiguity. By decoupling analytical reporting from the OLTP system, the study demonstrates improved performance and efficiency in both data processing and service delivery. Furthermore, it reinforces the role of academic inquiry in exposing gaps and proposing scalable reporting models in public financial management, thereby laying the foundation for future data-driven governance within IRD. The research highlights the need for ongoing collaboration between technical experts and administrative personnel to ensure practical implementation and operational sustainability. Despite its contributions, the study has certain limitations. It covers only selected key reporting processes due to the complexity and breadth of IRD's operations, with data limited to the most recent six tax years due to structural inconsistencies in earlier records. Additionally, privacy regulations restricted access to disaggregated data, resulting in the use of aggregated datasets that may contain outliers. In light of these constraints, the study recommends that IRD establish a dedicated data warehouse integrated with OLAP capabilities, standardize its analytics models, and create modular, visualization-rich reporting interfaces. Further research should also explore the integration of machine learning and AI techniques to detect tax fraud, improve compliance, and optimize tax policy formulation based on behavioral patterns. These steps are essential for building a transparent, responsive, and efficient tax administration system.

References

Annual Report 2022/023 (2023), Inland Revenue Department, Kathmandu, Nepal https://ird.gov.np/publication/category/annual-reports

Arnott, D. and Pervan, G. (2005), A critical analysis of Decision Support Systems research, Journal of Information Technology, 20, 2, June, 2005, pp67-87.

Atanasijević, J., D. Jakovetić, D., Krejić, N. et al. (2019), Using Big Data Analytics to Improve Efficiency of Tax Collection in The Tax Administration of The Republic of Serbia, Ekonomika preduzeća., vol. 67, iss. 1-2, pp. 115-130

Bergmann, M., Brück, C., Knauer, T. et al. (2020), Digitization of the Budgeting Process: Determinants of the Use of Business Analytics and Its Effect on Satisfaction with The Budgeting Process, J Manag Control 31, pp. 25–54 https://doi.org/10.1007/s00187-019-00291-y

Biagi, Vittoria & Russo, Angela (2022). Data Model Design to Support Data- Driven IT Governance Implementation. Technologies.

Chizhevska, L. V. (2021). Formation of Management Reporting in The Company's Controlling System. Problems of theory and methodology of accounting, control and analysis, (1(48), 52–57. https://doi.org/10.26642/pbo-2021-1(48)-52-57

Dahr, J.M., Hamoud, A.K., Najm, I.A. et al. (2022), Implementing Sales Decision Support System Using Data Mart Based on OLAP, KPI, and Data Mining Approaches, Journal of Engineering Science and Technology, Vol. 17 No. 1 pp. 275-293.

Davidson, D.A., Elsky, S.P., Parkan, W.A. (2005), Tax scorecard reporting system. https://typeset.io/papers/tax-scorecard-reporting-system- 51npey5svt

Excise Act (2002), Nepal Law Commission https://lawcommission.gov.np/en/ (Accessed: 10 Oct. 2023)

Han, J., Kamber, M. (2001). Data Mining Concepts and Techniques, Morgan Kaufmann Publishers, USA.

Harinarayan, V., Rajaraman, A. & Ullman, J.D. (1996), Implementing Data Cubes Efficiently, Stanford University, ACM.

Hristidis, V., Chen, S.C., Li, T. et al. (2010), Survey of Data Management and Analysis in Disaster Situations, Journal of Systems and Software, Volume 83, Issue 10, 2010, pp. 1701-1714, ISSN 0164-1212

Ignatius J., Selvakumar, S., Govindarajan, S. et al. (2022), Data Analytics and Reporting API - A Reliable Tool for Data Visualization and Predictive Analysis, Information Technology and Control, Vol. 51, Issue: 1, 2022, pp 59-77 https://typeset.io/papers/data-analytics-and-reporting-api-a-reliable- tool-for-data-34slymm3

Income Tax Act (2002), Nepal Law Commission

https://lawcommission.gov.np/en/ (Accessed: 10 Oct. 2023)

IRD (1998), ProTax Operational Manual, Inland Revenue Department, Unpublished.

IRD (2012), Integrated Tax System of IRD: System Design Document, Inland Revenue Department, Unpublished.

IRD (2022a), Integrated Tax System Assessment Report, Inland Revenue Department, Unpublished.

IRD (2022b), Requirement Analysis and Development of Detail Implementation Plan of Data Warehouse and Data Analytics System for IRD, Inland Revenue Department, Unpublished.

IRD (2023), TADAT: Nepal Assessment Report, International Monetary Fund, Unpublished

Kaziyeva, G.D., Abzhanova, A.E., Sagnayeva, S.K. et al. (2020), Features of the Implementation of OLAP Systems in Environmental Monitoring of the Marine Environment, ICID-2019 Conference.

Liu, S.; Liu, O.; Chen, J. A. (2023), Review on Business Analytics: Definitions, Techniques, Applications and Challenges, Mathematics 2023, 11, 899. https://doi.org/10.3390/math11040899

Mainali, R.P. (2021), Latent Factors of Non-filer: An Analysis of Data from Inland Revenue Office Surkhet, South Asian Journal of Social Studies and Economics, 11(2), pp. 1-7, 2021 DOI:10.9734/SAJSSE/2021/v11i230278

Martikainen, J. (2012), Data Mining in Tax Administration -Using Analytics to Enhance Tax Compliance, [Master's Thesis], Aalto University School of Economics. https://typeset.io/papers/data-mining-in-tax-administration- using-analytics-to-enhance-41g6042m0z (Accessed: 5 Jan 2024)

Ngo, V.M., Le-Khac, N.A., & Kechadi, M.T. (2019). Designing and Implementing Data Warehouse for Agricultural Big Data, ARXIV, Cornell University.

OECD (2017), Standard for Automatic Exchange of Financial Account Information in Tax Matters, OECD Publishing, Second Edition, Paris. http://dx.doi.org/10.1787/9789264267992-en (Accessed: 21 Dec 2023)

Plotnikova, V., Dumas, M. and Milani, F. (2020), Adaptations of Data Mining Methodologies: A Systematic Literature Review, PeerJ Computer Science, May 2020, https://peerj.com/articles/cs-267/ (Accessed: 16 Nov 2023)

Scarcella, L. (2019). Tax Compliance and Privacy Rights in Profiling and Automated Decision Making. Internet Policy Review, 8(4). DOI: 10.14763/2019.4.1422

Timilsina, N. (2022), Data Analytics in Tax Administration in The Context of Nepal, Inland Revenue Department, National Tax Day 2022 Souvenir Book (Smarika), pp.190-194

Value Added Tax Act (1996), Nepal Law Commission, https://lawcommission.gov.np/en/ (Accessed: 10 Oct 2023)