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SCIENCE AND TECHNOLOGY IN AUDIT

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Believing the Impossible – the Role of International Cooperation

By Mr. Janar Holm, Auditor General of Estonia, Chair of EUROSAI IT Working Group

Scientific and technological development has become an unnoticeable element of our everyday tasks and interactions, reshaping our society, economy, culture and lifestyle. It has been said that technological development is faster than ever before, but it is more accurate to say that technological development will never be as slow as it is now.

Digital innovation promises tremendous benefits, but it also raises complex challenges: new divides around access to and control of data, manipulation of information, cyber threats, inequality caused by the “digital gap”, etc.

EDITORIAL

This progress also has opened up completely new horizons for public governance – creating new opportunities, but also threatening with new risks. Smart and systematically driven digital transformation in the public sector can lead to more effectively functioning and more efficient state – with more active civic participation, better policy-making, more open government, better administrative capacity-building, better public services and, last but not least, reasonable use of public money. While many changes are visible and positive, others are problematic, and the risks associated with these problems need to be managed. Threats yet unseen in modern technology may emerge from unexpected directions during the process.

All these changes are important for supreme audit institutions both at operational and strategic level. There is barely a single audit topic that has no relation or potential relation to these developments. In Estonia, we see more and more processes automated: State provided counselling is being handed over to speech robots in some circumstances, decisions to allocate funds are based on satellite image recognition etc.

> *"We see practical value in cooperation among institutions, especially considering the technological turmoil we all are experiencing."*
>
> - Janar Holm

This also has an impact on the auditing methodology. Rapid scientific and technological development has taken supreme audit institutions to a new situation – to an unknown land. As Lewis Carroll put it – it takes effort and practice to believe in something not considered possible before.

As stakeholders from various domains are trying to exploit new technological horizons, supreme audit institutions need more resources and competences to adapt to the situation. It also requires innovation in monitoring, to keep institutions up-to-date with usage of funds and potential threats of artificial intelligence (AI), cloud computing, blockchain technology, etc.

All these developments should be monitored by supreme audit institutions, but the pace of their implementation is faster than the capacity of most institutions to respond. The task may seem impossible.

International cooperation is here to open up the scenery – to look beyond what has been audited and share viewpoints among field experts, how to deal with these developments – collaborating with its members, NGOs, governmental agencies and academia.

EDITORIAL

EUROSAI IT Working Group, uniting 43 supreme audit institutions, has strived towards being an "exploration hub". Particularly, we have tried in EUROSAI IT Working Group to widen the picture with our virtual and hybrid interactive seminars open for the whole INTOSAI community – regarding data exchange, use of AI in auditing, electronic identity etc. – and these are not mere ways to share experience but also experts' opinions and panel discussions that present technological, legal and social perspective. We invite our members and partners to present not only their audit findings, but also their viewpoint on auditing new developments in the future. While it is our mission to present clear audit findings and recommendations for our auditees based on sound evidence and standards, we should be more open to explore innovation in auditing methodology among our own community. We therefore strive to give context to our colleagues that they could apply in their individual cultural, legal and technological ecosystem. Technology and its advancement are not subject to state or even regional borders, and this applies also to cooperation between supreme audit institutions in this regard – a good example is our partnership with the ARABOSAI region, which explored the potential and application of electronic identity during our last virtual seminar in spring.

Institutions often refrain from audits regarding technology they are not familiar with, and from applying different technological tools and methods while auditing due to the shortage of qualified staff. As technology has gradually transformed all public domains, it has become clear that supreme audit institutions need open- and experiment-minded auditors in all fields, also knowing at least the basic concepts of IT auditing. Training of existing and valuable SAI personnel with limited knowledge about IT auditing has therefore been selected as a strategic goal for EUROSAI IT Working Group and for this purpose, a comprehensive training program "Introduction to IT auditing" has been launched in collaboration with academia and SAI Germany (Bundesrechnunghof). About 2000 people all over the world are registered to the dedicated platform (training.eurosai-it.org) and the number of participants will increase as supreme audit institutions see the practical value this program adds to the auditors' knowledge portfolio. During the past year, we have seen interactive courses paving the way for understanding complex theory, and therefore we are looking for ways to use the same pattern – in collaboration of innovative SAIs and academia – for enhancing auditors' IT-using capacity.

I have been asked, why has National Audit Office of Estonia – one of the smallest audit institutions – has invested so much effort and resources in leading the EUROSAI IT Working Group. The answer is simple – because we see practical value in cooperation among institutions, especially considering the technological turmoil we all are experiencing. Reaching the ever-moving target of technological advancement seems impossible. But believing in something not considered possible before – this is the key to audit innovation and our development as valuable contributors in our respective societies.

FEATURE ARTICLE

Pioneering Sustainable Technology Audit Practice in SAIs for Better Use of Technology by Governments: IDI's LOTA Pioneers

By the INTOSAI Development Initiative

Global technology trends are changing our world and the way we live. How can SAIs respond meaningfully to these changes and conduct audits which provide robust external oversight on the use of technology by governments?

Listening to the growing demand for technology audits and use of technology in audits, IDI launched the Leveraging on Technological Advancement (LOTA) Pioneers initiative at INCOSAI in November 2022. It is a response to the growing need for using technologies in audits in order to ensure relevance of conducted audits, maximize impact, run new types of audits, increase operational efficiency and maintain audit capacity. Placing audit leaders at the centre, the initiative focuses on the development and transformation of SAI audit leaders into LOTA Pioneers for bringing technology to the SAI audit world. It aims at helping SAIs in auditing government's use of technology to provide confidence in government technology, contribute to the better societies and better lives improved by technology, and create a culture of transparency, accountability and compliance leading to trust in government use of technology.

The LOTA Pioneers Launch at INCOSAI 2022

FEATURE ARTICLE

How will LOTA Pioneers help SAIs in building sustainable technology audit practices? Our strategy focuses on four core elements.

1. Growing competencies of technology auditors
2. Developing fit for purpose technology audit strategy based on a result of LOTA Scan
3. Conducting high quality and high impact technology audits
4. Fostering a learning network and community of technology auditors

We started our journey by establishing strong partnerships with INTOSAI working groups, including Working Group on IT Auditing (WGITA), Working Group on Impact of Science and Technology on Auditing (WGISTA), and Working Group on Big Data (WGBD). We have also partnered with INTOSAI regions, development partners like Inter-American Development Bank. We have received substantial in-kind contributions from SAIs of Brazil, USA, India, Jamaica, Costa Rica, UAE, Morocco, and Kenya for setting up a global team of mentors to design, develop and deliver LOTA Pioneers.

Growing competencies for technology auditors

We have visualised two types of LOTA Pioneers – LOTA Pioneer Strategy, a SAI audit leader who would lead a team to develop a strategic audit plan for technology audits and LOTA Pioneer Audit, an audit team leader who would lead an audit team to conduct an audit of technology. We defined common and role specific competencies for these two LOTA Pioneers.

What are the competencies? In the cross-cutting competencies, we have visualised effective, accountable and inclusive LOTA Pioneers who lead organizational change, create strong stakeholder coalition, articulate a commitment to diversity, equity, and inclusion, ensure accountability for self and the team, demonstrate emotional and cultural intelligence, demonstrate professional, responsible, and value-driven behaviour and communicate effectively and inclusively.

Besides these cross-cutting competencies, we have also identified specific competencies required by the LOTA Pioneer Strategy and LOTA Pioneer Audit. Please follow this link to see the competencies. IDI has set up an integrated professional education and support platform for helping LOTA Pioneers in developing these competencies. The education will be delivered in a blended mode by combining digital education and one-week long in-person workshop. LOTA Pioneers will be provided social learning opportunities, access to resources and support for development of technology audit strategy and technology audit.

Where do the LOTA Pioneers come from? We invited SAIs across the world to apply for this initiative. To begin with we had made a provision for supporting 50 LOTA Pioneers from 25 SAIs. Due to increased interest of SAIs in the audit digitalization and SAIs having digitalization high on their agenda, we received almost twice the number of applications! Considering the quality of applications and demand for the LOTA Pioneers initiative, we have accepted 68 LOTA Pioneers from 34 SAIs. We are delighted to see diversity in term of geographies covering all INTOSAI regions, professional skills, organisational maturity, and gender ratio (43% are female).

Developing a fit for purpose LOTA Strategy

The LOTA Pioneer strategy will lead her/his SAI team in developing a strategic audit plan which is based on a comprehensive internal and external scan at the country level. They will use the LOTA scan tool for this purpose. IDI has developed a model and guidance for strategic audit planning, which will help the LOTA pioneer drawing up a technology audit portfolio that responds to the expectations and trends in the country. As a part of this exercise the LOTA Pioneer will also draw up a capacity development plan for creating capacities necessary for implementing the technology audit portfolio.

Conducting high quality and high impact technology audits

The LOTA Pioneer Audit will lead her/his audit team in conducting a high quality and high impact technology audit in a high priority area identified by the SAI. The nature and focus of audit will vary from SAI to SAI. There are several entry points into a technology audit. These include audit of digitalization in an entity, sector, a service, and government accounts. SAIs can examine regulatory frameworks for emerging technology or examine the issue of digital divide and exclusion. Some of the SAI participating in the initiative have indicated that they want to conduct financial audits of government account maintained on digital platforms, some would like to take up more manageable IT audits, while some would like to look at data analytics and emerging technologies. Within LOTA Pioneers we will endeavour to provide space for SAIs with diverse needs. Audit quality requirements and audit impact considerations will be mainstreamed throughout the audit process of the technology audits.

Fostering a leaning network and community of technology auditors – LOTA Connect

We plan to create an alumni network for LOTA Pioneers and connect them with other networks of technology auditors. Besides knowledge sharing and supporting each other, this community is also visualized as a learning community where we will provide for continuous professional development of the LOTA Pioneers.

What does the future look like?

We recognize that delivering LOTA Pioneers as a one-off initiative will not help in development of sustainable audit practices. As a part of IDI's new strategic plan 2024-29 we plan to prioritize digitization and provide long term regular support for developing competent technology auditors. Based on demand we have plans to start two continuing streams of support for auditing use of technology by governments and using technology in audits.

We look forward to working with the entire community to grow technology auditors for sustainable technology audits that add value.

Please read more about LOTA Pioneers here. For any inquiries, please contact LOTA team at lo-ta@idi.no

FEATURE ARTICLE

Source: Adobe Stock Images, putilov_denis

Machine Learning Application for SAIs

By Tiare Rivera, Supreme Audit Institution of Chile (CGR)

Introduction

Supreme Audit Institutions (SAIs) are the cornerstone of maintaining accountability, transparency and effectiveness in the public sector, particularly in government operations. However, as technology evolves at breakneck speed, it is imperative that SAIs embrace cutting-edge data technologies, such as Machine Learning (ML), to revolutionize their auditing processes. With ML, SAIs can enhance efficiency, accuracy and effectiveness, providing a more comprehensive, data-driven analysis of government operations, thus ensuring the highest standards of accountability and trust.

In this article, we propose a roadmap for an SAI to incorporate these advanced data technologies with a focus on ML, mentioning the main algorithms currently in use and highlighting some important concepts. Finally, we try to show the impact that the use of ML can have on the performance of SAIs.

Engaging SAIs in Advanced Data Technologies

Several steps need to be taken to guide a Supreme Audit Institution towards the integration and effective use of advanced data technologies such as machine learning:

- **Develop a clear strategy:** A data- and technology-enabled SAI must have a clear strategy that outlines the organization's goals and objectives. It should be developed with input from all stakeholders, including auditors, IT professionals, and subject matter experts.

- **Invest in technology:** SAIs need to invest in the technology and tools necessary to collect, store, and analyze large amounts of data. This includes investment in data management systems, data analysis tools, and AI/ML technologies.

- **Build a skilled workforce:** To effectively use data and technology in the audit process, SAIs need a skilled workforce trained in data analysis, technology, and audit methodologies. This includes training auditors in data analysis techniques and hiring IT professionals and data scientists to support the audit process.

- **Promote data-driven decision making:** SAIs need to promote data-driven decision-making throughout the organization. This includes using data to inform audit planning and risk assessment, and incorporating data analytics into the audit process.

- **Develop partnerships:** SAIs should develop partnerships with other organizations, such as government agencies, to access and share data and to collaborate on the development and use of technology in the audit process.

- **Invest in data:** Data collected and stored by SAIs needs to be cleaned, scaled, and transformed to produce results after advanced analysis.

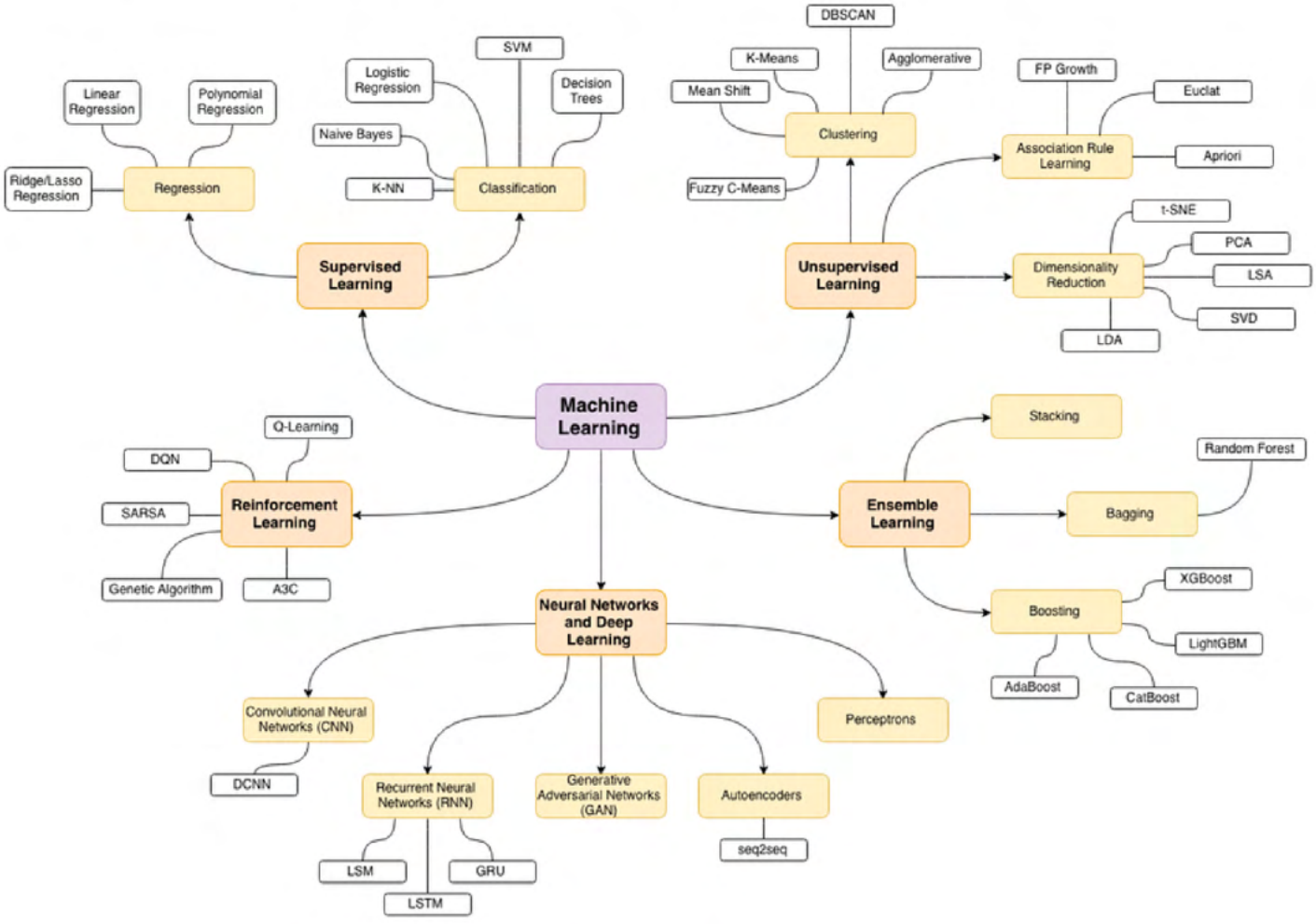
- **Build the algorithms:** The models to be used need to be selected according to the type of information being sought, and the model needs to be trained and fine-tuned to produce better results. The model must be evaluated on test sets for later application to real data, and the final models must be monitored and maintained on a regular basis.

