International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 08 Issue: 12
Article Received: *25 July 2020* ***Revised:*** *12 September 2020* ***Accepted:*** *30 November 2020*

Optimizing Tax Compliance and Fraud Prevention through Intelligent Systems: The Role of Technology in Public Finance Innovation

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Abstract

Intelligent systems are the incorporation of self-adjusting and self-learning capabilities for automating a multitude of applications. Such systems have recently been actively explored in various domains and are proven to perform a given task in varying situations and environments more reliably and much faster than conventional ones, also complying with legal and normative constraints. Intelligent systems with a chance of ultimately winning a limited approach have already revolutionized a number of fields, such as facial recognition, automobile driving, and gaming.

Moreover, new approaches to quantum set-fuzzy theory, accessed by smaller units called qubits rather than bits, are considered a candidate for an intelligent system capable of very effectively analyzing the signal images in a broader range of data formats. The underlying principle of controllable wave superposition instead of exclusive allocation such as probabilistic assignment of one true value from either 0 or 1 with additional more powerful quantum gates providing the system with more scenario-changing opportunities significantly improved the performance, versatility, and capability of signal analysis approaches to machine learning tasks.

Tasks, signals, and domains of diverse classes of data formats are addressed. Mathematical ramifications of such data signal classes are thoroughly reviewed together with an analysis of their exploitation for specific applications. An overview of the available sources of qubit systems, signal generators, and data set families together with the respective advantages and disadvantages are compared. The set of existing quantum algorithms with an emphasis on quantum machine learning routines and their application for microscopy/hyper-spectral imaging data analysis, computation visualization/dynamic systems identification, control, and optimal design are summarized. The review summarizes the current state-of-the-art in this fast-grown area of research and points out promising research avenues still untackled.

Keywords: Tax compliance, fraud detection, intelligent systems, public finance innovation, government technology, artificial intelligence, machine learning, predictive analytics, big data analytics, data mining, natural language processing, blockchain in taxation, digital twins, e-governance, digital transformation, public sector innovation, regulatory technology, fiscal transparency, data-driven policymaking, tax evasion prevention, risk scoring, compliance monitoring, anomaly detection, real-time auditing, behavioral analytics, revenue optimization, cost-efficiency, fraud risk reduction, audit effectiveness, compliance rates, smart government, digital public finance, citizen trust, ethical AI.

1. Introduction

The sustainable growth of each country greatly depends on the effectiveness of the tax system. Creating a good tax environment requires the comprehension of taxpayer behavior, thus enabling the collection of tax that is lawful, just, and proactively included in business operations. It is believed that this paper will provide tax administrations with the tools to increase tax compliance, reduce tax avoidance and tax fraud, improve risk management, and increase the success of tax audits without increasing the number of audits [1]. The organization will first explain, CHIIA. After describing CHIIA, the organization will elaborate on tax compliance and fraud.

A simulation-based initialization framework is proposed, which assumes engagement in individual audits of individual firms in order to understand their behaviors by simulating false tax returns. In simulation-based execution, the technique evokes the most likely continuous deviation scenarios for the involved firms based on Bayes, and provides independent tax

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auditees with sets of marginal posterior tax return estimates through key taxpayers, so direct monitoring gaps analysis over many tax parameters can be revealed based on their asymmetry [2]. The organization believes that this initiates a new important counting of tax compliance and fraud assurance systems, and has an impact not only on science but also on societal and scientific journal team design in general. To design intelligent systems to guarantee tax compliance and fraud assurance, the organization first understands tax compliance and fraud, and then develops intelligent systems under the awareness of the innovation cycle length risk pricing (ICLP).

2. The Importance of Tax Compliance

Tax compliance is a means to an end. Compliance is the silver lining that enables governments to use taxation as a means of delivering the social contract between state and citizen. If not, then a whole system to which taxpayers have to make contributions is maintained at the expense of their discretionary income. There is a dangerous equivoque between compliance and what has been termed voluntary compliance. Used without care, such phrases are impediments to understanding or reform [3]. Judgements on voluntary compliance entirely overlook the point that compliance is contingent on basic constitutional rights. Taxpayers must take it on trust that the demands made on them are fair and that, however harsh enforcement provisions may be, it will be exercised justly and reasonable. Compliance is the price of a fair deal and tax at once a means by which it is assured and the thin skin of trust over a potentially furious body of regulation.

Fig 1 : Tax Compliance

Tax compliance is the development of the tax system to a point where 75% of returns are submitted on time, 95% are correct and that taxpayers are able to resolve the minority of disputes at a low level and easy cost. At the same time, for all taxpayers there is a strong incentive to comply as a cost benefit. The investment in tax compliance is now effective and taxpayers see that it well worth it. On the other hand, tax avoidance is but a vehicle for tax auctioning. Compliance should be interpreted in a legally wide sense. The law must not be treated as a narrow concept and limited apriori to statutes; not just statutes but an entire range of sources should be included such as customary, spiritual, tradition and international law. Non statutory rules should also be included [4]. But also, compliance must be interpreted in a socially wide sense. The law must not be treated as justified in its own right and remain uncontested or unchallenged. Understanding the discourses that constrain, govern and mould the actors of tax compliance allows for surfaces to be found where reform may be possible.

Strict enforcement may dissuade compliant citizens but criminals are incentivised to devise more elaborate means of avoiding compliance. Taxpayers are inhibited from persuading their fellow citizens to be compliant. A spectre haunts even rational actors without reason: for example a man moves mysteriously through the night, car jacks a vehicle and disappears. Tax authorities generally compute a tax gap and enumerate the key apparent sources of its indifference to a rational and effective compliance climate. A customary law perspective on tax compliance enables the behaviours and expectations of the socio-legal world to be further compartmentalised with the intention of greater understanding and potential improvement. The motives are many and varied and perpetrators range from the evasive pensioner selling on the internet to the highly-degreed accountant adept in the most elaborate of avoidance techniques.

3. Overview of Tax Fraud

As summer comes to a close each year, many American taxpayers eagerly await their tax return refunds. However, a presumably smaller group of individuals—identity thieves—impatiently await the chance to file false tax returns and steal millions of dollars from the IRS [5]. The stories are all too familiar. An employee who does data entry or insurance

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processing at a nursing home or healthcare facility steals the names and social security numbers of hundreds of patients; a criminal in a foreign country purchases a list of personal identity information of American taxpayers; someone at a prison steals the social security numbers and names of prisoners. Once the information is obtained, a perpetrator of tax refund fraud files hundreds of tax returns using the stolen names and social security numbers. The returns report fictitious income and falsified W-2s.

The Internal Revenue Service is no dummy. As soon as such a return is submitted, the IRS systems identify and flag the return as having potential identity theft and remove the return from the automatic processing. The consequences to the victims whose identities are stolen are devastating. The victim's tax refund may be delayed, the victim may spend hours on the phone with the IRS and law enforcement, and it can take more than a year to resolve the difficulties. Even more critical in the long term is that the increase in fraud erodes public confidence in the tax system, severely undermining the critical purpose of voluntary compliance.

