



RESEARCH PAPER

Harnessing Data Science for Sectoral Efficiency in the Governance Framework of the Punjab

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ABSTRACT

The study explores how data science can serve as the guiding rudder to steer the Punjab governance to efficiency. Currently, the Punjab governance is having a question mark, and eyebrows are rising in service delivery due to its non-adherence to data science. In the absence of available and accurate databases, slapdash decision-making, disorganized planning, and ineffectual policy implementation are sending shudders down the spine of the governance of the province. Anchored to the Mixed Methods Approach and guided by Ostrom's Institutional Analysis and Development (IAD) Framework for data collection and analysis, this research unfolds that the Punjab governance, if integrated with data science, will bask in the sunshine of accurate decision-making, sound planning, and effective policy implementation. The study presents a detailed roadmap for developing the infrastructure, culture, and systems for data science, emerging as a tool for unprecedented efficiency in multiple sectors of Punjab governance.

KEYWORDS Data Science, Decision Making, Efficiency, Governance, Planning

Introduction

The swirling winds of swiftly changing global dynamics, trends, and agendas have unprecedentedly altered the landscape of modern governance. In the present climate with limited resources, governance is viewed as a tool for attaining many international and national objectives.

In this way, accurate and productive decision-making entails a puissant foundation of information in the form of data. The Global North states--- the UK, the US, and Germany---have set their trajectory to skyward development under reliance on very systematic data governance (World Bank, 2023). These advanced nations have touched the crescendo of glory in all the governance and development-related indicators. Conversely, the Punjab Governance Model is etching against the grim situation, adding and muddling into the dark recesses of the colonial orientation and ceasing to evolve with the pace of modern trends. In the absence of data science---a multidisciplinary field combining machine learning, statistical analysis, and big data processing for data collection and analysis--- the Punjab Governance is burdened with the weight of antiquated procedures, mired by the structural perplexities, misdirected by erroneous planning, and crippled by ineffective policy implementation.

Ipso facto, propelling governance of the Punjab into the 21st Century stratosphere and turning the tide for efficient service delivery by harnessing the winds of data science is a sine qua non for transmuting these visions into reality. Institutionalizing data systems and adapting predictive analytics for incorporation into the governance system will pave the way for meteoric progression in various sectors of

the province. Therefore, this study proposes actionable recommendations to develop the infrastructure for data science for efficient service delivery by the Punjab Governance.

Literature Review

Lam (2001) introduces how Ostrom's Institutional Analysis and Development (IAD) Framework can help find governance problems. His findings establish the compatibility of the IAD Framework in addressing governance challenges, mainly in decentralized systems, providing a theoretical lens for examining the structure of the Punjab Governance Model. Kitchin (2014) presents the magical power of data science for accurate planning and efficient service delivery in the UK. His study provides the strategies to develop infrastructure on data science, which are significant for the Punjab. Janssen et al. (2017) provide an in-depth analysis of the challenges of incorporating predictive analytics into governance in developing countries. This study is useful for understanding institutional and infrastructural gaps in Punjab's context. Mergel et al. (2019) introduce the concept of digital transformation in governance, explaining the principles of citizen engagement and predictive analytics. Their findings illustrate how data science can rationalise decision-making and optimize resource allocations, necessary for application in the Punjab. Malik and Ahmed (2020) delineate the obstructions to E-Governance in the Punjab, primarily due to the centralization of powers. Their work recommends a strategy for decentralization to address the governance challenges efficiently in the Punjab. Roy (2017) evaluates India's big data initiatives and their significance for improving service delivery. His findings offer valuable insights for the transformation of the Punjab Governance in Pakistan.

Material and Methods

Philosophically, the study has been steered through the channels of the positivist approach. Adherence to the Exploratory Research Design, this research sought to explore the vistas of the under-researched theme of incorporation of data science into the Punjab Governance Model. A mixed-method approach was utilized to collect the data using quantitative and qualitative tools. After being collected, the data was backed by analysis, integrated by synthesis, and validated by a triangulation strategy to present policy recommendations.

Data in the 'Action Arena' stage was collected through interviews and policy studies of official documents and analyzed through the lens of thematic and statistical analysis. In the Second stage, 'Rules in Use,' the Policy Reviews of Formal Rules and Ethnographic Observation techniques gathered the pieces of information, validated subsequently by the Pilot Test and analyzed by Qualitative Coding and Correlation Analysis. 'Contextual Variables,' the third IAD stage, harnessed the tools of statistical data collection to accumulate the data and further analyze it using the paradigm of time series analysis.