- **Continuous monitoring and improvement:** SAIs need to continuously monitor and evaluate the use of technology and data in the audit process to identify areas for improvement and make necessary adjustments. This includes regularly reviewing and updating the organization's technology and data strategy.

Basic characteristics of machine learning algorithms

Once the SAI is ready for the next step, there can be two basic approaches to applying machine learning, depending on the availability of suitable data and whether there is an underlying structure in it.

- Supervised learning: These algorithms are used to classify and predict outcomes based on labeled training data. They can be used in SAIs to classify transactions as fraudulent or not, predict the likelihood of fraud in a given area, or classify vendors as high or low risk.
- Unsupervised learning: These algorithms are used to identify patterns and structure in unlabeled data. They can be used in SAIs to identify patterns of financial mismanagement, detect suspicious transactions, or identify outliers in spending patterns.



Types of Machine Learning algorithms that can be used by SAIs

There are several types of machine learning algorithms that can be used in SAIs to improve the efficiency, accuracy, and effectiveness of the audit process. See diagram for a broad overview.
Some of the most commonly used ML algorithms and their potential applications in SAIs include:

- **Clustering:** These algorithms group similar data points together. They can be used in SAIs to group similar datasets, such as spending by department, or to identify groups of similar government programs or projects, making it easier to compare and evaluate their performance.

- **Anomaly detection:** These algorithms are used to detect data points that deviate significantly from the norm. They can be used in SAIs to detect budgetary irregularities or to prioritize audits based on areas where performance deviates from expected patterns.

- **Artificial neural networks:** These algorithms are modelled on the structure of the human brain and can be used for a variety of tasks, including image and speech recognition and natural language processing. They can be used in SAIs to process and analyze large amounts of unstructured data, such as text and images, and extract insights.

- **Decision Trees:** These algorithms are used to classify data points based on a set of decision rules. They can be used in SAIs to classify transactions as fraudulent or not, to classify vendors as high or low risk, or to predict the likelihood of fraud in a given area.

- **K-Nearest Neighbors:** These algorithms are used in image and video recognition, stock analysis and handwriting recognition applications. It uses labeled data points to label other points. The methodology is to create a voting system of nearest neighbors. The “k” is the number of neighbors that it checks. Its advantages are simplicity of implementation and that it works well with noisy data. The main disadvantage is that they require a significant amount of computation, which can be expensive for large datasets.

Potential barriers

While ML tools exist for fraud detection and financial oversight, it is not always easy to implement them operationally, adopt new digital tools, or integrate them into audit institutions. There are several barriers to machine learning innovation in SAIs and government agencies.

For example, many SAIs may lack accurate or consistent data, which can negatively affect the performance of machine learning algorithms and limit their effectiveness. A lack of technical expertise may affect SAIs' ability to implement and successfully use machine learning algorithms, requiring specialized training and support. In addition, SAIs may need to integrate these algorithms into their existing systems and processes, which can be challenging and require significant resources.

Many agencies face cultural and structural barriers to change. These include a reluctance to innovate, a preference for the status quo, a fear of failure, excessive silos where different departments handle different data and segments of key missions, and a lack of leaders and managers who are skilled at facilitating change. In many organizations, the barriers to change are not only technical, but also structural, operational, managerial, and cultural. Unless leaders are committed to building a culture of innovation, the adoption of new technologies will almost always fall short of the intended benefits.

Ethical considerations and accountability

Machine learning models have the potential to perpetuate or even exacerbate societal biases. Therefore, it is important to consider the ethical implications of the model, be aware of its limitations, and take steps to mitigate any negative consequences.

One of the biggest challenges is figuring out how to translate broad ethical principles such as fairness, equity, privacy, transparency, accountability, and human safety into concrete applications. These principles sometimes conflict, and SAIs need to define their meaning in the context of the particular system and determine how to evaluate machine learning algorithms accordingly.

In addition, some models are complex and difficult to interpret. It is important to understand the model's decision-making process and to have interpretable models to explain the reasoning behind the model's decision.

Expected impact of SAIs' use of machine learning

One of the key benefits of incorporating advanced data technologies into the audit process is the ability to quickly and accurately analyze large amounts of data and identify patterns and trends that may not be obvious to human auditors. This can help SAIs identify potential fraud or financial mismanagement and make more informed decisions about where to focus their audit efforts.

By automating certain tasks, such as data entry and analysis, auditors can focus on more complex and high-value tasks, such as interpreting audit findings and making recommendations for improvement.

The use of machine learning by Supreme Audit Institutions has the potential to enhance SAIs' ability to communicate and engage with the public by providing interactive tools such as real-time dashboards and customizable reports. These expected impacts could lead to a more transparent and accountable public sector, contributing to better governance and trust in institutions.

Source: Adobe Stock Images, boscorelli

Killer Robots – A Case for SAIs

Author: Jan Roar Beckstrom, Chief Data Scientist,The Office of the Auditor General of Norway (1)

Killer robots, also known as lethal autonomous weapon systems (LAWS), is not science fiction. They exist. Soon we can have AI-powered drone swarms where the drones themselves decide who to kill and what to attack. SAIs should play a role in keeping the development and use of such weapons under human control, in line with international law.

Introduction

Imagine this: You take a swarm of very small drones, load them with an AI-algorithm trained to recognise a certain type of military uniform, add 5 grams of high explosives, and send them out to hunt for enemies to kill.(2) After deployment of the drones there is no human involvement, and the drones themselves decide who to target and attack. However, one of the drones decides to target and subsequently kills a soldier that is surrendering. This will be a clear violation of International Humanitarian Law (IHL), as expressed in the Geneva Conventions.(3)

Or what about a situation where an AI-powered LAWS decides to acts on a false positive and erroneously engages a similar enemy system, in a "clash of the machines"? Whereas the enemy system responds and also calls in reinforcements. Then, we might have an unintended war on our hands in seconds. Such weapons are not science fiction. The necessary technology is to a large degree already available and the remaining challenges are engineering problems of miniaturisation and systems integration.

The potential inherent in LAWS regarding death and destruction and a new arms race cannot be overestimated. While a total ban on certain types of LAWS may be a possibility, a far-reaching ban is difficult to foresee. The possible military advantage posed by such systems will probably be far too great and too tempting for the governments of the world. If anything, you will not want to be the only one without them. So, they need to be regulated and governments and armed forces need to be held accountable for the research, development, procurement, deployment and use of such weapons. "Accountability" is the cue for the SAIs of the world to enter the scene.

Killer robots – the Technology

Weapons with some kind of autonomy have been around for a long time. Some simple examples are tripwires, anti-personnel mines and cruise missiles. These are typically "set-up-and-forget" or "fire-and-forget" systems. For example, once a cruise missile's target is programmed and the missile is launched, it steers itself towards the target chosen by humans. In addition, the amount of time between launch and impact by a cruise missile is normally quite limited, which is important in order to avoid civilian causalities.

The new thing about LAWS is that artificial intelligence (AI) has entered the field. Cruise missiles are preprogrammed and they don't themselves make any decisions on which target to hit.

AI-powered robots, for example drones, can make such decisions. Then we are in a situation where machines decides, without human intervention, who might live and who might die.

To be able to do this machines need to be equipped with an AI-algorithm based on machine learning. Take the example of killer drones: By using machine learning, you can, for example, train an algorithm to separate between civilians and military personnel, by feeding labelled images to the algorithm. Simply, image1 = "civilian", image2 = "enemy soldier", repeat a few thousand times with similar images and you have taught the machine to discriminate between civilians and soldiers. Such an algorithms should be very good (perhaps 99% correct) at separating between these two groups. It is not very different from an AI-powered spam filter deciding what is spam and not.

Another "feature" with AI-powered LAWS is that, as the machine itself potentially can decide when to attack, it does not have to attack immediately. A drone might "loiter" until the probability for maximum success reaches a certain threshold. For example where "estimated number of casualties > 5", as predicted by the proximity of probable enemy soldiers within view of the drone's camera. Such "functionality" could obvious be of interest for military commanders.

Meaningful Human Control

It is an important dictum in international law that if you as a soldier kill an enemy, you should be well aware that you do. Human lives should not be taken lightly, not even in war. The importance of human agency counts for the entire military command chain, and it means that all use of lethal weapons should be under what has been labelled "meaningful human control".(4)

The development and use of autonomous weapons has the potential to change this in fundamental ways. An AI-powered machine that itself makes the decision to kill civilian A instead of soldier B cannot be sent to the international criminal court in the Hague. To kill or not is not a moral question for a machine. It is merely a probability calculation by an algorithm. So, who should be held accountable? The commander deploying the flawed killer robot? The department of defence which procured the system or paid for its development? The civilian contractor who developed the flawed algorithm? These are important but undecided questions.

Further, according to IHL armed forces should not use more force than necessary to achieve a military goal.(5) This makes the choice of weapons important and dependant on operational understanding. Thus, the amount of time between launch of a weapon and impact becomes important. Thus, if a commander uses an autonomous weapon that he/she doesn't really know when will strike, then it also becomes difficult to know if the said weapon was the right choice, given what was known about the situation. In addition to the fact that you don't really have control over whether a soldier or civilian were targeted.

Killer Robots and the Role of SAIs

In 2015, at its 69th session, the General Assembly of the UN adopted resolution 69/228 on "Promoting and fostering the efficiency, accountability, effectiveness and transparency of public administration by strengthening supreme audit institutions".(6)

The UN General Assembly here recognized "the important role of supreme audit institutions in promoting the efficiency, accountability, effectiveness and transparency of public administration".

One of the defining traits of a state and its government is that it has monopoly regarding the use of military force in defending the territorial borders of the country. National defence is as such a central part of public administration which SAIs need to audit on behalf of the parliament. The scope for auditors cannot just be the more administrative and bureaucratic parts of the defence sector. It must also include the operational and "combat-near" parts as it is here efficiency, accountability and effectiveness of a country's defence are first revealed. In addition, the defence sector is (naturally) to a large degree shrouded in secrecy, which itself is a reason why SAIs should address defence in order to secure accountability on behalf of the parliament. Basically, transparency fosters accountability.

Still, sometimes SAIs often shy away from the raison d'etre of national defence; the possible use of military force, including which weapons are developed, procured and deployed. War is brutal. In a very basic sense it is about defeating the enemy by killing the soldiers of the opponent. How war is to be fought is regulated in IHL, as codified in the four Geneva Conventions with Additional Protocols. These conventions, and especially the Additional Protocol I (API)(7), define "the rules of war".

Is it not a bit far-fetched that a SAI can audit what weapons are developed and eventually used? I think not. When a country has ratified relevant conventions on international law, these conventions can be used as audit criteria for SAIs.

For example, article 36 – "New Weapons" of the API states that:

> "In the study, development, acquisition or adoption of a new weapon, means or method of warfare, a High Contracting Party is under an obligation to determine whether its employment would, in some or all circumstances, be prohibited by this Protocol or by any other rule of international law applicable to the High Contracting Party."

Thus, a new weapon system, including LAWS, should undergo a review when developed, procured or adopted, to decide if the weapon is legal to use in the course of war. This is a requirement that SAIs can check if it has been fulfilled.

Further, article 57 – "Precautions in attack" of the API states that an attacker should:

> "take all feasible precautions in the choice of means and methods of attack with a view to avoiding, and in any event to minimizing, incidental loss of civilian life, injury to civilians and damage to civilian objects"

and

> "an attack shall be cancelled or suspended if it becomes apparent that the objective is not a military one"

If we start using lethal, autonomous machines, where the question of life and death is reduced to a probability equation: can we be certain that a machine will "take all feasible precautions" to spare civilians? How do we secure accountability for suspension of an attack on a non-military target, if the decision to attack or not is done by the machine itself? Are we starting to lose meaningful human control over lethal weapons?

These are big questions, and are far too important to leave for the defence sector itself to sort out. We cannot have accountability without external control. This means that a SAI is one of very few national institutions that can hold the government and defence sector accountable for the development, procurement, adoption and eventual use of autonomous killer robots. LAWS have the potential to make the world a much more dangerous place. Still, SAIs can definitely play an important role in reducing the dangers and risk associated with LAWS. We need to rise to the occasion.

1. I would like to thank Cathleen Berrick, Managing Director for Defense Capabilities and Management, US Government Accountability Office and the Norwegian National Human Rights Institution for highly valuable input to this article. All views expressed are naturally my own.
2. As shown in the short movie "Slaughterbots". See https://www.youtube.com/watch?v=9CO6M2HsoIA
3. Geneva Conventions, Additional Protocol I, article 41 – Safeguard of an enemy hors de combat
4. "Meaningful human control" in the context of LAWS was introduced by the NGO Article 36. See https://article36.org/
5. Geneva Conventions, Additional Protocol I, articles 51 – Protection of the civilian population & 57 – Precautions in attack
6. https://www.intosai.org/fileadmin/downloads/documents/open_access/intosai_and_united_nations/69_228_2014/EN_un_resol_69_228.pdf
7. The Additional Protocol I of the Geneva conventions is ratified by 174 countries

FEATURE ARTICLE

Source: Adobe Stock Images, Shutter2U

Evolution and Applications of Artificial Intelligence in SAIs

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What is Artificial Intelligence?

Over time, many definitions have been given to the term Artificial Intelligence (AI), and the association of the term with others, such as machine learning and deep learning, has resulted in difficulties for a better understanding of the topic.

AI's artificial aspect is relatively simple. It refers to any non-natural thing created by humans. Using terms such as machines, computers, or systems can also represent it. Intelligence, however, is a much broader, challenged concept, which explains why an agreement on defining AI has yet to be reached (Miaihle and Hodes, 2017).

AI can be defined as the use of digital technology to create systems capable of carrying out tasks usually thought of as requiring Intelligence.

In this context, we can mention the Organization for Economic Cooperation and Development (OECD)'s definition, which considers AI as a system based on a machine that can, for a specific set of objectives defined by humans, make predictions, recommendations, or decisions that influence real or virtual environments.

Current AI mainly involves machines using statistics to find patterns in large amounts of data and carry out repetitive tasks without needing constant human guidance. Thus, AI is unrelated to a technological solution applied to all cases since it generally only provides good performance with significant, relevant, and high-quality data.