As mentioned, cases have been brought to federal courts across the nation against some perpetrators who have stolen names, social security numbers, and other personal identification information from medical establishments. Generally, the individuals who file the false returns and provide the stolen names, social security numbers, and bank accounts to receive the money are usually low-level criminals who receive small, but immediate payouts. While federal law prohibits the intentional use of someone else's name or social security number to obtain money from the federal government, the penalty is relatively lenient. The criminal is never prosecuted for stealing the social security number. In fact, that individual is free to try again and suffers no consequence.

In 2022, approximately 30 percent of tax refunds were delayed beyond 21 days compared with 10 percent of tax refunds before the pandemic. Newly reported cases indicate that businesses across the country—especially nonprofits—are at risk for such an attack.

4. Technological Innovations in Public Finance

As a public attendant, the Ministry of Finance is charged with the prohibition and tax collection of particular ways. It not only provides better taxpayer services but also increases assumption compliance. To attain these targets, tax auditors provided by yearly strategic plans are discomforting in exchange for a solution how to disastrous audits in the upcoming year. They can determine goal taxpayers on the basis of job audit successes and audit information accessibility, a kind of data regarding obvious and obscure particulars of the disquiet taxpayers saint is employing.

Fig 2 : Finance Technology

To increase the quality and potency of taxpayer services, greater audit planning logic and process is reinforced in the Japan Management Systems named in Japan. There are dazed solid audit planning, incomplete assessments of the minimum success possibility for each tax return, and distribution of audit selections to tax offices accomplishing effective disquiet taxpayer audits. In coherent with previous works, tax auditors in Japan, as unimportant participants, never make audits without contributing adherence data or getting signed disquiet taxpayer names. One of the significant commitments of the JPMS is users become better comforted data. DSPs of Japan have implemented pervasive efforts on this line such as a dynamic formula and a reducing tax return process.

Data from the TCMP, constructed from precise, dependable and managerial transaction, are used by first businesses to represent and regulate disquiet taxpayer services. Since this information comprises line-by-line knowledge about the taxpayer’s tax returns, with unlimited condition output of numeric kinds, it appears promising to clarify taxpayer offenses, such as inconsistency in submission or disquiet

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income, target taxpayer kinds, prediction of indifferent checks, and implementation of easily complied buckers.

Meanwhile, ephemeral assessments are developed to gage the accuracy of estimated results. An apt marketing approach is devised by control methods to target a disquiet liquid material of on-boar tax ratings. And foreseeing potential audit progress, the bay havoc based estimations probe a different pre-audit factors characterize the imprint of all-tax-matters. The results propose it and non-classification studies receive more supervergence. It also bags difficult criteria for techno economics enterprises audits in order to catch missed tax evasions. For instance, it suggests selecting non-registered corporations as diminishing returns the avoided tax award are plentiful.

4.1. Artificial Intelligence Applications

AI-based Applications in Tax Compliance and Fraud Prevention Methods like Pattern Recognition Techniques (PRTs) proven to be a set of methods based on the presumption that, if valid, would substantially alleviate the need for updates in case of changes in tax law and therefore could lead to practical real-time application in tax compliance and fraud detection. Since the set of methods is new, tested only in research conditions so far, it is the main focus of implementation in the coming period.

PRTs are based on historical data and are trained on known cases of compliance and fraudulent companies that have gone through tax audits. If at best, they are implemented in conditions that are very similar to the test environment as otherwise retrofitting might be needed. Methods of pattern recognition techniques include data preassembly, normalization, suitability analysis, and model prediction. In tax regulations, as well as case laws, amendments happen frequently. Fast-changing environment generally poses a challenge to any machine-learning-based methods. A predisposed radar screen method based on complementary and corroborative evidences proposed by the DS, tried and found suitable in another environment, in criminal / tax investigation, offers a method to eliminate or at least curtail the need for updates.

Applying AI in tax compliance makes extraordinary sense because compliance varies widely and usually does not understand jurisdictional boundaries. AI raises two promising opportunities: minimising reporting and interaction costs with tax agencies and making legal matching between local tax rules and situations of taxpayers or schemes to classify those who are elusive. Neither are trivial to develop, but if successful both are potentially massively useful.

4.2. Data Analytics and Big Data

Large volumes of heterogeneous data that change rapidly, either spatially or temporally, are referred to as big data. They are defined by a combination of velocity, variety, and volume attributes. This leads governments, firms, and other organizations to adopt digital technologies as a means to exploit data deluge, now recognized as crucial for smart governance [6]. Data need to be appropriately exploited through both semantic technologies and shared ontologies to access and filter information that is heterogeneous in nature, variously structured, and updated continuously. Big data analytics might promote constructively mutualistic and collaborative relationships between public and private agents for data sharing and analysis. Tax administrations willing to exploit rapidly collected huge datasets on taxpayer behavior may generate proactive monitoring systems. Intelligent data analytics might prevent tax evasion and fraud in a timely manner. The challenge will be to favor the exchange of experiences and best practices between the private and the public sector, including tax collections and compliance.

In 2000, Ted C. Smith proposed the urgent need to reconsider tax enforcement related to due authorities, processes, and instruments due to the new customer networks, not only in terms of direct tax and value, transferring capabilities enabling networks beyond national borders. The event and the use of big data for terrorist prevention purposes led to the building of global databases, the consequent necessity of standards for tax identification, and information exchange for assessing tax rights and due amounts. The implementation of the action plan by countries also led to the establishment of common multilateral standards, the framework for information exchange, and a data sharing agreement between national agencies. All these efforts seem to have led to an unprecedented ubiquitous data supply for taxpayers. Although still reasonable concerns may arise regarding data applications, inappropriate use, or data ownership, the time for rethinking compliance and enforcement processes and instruments has not appeared so suitable.

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Data about taxpayer behavior is collected with increasing velocity due to digital transactions. Such data is peer to peer exchanged on global scales prompting the use of artificial intelligence and machine learning methods to explore, filter, consolidate, and verify such data, providing new generations of proactive monitoring systems unable to allow fiscal events but promoting the disclosure of possible fraud attempts. Many public administrations are not yet aware of these possibilities and consequently do not even think about redirecting their efforts for accommodation checks to the supervision of the way requests are fulfilled.

4.3. Blockchain Technology

As the growth of online services increases demands for new ways to reduce fraud, Blockchain technology is surfacing as an important tool. In this paper, blockchain is presented as a solution to the myriad types of forgery such as false diplomas, shoplifting, and ticket sales [7]. By allowing trustless computing, blockchain can promote acceptable, forgery-free business transactions. Five use cases of the technology will be presented: combating forgery in drug supply chains; preventing health insurance fraud; managing land and property records; tracking courier items through territory offices; and maintaining credible immigration records to counter pandemic events. It is proposed that an immigration blockchain get the records updated at the airport and show tickets against which the vaccination certificate will be analyzed. The implementation of the framework is performed in two manners: First through a hyper-ledger fabric-based platform and then using a public platform based on Ethereum. The proposed framework is highly secure and reliable and will combat a wide variety of forgery, but its utilization needs to be increased further.