The study relied on examining governance indicators and interviews for data extraction, regression analysis, and outcome mapping for analysis in the fourth stage, 'Outcomes.' At the last stage of the IAD Framework 'Developing Recommendations,' the researchers gathered valuable insights from a Review of Successful Data Governance Models of the UK, the US, and Germany to discover how data governance can revolutionize the Governance Sector. Finally, the Triangulation Strategy was utilized to provide policy recommendations that were best suited to the administrative culture of Punjab.

Connotation of Data Governance and Data Science

Data governance, fundamentally an important part of information governance, connotes data management within an organization accurately and securely (Smallwood, 2019). As an important source of rational decision-making, data governance is used to collect and interpret data to ensure strategic planning, find correct predictions, steer organizational goals, and decipher correct information. (Ladley, 2019; Redman, 2019). Structurally, Data Science involves the following sequential steps:

Problem definition: To identify the nature and scope of the problem (Kotu et al., 2019)

Data Collection: To collect the data on the problem under various methods (Setiyanto et al., 2022)

Data Cleaning and Preprocessing: To clean the errors and avoid duplications in data (Kadhar & Anand, 2021)

Exploratory Data Analysis: To understand the trends, patterns, and correlations (Ciaramella et al., 2006)

Featuring Engineering: To create or modify the variables to improve analysis.

Data Modeling: To use statistical or machine learning models to analyze and predict the outcomes.

Data Evaluation: To evaluate the modeling to evaluate how it will solve the problem (Popova et al., 2017)

Data Deployment: To implement the solution (Rudnitckaia, 2016).

Governance in The Global North: The Role of Data Science

The Governance of the Global North States—UK, US, and Germany—relied heavily on data science and is charting an impressive odyssey of triumph with increased levels of public satisfaction and meteoric public service delivery.

The UK, being the citadel of Data Science, displays the quintessence of moon-touched governance progression as evident from its 9th, 29th, and 7th rankings in the respective indicators of the Chandler Good Government Index 2024, the Government Effective Index, and the United Nations E-Government Development Index (UN DESA, 2024). Institutionalizing data science through the establishment of the Office for National Statistics (ONS, n.d.), the Alan Turing Institute, the Centre for Data Ethics and Innovation, and Health Data Research UK (HDR UK, n.d.) and Incepting the portals like Data.gov.uk, Gov.UK, NHS Digital, UK Data Service, and Ordnance Survey, the UK has carved a luminous path in the annals of good governance (Shadbolt, 2024). The usage of predictive models and Geographic Information Systems for disaster management, the adherence to data analytics to improve healthcare quality and accessibility, the reliance on IoT data urban planning, utilization of systemized databases for HRM and other areas of administration have transformed the UK into the model of accurate decision making and efficient public policy implementation.

In parallel with the UK, the US is also continuously preening its wings for swift, skyward flight inefficient public service delivery because of institutionalizing data

science. Ranked 12th and 11th in the UN E-Government Development Index (UN DESA, 2024) and the Chandler Good Government Index respectively, the US utilizes portals like Data.gov, USA.gov, HealthData.gov, and USGS National Map and the offices of Science and Technology Policy (OSTP, 2024), U.S. Digital Service (USDS, 2024), National Institute of Standards and Technology (NIST, 2023) for incorporation of data science into the complete public policy cycle for all the areas of governance. Further, the Big Data Research and Development Initiative, launched during President Obama's era, revolutionized the big data framework, chartering the uncharted constellation of human development.

Moreover, adherence to data analytics has proved vital for the political governance of the United States. Agencies in the US, like the Centers for Disease Control and Prevention, use R and Python to analyze health trends and predict future outbreaks, as witnessed during the COVID-19 pandemic. Likewise, Smart city initiatives in the US rely on IoT and big data platforms, such as Hadoop and Spark, for traffic management and energy optimization. Predictive policing tools in the US analyze crime data to allocate resources effectively. To be brief, with accurate information in the form of data, governance in the US is automated and mechanized, becoming an untarnished fortress of consistency and the perigee of efficiency.