Artificial Neural Networks

Traditional machine learning algorithms heavily rely on data representation to create relationships between the data and the predictions they can lead to. For example, consider the difference between a diagnostic system that depends on patient information a doctor provides (e.g., brain-machine interface – BMI, blood type, blood glucose level) to propose a diagnosis and a system capable of identifying tumors from a radiographic image. While traditional algorithms can extract correlations between the first group of information provided by the doctor, referred to as features or attributes, and a potential diagnosis, in the second example, such systems have limitations in analyzing unstructured data like images, as they cannot extract meaning from just a set of pixels.

One solution to this problem is to use techniques to learn the relationships between attributes and the output (prediction) and the best way to represent the input data.

In this context, the technique of transfer learning stands out. It is increasingly employed, especially in computer vision and natural language processing (NLP), where the knowledge acquired by a pre-trained model in a specific domain/task is "transferred" to another domain/task. It enables the "democratization" of using AI models since new models can be trained with only a fraction of the data and computational resources that would be used if a model had to be taught "from scratch". Transfer learning is inspired by how humans learn, as we rarely learn something from scratch but often learn by analogy, incorporating previously acquired experience into new contexts.

There is no doubt that the architectures and training strategies of neural networks adopted in recent years have led to considerable advancements in tasks such as text translation, question answering, and chatbots, even in tasks trained from scratch. However, significant changes in the sample distribution of the data led to performance degradation, indicating that the models had become specialized in performing well only with specific inputs (e.g., specific languages or text types).

Challenges remained to be overcome for less popular languages than English or even more specific or unexplored tasks. In the case of languages, there is a problem with less-spoken languages that have limited availability of labeled corpus for training NLP models.

In the 1960s, the first step towards transfer learning was using vector spaces to represent words as numerical vectors. In the mid-2010s, models like word2vec, sent2vec, and doc2vec were introduced. These models were trained to express words, sentences, and documents in vector spaces so that the distance between vectors was related to the difference in meaning between the corresponding entities. The training aimed at associating the meaning of a word with its context, i.e., adjacent words in the text, representing an example of unsupervised learning.

Once words, sentences, or paragraphs are represented as vectors, it is possible to use classification or clustering algorithms, where the input data is represented as points in a vector space. For example, in the case of classification, it is a semi-supervised approach since the classification task is supervised, but the representation of the input data was obtained in an unsupervised manner while still embedding textual semantics.

Subsequently, character-level vectorization started being used to deal with words not seen in the initial vocabulary (e.g., new words, slang, emojis, foreign words, or names of people).
This description can be understood as an early form of transfer learning since the pre-trained vectorization model can already embed a certain level of semantics or meaning to words, sentences, etc.

In 2018, there was a true revolution in the NLP field when researchers began to apply transfer learning at a more abstract level, providing not just pre-trained vectorization models but entire neural networks pre-trained on generic, unsupervised tasks at a higher level. Examples include neural networks implementing language models, statistical models trained to predict the next word or set of words given the previous terms. Through a process known as fine-tuning, one can take one of these pre-trained models and perform additional brief training focused on optimizing the model for the specific task to be trained, adjusting the network's weights. This movement is even referred to as the "ImageNet moment," about the widespread use of pre-trained neural networks on the ImageNet database for various applications in computer vision.

The OpenAI Generative Pretrained Transformer (GPT) stands out among the pioneering innovations in transfer learning for NLP.

Based on the neural network model called Transformer (Vaswani et al, 2017), which allows greater parallelism and performance compared to previous architectures that lacked the same degree of parallelism and had difficulty dealing with long texts. In its most recent formulation – GPT-4 – it is capable of generating realistic texts automatically, similar to those written by humans.

ChatGPT, Large Language Models, and Generative AI

In November 2022, OpenAI ChatGPT was launched, leading Artificial Intelligence to a new stage: in a few days, the chatbot became the most famous achievement in recent technology history due to its impressive capabilities of understanding and generating texts.

Despite its "intelligence" and popularity, ChatGPT's core is based on an old technique – language modeling. In a simple definition, language modeling is concerned with using statistical models to predict the most common sequences of words in a language. So, they are just models capable of predicting the next most probable word given a series of words. Each element predicted by the model can be reused to predict another word, and so this process continues until we get complete paragraphs and texts.

In the last few years, researchers started to use neural language models. In simple terms, these are language models implemented as neural networks. So, suppose we have a massive dataset of texts. In that case, we can use it to train a neural network whose optimization objective is to generate the most probable word from the sequence of words given to it until the current iteration.

This idea was initially implemented with recurrent neural networks. Still, in 2018, the Transformer architecture – a new family of models based on attention models and feed-forward neural networks – demonstrated even better results.

Next, as the number of parameters in these neural models increased from millions to billions or trillions, they became called large language models.

A significant advantage of training language models comes from the dataset: it does not need to be labeled by humans. This occurs because, if we have a corpus of texts, it is already "annotated" in the sense that we always know the next word. The labels are already there even in settings with slightly different optimization objectives (e.g., masking some words and training the model to predict the masked words). This technique is called self-supervision but can also be considered a kind of unsupervised learning (at least from the point of view of human annotators).

We currently do not have many details about the inner workings of ChatGPT – we only know it uses additional techniques from Reinforcement Learning besides traditional language modeling. However, several skillful open-source language models have been launched thanks to its advent. These models are particularly interesting to researchers and government institutions because they are cost-friendly compared to OpenAI models Furthermore, we possess complete control over the model, allowing us to customize it according to our requirements (e.g., understanding legal texts).

Finally, in the Brazilian Federal Court of Accounts (TCU), we launched a tool based on ChatGPT called ChatTCU. The current version is a secure wrapper over the underlying OpenAI model because it enables the auditors to traffic messages securely without sending classified data to OpenAI. In future versions, we will extend ChatTCU features with data related to TCU jurisprudence, besides several other public or non-public data owned by the institution.

Conclusions

The incorporation of AI in the audit activity offers SAIs a unique opportunity to improve the effectiveness and efficiency of their operations. Through automated analysis of large volumes of data, AI can identify complex patterns, anomalies, and trends in real time, providing valuable insights for auditors. Additionally, AI can streamline review and analysis processes, significantly reducing the time required to perform a full audit. By freeing audit professionals from routine and repetitive tasks, AI allows them to focus their expertise on high-level analysis and strategic decision-making. Finally, with the use of AI, SAIs can strengthen the accuracy, completeness, and reliability of their audit activities, thereby strengthening public trust in financial institutions and audited bodies.

FEATURE ARTICLE

Source: Adobe Stock Images, Tom

Leveraging AI in Performance Auditing: A Feasibility Study for the State Audit Office of Thailand

Author: Dr. Sutthi Suntharanurak, Director of the International Affairs Office, State Audit Office of the Kingdom of Thailand

The State Audit Office (SAO) of Thailand has embarked on a journey of digital transformation. The objective is to leverage AI to enhance audit performance and foster a data-driven culture within the organization. This initiative is in line with their audit policy, which emphasizes the importance of using advanced technologies in audit processes. *This article focuses on the feasibility of incorporating the advanced language model, as generative AI like ChatGPT, in SAO's performance audit.*

Challenges and Readiness:

Implementing a Generative AI system like ChatGPT or Google Bard in audit processes presents several challenges. Infrastructure must be established, financial investments made, data privacy ensured, and complex legal landscapes navigated. The auditors themselves face the need to acquire new skills, deal with changing roles, and overcome potential mistrust in AI technologies.

For a smooth transition, SAO needs to be AI-ready. This means creating robust technical infrastructure, implementing data governance, developing skills through training, and managing change effectively. A strategic alignment with the organization's goals and compliance with legal and ethical considerations are vital.

Measuring Benefits:

The benefits of AI implementation can be quantified through various metrics. Efficiency, accuracy, cost savings, auditees' satisfaction, risk mitigation, and learning capabilities are all parameters that can indicate successful implementation. Maintaining a balanced scorecard of these measures is important, as benefits often become more apparent over time and with continued use.

Figure 1: Benefit of AI Implementation for SAIs

The State Audit Office (SAO) of the Kingdom of Thailand, has shown a pioneering stance towards incorporating artificial intelligence (AI) in its auditing operations since 2021. Particular emphasis has been placed on performance audits, with the aim of launching an AI-driven copilot project. This initiative aligns with the State Audit Policy of the State Audit Commissioner, which encourages digital transformation through a data-driven approach to audit, implementation of scientific and technological tools for audit, and fostering a data culture within the organization. The proposed study aims to explore the feasibility of utilizing Generative AI like ChatGPT, an advanced AI model, to further leverage the performance audit.

SAO Thailand conducted this foresight approach to explain the preferable future of AI implementation in performance audits. Four scenarios were developed based on the feasibility study of implementing ChatGPT in performance audit at the SAO Thailand. They reflected diverse possibilities ranging from highly favorable conditions with immense benefits to scenarios where numerous obstacles impede the successful implementation of ChatGPT.

The four scenarios were constructed based on varying levels of readiness and potential benefits that may be obtained from implementing ChatGPT in performance audit at the SAO Thailand.

01

Scenario 1 AI Harmony
High Readiness, High Benefit:

In this ideal scenario, SAO Thailand is fully prepared for the integration of ChatGPT. Infrastructure, training, and organizational culture are at a point where they can readily incorporate AI. The performance audit significantly improves with the integration of ChatGPT, with a substantial increase in audit speed, accuracy, and comprehensiveness

02

Scenario 2 Technical Triumph
High Readiness, Low Benefit:

SAO Thailand has high readiness, with a strong infrastructure and a supportive organizational culture. However, the integration of ChatGPT does not significantly improve the performance audit due to unforeseen limitations or obstacles in the AI's application to specific auditing tasks.

03

Scenario 3 Benevolent Surprise
Low Readiness, High Benefit:

Despite not being fully prepared for AI integration, the implementation of ChatGPT in the performance audit yields significant improvements. However, low readiness may result in initial difficulties, slower uptake of the AI, or inefficient use of the technology, limiting the potential benefits.

04

Scenario 4 Rough Waters
Low Readiness, Low Benefit:

In this least ideal scenario, SAO Thailand is not well-prepared for the integration of AI in terms of infrastructure, training, or culture. Furthermore, the integration of ChatGPT does not substantially enhance the performance audit, either due to the nature of the tasks or inefficiencies in AI use.

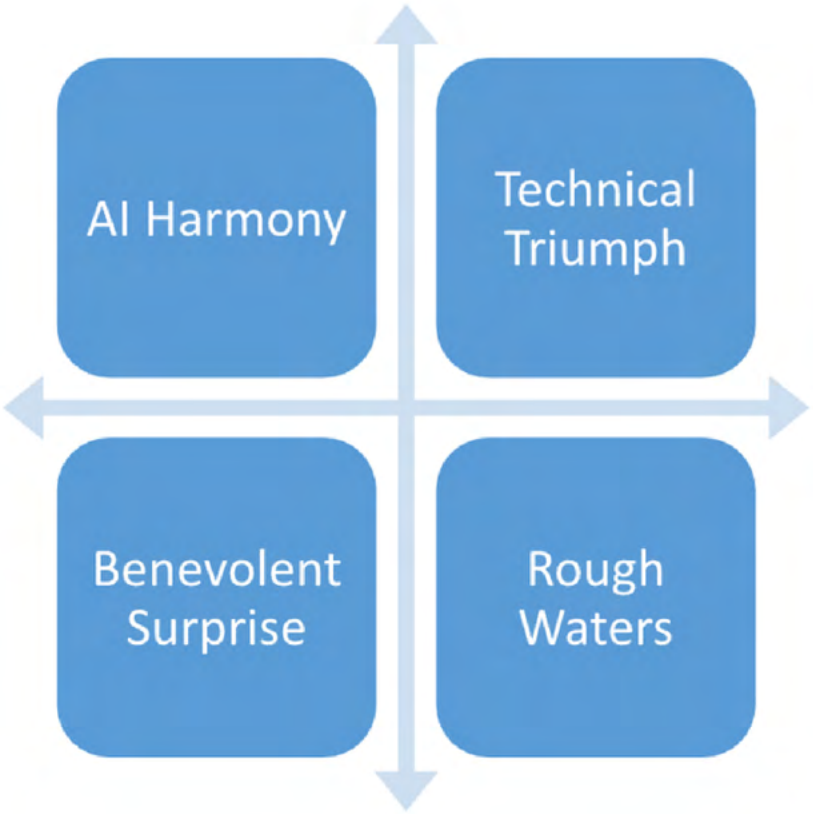

Figure 2: Four Scenarios of AI Implementation for SAO Thailand

These scenarios provide a comprehensive range of possibilities that could emerge from the integration of ChatGPT into SAO Thailand's performance audit, and emphasize the need for preparedness and realistic expectations regarding the benefits of AI integration.

Constructive Recommendations

To be prepared for AI integration, SAO Thailand can consider the following recommendations:

1. **Technological Adaptation:** It is recommended that SAO Thailand invest in technological infrastructure and training programs to facilitate the smooth integration and use of ChatGPT.
2. **Regulatory Adjustments:** Legal and ethical guidelines need to be reviewed and updated to accommodate the use of AI in auditing processes.
3. **Data Culture Enhancement:** A continued emphasis on fostering a data culture, where data is valued and effectively utilized, should be upheld.
4. **Regular Evaluation:** Post-implementation, a regular assessment of the impact of ChatGPT on the performance audit should be carried out to ensure its effectiveness and address any issues promptly.

Strategy for the Implementation of Generative AI in SAIs

Generative AI, like ChatGPT or Google Bard, is a rapidly evolving field with the potential to revolutionize the audit process. By automating repetitive tasks, identifying patterns and anomalies, and generating insights, Generative AI can be a tool to help auditors to be more efficient, effective, and objective.

To ensure a successful implementation of Generative AI in SAIs, the following strategic approaches should be considered:

1. Build awareness and literacy in Generative AI. SAIs should promote knowledge about and capacity around employing Generative AI among their stakeholders, including auditors, managers, and decision-makers. This can be done through workshops, webinars, and other educational initiatives.
2. Clear goals for Generative AI. SAIs should define the specific outcomes they expect from integrating Generative AI into their processes. These goals could include increasing efficiency, improving accuracy, or reducing risk.
3. Assess the feasibility of Generative AI. SAIs should evaluate their current audit procedures and infrastructure to determine whether Generative AI is a feasible solution. This includes assessing the availability of data, the technical expertise of staff, and the regulatory environment.
4. Develop a Generative AI blueprint. SAIs should develop a roadmap that outlines the vision, objectives, and steps for integrating Generative AI into their operations. This blueprint should be flexible enough to adapt to changes in technology and the audit environment.
5. Conduct pilot projects. Before deploying Generative AI on a large scale, SAIs should conduct pilot projects to test the technology and identify any potential challenges. This will help to ensure that the technology is fit for purpose and that the SAI is prepared to manage any risks.
6. Implement Generative AI iteratively. SAIs should implement Generative AI in an iterative manner, starting with small-scale projects and gradually expanding its use over time. This will allow the SAI to learn from its experiences and make necessary adjustments as needed.
7. Train auditors on Generative AI. SAIs should provide training to their auditors on how to use Generative AI effectively. This training should cover the basics of Generative AI, how to apply it to specific audit tasks, and to check for inaccuracies and biases.
8. Adhere to ethical and compliance standards. SAIs should ensure that their use of Generative AI adheres to ethical and compliance standards. This includes ensuring that the technology is used in a fair and unbiased manner, and that it does not violate the privacy or confidentiality of individuals.
9. Establish partnerships with Generative AI experts. SAIs should establish partnerships with Generative AI experts to stay up-to-date on the latest developments in the field and to obtain guidance on how to implement the technology effectively.