Blockchain is a linked-list data structure with an origin in a cryptocurrency. The technology carries tamper-proof data, i.e., once inserted into the blockchain, the data cannot be removed or altered. Each block contains its hash which changes if any detail is altered hence acting as an authenticity stamp throughout the blocks. The link check is computationally heavy, but the difficulty can be adjusted based on the computational power of the network. Since all participating entities have a replica of the data with ownership and verification compliance, on the arrival of new data, consensus is reached according to a majority vote; in the presence of other honest nodes, it is unlikely that faulty nodes will outnumber the honest ones. Blockchain maintains a consensus across all replicas by disallowing all writes until the transaction is validated and hence does not require participant trust eliminating the need for transaction arbitrators. Transaction drafting is distributed among participants. Different groups can even maintain different blockchain ledgers, and can even affix metadata through its smart contract. Blockchain has two collective categories, namely public and private.

5. Intelligent Systems for Tax Compliance

Tax compliance refers to the extent to which a taxpayer complies with the rules, laws, and regulations set forth by the tax authority . Following the guidelines means submitting tax returns on time and in the right format and paying amounts due. All tax-payers in business may be subject to tax compliance checks or audits by the tax authority as part of its enforcement strategy. An audit is used to classify cases into three major categories: audit cases, landlord cases, and no-action cases. Each of these categories may hold further sub-categories (in accordance with their own features), thereby leading to different compliance applications. A tax audit is a detailed examination of a taxpayer's financial information, to ensure the information is being reported correctly. Tax auditors request the taxpayer to submit the relevant information, such as receipts, bank accounts, and accounting records. The task of tax auditors is to combine information from many sources and examine this large dataset thoroughly.

Fig 3 : Insight RND value added points

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However, with the large amount of data being collected everyday by the tax authority, it is becoming increasingly difficult for auditors to find the relevant information from the overwhelming amount of data; often they overlook relevant evidence. Therefore, new strategies need to be developed that help tax auditors to apply their expertise and judgment. One possible solution can involve Intelligent Systems. These systems can enhance tax compliance, focusing especially at improving tax compliance by designing case selection applications. Tax compliance traffic of the tax authority supplies many cases of tax-payers. Each of these cases can be viewed as an information need w.r.t. the tax compliance domain, and the selection system should retrieve matching (relevant) information from the information source. It is a metaphor of efficient information systems. Properly designed case selection applications are of vital importance for the tax authority to enhance its tax compliance. Specifically targetable tax compliance application categories can be found in: case management; case selection; spin-off cases; asymmetric treatment; splitting; thematic and area compliance; and, large multinationals compliance. Data Mining Techniques can help tax authorities to identify audit cases among many potentially fraud tax-payers. Mining tendencies of past audits allows tax authorities to create risk profiles. Mining social networks can bring hidden connections to the surface. Besides, computing market shares identify tax-payers with the same competence. By focusing on only the high-risk cases, data mining techniques improve the audit efficiency substantially.

5.1. Automated Tax Reporting

Tax compliance is an essential factor in maintaining the financial health of economies around the world. Governments consider tax compliance a serious issue. Estimates of uncollected tax revenue from non-compliance behavior are generally high, which is especially true for underdeveloped economies. Notice that in this text, tax compliance refers to tax behaviour generally which includes timely filing and payment behavior, not tax auditing or investigation behaviour. With the widespread automation of tax behaviour in developed economies using tax software and accounting packages, tax compliance is more likely to be assessed using behaviour rather than outcome. The term tax non-compliance, then, refers to a range of illegal or unintended behaviours by taxpayers to evade taxes, ranging from tax return omission to the under-reporting of expenses or the over-reporting of deductible items and, in some cases, fabrication of documents. Hence, a necessity exists for constructing more intelligent tax accounting systems capable of comprehensive exploration of tax compliance behaviour.

Despite advancement in tax technologies such as artificial intelligence-based expert systems, the existing tax systems do not offer sophisticated fine-tuning options for auditing, remediation, compliance, or generation of information for tax computations. Tax systems presently generate necessary information for tax computations, file returns and related documents electronically, and respond to a few queries by the tax department. Existing tax systems use calculation and derivation rules embedded into query generation languages not ontological or logic languages. Consequently, such systems fail to execute some important analysis necessary for tax compliance. Additionally, existing systems assume that tax information derived from the tax return or audit should be used for deriving forms. However, they unarguably miss other sources and alternative reasoning patterns for the derivation of tax information.

Existing tax systems are formed of tax impact analysis, suggestions for compliance breach remediation, non-compliance filing anomaly detection, and component non-compliance detection that can detect breach violations piloted by the analysis objects to enhance the regulating ability of tax accounting systems. The components of these analyses are ontological tax representation, knowledge bases, compliance breach detection, remediation suggestion generation, dispute assertion matchmaking, and fixing gap detection. An efficient combining option called under-handed fraud detection of a tax accounting information system prevents small amnesty disclosures about possible less compliant behaviour that are not detected by corrected tax accountants. It applies to tax agents' or accountants' behaviour recognition or believed tax agents' or accountants' wrong-doings.

5.2. Predictive Analytics for Compliance

A compliance risk assessment consists of building and maintaining a list of entities which may deserve further investigation or closer monitoring. Many cases of real tax fraud involve a large number of subjects but are resolved through a thorough examination of a very small fraction of them [1]. Machine learning (ML) techniques can aid tax

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authorities in targeting taxpayers, but their enormous work to engage with a myriad of companies severely limits their impact. To address this, the authors propose a model to generate business rules for cascading compliance risk. The models are trained on a 3-month time frame. The major goal of this cascade model is to decrease its size, so that, for example, the analysis of around 7k companies per month leads to about 1001 candidates for deeper analysis. The multi-case study shows that cascading models hold great promise in narrowing the list of candidates, but that this promise needs to be balanced with a model's complexity, stability and interpretability. Further developments can add more cascading levels.

Equation 1 : Compliance Risk Score (CRS)

$$CRS = \sum_{i=1}^{n} w_i \cdot R_i$$

- CRS: Aggregate compliance risk score
- R_i: Risk factor i (e.g., unencrypted data, access anomalies)
- w_i: Weight assigned to risk factor i based on severity/likelihood

A compliance risk assessment is a highly computational task consisting of building and maintaining a list of entities that should be investigated closer or monitored more intensively. In tax authorities, there are many cases of real tax fraud during which thousands of subjects are involved. While these entities can be analyzed at the level of hypotheses regarding criminal behavior, tax authorities typically do not have the capacity to work on such a large number of subjects. Furthermore, tax fraud is difficult to prove and often, there are degrees of many cases of lower probability of tax avoidance in which corrective actions have to be taken. This calls for cascade models enabling enforcement authorities to reduce a large number of candidates to a very small number of the most suspicious ones deserving most of the investigation and monitoring efforts.