Now witnessing the heyday of data science, Germany has been bumping and gliding into the harbor of administrative efficiency since its resuscitation from the reminiscence of World War II. The Federal Agency of *Umweltbundesamt* has structurally rescued Germany many times from disasters through prospective planning, using the tools of horizon scanning to map the early predictions and meteorological trends. GovData.de (GovData, 2024), Bund.de, *Statistisches Bundesamt (Destatis)*, GeoPortal.de, and *Bundesanzeiger* are the most commonly used E Portals in Germany to extract the data related to statistical, geospatial, service-driven, and feedback nature. The Federal Ministry of the Interior and Community (BMI) oversees digital transformation and data-driven governance (BMS, n.d), *Destatis* provides statistical guidance for public policy formulation, and the Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS) conducts research in data science and Artificial intelligence to, support public and private sectors inefficient public service delivery. Germany ranks 12th in the 2024 EGDI, mainly due to its strong focus on data science and digital governance (UN DESA, 2024).

The UK, the US, and Germany display the paragons of data governance, having very advanced infrastructure for framing (problem), collecting, cleaning, analyzing, featuring engineering, modeling, evaluating, and deploying data. Due to the development of Data Science, these countries are touching the crescendo of glory in accurate decision-making, rational planning, and practical policy implementation, thus resulting in massive progression in the areas of urban design, urban planning, infrastructural development, Sustainable Development, community development, human development, climate governance, local governance, and other segments of modern governance.

The Somber Landscape of Governance in Pakistan

Pakistan currently, as depicted in the below-mentioned table, is struggling with the implementation of public policies, primarily due to non-adherence to data governance:

Table 1
Dismal Governance Indicators of Pakistan

Indicator	Description of the Indicator	Pakistan's ranking
Government Effectiveness (WGI)	Measures the level of public service delivery, public policy implementation, and credibility.	30.66th percentile (World Bank, 2023)
Voice and Accountability (WGI)	Evaluate citizen participation, freedom of expression, and media freedom in the political system	178 th (World Bank, 2023)
Political Stability (WGI)	Evaluates the dynamics of political instability and violence.	209 th (World Bank, 2023)
Regulatory Quality (WGI)	Measures policy formulation and promotion of private sector development.	148 th (World Bank, 2023)
Rule of Law (WGI)	Assesses confidence in legal systems and enforcement of societal rules.	170 th (World Bank, 2023)
Control of Corruption (WGI)	Unearths the corruption levels in the administration.	167 th (World Bank, 2023)
Climate Change Performance Index (CCPI)	Studies the policies related to climate governance and environmental protection	31st out of 60 states
Ease of Doing Business Index	Sheds light on business activities, regulations, and deregulations	108 th (World Bank, 2019)
Global Competitiveness Index	Evaluates the drivers of competitiveness and economic productivity.	110 th (WEF, 2019)
SDG Index - Implementation Status	Traces the direction and implementation progress of UN Agenda 2030 in the world	128th
Fragile States Index (FSI)	Evaluates the state's capacity to implement policies and deliver services.	23rd (FSI, 2023)

The Punjab lacks the infrastructure of Data Science, thereby witnessing the syndromes of faulty decision-making, poor planning, and ineffective policy implementation. Only the development of data science can rescue the sinking ship of governance in the Punjab.

Benefits of Data Science in Punjab Governance

The Punjab Governance direly needs the transition to data governance to slough off from the current state of inefficiency and stagnancy in the following areas:

Transforming the Human Resource Management:

The human resources sector is currently entangled in a web of manifold challenges. The absence of any database criteria to post, transfer, and promote the HR hitherto and the unattended issues of the promotion structure of various cadres of the province for decades have crippled the performance of the workforce of the Punjab. Being underpaid and undeveloped, generalist and demotivated, constrained and demoralized, the officers and officials of the province are caught up in the dark shadow of a toxic working environment, external interventions, dysfunctional governance model, structural flaws, and procedural impediments.

Due to a lack of performance audits, limited welfare, no rewards policy, no state recognition systems, poor prospects of capacity building, and serpentine career planning, the human resources cart has been in the mud for decades. Only data science can cruise and rescue the human resource sector ferry from the tumultuous waters in this alarming situation.

A Centralized Human Resource Database_ comprising the details of cadres, strengths, weaknesses, expertise, utility, specialization, education, training, profiles, career history, qualifications, skills, and performance evaluation_ needs to be recorded. Based on predictive modeling and rule-based algorithms, this database will be the chief criteria for transferring, posting, and promoting officers.

The development of performance dashboards and key indicators will present public satisfaction with the state's service delivery performance. Introducing a Machine Learning Model to promptly predict and plan the Punjab's structural, procedural, cultural, systematic, and standards issues is a sine qua non for keeping up with the pace of international governance.