By considering these strategic approaches, SAIs can ensure a successful implementation of Generative AI and realize the full potential of this technology to improve the audit process.

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Source: Adobe Stock Images, THANANIT

SAI Albania Audit 5G Implementation

Authors: Bujar Leskaj, Chairman of ALSAI, and Rinald Muça, former Director General of ALSAI

Albania is in a favorable geographic position to serve as a trade hub, tourist destination, and provider of financial and other services. The enhanced use of technology in manufacturing, infrastructure, and communications could give the country a competitive advantage in these fields.

However, Albania is still far from effectively using technology. Over the last several years, the Supreme Audit Institution (SAI) of Albania has conducted performance and information technology (IT) audits of the public sector—whose activity represents about 30 percent of the country's annual gross domestic product (GDP)—and found that it has paid insufficient attention to technology.

Key institutions, such as the General Directorate of Taxation; National Civil Protection Agency; Institute of Geosciences, Energy, Water, and Environment; and Electronic and Postal Communications Authority (AKEP), lack strategies and action plans for developing and implementing new information technologies. The SAI's audit on the use of the internet in public administration found a lack of procedures for managing incidents on computer platforms and their networks; inappropriate use of internet traffic; and a lack of controls over users, which increases the risk of data breaches.

There is little use of modern technology in the private sector, which largely consists of agriculture, fishing, trade, transport, hotel and food services, and the construction and FASON (processing industries of textile, garments and footwear manufacturing) industry. Activities that require the use of more advanced technology, such as information and communication processing, financial and security services, and research, comprise only 10 to 12 percent of GDP.

While Albanians make little use of technology for business purposes, they make abundant use of it for entertainment, information, and communication. For example, the number of active users of mobile services in 2018 was about 2.7 million (out of a total population of 2.85 million), generating about 6 billion minutes per year, and this figure continues to increase.

The transition of mobile infrastructure from the 4G to the 5G network represents an opportunity to reorganize the entire economy—not just consumption—around technology. 5G technology promises artificial intelligence, autonomous means of civilian and military transport, smart cities where traffic lights are activated according to traffic, and hospitals where operations are performed by a robot led by a doctor 10,000 km away.

However, such technology brings not only prosperity, but security risks. Based on a performance audit it conducted of AKEP, SAI Albania recommended that:

1. AKEP conduct a preliminary analysis of the impact that implementation of 5G technology would have on the country. Implementation must be carried out based on a clear and comprehensive national action plan, to protect against security risks.

1. The government establish a National Committee for the evaluation of strategic investments in Albania, including investments in 5G technology. This committee should include experts not only in economics but also in security, IT, and defense. For this purpose, a special legal basis must be approved by the Parliament. The tasks of this Committee should include assessing whether:

    - 5G technology providers are subject to control by a foreign government, without an independent judicial process;
    - Network suppliers and service providers are funded in a transparent manner, using best practices in procurement, investment, and contracting;
    - Service providers have transparent ownership, partnerships, and corporate governance structures;
    - Providers are innovative and respect law enforcement and intellectual property rights;
    - Providers and network technologies create a secure environment, independent of government influence, and comply with industry standards.

The Chairman and Director General of SAI Albania presented the audit's findings and recommendations at the Summit on Cyber Security organized by the U.S. Senate on 03.02.2020.

FEATURE ARTICLE

Data Science as a Catalyst for Audit Transformation

Authors: Colombo Gardey Julieta and Kugler María Paula,
Auditoría General de la Nación Argentina

> *"In a world deluged by irrelevant information, clarity is power."*
>
> - Yuval Noah Harari, 2018

In the context of information society, digital transformation has led to an exponential growth in the production and storage of data, giving birth to what is known as data science, to address the need for new tools capable of smartly processing great volumes of data and transforming them into actionable information for decision-making in multiple environments.

This scenario suggests that the old adagio by Hobbes (1651), "Information is Power" will soon be replaced by the newer "Clarity is Power" (Noah Harari, 2018) to more accurately convey the implications of a new model involving the management of data, information and knowledge.

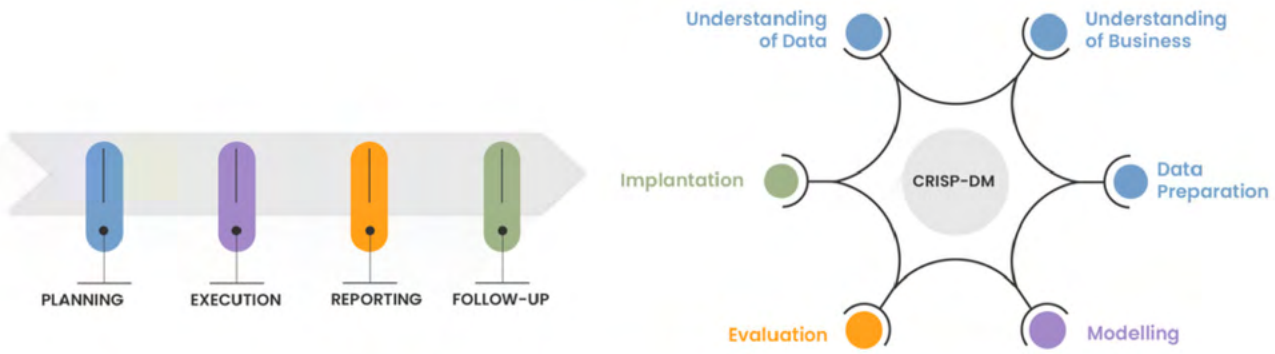
This is a unique opportunity for Superior Audit Institutions (SAIs) to exploit the potential offered by new technologies and the great amount of data generated within public agencies, and integrate them into their auditing processes to ensure a better management of public funds. **Data science works as a catalyst for audit transformation, which strengthens SAIs' independence while increasing public confidence and accountability.**

Data science methodologies can optimize audit processes, leading to audit reports of greater value, accuracy and scope, and more timely and relevant recommendations. High-quality reports foster a more effective and efficient public administration, having a significant impact in the improvement of citizens' quality of life. Integrating data science into the auditing processes requires a roadmap that can guide SAIs in the use of these new tools.

Data Science in the Auditing Process

Data science, tools, and techniques can be integrated to any instance of the auditing process. The analysis below is based on the INTOSAI guidelines for Performance Audits and the CRISP-DM (Cross-Industry Standard Process for Data Mining) Model. Both processes constantly feed into each other in an iterative manner. Their stages are comparable and can be combined as data science is introduced in audit activity:

Figure 1



Source: Own, based on GUID 3920 (INTOSAI, 2019); Han, Kamber y Pei (2011).

CRISP-DM Model includes the three core dimensions of data science: 1) Database management; 2) Creation of machine learning models through algorithms that enable computers to learn a task, such as automatically recognizing complex patterns and improving their performance over time through the use of data, and; 3) Data analytics, to explore, clean and transform data to extract and present useful information for smart decision-making.

Figure 2

Database Management

In the planning stage, both the selection of the topic and the audit design are vital, because these determine what the audit object will be.

In this sense, data science is a key tool that ensures the topics to include in the report planning are strategically and efficiently selected. It also enables a thorough initial assessment of the universe of possible audit objects through statistical models applied to great volumes of data. This allows SAIs to identify audit critical points and risks more accurately, and select the most relevant, auditable objects in line with the SAI's mandate.

An audit plan design begins with a thorough search of relevant information, thus rendering data access vital. Today it is possible to access open data in multiple public and private platforms (scraping/crawling, APIs, GPT). These tools facilitate and speed up access to the information needed for audits.

Planning begins with an initial assessment of the structure and composition of the database, and this assessment informs how it will be cleaned up and transformed to adjust it to the audit project goals. This entails estimating the number of registries, types of variables, summary measures and the presence of outliers, noise (error characters) and duplicate data, as well as any missing data. Visually presenting this exploratory assessment enables a better interpretation of raw data. Visualization tools are an excellent resource to create summaries, graphics and reports quickly and with a wide variety of designs.

Data quality impacts the results of the models, their analysis and the conclusions drawn. Although organizations have advanced in digitalizing, standardizing and structuring data, agencies usually obtain databases that need cleaning to be used. Thus, during this stage, raw data are cleaned and refined through various techniques, in order to obtain an adequate dataset to perform the job based on the goals of the audit. Data structure and features are vital aspects when it comes to defining the relevant statistical models.

As relates to sampling, as a general rule, the whole universe of data is considered, due to the big potential of data science tools. One or more samples are obtained to create and train the algorithms. This way, one dataset is used to create and train the algorithm, and others are used to assess the predictive ability of the model.

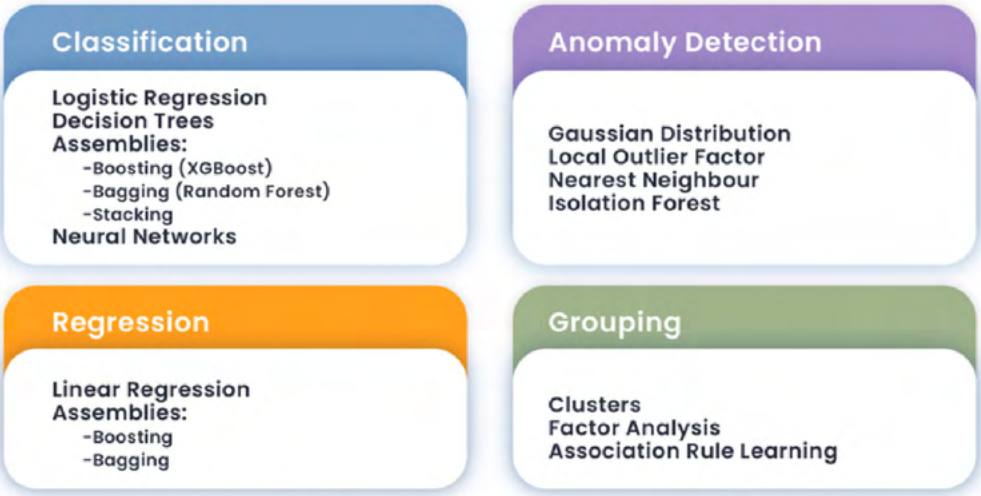
The software options available for each process in data science are virtually endless. It is recommended to use tools that enable interaction with computer thinking and that do not limit the user. The most comprehensive and widely used software utilized for data processing and analysis are Python and R. Both are open source, free, and their language is high level. They offer toolkits known as libraries and functions used in every stage of data science, from simple visualization to the construction of more complex algorithms. One of the main advantages these high level software options offer is that one can create their own function with all its action items and rules to apply to a database and then use this same function with other datasets without the need to duplicate processes manually or rewrite any codes.

Figure 3

Creation of machine learning models

During the execution and modelling stage, models are created and assessed to find evidence that will support future findings. The chosen models will depend on the audit's goal, the scale of the available data and the type of issue that will be addressed. These can be classified into two distinct types, based on how much their variables depend on one another and the peculiarities of the issue addressed: Supervised learning models, used to predict new cases (regression) or unsupervised learning models (used to sort and group cases). The following chart contains examples of these learning models as they relate to the type of task to be performed:

Figure 4



Source: Own, based on Han, Kamber and Pei (2011).

Every model should be evaluated against the validation data to determine their predictive or classifying ability. To this end, there are various techniques to measure variance, bias, errors and the cost of detecting those errors. The model is then applied to the remaining data in order to find relevant and accurate evidence that can support recommendations.

Figure 5

Data analytics

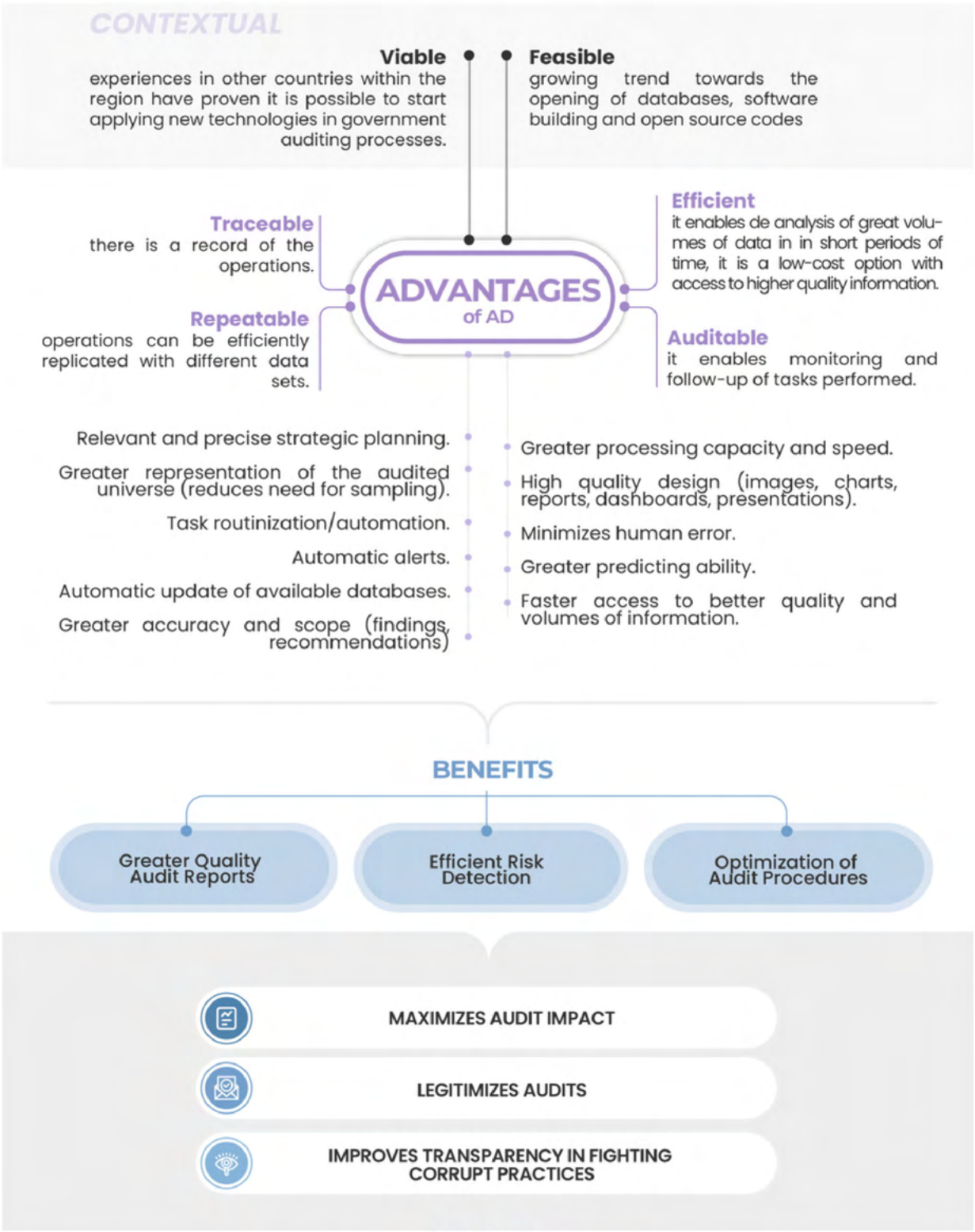
In the reporting stage, visualization tools have an extremely relevant role. The variety and number of visualization options offered by data science represent a meaningful improvement since they clearly convey information through high quality graphs and videos with the possibility of selecting different aesthetic parameters and easily creating reports. Moreover, there are several intuitive tools (Power BI and Tableau) which enable the creation of dashboards to inform decision-making (known as business intelligence).