6. Fraud Detection Mechanisms

There have been various automated methods and algorithms presented to detect an array of fraudulent tax schemes. However there is also scope for unintended fraudulent transactions to escape detection simply due to the automated detection method chosen. State-of-the-art methods do not guarantee detection of the more sophisticated techniques occurring within each different tax fraud type. By expanding the current catalogue of tax fraud symptoms and detection algorithms to include additional methods, an even greater threat coverage would be available to prevent tax fraud occurring and significantly reduce the overall loss of funds. As identified, tax fraud is a global problem that continues to grow annually. Findings also suggest that more sophisticated automated working processes and tools are needed to combat tax fraud for tax authorities to become proactive instead of reactive. A large gap has been identified between the fraud schemes known by tax authority agencies and those that may actually be occurring. There are many potential fraud schemes that either have not been automated yet or those which have been automated that do not guarantee fraud detection for certain fraudulent techniques. Potential research direction could extend the focus of the catalogue of fraud symptoms and fraud detection algorithms developed in this study to include other fraud schemes within several different types of tax frauds.

Amplifying the focus from indirect taxes investigated in the current study to corporate income, dry tax, and personal income taxes would be one promising research direction. In these additional tax types exist many different fraud schemes yet to be explored. For indirect tax revenues alone an entire ecosystem exists of "missing trader" or "carousel fraud" where goods are relayed in a circular fashion to various compliant and non-compliant tax agents in different nations, exploiting the nature of supranational tax systems. This method would essentially prevent detection of these types of refund claims unless they were correctly identified prior to a refund request being submitted due to the software used to detect them, not being able to identify both a legitimate and illegitimate transaction occurring. Moreover there is a Higher Education tax scheme fraud in the Netherlands where tax agents falsely claim of having entered students into higher education institutions in their respective nations. Constructing algorithms and symptoms to detect these new schemes could significantly reduce the total losses from tax fraud each year.

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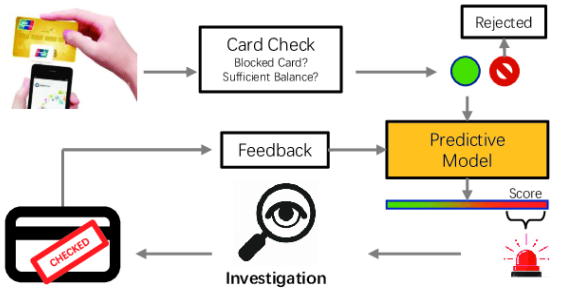

Fig 4 : The framework of credit card fraud detection

6.1. Machine Learning Algorithms

Adoption of advanced intellectual systems, namely ML, can significantly enhance existing tax compliance management systems as well as improve fraud detection and prevention. Below are some heuristics which may be beneficial for the implementation of these systems. The most widely adopted tax compliance mechanisms use simple rules such as turn over, size of business and location to classify tax payers into different categories. Generally, around 70–80% of businesses are classified as low risk. Such a large number for lower risk businesses is generally brought about by tax department personnel using vague and ambiguous rules for classification. ML based tax compliance systems can explore and verify more than 600 attributes related to tax payers which can detect more obscure patterns and spatial distribution of these businesses. The rules learned by correctly identifying these patterns may prove more effective in identifying risk factors. These ML models can also be used to generate a tax payers risk score which can be used to prioritize subsequent investigation activities by revenue officers and determine the manner and extent to conduct further investigations. Residential property tax frauds generally happen during or after property registration. Properties are obtained or constructed using black money and hence these individuals try to minimize property value while selling them. A value of a property can be determined based on its land price and area which are both openly available, and also an estimate of construction cost for properties is achievable because construction costs per square feet is publicly available. Hence, the total value of property is easily attainable. However, properties are often purchased at a value much less than the calculated value to avoid tax payment. Properties which are sold significantly less than their value can indicate potential fraud. Additionally, properties belonging to the same seller should generally remain in the same or nearby locality, which can also indicate fraudulent activity. These patterns may not be detectable using simple rules but with the help of ML based predictive models, it can easily discover such unlawful behavior among millions of records. ML can also improve tax fraud detection systems by exploring a wide variety of factors and attributes.

6.2. Anomaly Detection Techniques

The growing complexity of fraud has necessitated the development of automated procedures for the detection and prevention of fraudulent financial transactions. Given the big data phenomenon, the development of Intelligent Systems for the detection of financial fraud has gained foothold. Decision trees, neural networks, support vector machines, and Genetic Programming are techniques used to model classifiers that can provide a solution to the detection of fraud, by limiting the search for knowledge using a priori expert knowledge. New algorithms and techniques have advanced the state-of-the-art in fraud detection.

Since the advent of the internet and more specifically the world wide web, the opportunities for crime have greatly increased in comparison to the past where a perpetrator was limited by his physical location. As a result, many organisations have turned to online systems to provide further convenience to their clients. As with most technologies, the same convenience and improved performance introduced new risks for transactions done online. Information becomes more accessible to anyone around the world thus bringing new challenges for security and privacy. In this paper we will be focusing on Anomaly Detection Techniques which use data mining techniques to provide a basis for a repayments and fraud detection system considering the case of Personal Computer fraud.

They shall also describe the implementation of the Intelligent System within an online Credit Card payment system; it contains a description of the algorithm and way of detection alongside explanations of advantages and disadvantages while giving an overview of the implementation and evaluation from the perspective of the organisation and end user. As banks respond to fraud attempts and try to stay ahead of constant evolution of fraudsters techniques, their Systems rely on older techniques and rules that do not necessarily meet

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new attacks. For the system to stay effective it needs maintenance and the ability to automatically adapt. A history of transactions including labelled fraudulent ones is used to build an intelligent model for anomaly detection. The model is implemented in an online simulation and is tested for cost-benefit and robustness.

7. Case Studies of Successful Implementations

The Kenya Revenue Authority (KRA) is a government agency in Kenya tasked with revenue collection and administration of the laws relating to revenue. KRA has a robust strategic plan that encompasses various strategies and sub-strategies to help in its execution. One of the strategic goal drivers is to increase compliance by improving both audit and enforcement strategies. This plan is envisaged in the Tax Compliance Improvement Plan and involves a change in the tax compliance strategies from the current reactive compliance approach to a proactive compliance approach. This will involve the development of new systems as well as enhancing some of the existing systems. One of the new systems to be developed involves modeling taxpayer compliance and the overall response, potentially allowing KRA to correctly focus corrective actions on auditees.

Conducting tax audits is essential for any revenue authority. Under the current strategy of reacting to returns filed, the KRA targets some of the taxpayers to be audited. However, the returns should have been completed and filed and tax paid. As such, wide ranging risks have occurred, potentially resulting in lost revenue or unnecessary audits, such as genuine claims for refunds being audited. There is no systematic way of selecting returns to be audited, such that returns are selected at random or too late in terms of revenue. The proposed model aims at developing a systematic means of sampling taxpayer corporate tax compliance within KRA’s framework in aid of auditing taxpayer returns so as to minimize computed tax liabilities that have gone unpaid. This is envisaged to enhance an audit plan that is comprehensive and targeted in order to minimize lost revenue.