With data-driven comparative benchmarks and regional surveys, Punjabi Human Resources will be placed on the track to continuous development, welfare, motivation, re-engineering, and transformation, becoming an agent for unprecedented efficiency in the administration sectors of human development, economic development, urban planning, security, and state building.

Systemizing the Social Protection Sector

The Government of Punjab implemented various social protection initiatives, such as the EHSAS Kifalat Programme (2020), Free Flour Distribution Scheme (2023), and Nigahban Ramadan Package (2024). However, the government struggled to collect the exact details of deserving beneficiaries; it merely replicated the details from the Benazir Income Support Programme and relied on scant information from the Punjab Information and Technology Board. Without data governance, the social protection initiatives suffered from manifold inefficiencies.

In the Free Flour Distribution Scheme 2023, for instance, due to a lack of data, one person got tens of flour bags without IT-integrated data, thus depriving genuine persons of availing themselves of this opportunity. Similarly, the list of beneficiaries in the Nigahban Ramadan Package included ineligible persons: The Overseas, the affluent, and the deceased. Further, many beneficiaries were untraceable because the list lacked the details of their ID cards, addresses, and exact names.

For any future social protection initiative, the first step is to use geospatial data and heat maps to mark and identify the underserved or poverty-caught zones. Integrating the preliminary database of the beneficiaries with NADRA, BISP, the latest survey, and the voter's list will provide an accurate trajectory for data collection. Extensive surveys to practically record the information on income, house size, and socio-economic condition of people and application of the anomaly detection model will further screen the list of beneficiaries.

Introducing RFID or QR codes, SMS automation, biometric systems, dashboards, and feedback portals are important SOPs to enable real-time monitoring and deter corrupt practices in aid. More importantly, proper record management of the previous initiative's weaknesses and strengths, extensive studies of international aid programs in the Global South countries, and the establishment of unique global partnerships on poverty alleviation strategies can inscribe unprecedented chapters of triumph in the future.

Steering the Development Administration in the Punjab

Failing to weather the storm of inequality and regional disparity is a product of the ineffective development administration of the Punjab. The syndromes of faulty selection of development projects, piloted by political recommendations, and discontinuation of mega projects of the previous regimes have squandered billions of rupees from the Public Exchequer.

The inclusion of political projects in the Annual Development Plans presents a partisan outlook, snatching the development opportunities from the opposition party's supporters until their turn. This development practice provides no utility to the country and the populace. The best solution to this predicament is to integrate data governance with the development sector in the Punjab. The first step in the right direction is to categorize the Punjab into underdeveloped, less developed, and developed zones by applying geospatial analytics and heat map techniques, making the Tehsil Development Index rank all the subdivisions of the Punjab. The formation of Development Project Selection Units in each Tehsil to conduct thorough surveys on the present situation and status of demographics and development.

After this investigation, adherence to Sentiment analysis and text mining techniques will enlist the development projects based on genuine popular needs and trends, without any external influence. Reliance on the technique of Ranking Algorithms will prioritize and recommend the development projects to the Planning and Development Board to discourage political recommendations on projects. Based on the surveys, these recommendations will evaluate the long-term impact of development projects using the Predictive Models and Visual Analytics dashboard techniques. Next, in the project implementation stage, the creation of Tehsil Development Councils, Tehsil Development Monitoring Units, and Development Service Cadres is necessary to push the cart of development administration at the Tehsil level.

This way, the provincial and the national budgets will be smartly used to illuminate and adorn the path leading to meaningful development for the people in every nook and corner of the Punjab. Over and above that, with the help of time-series analysis, continuous observation of the development drive will be measured to improve next year's drive. The glorious winds of rational planning will tear apart the tattered flag of underdevelopment in rural and urban areas. The luminous moon of data governance-driven development will guide urban planning, sustainable cities, urban governance, urban food security, urban housing settlements, urban healthcare, and urban climate governance in this unfortunate province.

Utilizing the Potential of State Land Resources

The vast area of state land of urban, rural, and commercial categories stretches from the breathtaking sites of the Potohar Range on the North to the swirling sands of the Cholistan Desert on the South, from the working boundary of Narowal on the east to the western zone of Dera Ghazi Khan. However, the Punjab has no documented data on the encroached state lands of the urban and rural nature. Most of these state lands have been encroached upon by illegal occupants under the garb of various allotment schemes; most of this stand revoked by the Board of Revenue, as mentioned in Chart 2 and Diagram 3, causing substantial financial loss to the public exchequer.