Figure 6

Data science techniques allow automatization of audit processes. By maintaining criteria unchanged and adding or replacing data (input) the model can enable the detection of continuity and/or disruptions (anomalies) in the analysed information.

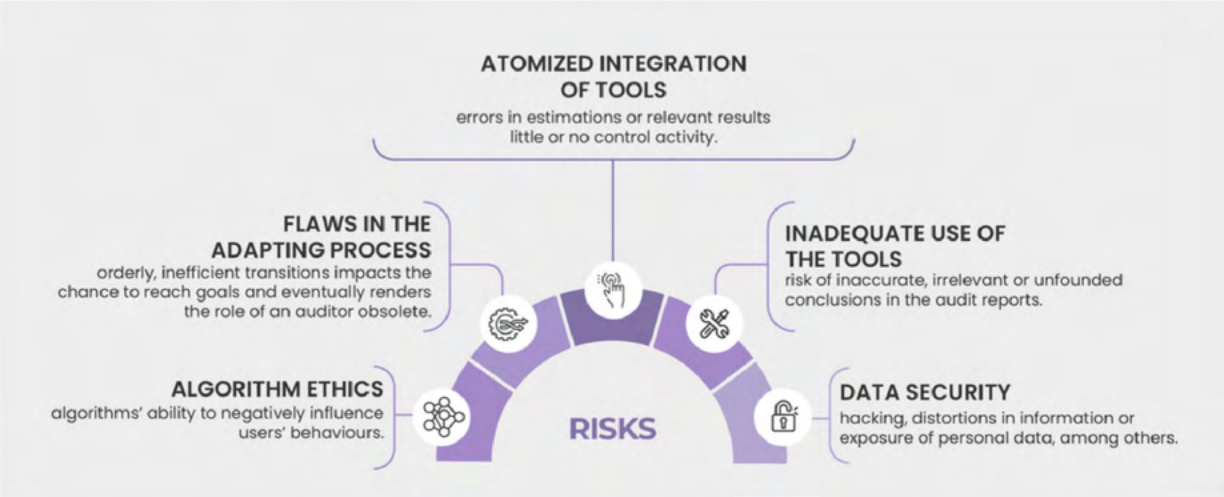
Figure 7

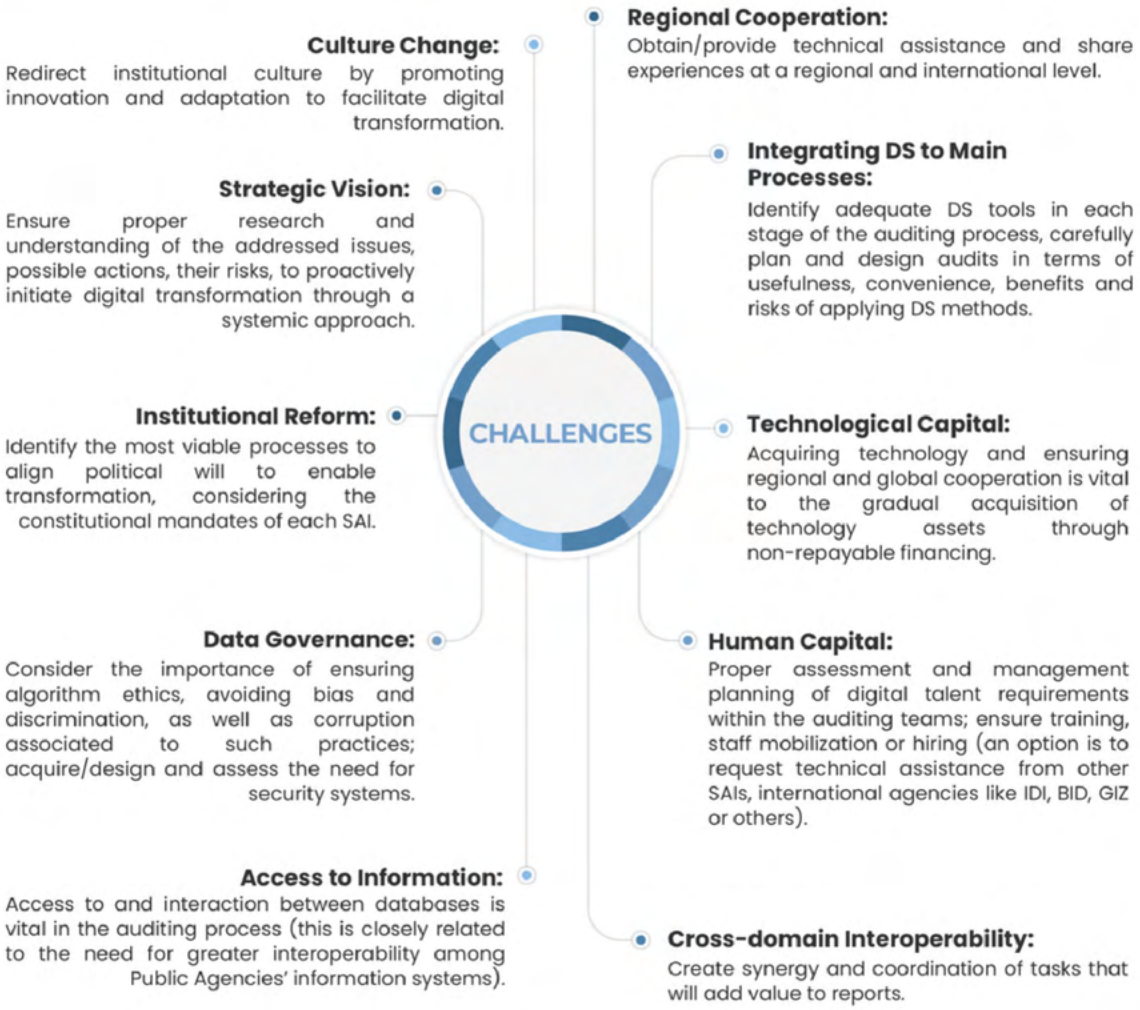
Advantages, Risks and Challenges of Incorporating Data Science to Control Tasks



Source: Own

Figure 8





Source: Own

Strategic Action Items

Figure 9

Source: Own

Conclusion

The strategic and progressive deployment of information technologies for auditing activities has the potential of driving significant changes in the auditing processes.

The advantages of integrating data science outweigh, by far, the risks. This is why it is strongly advised that SAIs begin reimagining their auditing and monitoring activities to include such practice.

A series of strategic guidelines have been outlined to ensure the understanding that integrating data science into the auditing processes should not be considered as an isolated measure, but rather as part of a set of steps towards gradual escalation.

Special emphasis has been put on the unique opportunity the SAIs have to enhance their role and capitalize their cross-sectional and multidisciplinary activities to spearhead the culture change that digital transformation requires. It is an enormous challenge, but overcoming it is not only necessary and timely, but also viable and feasible. Rather than considering technology as a limitation or as an end in itself, it is important to understand the positive impact of data science, to avoid "putting the cart before the horse", or technology before knowledge.

Digital transformation should be approached through specific measures and a strong political will oriented to the fight against corruption. To this end, data governance should be widely and effectively addressed.

A timely, accurate and efficient governmental control based on data science adds value to the administration, optimizing public expenditure. Furthermore, leveraging the potential of technology to implement data science can contribute to the reduction of development gaps and lay the foundation for a more solid and sustainable growth worldwide.

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BPK Big Data Analytics (BIDICS): From a Question that has No Answer

Authors: Muhammad Rafi Bakri and Rio Tirta, SAI of Indonesia

Introduction

Big Data Analytics (BDA) has increased significantly in recent years. BDA is frequently used to represent immense amounts of data, so users can analyze it more efficiently and make judgements in audit process (Saggi and Jain 2018). Consequently, the worldwide auditing community has formed to mobilize the use of BDA in auditing (Appelbaum, Kogan, and Vasarhelyi 2017).

INTOSAI, as the worldwide supreme audit institution (SAI) organization, started the BDA movement by forming the INTOSAI Working Group on Big Data (WGBD) in December 2016. The establishment of INTOSAI WGBD aligns with Strategic Goal III, which aims to increase SAI capabilities worldwide in the big data era.

Based on the INTOSAI WGBD Development Overview (INTOSAI 2022a), at least 9 SAIs have introduced big data audit infrastructure such as China, Russia, Brazil, Norway, Estonia, Turkey, and the Philippines. Moreover, the European Court of Auditors has also erected a big data audit platform that EU countries can utilize in 2021. SAI of Indonesia, known as the "Badan Pemeriksa Keuangan (BPK)", was an early adopter of BDA by introducing a big data audit platform in 2017. BPK's platform, BPK Big Data Analytics, or BIDICS, can be used as a forum for collecting, processing, and conducting various data analysis according to audit needs (INTOSAI 2022c).

E-Audit: The Origin of BIDICS

BIDICS is a platform that assists the BPK audit process by utilizing BDA. Before becoming a platform, BIDICS had a more old-school form called e-Audit. E-Audit,developed from 2010-2014, ussed the Collect-First concept, where BPK needed to collect the necessary data first and then validate it. Once the data is valid, the data can be used for audit analysis. The E-Audit format is the foundation to the formation of a data-driven organization.

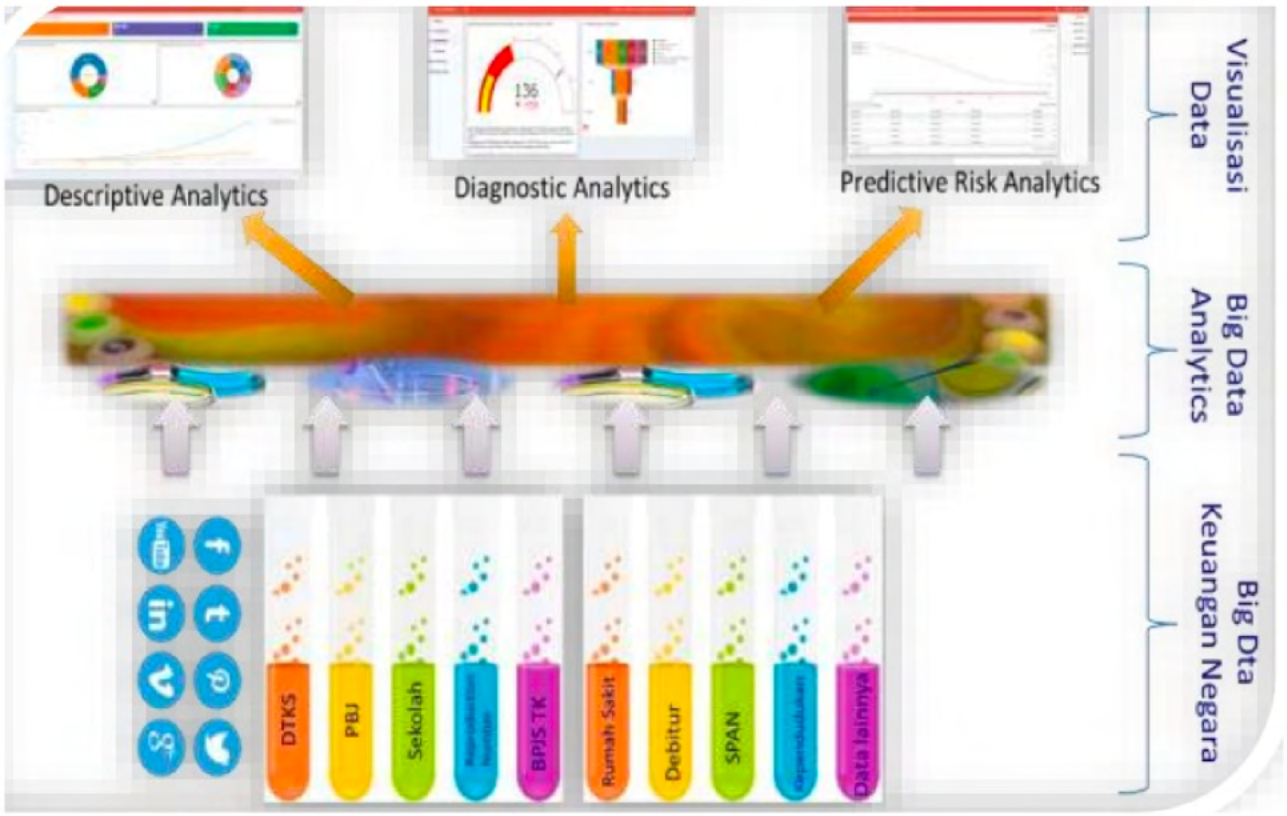
E-Audit requires synergy between BPK and auditees in terms of data collection. BPK enters into an agreement with the auditee to request data related to financial reports so that it can be entered into the database. In 2014, BPK entered into 767 memorandums of understanding (MoU) with state institutions (auditees) to collect large amounts of data.

After the data is collected, BPK will re-validate the data. When the data is validated, BPK's auditors can scrutinise all financial data from state institutions more quickly, easily and effectively. The use of e-Audit also makes audit activities more adequate and efficient. The procedure for collecting and using big data in the e-Audit application follows the technical pedagogy issued by INTOSAI (2022b) in 2022.

The implementation of e-Audit has a positive result on state finances. As of 2014, BPK could review 46,586 accounts, of which 19.95% were successfully sealed. Closing these accounts saw a saving of USD 11.8 million or IDR 7 trillion in state funds. These results made all of BPK's internal and external parties more aggressive in evolving this platform and encouraging the broader use of BDA in audits.

BIDICS Enactment Framework

BPK Secretary General Decree Number 206/K/X-XIII.2/8/2021 underlies the grand design in implementing and developing BIDICS. The following figure shows the appointment and plot of enforcing BIDICS within the BPK circumstances (2021a).



This scheme shows that BIDICS is a device for performing three types of analysis: descriptive, diagnostic, and risk prediction. These three analyses can demonstrate a pattern from the existing data set. Auditors can use these results to assist in inspections.

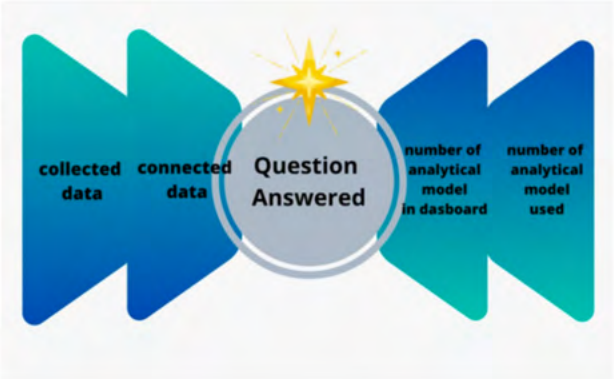
Two activities are interconnected in applying BIDICS, namely exploratory and confirmatory. Exploratory activities aim to find hints or signals of an anomaly, irregularity, or pattern of events. The information obtained through exploratory activities is then followed up to a confirmatory procedure to ensure that the results of the exploratory activities are sufficient enough to become audit evidence that is accurate, relevant, and competent. These two activities are the perfect combination for the auditor to conduct the audit.