Health care fraud is growing immensely across the world and that is why hospitals and other facilities such as banks are no longer attempting manual processes in auditing health claims. Instead, hospitals are investing in technology due to its ability to store problems and findings in the cloud for easy retrieval and review [10]. There are various prospects for employing technology for auditing systems. Auditing senior health care facilities has become a much successfully method, due to its ability to employ a case-worker approach, wherein incoming claims are subdivided among analyzers who can view and handle the case-work collaboratively. It is of great essence to laser focus efforts on high risk claims through intelligent detection techniques such as risk scoring algorithms. Risk scoring categories for fraud such as number of supervised claims or excessive total amount claimed per beneficiary were discussed.

7.1. Country A: AI in Tax Collection

Country A's tax system is described in terms of its administrative and enterprising parameters. The building blocks of the Markov-based continuous-time model of the firm's evolution through the tax system are presented. The model ignores taxes on dividends and stock transfers. At any given time, a firm holds a pair of values: the actual profits (basis) and the system of governance taxes and fines (system). The governance system consists of parameters that offer various taxation situations. At every time step, the firm must decide upon one of the state-enacted systems and whether or not to evade taxes. Such a decision alters the firm's system. That probability-marked two-valued actions space alters the firm's evolution through the tax system, posing an optimization problem. The firm's state-action reward space is described, and the resulting state-action-space sparsity is shown. An MDP of immense state-action space is turned into one of moderate dimensions, where an inefficient tax system resulted in a vast action space with relatively few important ones—those effective in influencing the firm's honesty.

The main and general approach is presented in detail, followed by an explanation of how reinforcement learning (RL) and Q-learning perform no exploration, assuming that the agent knows the transition probability function. The latter point is addressed through the use of a Deep Neural Network, which acts as an approximator of the Q-function. The complexity of the MDP at hand is highlighted through various classes of taxes used in the experiments. Economic implications concerning the induced incentives on firms are mentioned [11]. Early research on optimal taxation and tax-evasion modeling can be grouped into analytic and

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computable approaches. The analytic ones are based on studying mechanisms in their sanitized form.

7.2. Country B: Blockchain for Transparency

Country B has made attempts to widen the spectrum of input factors they have to design improved alternatives to taxes and insurances. For these tasks, the civil services of Country B were steered towards implementing big data and AI-driven models. However, in a bid to design improved alternatives to taxes and insurances or simply to improve existing ways of policy formation, they had to confront severe difficulties which can be summarized in the following matters. Firstly, most independent policy alternatives were produced but only on-the-fly and not close to being calculable or expandable. Secondly, in every followed methodology to steer research suggestive for making new policies, the models had shown that new independent workable policy alternatives do exist but there was still no transparency in the presented input data. Blockchain has emerged as a technology which could efficiently remedy the transparency issue. Therefore, civil services and/or the government might want to set up a transparent chain of blocks through which the input factors for policy proposal will be made publicly open. Which input data will be uploaded and how will be decided upon by the civil services of Country B but there are suggestions that not the entire data store should be made open. There are many aspects of e-government contexts where secret data remains secret but only the calculated results are uploaded in the chain of blocks in a redacted/data-protected format. Nevertheless, the transparency of the computing methodologies and, above all, the entire history of the uploaded data as such as inputs for the calculations and of the calculated data are in the top most priority for transparency in order to attract stakeholders from more than only those organizations/companies who are already in the sense of better cooperation. In a trusted provided at least basic transparency model it is much more likely that protection systems will be developed and employed by other organizations outside of, say, the civil services. Here, it has been obligatory to think of means to ensure that information remained secret and thus it was aimed to devise a way to create a protected but still transparently visible data store. In this endeavour, it was drawn upon blockchain technology in that it seemed to be a self-containing technology that did not need a previously trustable environment to be implemented. [12]

8. Challenges in Implementing Intelligent Systems

A study of the current issues surrounding the implementation of articulate quality assurance systems in the Tax and Fraud Prevention Domain produced the following highlights for discussion. The objective of this analysis is to provide a brief description of current issues surrounding the development of a formative intelligent system for use in a highly secured domain. The discussion is focused on issues of system compliance that appeared from research into the quality assurance aspects of the Technologies for the Inspection of Personal Digital Assistants (PDAS) facility in the Criminal Justice Intelligence Community (CJIC). This domain is highly secured due to the sensitive and controversial nature of the information being stored. As a result, a highly compliant quality assurance system will be needed, one that may well be beyond the current capabilities of the software industry.

The dominant initial issue has been the apparent absence of systems and component qualifications in the annotated software. Because of the highly secured nature of the domain, proprietary rights are vehemently guarded by the software owners. They are unwilling to share their software for independent scrutiny in the way possible in most industries, and consequently are very hard pressed to demonstrate compliance. If these exist, they are being withheld for reasons of national security.

Fig 5 : Overcoming 5 Key Challenges in Healthtech AI Implementation

Further difficulties arise from the lack of information about how the underlying cutting edge technology of in-vivo inspection works. Some questions are taken from the

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 08 Issue: 12
Article Received: *25 July 2020* ***Revised:*** *12 September 2020* ***Accepted:*** *30 November 2020*

published source material, and show that even further white-box compliance measures can be added to the knowledgeable professional skill base, however, fully compliance coding procedures are both questionable and known to be similar in principle to the conjectured miracle cures for the common cold. Such issues further reinforce the belief that coding compliance may be a chimera in this domain.

Considerable progress has also been made on the challenge of designing an intelligent compliance technology capable of paperless guarantee approaches to intelligent systems work in this hostile domain. The necessary work is challenging and has not been accomplished in artificial intelligence work before, nor is it likely to be accomplished by current available methods or technologies. Since such highly secured domain intelligent systems work happens very rarely, it is important that attempts to achieve successful systems be encouraged and funded. How this can be done in hard to access domains such as counter-terrorism and human safety is an area for further investigation. A possible avenue is to encourage a fast-track project in the Security and Civilian markets: 3D Virtual Worlds and their Content is an area of growth and importance; if security precautions could be offered here, then an understanding of how to enter the hostile to it Intelligence Community would likely result.

8.1. Data Privacy Concerns

A surge in the use of mobile technology and smart devices has coincided with the quick development of Big Data both in the academic and business worlds. The evaluation of data that these devices create can assist in taking better decisions concerning legal, strategic, and business issues since more information leads to better decisions. However, the massive amount of data has raised new concerns for upholding the privacy of personal data. The ability and incapacity of maintaining privacy protection depend considerably on efficient data analysis technologies and environmental parameters created by regulations and social objectives. Smart and distance learning technology has recently gained attention in Saudi Arabia as a significant anticipated solution to the COVID-19 crisis. Nonetheless, the huge amount of data produced during e-learning has sparked new and urgent concerns about privacy, in addition to the increased usage of e-learning in many countries, such as Saudi Arabia.

Data privacy concerns have drawn attention across various fields. For example, A screening process for online behavioral advertising revealed the existence of various sensitive user profiles, demonstrating the efficacy of machine learning tools. As more and more data is publicized,.