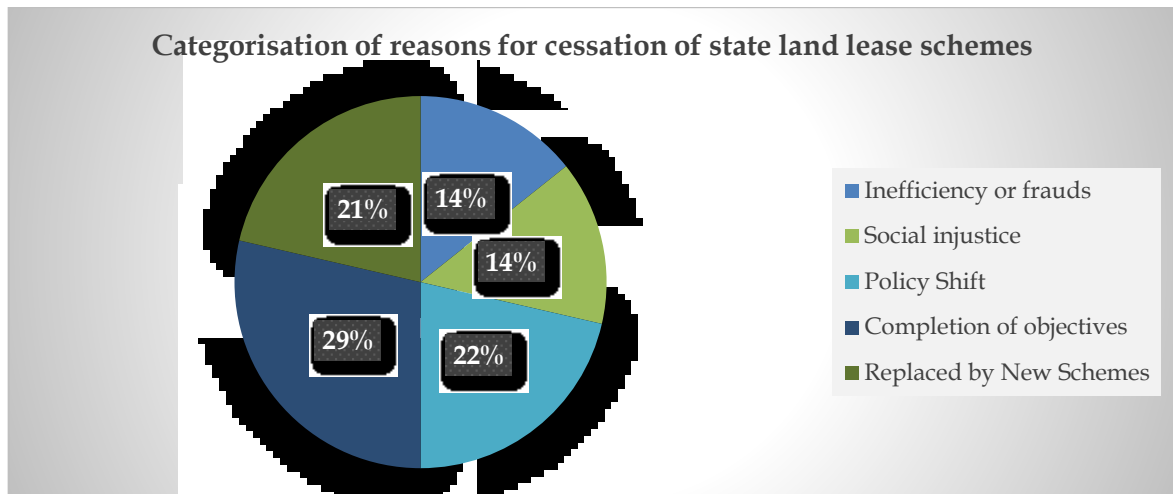


Chart 2: Categorization of Reasons for abolition of state land schemes

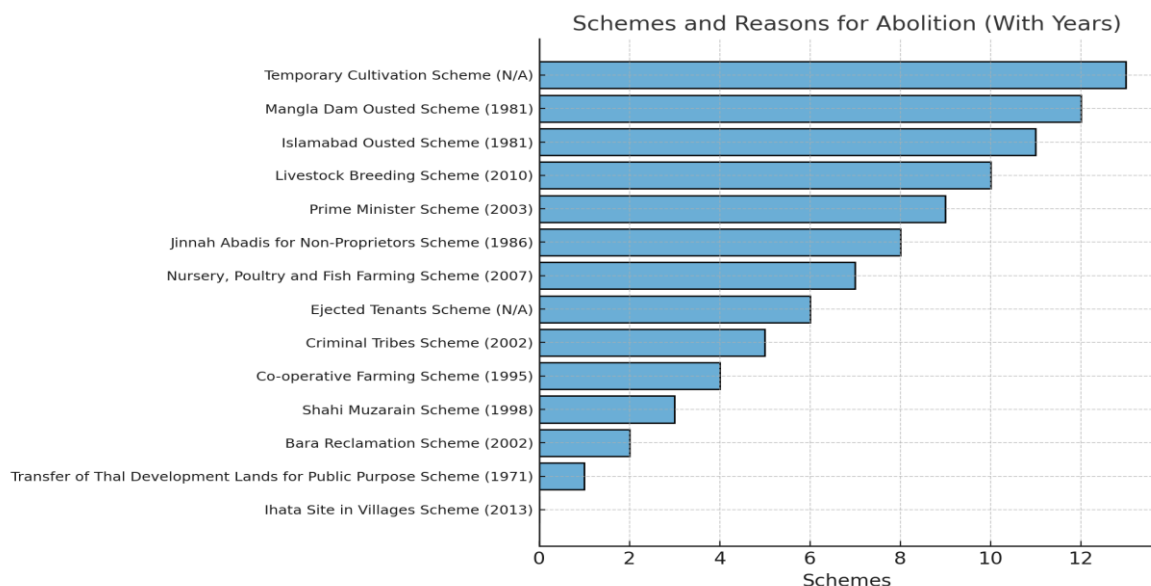


Diagram 3: Years of the abolition of State land Schemes

More shocking to the business model reason are the poorly leased state lands of a commercial nature to Lahore Gymkhana and the Chenab Clubs. The former utilizes 1030 kanals of extremely precious pieces of state land of Lahore on a meagre sum of just Rs 5000 lease per annum (Sheikh, 2023), incurring mammoth financial loss to the provincial capital. In the same analogy, a huge chunk of state land is used by the Chenab Club in Faisalabad for thousands of leases and rents annually.