The application of BIDICS uses a goal-based approach. In practice, auditors use BIDISC when a question arises. These questions are submitted to the BIDICS laboratory team to discuss the need for auditors and the availability of data to answer these questions.

The level of success in answering the auditor's questions depends on data availability in the BIDICS database. This is the main background in applying the Collectability Over Validity principle by BIDICS. This principle emphasizes collecting as much data as possible before validating it by the laboratory team when the data will be used. This principle gives BIDICS an extensive and diverse range of data that can meet the needs of auditors.

Different conditions ensue when the data required by the auditor is not available. The BIDICS labor team will execute a search for related data so that this deficiency makes BIDICS develop even more extensively. It can be concluded that BIDICS was created from a question that has no answer.

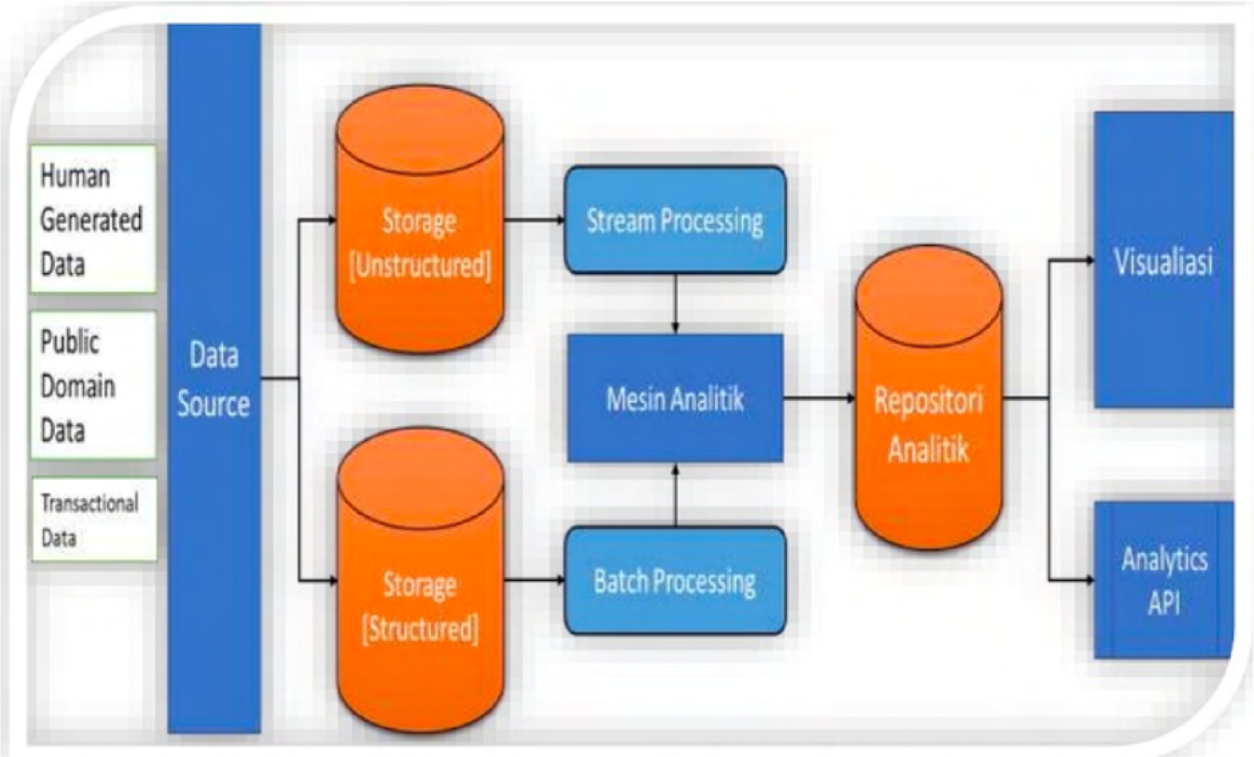
Based on the BIDICS Development Report (2021), BPK uses a performance measurement method called the North Star Metric. This method allows BIDICS to grow rapidly and without limits. The measurement of BIDICS performance is highly dependent on how many questions the auditors answer by the analytical model of the platform. Moreover, the North Star Metric will encourage other metrics to develop, namely (1) growth in data collected, (2) growth in connected data, (3) growth in the number of analytical models presented in the dashboard, and (4) growth in the number of analytical models used in line-of-business applications.



BIDICS Architecture

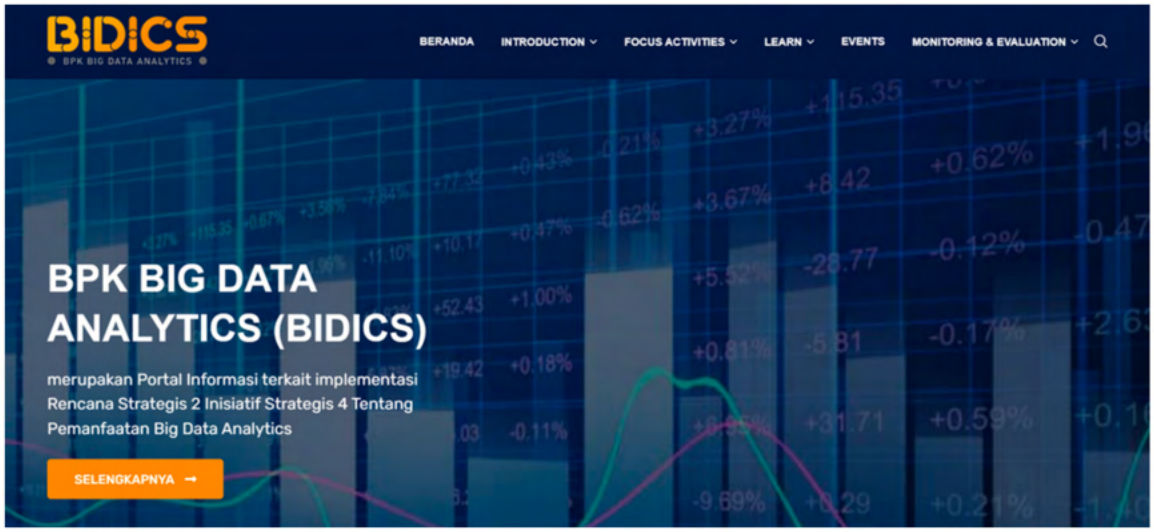
BIDICS performs an analysis of big data, which has very diverse variations. BIDICS can analyze structured, semi-structured and even unstructured data. Each of these types of data is commonly received by auditors when conducting audits. However, not all data received can be examined directly. For that, the role of BIDICS is beneficial here.

Structured data is the easiest to process because it is in the form of a table with rows and columns. Unstructured data is text, images, sound or video, so it does not have a clear pattern. The combination of these data is called semi-structured data. Examples of semi-structured data are data in the form of JavaScript Object Notation (JSON) files, Extensible Markup Language (XML) files, or HyperText Markup Language (HTML) files obtained from government websites or other organizations.



Structured data is processed through batch processing by an analytical engine, while unstructured data is processed through stream processing. This analytical engine then analyses based on statistical and mathematical algorithms. The analysis results are then stored in the analytical results repository to be displayed visually through a dashboard or consumed by applications commonly used by auditors.

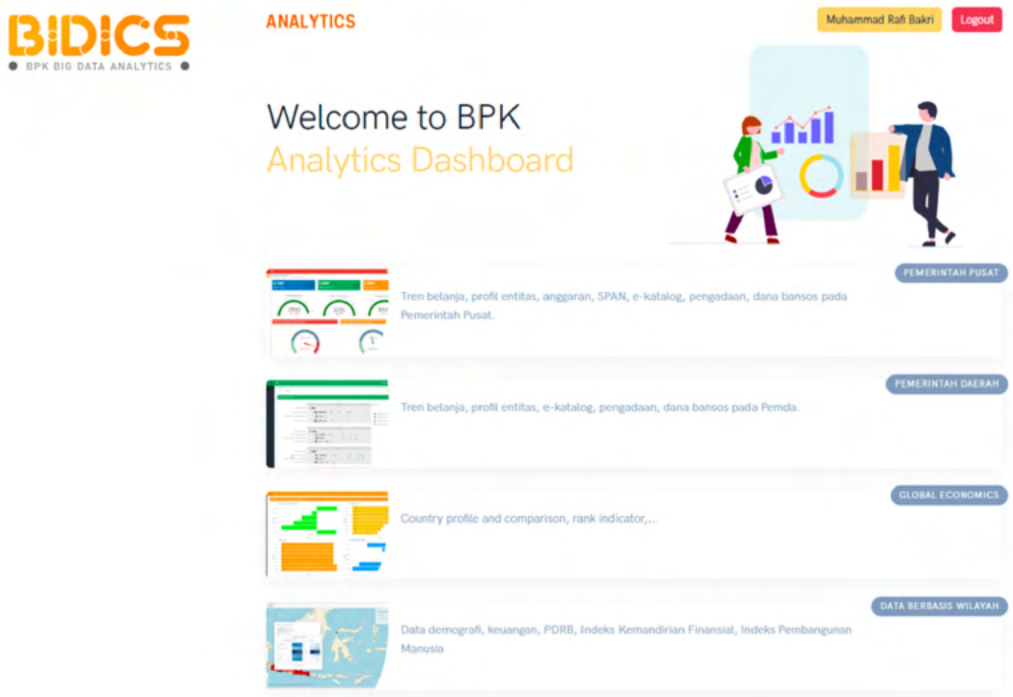
The Application of BIDICS



FEATURE ARTICLE

BIDICS is currently experiencing very significant evolution. BIDICS already has an intelligence dashboard that can be a medium for auditors to get to know the situation of the auditee, both financial and non-financial. The auditor can independently analyze the data from the available dashboard and answer the questions.

BIDICS can be accessed via https://bidics.bpk.go.id/ with a display that has several main menus, namely homepage, introduction, focus activities, learn, events, and monitoring & evaluation. Each existing menu has several sub-menus related to the introduction of BIDICS to the BIDICS report.



This condition transpires because the state financial big data in BIDICS is pervasive. As one of the prerequisites for facilitating the analytical process, Big Data on State Finance is equipped with a Data Catalog and implements Data Governance practices to increase reliability and confidence in optimal data utilization.

In addition, there is also a State Financial Analysis Laboratory whose function is to develop analytical models from BIDICS. This laboratory has an end-user computing function, a system for developing automation tools and making self-reporting. This laboratory is equipped with several workstations/computers with access to an analytical engine with sufficient computational power.

As of 2023, BIDICS has a total of 10 analytical data clusters that can be used in audits, namely central government, local government, global economy, area-based data, covid-19 data, social assistance and subsidies, national development maps, LPSE, search financial data, and institutional evaluation monitoring. These clusters have their sub-clusters, making it easier for the auditor to select the data to be used.

As part of BPK, BPK Jambi Province Representative has utilized BIDICS to reinforce audit activities executed on local governments. Auditors can see trends in local government spending and revenues as part of audit planning. In addition, the auditor also can see the process of procuring goods and services and the e-catalog from the auditee within a particular period. Therefore, the auditor can measure the risk level of the auditee with low cost and fast time.

With the complexity of audit issues, BIDICS will continue develop. For this reason, BPK is collaborating with the University of Indonesia. For BPK, this collaboration adds insight into the story and utilization of BIDICS. In addition, BPK internally also formed special working groups from each work unit to develop BIDICS.

Conclusion

BPK has answered very well to challenges related to the flow of big data use in audits. Taking a long time, BPK succeeded in developing an analytical data-based audit platform called BIDICS. Today, BIDICS already has 10 data clusters that auditors can utilize in examinations. In the future, BIDICS will experience many challenges, given the increasingly complex audits conducted by BPK. For this reason, it is necessary to carry out unlimited development of BIDICS so that it continues to be helpful in audits.

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Technology is Advancing Every Day, We Think Oversight Should Too!

Author: Taka Ariga, Chief Data Scientist and Director of the Innovation Lab, U.S. GAO

The Government Accountability Office—the United States Supreme Audit Institution—established its Innovation Lab in 2019 as a research entity dedicated to exploration and experimentation of data science techniques and emerging technologies. The goal is to amplify GAO's oversight capabilities across the evolving web 3.0 landscape. The INTOSAI Journal recently joined the Lab for a tour of the facility at GAO headquarters where an entrepreneurial team of data scientists, technologists, and analysts come together collaboratively across a portfolio of novel projects ranging from deployment of large language models to use of extended reality.

Taka Ariga, Chief Data Scientist and Director of the Innovation Lab, U.S. GAO

SPECIAL CONTRIBUTION

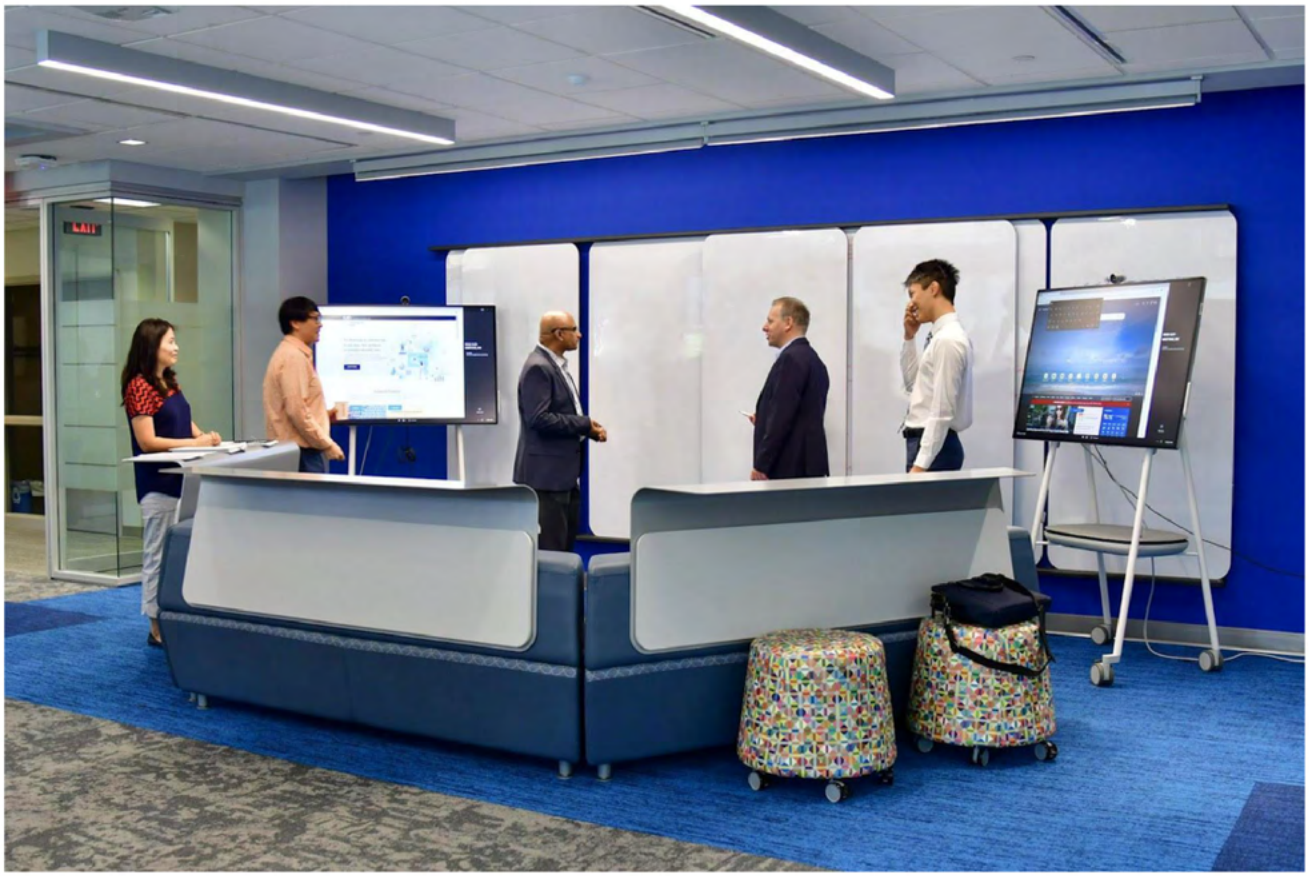
As a research entity, the Lab looks at a variety of systemic challenges facing the public sector from the vantage point of what is possible? The design of the lab space itself reflects and supports how specific functions across the innovation lifecycle can best be carried out. The anchor area of the Lab is affectionately referred to as the living room where multidisciplinary stakeholders—ranging from mission team subject matter experts to cybersecurity professionals—come together regularly to ideate and collaborate. The Lab has also integrated enabling technologies for seamless involvement of both virtual and in-person participation.