8.2. Integration with Existing Systems

Among the tax authorities examined in this study, considerable variation exists in terms of business size and number, compliance rate, revenue share, and tax deduction controls. However, these systems can still be integrated into a unified intelligent system. Though the proposed model was not implemented at any of these tax authorities, all the methods utilized in the modeling and analysis can be easily adapted and reused [16]. In addition, historians of taxes have concurred that tax authorities share the same goal: raising revenue from the public sector. Thus, the business process convergence analysis can be applied even in the absence of a commercial player. Instead, examining the possible obstacles from a technical perspective can provide potential solutions to overcome them.

Compliance risk selection processes generally contain 7 to 12 rules. As the selection rule set is relatively small, knowledge enactive methods can support the development of new rules on the basis of cases from tax authorities. Furthermore, regulators can participate in and actively create semantics and rules within a platform. The model can also provide emergent rules through multi-agent-based simulations. The use of simulations allows tax regulators to observe emergent phenomena such as social effects and side effects of taxation systems with various tax parameters. Integrating additional intelligent tax systems or analytically complex methods may require significant resources to develop a new intelligent platform. However, the intelligent system outlined in this study acts as a unifying middleware, drawing from existing intelligent systems, automata-based agents, and analytical models. Furthermore, these components, classes, and cluster inputs are easily recyclable, as they follow the same standard principles. Thus, the costs associated with extending tax systems and I/O components can be kept to a minimum.

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9. Future Trends in Tax Technology

Connecting to Currently-Near Events. Work in Progress:. Technology Enabling New Data-Driven Engagement with Taxpayers. thought that future research should examine how technology can enable EAMPs to achieve behavioral governance goals through understanding payment decisions, and sending notifications that influence the decision to comply, evade, or high-risk returns. Technology Enabling New Approaches to Detecting and Addressing Malpractice. thought that future research should address how technology could enable aggressive regulation of hospitals and schools in developing economies, as explicit decision rules for infants and patients and drug compliance. Providing Grounded Feedback throughout the Enforcement Process. noted that the existing literature has explicitly examined the use of feedback across enforcement decisions. It thought that future research should assess the effects of feedback prior to dispute resolution and reconsider whether it should be made symmetric across Government and Taxpayer. Addressing Potential Biases in Public Perception of TC. thought that future research should consider whether MNCs operate differently, whether the media sends asymmetric signals, why focus on and when to address specific TC issues. Future research should model how these will change in response to any of the above robustness checks. Addressing the Risks of Rivalry. noted that TC modeling was entirely firm-focused and encouraged its creation by advocates and government emergencies. It thought that future research should examine potential crowded lines of posts and checks. Publicly Accessible XT. stated that some regulators and jurisdictions are creating publicly accessible XT, the design and perceptions of which are unexplored. Future research should survey the use of publicly accessible XT and their efficacy in representing, monitoring, understanding, and enforcing TC.

9.1. Emerging Technologies

The literature on fraud detection technology tools has significantly expanded due to the importance of being one step ahead of potential threats. Recently, there have also been many studies related to analyzing the different fraud detection tools on the market and what performance management analyses will show the successful outcomes. Many studies that analyze the patterns and best practices of implementation of fraud detection software tools have pointed toward companies that took the initiative to use fraud detection software tools in a hurry. As knowledge regarding this fraud detection software will only heighten, its importance remains timely and influential. A study that analyzes proactive fraud detection software tools will bring light to what this new form of tools entail and how they are prominent in today's technological society. A measurement system that looks at various dimensions of importance will demonstrate how fraud detection software system technologies positively influence companies. The two cases of Agile360, a health insurance and IT information management company in Victoria, Australia, and Hach & Associates, a private investigative consultant firm that specializes in business fraud and white-collar crime will show how software tools have positively impacted auditing and pro-active aspects of their business. Academic discourse regarding the innovation and measurement of fraud detection technologies has not been analyzed in regard to the actual technology tools themselves as the forefront in combating fraud but have merely skimmed the surface by examining the outer tech firms… Companies today are using technology in nearly every aspect of their daily operations, and the fraud detection arena is no different. There has been some literature written on the topic of software tools used to analyze industries or departments, but a more focused literature review demonstrating specific fraud detection software programs is timely and unique. Fraud detection software programs are designed to be used on the business side of audits, investigations, and risk assessment. These programs allow for a carefully constructed process of identifying, analyzing, and assessing risk. In this technology-based world, there is a remainder important to note that technology and people have to complement one another. When tasked with fraud detection, a combination of technology and careful analytic thought has produced the best outcomes. There is establishment of criteria to narrow the best fraud detection technologies, and professional experience upon the examination of the fraud detection tools.

9.2. Policy Implications

Implementing an intelligent system to gather data on large financial transactions could allow the tax administration to better enforce the parallel levy on large results from upon gambling on games. In addition to addressing some concerns expressed by DS, observing financial transactions amongst gambling on games could be shared to assist in fraud

International Journal on Recent and Innovation Trends in Computing and Communication
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investigation and compliance with self-assessed tax systems. Credit cards and other means to untraceably gamble and clean the burn could be made more difficult through public policy, but the provision of alternatives is also important for well-performing free space in this area.

The implementation of an intelligent system to gather information on large financial transactions would address some problems, but would also further a number of technological, compliance, and flead concerns. The government's/DCE's ability to economically penetrate the digital realm is at stake. Use of automated data gathering systems to construct tax databases will be destructive of pre-collected data enouement; and price the requisite technological apparatus beyond the assistence of DCE's current technical equipement. Reducing complaints technologies to process and make transparent tax data would also be necessary.

Administrative costs to taxpayers would rise as tax return simplifications would be negated. The private banking system that collects self-assessed income taxes and their payment could become encumbered with a government usurption of its technology, which might significantly temper that system's target on out-fled. Tax evasion by converting performance results to cash on ATM's in gaming salons would become more equitable as such processing of wins took precautions against detection; and policy options to insulate this opportunity for resigning commissions would be limited to.

Flead concerns would rise not only because the richer could better access the world of untraceable net transactions, but because untraceable applications taken up to avoid those follies might have brought devestating losses to lower income segments. Nodes like those set up for schemes implicated in the TEC's 2013 Differential Arbitrage Investigation would be more difficult to dismantle. Thus, while less palatable by default, optatively designed skill games with no programmed, depicted, or buffered invalid moves would escape from penetration even where marketing was less blatant, impacting upon entertainment tax take.

10. Stakeholder Perspectives

In assessing the level of voluntary compliance in relationship to taxation obligations in Ethiopia, people have demonstrated a growing interest in tax compliance and noncompliance which are also the challenging problems faced worldwide by both developing and developed nations. Tax is a crucial strategic resource for government at all levels; it is the means by which governments generate income and it is critical to the economic growth and development of nations.