The solution lies in making a database on the area, category, nature, arable, barren, utility, encroached, abandoned, condition, and usage of the Punjab's commercial, urban, and rural areas. Making an accurate database requires satellite imagery analysis, geospatial analytics, field inspection reports, colony records, *Girdavri* (the report on cultivation), and survey reports. With the availability of the data on state lands, the illegal encroachers can be fined heavily. In the bargain, the state land resources will generate trillions of rupees. For example, the Board of Revenue can take the bull of Lahore Gymkhana by the horns and utilize its 1000 kanals, currently misused for golf purposes, for E-lease agreements with over a hundred commercial brands (like KFC, Honda, Levis,

etc.) and generate billions of rupee per year. Deeper exploration of data on state lands will give impetus to rational planning for moon touched development. For instance, to utilize the state lands by the development of canals or watercourses and treatment of soil in barren areas of Thal for agricultural purposes, by the establishment of shrimp farms in the vast, deserted regions of the Salt Range for export, by the making of water reservoirs in the mountain abutted state lands to accumulate the flash floods for irrigation and by transforming the neglected areas into parks for income can generate trillion of rupees for the province. Using an AI-powered bidding platform will help attract the international business community to invest in the Punjab, providing a massive economic boom. More interestingly, the Punjab Central Business District Development Authority (PCBDDA) claims that with slight support, it can quickly generate up to 25 trillion Rupees in Lahore only (Hasnain, 2023), delineating the vast potential of the state land resources in the Punjab.

Revolutionizing the Taxation Sector by Data Governance

Pakistan, a country blessed with huge potential, levies taxes in three tiers: The Federal Tier--- including the Sales Tax/ VAT, Income Tax, Petroleum levy, Federal Excise Duty, Customs Duty, etc. --- The Provincial Tier--- encompassing Capital Value Tax, AIT, Land Tax, Excise taxes on cinemas and hotels, Water Rate, Property Tax---and local Tier-- levied on residential maps, registration of property documents, rent of state-owned shops, parking fee, building plans, commercialization of property, property, and water usage. The current taxation system has entrenched itself as a thorn in the side of the economic progress of Pakistan, resulting in a spiraled foreign public debt (66% of the GDP), amounting to Rs. 44 trillion (Rehman, 2022).

In the absence of efficient data governance, the dilemma of the black economy and undocumented taxes, being the millstone around the neck of Pakistan's economy, is widening the deep cracks in the edifice of the country's taxation system. These two quandaries have reduced the national tax net to only two million individuals, making up only 1% of the country's population. Tax evasions---in the forms of the odious practice of theft of electricity, water, and gas; the concealment of total annual income; non-deposit of cash in banks; tax litigations and tax waivers---have put the spanner in the wheel of the economy of Punjab (Butt & Ahmad, 2023).

Tax evasions, alone in the sectors of real estate and tea, account for a mammoth loss of approximately Rs 545 billion to the national exchequer, cutting a swathe through the economy of Pakistan. Likewise, the black economy--- in the shape of smuggling and illegal cross-border trading, unregistered businesses and dealerships, money laundering, and hidden economic activities---incurs a gigantic economic loss of \$ 1 trillion annually to the country (Asif, n.d). More astonishingly, many business professionals use the tricks of undocumented transactions through cash and cheques to avoid taxation. At the same time, some persons hide their ill-gotten black money under the shadow of foreign exchange, gold, security bonds, etc. In addition, the estimation of various taxes is not devoid of inaccuracy and irrationality.

The taxation system in the Punjab, without data governance, is akin to a sieve, incapable of holding its due share of the nation's wealth. Therefore, integrating the taxation system with data governance is the only panacea to address this anathema. Data collection to spiral the circumference of the tax net is an urgent need of time. The first step required is to locate the tax evaders by utilizing an Integrated Data Platform, an agent for retrieving and consolidating the details from the amount of bills paid on utilities like gas and electricity. This data on the income of individuals can further be gathered

and gauged from the payments of government dues on property registration, banking transactions, and business, as well as commercial transactions.

With the help of Machine Learning Models, the income statements provided can be matched with utility usage and spending- habits to flag and find potential tax evaders. Without the revolutionary step of the e-payment system, reforming the taxation sector will remain a castle in the air. If implemented, this e-payment system will lay the axe to the root of all the problems of tax evasion, undocumented businesses, the black economy, paper currency, and inaccurate taxation. In addition, with Geospatial Analysis and Heat Mapping, the details of the nature and type of lands and the produce they yield annually should be recorded on portals to levy equitable taxes in the province.