One of the most exciting part of the Lab is a space called demonstration. Flanked by large touch displays, the Lab is able to provide a tactile experience to explore data science features and facets of digital prototypes.

SPECIAL CONTRIBUTION

The journey of Innovation Lab has been exhilarating. We started out as a startup entity and have evolved our management processes to balance the entrepreneurial spirit with critical compliance functions, all while maintaining our own brand of agility. As the Lab navigates the uncertainties across our portfolio of projects, we are making sure that complex technical work and associated risks do not jeopardize GAO's principles of quality, non-partisanship, and objectivity.

The Lab space is buzzing with activities today. As for tomorrow, we will continue to grow our capacity and to build on our successes with a continued sense of urgency. We are looking to move the needle on systemic opportunities such as generative AI, portfolio knowledge management, improper payments, and diving into the deep ends of cybersecurity implications through the use of emerging technologies. One of the assistant Lab directors is fond of quote by the French statesman Charles Alexandre de Calonne, and his words are certainly relevant here: "the difficult is that which takes a little time, the impossible is what takes a little longer."



The Australian National Audit Office and the Australian Capital Territory Audit Office host the International Meeting of Performance Audit Critical Thinkers (IMPACT) Conference

By the Australian National Audit Office

The International Meeting of Performance Audit Critical Thinkers (IMPACT) Conference, an initiative of the Australasian Council of Auditors General (ACAG), is intended as a biennial professional conference for performance auditors. The event brings together auditors to discuss emerging issues and best practices in performance audit with industry experts, practitioners and those interested in government accountability.

The 2023 Conference, hosted by the Australian National Audit Office (ANAO) and ACT Audit Office (ACT AO), was the third since its inception in 2016, and the first since the COVID-19 pandemic. Over 230 attendees from Australia and across the globe gathered for the 2023 conference in Canberra, Australia from 19–20 April 2023.

The theme of this year's conference was 'The Auditor of the Future' with two sub themes — 'technology as a tool' and 'technology and the impact on the auditor'. The conference featured two full days of presentations, breakout sessions, and networking opportunities.

CANBERRA, AUSTRALIA – APRIL 19, 2023: The IMPACT 2023 conference was held at the Realm Hotel in Canberra. Picture: Gary Ramage

Mr Grant Hehir, Auditor-General for Australia provides the welcome address to attendees.

Conference highlights

Provide assurances to the Parliament

Senator the Honourable, Katy Gallagher, the Australian Minister for Finance, Minister for Women and Minister for the Public Service addressed conference attendees as a keynote speaker. Minister Gallagher highlighted the importance of auditing as a profession and reminded those in attendance of the critical role that auditors play in providing Parliament, and the public which they serve, assurances that public sector entities are providing services and using public money in accordance with the Parliament's intent.

Technology as a Tool and Technology and the Impact on the Auditor

An emerging theme for the future of auditing is the role of data and artificial intelligence (AI) in public administration. Performance auditors are faced with the challenges of understanding complex data and AI, what it is, and what are the implications for the auditor of the future.

SPECIAL CONTRIBUTION

Ms Tina Kim, Deputy Comptroller for State Government Accountability for New York, spoke about the rise of artificial intelligence and the role of the auditor. Ms Kim discussed how auditors will remain a critical component of providing oversight and accountability of public sector performance and how auditors can use technology to their advantage. She emphasised that auditors possess deep knowledge about organisations and are trained in professional scepticism to understand the effects of data and the presentation of information from government.

Ms Xiaoyan Lu, Executive Director, Systems Assurance and Data Analytics, from the Australian National Audit Office (ANAO) spoke to conference attendees about the increasing use of advanced technologies and data by entities to deliver government programs. Ms Lu provided insights into how the ANAO embeds data analytics and relevant technologies into its performance and financial statements audit practices. Ms Lu also provided a framework for how other audit institutions can create an operational strategy for incorporating data analytics into audit work.

Environmental audit

Environmental protection and sustainability is an increasing focus of governments and private sector globally. This has required the performance auditor to adapt to new frameworks and understand sustainability outcomes. The conference featured two break-out sessions on environmental sustainability.

The first session featured a discussion on the role of audit institutions in responding to the global focus on the impacts of environmental and climate change on the lives of citizens, particularly through the lens of the United Nation's Sustainable Development Goals. The session included presentations from the Controller and Auditor-General of Samoa, Mr Camilo Afele Fuimaono and Dr Wendy Craik AM FTSE, One Basin Cooperative Research Centre (CRC) Chair. Mr Fuimaono presented on the 'Ambitions of the Samoa Audit Office in Assuring a Sustainable Future for Samoa' emphasising that auditing of environmental and climate change programs provides the Parliament with valuable information about the effectiveness of these programs and makes an important contribution to ensuring the development and future of Samoa is sustainable. He also discussed the need for strong legislative frameworks to enable independent auditing across the breadth of the audit activities.

SPECIAL CONTRIBUTION

Ethical and integrity challenges in government

A panel discussion was held on ethical and integrity challenges in government. Panel members included Mr John Ryan, Controller and Auditor-General of New Zealand, Ms Daniele T. Bird, Partner at EY Australia, and Dr Gordon de Brouwer PSM, Secretary for Public Sector Reform, Australia. The panel provided insights into the role of the auditor to scrutinise ethics and integrity in the delivery of government programs to ensure auditors are looking beyond technical compliance and toward operating within the intent of established rules and frameworks, alongside community expectations of integrity.

In addition, the conference featured several outstanding presentations from the INTOSAI community as outlined below.

- Dr Agus Joko Pramono, Vice Chairperson, Audit Board of Indonesia gave a keynote address on the challenges of attracting the auditor of the future particularly focusing on the skills audit professionals will need in a rapidly changing digital environment.
- Ms Karen Hogan, Auditor General of Canada, delivered a presentation on audit impact and the relationship with Parliament.
- Mr Shri Girish Chandra Murmu, Comptroller and Auditor General of India, provided conference attendees with an overview of the impact of audit findings in India, including in relation to citizen centric services, public transportation, and disaster management.

Conference attendees were invited to attend a formal dinner at The Marion on the shores of Lake Burley Griffin. This provided an opportunity to network, to share knowledge and experiences and to hear from Mr Li Cunxin (see Author & Speaker – Li Cunxin – Mao's Last Dancer), who shared his inspiring story of courage and determination.

Further, the ACAG Performance Audit Awards were presented at the dinner. These awards recognise outstanding performance audits in three categories: communication, excellence, and innovation.

The winners of the 2023 awards are outlined below:

- Communication: Office of the Auditor General for Western Australia, Public Trustee's administration of trusts and deceased estates
- Excellence: Queensland Audit Office, Delivering Social Housing Services
- Innovation: Victorian Auditor-General's Office, Managing Body Worn Cameras,

SPECIAL CONTRIBUTION

Dr Agus Joko Pramono, Vice Chairperson, Audit Board of Indonesia gave a keynote address on the challenges of attracting the auditor of the future.

Mr Shri Girish Chandra Murmu, Comptroller and Auditor General of India, presents on the impact of audit findings in India.

Mr Michael Harris, Auditor-General of Australian Capital Territory, shares a closing address.

CANBERRA, AUSTRALIA – APRIL 19-20, 2023: The IMPACT 2023 conference was held at the Realm Hotel in Canberra. Pictures: Gary Ramage

SPECIAL CONTRIBUTION

IMPACT 2025

The next IMPACT Conference will be in 2025 and will be hosted by the Office of the Auditor General, Western Australia.

For more information about IMPACT 2023, including the conference presentations, please visit the ANAO's website: https://www.anao.gov.au/work/events-and-seminars/impact-2023-conference-19-20-april-2023.

CANBERRA, AUSTRALIA – APRIL 20, 2023: The IMPACT 2023 conference was held at the Realm Hotel in Canberra. Day 2 Picture: Gary Ramage

The Australasian Council of Auditors-General Auditors-General, Auditor-General of Samoa and Deputy Auditor General, State Audit Office of Viet Nam

SPECIAL CONTRIBUTION

GAO Launched First-Ever Virtual International Fellowship Program in 2022

By Mark Keenan and Brenda Fernandez, U.S. GAO

After 40 years of conducting its International Auditor Fellowship Program (fellows program) in-person, the U.S. Government Accountability Office (GAO) launched its first ever virtual fellowship program—Pathways—in 2022!

GAO initiated its fellows program in 1979 and this flagship capacity-development program has over 630 graduates from over 100 countries, many of whom have gone on to leadership positions in their Supreme Audit Institutions (SAIs) and within their respective governments. As a result of the pandemic and prevailing public-health concerns, GAO cancelled the in-person fellows program in 2020 and 2021.

Recognizing the importance of capacity-building and SAI collaboration during these critical times, GAO launched its innovative remote Pathways Program in 2022. Due to the logistical challenges with time-zone differences, the 2022 program was open to SAIs in the Caribbean Organization of Supreme Audit Institutions (CAROSAI) and the Organization of Latin American and Caribbean Supreme Audit Institutions (OLACEFS) regions of the International Organization of Supreme Audit Institutions.

SPECIAL CONTRIBUTION

The inaugural Pathways, A Virtual International Auditor Fellowship Program, was held from June 6 – September 16, 2022. The cohort of 10 fellows hailed from 10 countries from the SAIs of Argentina, Aruba, Belize, Chile, Costa Rica, Grenada, Guatemala, Haiti, Mexico, and Peru. After the program kicked-off with spirited team-building and getting-to-know-GAO events, the fellows participated in live virtual training where they learned about GAO auditing methods, leadership skills, and change management, among other topics. Additionally, fellows eagerly shared auditing practices and experiences from one another's SAI during the interactive sessions. While the fellows "zoomed" through their courses, discussions, and activities, they also developed strategies to implement change within their SAIs.

Picture 1. Pathways graduating class of 2022

As a program prerequisite, fellows worked directly with the Head of their SAI and other leadership to identify a specific topic of change or area of interest for advancing capacities in a capstone strategy paper. Upon graduation, the fellows would then introduce and champion this topic within their SAI. Throughout the virtual program, fellows worked with a GAO mentor and other GAO experts to develop their capstone papers. For the first time, GAO introduced the role of a SAI sponsor—a senior leader at the fellow's home SAI selected by the Head of their SAI to provide guidance and serve as another resource to the fellow. In addition, SAI sponsors are assisting the fellows in the implementation of the recommended changes identified in their papers.

SPECIAL CONTRIBUTION

Picture 2. IAFP Alumni Panel: Alicia Garcia (2006, SAI Spain), Nabil Larhmam (2011, SAI Morocco) & Tashi Lhamo (2019, SAI Bhutan)

In keeping with GAO's commitment to diversity, equity, and inclusion, the fellows participated in cultural exchanges to learn about the culture of the United States and share information about their cultures. The fellows also held a well-received Cross-Cultural Fair, where fellows shared their country's culture with GAO staff, with a focus on geography, people, music, food, crafts, and more. The fellows also learned about the dimensions of diversity and ways to support inclusion and equity in their workplaces. These activities strengthened the connection among the fellows and GAO staff.

The Pathways virtual graduation ceremony was held September 15, 2022 with U.S. Comptroller General Gene Dodaro providing the keynote address. Per Mark Keenan, SPEL International Auditor Fellowship Program Manager, and Brenda Fernandez, SPEL International Auditor Fellowship Program Analyst, "We are proud of the great work completed by our first class of virtual fellows." With the success of the 2022 program, GAO plans to expand Pathways to additional INTOSAI regions in the future.

Picture 3. Country flags of participating SAIs.

Source: Adobe Stock Images, Lucky Ai

The Use of Artificial Intelligence (AI) in the Execution of Audits

By ASA's working team concerned with INTOSAI subcommittee on Internal Control Standards.

Introduction:

In the light of the world's developments in information technology, the term Artificial Intelligence (AI) has been traded in discussions often in recent times. It is considered a modern field that attracts the attention of all societies, which is constantly evolving, and it is expected to play a crucial role in humanity's future. Utilizing AI systems and modern information technology is key for the future of data processing in auditing to complete the audit work efficiently and effectively.

What is AI?
AI is defined as "a modern science that is harmoniously built and interconnected between mathematical rules, devices and programs that have been assembled in computers, which in turn perform many operations and tasks that a human can accomplish, but they differ from it in terms of speed and accuracy in finding solutions for complex problems, which are difficult to solve".

More broadly, AI has a number of benefits:

- *Productive efficiency:* AI can automate various tasks, leading to increased productive efficiency.
- *Accuracy:* AI can process large amounts of data, identify patterns that humans may not be able to detect, which can help make more accurate predictions and better decision making.
- *Innovation:* AI can contribute to the development of new products and services that were not previously possible.
- *Cost-effectiveness:* AI helps to reduce costs by automating tasks, reducing the levels of human intervention.

Advantages of AI for Auditors

There are advantages from using AI systems in the field of external audit:

- External auditors can access information and evidence required in the audit process in an appropriate time. The timely provision of information increases the accuracy of information, and can help auditors reach reliability and transparency.

- Auditors can further develop accounting and the auditing profession, in order to raise competitiveness in the field of accounting and auditing to keep pace with the speed of other sectors, and reduce fraud, financial and administrative corruption.

The accounting and auditing profession is considered one of the most affected professions by the use of AI, as auditors need to keep pace with the accounting systems of the auditees. Therefore, the auditing profession cannot rely on traditional methodologies, and auditors must respond technological developments and enhance their technical, technological, and knowledge skills and capabilities continuously and appropriately. Using AI in the audit process can help improve the efficiency and effectiveness of the external audit process.

To determine the impact of AI on auditing, we must ask several important questions:

1) What are the benefits of AI in the audit field?