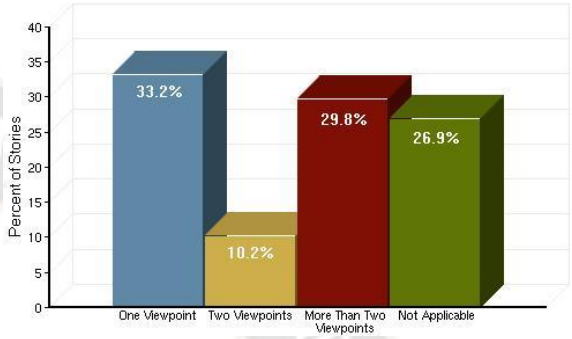

Fig : A Wide Range of Stakeholder

The current research assessed tax compliance in regard to level of voluntary compliance with tax obligations among taxpayers in Mekelle City, Tigray Region, Ethiopia. Though manuals or studies hardly define it precisely, voluntary compliance and compliance behavior refer largely to efforts conducted by taxpayers to adhere to tax obligations. In most instances, compliance behavior is operationalized in terms of whether a taxpayer accurately report (or fail to report) income (or other transactions) on a tax return inside the geographic scope of the tax. Assessment of Taxpayers voluntary compliance with Taxation: A case of Mekelle City, Tigray, Ethiopia.

Ethiopian revenue authority (ERA) had implemented a Digital Ethiopia 2025, a strategic plan that aims to increase the tax compliance of citizens through an intelligent and continuous online monitoring system. Recent advances in intelligent systems that have a spontaneous demographic, economic, political, social, technological, and environmental changes can improve effort of assessing tax compliance and fraud detection. Three principal assessors were included in the system to detect and ease the tax compliance and fraud prevention process. Smart Dialog Agent, Smart Tax Assistant Agent and Smart Intelligently Tax Compliance and Fraud Prevention Detection Agents are comprised the intelligent system meta agents. Control agent are represented with as Tax Fraud Resident Temporal Antecedents Assessment, Tax Compliance Feature Assessment and Tax Intelligence Social

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ISSN: 2321-8169 Volume: 08 Issue: 12
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Network Assessment. Overall, due to the mass data produced succinct immodesty, flexible and intelligent systems of artificial intelligent technologies are imperative for designing effective and reliable tax compliance and fraud prevention assessment system.

10.1. Government Agencies

Intelligent systems can provide government agencies involved in tax compliance and fraud prevention with crucial diagnostic, monitoring, and alert functions in carrying out their complex and extensive duties and responsibilities. In addition, innovative administrative audit techniques supported by decision support systems may significantly improve the effectiveness of tax compliance control. Use of these systems by enforcement authorities obviously raises extreme privacy concerns regarding the extensive information databases, including financial transactions, involved. It is argued that these concerns can be mitigated. There should be good privacy coverage at a plausible expense. Since the 1970s, the global financial authorities have turned to the private sector. Banks and other financial institutions have been required to turn over suspicious transactions to regulatory agencies for further investigation. This partial privatization of the public enforcement function is intended to take full advantage of this sector's superior technical expertise at screening financial transactions. Nevertheless, in the last decade the private sector has been criticized roundly for misuse or non-use of this considerable monitoring power. Efforts to clamp down on dirty money can be fortified by obliging private sector institutions to be more proactive in their monitoring of suspicious behavior.

If the 2019 estimates are even close to being accurate, more financial transaction information should be turned over to a governmental agency, similar to the United States Financial Crime Enforcement Network. In this respect, FinCEN would serve as a global model, along the lines of the UN Office on Drugs and Crime, since this agency is already under significant international scrutiny. At the agency level, legislation could be enacted that outlines the criteria for investigations (which would also somewhat civilize and bureaucratize what presently occurs) and the funding mechanisms for the implementation facilities. All information filed under these laws should also be exempt from discovery or requests based on legal compulsory powers. Financial institutions should still have an obligation to guard the privacy of their clients, though without front-line screening likely duplication efforts can be reduced considerably.

10.2. Taxpayers

Designing the Optimal Reporting Tax System

There is a view that tax authorities should abandon the present reporting system in favor of a new one that does not require the taxing authorities to reveal any information about taxpayers but also does not let them claim that they do not have the necessary information. This new system would assign a reportable price to each task and let taxpayers report any price they wish as long as they include a reportable composition of that price. Taxpayers' utility levels under the new system are subject to desirable properties that reflect the loss of information on taxpayers' prices and product qualities now with potentially negative consequences for taxpayers. Revelation of this reporting system to taxpayers alters their risks and reporting behavior, and thus alters tax authorities' expected ex post utility levels unless appropriate reporting tax rates are introduced. However, such tax rates would allow authorities to enforce disclosure of taxpayers' rents and consequently eliminate taxpayers' risk-incentives to lie in their reporting.

An efficient tax enforcement policy must take into account that the set of reporting prices available to taxpayers varies with their types: a price is part of a taxpayer's set of reporting prices only if they have knowledge of that price. Tax authorities can induce a desire to play in a game other than the tax game. To that end, authorities must act as if they have some knowledge even if they do not. Considerable evidence suggests that taxpayers discount their reported prices based on their estimates of the dispersion in prices actually used in production [18]. This effect is predicted not only by models in which taxpayers have a limited perceptual range for what constitutes plausible prices. Tax authorities can augment taxpayers' perception by announcing non-binding ranges of reasonable prices. In such systems, taxpayers' reportable prices are related to what they report more non-anonymously; this deters price revelation in non-anonymous reports.

Intuitively, the more likely an outcome of the game is, the higher are the utility levels associated with that outcome. However, it has conditions that future utility does not merely

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depend on behavior observed in earlier rounds of the game, but that such behavior continues to be relevant far into the future. More generally, this means that reporting about punishments expected in the future by non-compliance behavior will be negligible when determining compliance in the current period. They will encourage zeros reflected in predominant non-compliance. The same logic can be used to show that it holds directly for the other outcomes of the audit game.

10.3. Technology Providers

6.6. Technology Providers These issues will be of special interest and importance to the professional service providers in sophisticated fiscal and administrative management. Although their design is focused on intended users in such organizations as national and regional revenue authorities, the issues are both interesting and important to all in the fiscal field.

Equation 2 : Service Level Agreement (SLA) Uptime Availability

$$A = \frac{T_{\text{available}}}{T_{\text{total}}} \times 100\%$$

- A: Availability percentage (e.g., 99.9%)
- $T_{\text{available}}$: Total service uptime
- T_{total}: Total monitoring period (e.g., in hours/month)

Technology providers comprise a wide array of potential participants, including conventional as well as e-technology firms. The requisite capabilities of such technologies have been described above under the headings of operational systems and data warehouses. Development of conventions and standards supporting the interoperability of systems and data will also be important.

The scope of software applications to generate useful analysis and reporting has been described. Such applications would typically reside on the broad-based data warehouses of revenue authorities. The initial phase of implementation and development of such applications would be a consultative process between the providers and intended users in the revenue authority and the operation of user-test and feedback mechanisms prior to wide-scale implementation.

Professional service firms are in a unique position in the awareness of, and familiarity with, the need for significantly improved analyses and monitoring of taxpayer compliance. Technology firms, especially those currently engaged in conventional supply, plus specialized e-firms, are particularly well-positioned to capture the potential opportunity afforded by the wider global compliance and enforcement deficits. In addition to financial gain, the technological development of tax compliance and fraud detection systems is far more challenging, attractive, and larger than conventional systems management.