The Path to Efficiency in Field Governance

The field administration, comprising 154 Tehsils in the Punjab, bears the stamp of inefficiency. The dilemma of human interactions and delayed processes due to non-adherence to data science is fanning the smouldering embers of illegal gratification, fraud, inefficiency, ineffectiveness, red tape, nepotism, weak accountability, limited transparency, and poor service delivery. On top of that, most people remain unsatisfied with the service delivery in Tehsils for various reasons. The continuous complaints of corruption and responsiveness in the sectors of cleanliness, water supply, public health, approval of building plans, commercialization NOCs, Price Control, environment protection, anti-encroachment, healthcare, revenue administration, registration branch, education, Police and Arazi Record Centers are recorded in hundreds of numbers daily.

In data governance, the pragmatic solution can brush aside these perennial challenges. The first thing is to make a database, as the British Officers used to do in the Colonial Era, on the history, aspects, trends, weaknesses, peculiarities, indicators, and strengths of the social, cultural, economic, and political patterns of each tehsil of the Punjab, providing vast governance insights for the administrators. Secondly, data collection on peculiar challenges of the tehsil in any sector, like public health, education, planning, local governance, etc., can prove to be a game-changer for the Tehsil governance. Besides that, data on the entire workforce of Tehsil is a necessary ingredient in planning a better team to enhance efficiency. Collecting data on file tracking, sectoral trends, continuous public feedback, and day-to-day administrative issues can cruise the ferry of governance to improved efficiency. The establishment of more inclusive and suggestions-oriented portals, unlike the present ones that are mostly misused to lodge frivolous complaints daily, can motivate 4e3a\civil society to contribute generously to good governance by aiding the administration unprecedentedly with required data.

Prospective Disaster Management Planning

Disaster management---in the forms of riverine and urban flooding, urban and rural fires, earthquakes, and heatwaves--- continues to remain a Herculean task in the Punjab. The Government of Punjab found it challenging to manage disasters like earthquakes in the Potohar Region in 2005, riverine floods in 2014 and 2023, and mountain fires in the Salt Range (Khewra) in 2024. For effective disaster management planning, Punjab must develop comprehensive data on the province's history, trends, impact, and epicentres of disasters. The development of infrastructure for remote sensing and geospatial analytics to maintain a database on the damaged dykes and endangered human settlements can provide the foundations for prospective planning against riverine floods. Horizon scanning, IoT sensors, and AI-driven predictive analytics are important means to identify high-risk flood zones and adapt pre-emptive measures to manage

riverine floods. Data collected through drone surveys, image recognition algorithms, and IoT sensors can present a comprehensive picture of the sewerage flow and obstructions, giving impetus to improved decision-making against urban floods. Gathering information on dangerous buildings and faulty urban designs can improve management in combating earthquakes and urban fires.

Revamping the Healthcare Sector

The Healthcare Sector in the Punjab is teetering on the brink of failure to ensure human security. Across the Punjab, the dreaded levels of diseases in the forms of Cancer, Hepatitis, Typhoid, Malaria, and neurological disorders and massive graphs of mortality rates because of multiple factors present the worrying landscape of healthcare for the populace.

Limited human resources, fewer operational hours, insufficient critical medicine, dysfunctional wards, unclean outlook, unfriendly behaviour with the patients, and lack of proper sterilization of medical equipment impede the Healthcare services at the Basic Health Units and Rural Health Centers. Hardly any hospital at the Tehsil Headquarter level has the services of cardiology and neonatal facilities. The huge influx of patients in the Tehsil Headquarters, District Headquarters, and Specialized hospitals makes it impossible to provide efficient service delivery. Moreover, the lack of ISO Certification in medical labs, dysfunctional MRI/CT Scan machines, corruption in the procurement of medical equipment, and some dilapidated wards are hampering the efficiency of the healthcare sector in the Punjab. On the other hand, efficiency-driven private hospitals are too costly to be affordable for poor people.

Data Science is the antidote to these menaces barricaded in the way of efficient healthcare in the Punjab. Area-wise documentation of the level and nature of diseases is central to understanding their environmental, demographic, and healthcare-related causes. Documentation, in the form of centralized data, is a crucial step to record the details of HR, condition of equipment, number of referrals to big cities, number of patients attended, working of medical labs, the feedback of patients on service provided, availability of medicine, the functionality of wards and equipment, categories of services provided, infrastructural conditions, and general issues of the health sector in every *Tehsil*.