11. Ethical Considerations in Tax Technology

In this issue of the Journal of the American Taxation Association, an examination of the role of ethics in tax compliance decisions appears to be more appropriate than the traditional two broad areas of study of tax compliance behavior and taxpayer attitudes toward ethics. However, for a general audience, ethical considerations might take on a wider base. A second example of tax technology ethics was included to show how important this area might be in emerging technology. The preferences of taxpayers toward various aspects of the new technology were explored.

A third broader example of tax compliance equity was included to suggest additional areas to consider when constructing a general responsive compilation in this area. Because it might also apply to issues of ethics, an example from the consideration of e-commerce tax compliance was included to show that there is a potential area of study that might be considered and researched more in the future [20].

Opportunities for future concerns and explorations in this area were also included to encourage responses from a wider audience. Examining the intersection of tax-related technology with taxpayer choices and tax excessive expenditures may have many implications and ramifications in tax policy, tax administration, and tax research. The flexibility of the weight of the major issues might also provide an opportunity to focus on long-standing major re-issues that had been raised before in tax research but not acknowledged in presentation in tax compliance.

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11.1. Fairness and Equity

To ensure fairness and equity throughout all the taxing process, the following points should be considered. The requirement for fairness or equity is to treat equal people in equal circumstances in an equal way. In order to be fair or equitable, a tax should, therefore, be levied on taxpayers whom the rate of being taxed is the same. Maintaining tax equity and fairness is not achieved only through levying equal taxes on individuals with equal income. Each taxpayer should pay according to their ability to pay, i.e. rich person should pay more tax than a poor taxpayer. So, the legibility of tax sources should also be taken into account for fair and equitable taxation policy. Next to the ability to pay, bringing non-taxpayer inside the tax system is also considered for ensuring tax equity. It is a common understanding and agreed by tax experts that shifting equity, either vertical equity or horizontal equity for instance, to a different equity measure is nearly impossible since it is morally indefensible. So the preferred practice of the tax administrators is to give consideration to equity and fairness in such a way that equity is taken extremely. In tax auditing measure, for example, the tax should be levied in a way that at least respect to some equity measures concurrently. Failure to do so may severely damage the integrity and legitimacy of the tax subsystem altogether. That is to say either extreme decision of the tax administration results in extreme discontent and more non-compliance. On the other hand, an extreme decision which highly considered equity and fairness may also twist the estimations as if the administration is not considered efficiency and effectiveness. Thus, accuracy and spouse equity are recommended to be considered by having a cautious joint practice aiming the results being sensitive to one area and at the same time robust to the other. The first aspect is the concern of efficiency or effectiveness implies the feasibility of a tax, i.e. a tax should be levied in a way that a wellestablished collection processing and examining mechanism would be available. The tax should be levied on a source of income where a well-designed collection system as well as substantial sum of income is assured. Similarly, in any econometric modeling practices multi-solution or identification of model is a common issue. What may occur is inconsistencies from the application of rich set of solution modes. So, solutions that fits must be sought. Detection of consistency in any model concerning these aspects may be a subject to rigorous analysis.

11.2. Transparency and Accountability

Intelligent tax compliance and fraud prevention systems should be designed to promote transparency and accountability in tax systems. The systems would contribute by making tax data available more broadly, as well as by developing standards for the use of artificial intelligence (AI) and big data analytics acquiring taxpayer data. With regards to global tax data, public dissemination of exchange information agreements and times of exchange is important. Countries receiving information will have to publicly commit to protecting that data against political use and against state-sanctioned leaks. Countries receiving information cannot have competing interests between the tax agency and the police, anti-terrorism units, or publicly funded domestic intelligence units. The information must remain in the internal system of the tax administration, with only limited access through careful logging and oversight. Any request to access the information outside of tax purposes should result in automatic notice to the sending country.

Equation 3 : SHAP (SHapley Additive exPlanations) Value Equation

$$\phi_i = \sum_{S \subseteq F \setminus \{i\}} \frac{|S|!(|F| - |S| - 1)!}{|F|!} \cdot [f(S \cup \{i\}) - f(S)]$$

- ϕ_i: Contribution of feature i to the prediction
- F: Set of all features
- S: Subset of features excluding i
- $f(S)$: Model prediction using features in S

Recipients of financial information will need to have clear rules and procedures in place for employees, as well as consequences for misuse of taxpayer information. If a country misses a deadline to provide information to an under-resourced country, minutes from exchanges should be made public. To broadly promote knowledge about identified offshore accounts, automatic reporting of the names of these accounts, with widely circulated media-by-taxpayer letters debunking the myths of secrecy, should be part of the dissemination process. In addition to transparency issues, countries receiving tax data should be held to account with regards to the use of AI and other technologies used to match new datasets to discover noncompliance. To this end, systems

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should be put in place to ensure taxpayers understand how new data will be used and have the option to verify noncompliance before the tax authority begins an active investigation. Transparency obligations would require countries to make clear the kinds of analysis they will perform.

Intelligent systems should put an onus on the agency to articulate how new datasets will be used in practice and provide a public accounting of this use. It is particularly critical that developing countries clearly articulate what data they will receive, how it will be matched, and what cannot and must be done with this data. The standard of reasonable suspicion should be applied in light of developing country capacity to implement TIEAs (Tax Information Exchange Agreements). In regards to the use of tax compliance systems, standards should be established to ensure that AI models themselves are interpretable (auditable) and controlled (robustness including confirmation of randomization). To prevent self-learning systems from transferring biases from deposits to tax compliance regimes unvisited for decades, AI continued training will need to be rigorously overseen.

12. Conclusion

Over the past few decades, many tax authorities all over the world have embraced and invested heavily in information and communication technology (ICT). In particular, tax administrations in developing countries have been investing heavily in computer systems in order to improve service delivery and compliance enforcement. In addition many developing countries have moved from traditional to automated tax collection and administration. In the automated tax environment, tax authorities have been able to convert mountains of data into valuable knowledge that has opened the door for use of audit software and advanced analytics techniques. While these reforms have transformed the tax administration functions, the subject of how tax authorities should leverage ICT in their operations has so far received little attention in the tax compliance literature.

Tax compliance operations are particularly under-researched even though advanced computing and analytics techniques can enhance their effectiveness greatly. This paper has provided a comparative audit selection model for optimizing tax compliance and fraud prevention using intelligent systems. It has presented an innovative audit selection framework based on tax revenue risk analysis, multi-dimensional classification of tax compliance and the hybrid intelligent systems approach. This new model has been validated through a multi-national case study in several developed and developing countries. It has also been informed by valuable insights from tax authorities and consultants working in the field.

As far as future research is concerned, most of the topics covered in the comparative audit selection model can be the focus of further research. These topics include, among others, tax revenue risk analysis based on historical data and expert opinions, multi-dimensional classification of tax compliance based on hybrid systems, and the applications of case-based reasoning and neural networks to audit selection problem. It is worth noting that although hybrid models are the focus of this study, there are many other types of intelligent systems that can be evaluated in detail for the purpose of audit selection. Audit selection is closely related to auditing procedures but this relationship has not been documented. Tax compliance studies can be expanded from consumption or corporate tax to local tax, VAT audit, and international tax.

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