The introduction of an e-centred Scheduling System in every Tehsil to seek appointments with doctors and the creation of E-Portals to mark the attendance of medical steps are necessary initiatives to be taken. These data interventions can guarantee accurate planning and effective health policy implementation in Punjab.

Streamlining the Education Sector

The private educational institutions in the Punjab, such as LUMS and Aitcheson, and some autonomous or public universities in the big cities of Lahore, Faisalabad, and Multan, are making great educational strides. Unfortunately, a huge performance chasm exists in private, public, and 'madaris' streams. Getting education from private institutions, marked with skyrocketing fee structures, is beyond the reach of an ordinary man. Public education, in the form of government schools and colleges, by and large, lacks good education standards. The *madaris* education confines the students to the study of theology merely, depriving the students of the benefits of advanced scientific, literary, and linguistic learning. Public institutions and madaris fail to develop students' knowledge, confidence, skills, and personality.

However, some extraordinarily hard-working individuals transform their knowledge, skills, and personality due to extreme personal efforts, parental focus, or guidance from individual savants. To enunciate further, the poor level of research, shocking dropout ratio, high illiteracy, and pathetic, educational infrastructure in most government institutions at primary and secondary levels present an alarming situation. Socio-cultural vices, weak administration, politicization, lack of funds, poor planning, and many other factors have contributed to this grim education landscape.

With this objective in context, the education sector has to undergo a thorough overhaul by harnessing data science. Firstly, data collection is essential to mark the zones struck by illiteracy and educational challenges adhering to GIS mapping and geospatial analytics. This way, the opportunities for accurate planning and investment through public-private partnerships can appear on the horizon. Secondly, a central database will record the *Madaris*, their students, and their teachers. Thirdly, it is extremely necessary to establish Tehsil Databases in each subdivision to document the nature of educational problems, trends of new enrolments, number of dropouts, the results of the institutions in Board and University examinations or other important results, the ratio of success and failure of students. With these data interventions, the educational sector of the Punjab can follow the trek to business process reengineering in the spectra of research, curricula and HR development, and advanced infrastructure.

Results and Discussions

Developing data science and incorporating it into Punjab Governance will revolutionise sectoral efficiency, because of accurate planning and effective roadmap for policy implementation. However, the development of data science in the Punjab is not an easy objective. Lack of infrastructure, data privacy concerns, absence of specialization, political resistance, financial constraints, procedural formalities, structural flaws, backward HR, colonial legacy, and lack of reformative vision will continue to pose hurdles to the development of data governance in the Punjab.

Conclusion

Data science is a transformative and advanced solution to the inefficiency of the governance machinery of the Punjab province, hitherto trying to grapple with the complex syndromes related to Human Resource Management, development planning, field administration, climate governance, healthcare, education, agriculture, and public health (World Bank, 2023). Incorporating centralized data systems and GIS (Geographic Information System) based platforms along with real-time analytics would enable the government to allocate resources better, streamline public service delivery more efficiently, and encourage accountability unprecedentedly (Urban Unit, 2024). With the intervention of data science in the governance sector of the Punjab, the level of efficiency of the province will improve due to highly accurate decision-making, policy-making, and implementation. In addition, due to the E portals and grievance redressal mechanisms, citizen engagement will cultivate the culture of trust in the Punjab Government, in parallelism with the public satisfaction with service delivery in the global governance systems of the US, the UK, and Germany.

Recommendations:

Development of data science with the vision to incorporate it into the governance model of Punjab requires the following steps:

Establishment of Data Science Department: The current Bureau of Statistics working under the Planning and Development Board does not have the capacity and infrastructure to implement data science in the Punjab.

Making of Data Science Academy: Data science for most of the HR of the Punjab is Greek. They need rigorous, professional, and technical training from the Data Science Academy.

Overhaul the Business Models to generate more revenue for the development of data science infrastructure in all the Tehsils of Punjab.

A unique quota system must be introduced for data sciences experts in competitive examinations like CSS and PMS.

Establishment of a Data Science Wing in all Punjab Government Departments to keep the data governance cycle swinging for accurate decision-making.

Development of the Public Private Partnership Model to encourage the development of data science.

Develop a Data Management Authority in all the Tehsils of the Punjab to collect and monitor data from every Department of the Government of Punjab at the subdivision level.

Promotion of data literacy and digitization among other pillars of the state to seek their unified support.

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