Auditors can find benefits of using AI technologies in the following contexts :

- **Taking advantage of using expert systems in auditing:** Expert systems are computer systems which can emulate the decision-making ability of a human expert. In auditing, expert systems can achieve many advantages:
    - They can improve the efficiency of the audit process, reduce costs, reduce the audit workload, and deliver the results of the audit process in a timely manner.
    - Expert systems can increase the performance of auditors. In learning how to utilize and work with expert systems, auditors become trained and qualified, increasing their effectiveness. Expert systems can also serve as a documentary reference for auditors.
- **Contract Audit:** The use of AI in contract audit procedures is the most common, as a larger number of contracts can be analyzed continuously in real time. The auditor can automatically extract data from contracts using programming tools, identify relevant items for accounting processing such as the contract start date, contract amount, renewal options and termination, etc. Using AI, auditors can more effectively assess the risks in the contract.
- **Electronic auditing and achieving cost advantage:** The use of electronic auditing, or the digitization of audits, contributes to reducing the cost of audit services and increasing the profitability of audit firms. The use of audit software in the audit of financial statements, for example, can help expedite the completion of audit services. To achieve this, the auditor must be trained in using electronic audit software.
- **The ability of AI to detect fraud:** AI and machine learning can be used to detect fraud, as these technologies help to enhance the effectiveness of data analysis models. AI can study data and identify patterns that constitute fraudulent transactions.
- **Enhancing audit quality:** Electronic audits and its development through AI technology can save time and effort, and make the desired results of the audit strong and well supported. For example, AI can help detect fraud and anti-money laundering operations by meeting high audit quality standards.

2) What are the obstacles or challenges that prevent the use of AI in audit work?

As the AI field innovates and develops over time with technological advancements, auditors will continue to face challenges in utilize AI in audit work. A few current examples of obstacles include:

- Designing programs for AI for auditing purposes can be challenging due to complex data environments. Auditors collect and utilize a variety of data and evidence types, and integrating different forms of data into one AI model can be challenging. Additionally, audit programs need to balance how to integrate AI, while maintaining the roles of human auditors.

- Ensuring that audit staff are qualified to employ AI related methodologies, and are able to keep abreast of technological developments in the auditing field. Auditors also need to understand and explain the rationale behind audit findings. Ensuring the transparency and explainability of AI-generated results is crucial but can be difficult to achieve.

- Securing high quality data and information cyber security for the auditees as well as the SAIs. AI models heavily rely on high-quality and consistent data for accurate decision-making. Ensuring data integrity is a challenge, as inaccuracies in input data can lead to flawed audit outcomes.

3) What are the consequences on not having auditors respond to the requirements of AI?

Stakeholders and audit clients now have increased expectations for auditors, due to the need for more support as new risks arise with industry and government growth. Regardless of the need to respond to the requirements of stakeholders and clients, the audit profession will not be able to continue without adapting to the surrounding changes, especially technical changes. For example, how can an auditor examine the huge amount of data available to clients without using modern technologies? Is it possible to plan the audit process without taking into account the risks arising from these changes? How can the auditor perform his job if he does not keep up these variables? Auditors need to consider utilizing AI in audits to keep pace with the evolving landscape.

Conclusion:

In adapting to changes in society and technology, auditors need to use AI and expert systems in audit work, to be able to meet efficiency and effectiveness standards in audit work. SAIs should keep pace with technological development and digital transformation of their auditees. By using AI, SAIs will be able to process of big data to more efficiently identify risks of scam and fraud, and can enhance their role in protecting public money. In the face of continuous technological advancement in society, auditors should be well trained to utilize AI in audits to be able to deliver high quality accountability.

Source: Adobe Stock Images, NicoElNinoi

Supreme Audit Institutions and Applying the Value Creation Concept for Taxpayers in a Digital Era

Author: Dr. Sutthi Suntharanurak, Director of International Affairs Office, State Audit Office of the Kingdom of Thailand.

In the digital era, the one of the main challenges of public sector auditing is responding to digital disruption. Hence, several Supreme Audit Institutions (SAIs) have attempted to move from a traditional to a modern approach, which is steered by digital technology.

The digital approach in public sector auditing can be looked through the lens of the 5ABCDI concept, which stands for 5G, AI, Blockchain, Cybersecurity, Data Analytics, and Internet of Things (IoT). SAIs could use these advanced technologies to improve their performance. However, incorporating these advance technologies requires reorganizing SAIs' organizational structures and shifting the audit paradigm . SAIs considered an important question of how to create taxpayer value after the digital transformation.

SPECIAL CONTRIBUTION

Based on INTOSAI P-12, SAIs could make a difference in the lives of citizens by demonstrating ongoing relevance to taxpayers as key stakeholders. The digital revolution makes SAIs respond to the emerging challenges, following INTOSAI P-12 (principle 5). **Applying value creation can help explain how SAIs could create their values for taxpayers.**

A business model describes how an organization creates, delivers, and captures value. **The value consists of three types: cost, experience, and platform.** These values reflect disruptive business models. SAIs could apply the value creation for citizens as follows.

- **The cost value:** SAIs could reduce their costs by leveraging modern technologies. For example, SAIs have conducted remote audits and utilized telework during the pandemic. SAIs could blend on-site and remote audits after the pandemic to save on time and cost. Further, SAIs can use data analytics to optimize audit operations to lower costs. SAIs could also leverage cloud technology when collecting audit evidence. Digital technology could help SAIs complete more audit tasks for less cost.

- **The experience value:** SAIs could increase their value through digitalization, and by leveraging new ways to share citizens' experiences in public spending.. For example, the taxpayers are satisfied when they know their taxes are transparently spent and the taxpayer is receiving value for money. Under INTOSAI P-12 principle 6, communicating effectively with stakeholders, SAIs could create a digital platform for sharing citizens' experiences in public spending. For example, SAIs could open an online platform for taxpayers to monitor progressive public spending. SAIs could also utilize this digital space for citizens to give feedback when reading audit reports.

- **The platform value:** SAIs can leverage platform value to create accountability ecosystems, and can initiate a digital platform to create value for taxpayers interested in transparency and participation in the budgetary process to engage citizens.. Likewise, SAIs can utilize crowdsourcing, another platform value, to gather and publish information relevant to public spending transparency.

Figure 1: SAIs could create three values for taxpayers through digital transformation.

However, there are several key success factors to achieving the three values in digital transformation. These key success factors include; (a) adopting staff mindset to be proactive; (b) pushing cultural transformation to respond to digital disruption; (c) building auditors' capacities by upskilling and reskilling for digital literacy; (d) revising cumbersome regulations, which might not fit the digital era; and (d) seeking strategic partnerships to develop SAIs in the future.

In conclusion, value creation can help SAIs create concrete values for citizens in a digital era, and can reflect the new role of SAIs in navigating new, emerging technologies and the challenges that may come with them.

About the Author: Dr. Sutthi Suntharanurak is the Director of International Affairs Office, State Audit Office of the Kingdom of Thailand. He has been the researcher of ASOSAI Research Project since 2015. This paper was inspired by Associate Professor Atipol Bhanich Supapol from York University, who gave knowledge about value creation. The author thanks for his idea and inspiration. Please contact the author: sutthisun@gmail.com

The INTOSAI Donor Cooperation Determines a Path Forward for Supporting SAIs in Developing Countries

By the INTOSAI Development Initiative and INTOSAI Journal

Major donors, supreme audit institutions (SAIs), the INTOSAI Development Initiative (IDI), and key stakeholders gathered on June 20 to 21 as part of the 16th INTOSAI Donor Cooperation (IDC) Steering Committee meeting to discuss and agree on ways to further enhance the positive impact of the Cooperation. Running alongside meetings of the INTOSAI Capacity Building Committee (CBC), and the International Federation of Accountants (IFAC) MOSAIC, the Steering Committee took place in Kingston, hosted by the Auditor General of Jamaica, Ms. Pamela Monroe Ellis.

SPOTLIGHT ON CAPACITY BUILDING

The Kingston Agreement Outlines the IDC's Commitment to Further Enhance Accountability and Public Financial Management Throughout the World

The IDC Steering Committee discussed the future strategic direction of the Cooperation, identifying key strategies built on past successes and continuous learning to further enhance the Cooperation's effectiveness in achieving scaled-up support for SAI capacity development. The resulting Kingston Agreement commits IDC members to increase funding for SAIs, advocate for their independent operation, and raise awareness among key stakeholders. The Kingston Agreement also emphasizes the importance of involving the INTOSAI regions to improve coordination and enable better implementation of support by leveraging regional knowledge. The full Kingston Agreement can be accessed here.

Reviewing past and present successes for IDC's initiatives

The IDC plays a key role in brokering support to enhance the capacity of SAIs. The review of past and recent successes included overviews of new initiatives evolving from the previous Global Calls for Proposals Tiers 1 and 2. IDI's Marcela Hommefoss presented updates and led a discussion on the roles that partners can play to ensure the success of these initiatives.

SPOTLIGHT ON CAPACITY BUILDING

The BUSS initiative brings SAIs, donors, and partners together at a regional level by coordinating and finding common priorities for SAI development while adjusting its scope to suit the regional context. The pilot workshop in CREFIAF region connected fifteen SAIs and seven donor organizations and implementing partners. Next, the BUSS initiative will move to the OLACEFS region, with IDI actively seeking funding for SAI needs in the region.

The Global SAI Accountability Initiative, GSAI mobilizes well-coordinated support to a target group of SAIs in challenging contexts: Belize, Benin, Dominica, Haiti, Honduras, Lebanon, Kyrgyzstan and Tajikistan. Following a meeting in March 2023, these SAIs are working with peer SAIs on the design of an initial project for technical support, and are consulting with financial donors on funding to strengthen SAIs and engage in SAI advocacy.

In place since 2017, the PAP-APP initiative mobilizes scaled-up support to nine selected SAIs in Africa that face challenges: the Democratic Republic of Congo, Eritrea, Guinea, Madagascar, Niger, Sierra Leone, The Gambia, Togo and Zimbabwe. IDI and AFROSAI-E also have collaborated to provide support to the SAIs of South Sudan and Somalia since 2017. There is still continuous need to engage and develop effective and fundable projects.

In response to the COVID-19 pandemic, the Saudi Arabian General Court of Audit launched a new round of funding of USD 1 million through the Saudi Fund for Improved SAI performance (SAUDI FISP) to distribute amongst those INTOSAI members with the greatest need for support in developing and expanding their information technology infrastructure. Since the creation of the FISP fund in 2021, 28 SAIs have received grants, and 15 more have been accepted to be recipients.

SPOTLIGHT ON CAPACITY BUILDING

Chairwoman of SAI Aruba, Xiomara Croes-Williams also spoke about another initiative initially created by the Cooperation and rolled out by IDI, in her discussion about SAI Aruba's experience with the SAI Performance Management Framework (SAI PMF). SAI PMF, as a holistic assessment, found areas of improvement, including SAI independence. SAI Aruba is unable to administer its budget or appoint its own staff. SAI Aruba is taking action to address other areas, but noted that concerns about independence required a modernization of the SAI's legal framework.

Ensuring SAI Independence

Through discussions and panels, the IDC Steering Committee reflected on the Cooperation's work to ensure SAI independence, and how donors and stakeholders can promote independence through advocacy and coordination. SAI independence is challenged in many regions of the world, and independence has deteriorated in recent years. Comptroller General Gene L. Dodaro of the U.S. GAO commented that the IDC makes a positive impact by helping SAIs develop their own strategic development plan as a foundation of their independence.

To underpin these foundations, the IDC took the significant step in 2022 of appointing the Right Hon. Helen Clark, former Prime Minister of New Zealand and Administrator of the UN Development Program (UNDP) to serve as the IDC Goodwill Ambassador for SAI Independence from 2022 to 2024. As a global ambassador and voice for SAI Independence, Ms. Clark promotes SAI independence on the worldwide policy agenda on public financial management, integrity, and accountability.

Einar Gørrissen, Director General of IDI, shared how SAIs are impacted by independence threats at ground level and what can be done about it. IDI's SAI Independence Rapid Advocacy Mechanism (SIRAM) works quickly to address threats of independence to SAIs. Through the SIRAM, the IDI carries out an assessment of the threat of breach to independence, identifies an appropriate response. and monitors response implementation. The SIRAM started in 2019 with the pilot cases of North Macedonia and Somalia. Since, IDI has received requests for assistance from Ghana Cyprus, Colombia, the Dominican Republic, Myanmar, Poland, Sudan and Sierra Leone.

SPOTLIGHT ON CAPACITY BUILDING

Sharing the Pacific region's experiences, Ms. Sinaroseta Palamo-Iosefo, Director of Practice Development for PASAI, described the long journey for some SAIs to ensure their independence. The PASAI region developed an independent resource kit to help SAIs understand the principles underpinning SAI independence and access resources and information to establish, enhance or preserve their independence.

Speaking from the donor perspective, Ms. Susanne Wille of the European Commission shared how SAIs greatly benefit from donor and stakeholder partners to develop long-term sustainability to become strong and independent.

"It takes much more than one project to help an endangered institution to grow and to strengthen."

Mr. Sekou Keita from the African Development Bank, also shared similar sentiments, and emphasized that continued advocacy for SAI independence and support from stakeholders within a country's system will help drive long- term approaches to SAI independence.

From left to right, Ms. Susanne Wille, Mr. Sekou Keita, Comptroller General of the United States Gene L. Dodaro, Director General of IDI Einar Gørrissen, and Ms. Sinaroseta Palamo-Iosefo.

Exploring the Capacities of SAIs in Technology and Innovation, and Climate Change Action

As part of the IDC Steering Committee meeting, several sessions explored the roles that SAIs can play in technology and innovation, and fighting climate change.

Led by the World Bank, the first session showcased new and innovative practices using technology to improve audits, which fostered discussions around capacities needed to for SAIs to benefit from using technology, and how can donors support them.

SPOTLIGHT ON CAPACITY BUILDING

Minister Bruno Dantas, INTOSAI Chair, said that leveraging technology and digital innovation in audit has become imperative. Minister Dantas and Annette Kougbe of the German Agency for International Cooperation (GIZ) spoke about utilizing digital maturity models to help address different technological capacities for SAIs at varying maturity levels. Minister Dantas hopes the model will promote collaboration and knowledge sharing, and encourage use of technology in auditing practices.

Emilio Barriga of SAI Mexico and Taka Ariga of the U.S. GAO spoke about the implementation of big data, and artificial intelligence, respectively, in audits, and how SAIs can start to begin developing the capacities for these new technologies and innovations.

IDI's Camilla Fredriksen led the session exploring the role that SAIs can play in fighting climate change through relevant initiatives. Ms. Vivi Niemenmaa, Secretary General of the INTOSAI Working Group on Environmental Auditing (WGEA) assembly, spoke about the INTOSAI Donor Cooperation Working Group on Climate Change, which aims to scale up support on climate change audits and technical capacity building, and help to secure peer-to-peer support. Minister Bruno Dantas, INTOSAI Chair, shared information on the ClimateScanner, a project that encourages SAIs to produce an overview on global climate governance and governmental actions as a response to the climate crisis. Mr. Arturo Herrera of the World Bank reflected that emerging challenges over the last several years, such as climate change, require SAIs to adapt by expanding their scope and skills.





Scaling Up Donor Support for Climate Change Responsiveness

By INTOSAI Donor Cooperation

One of the new collaborations of INTOSAI Donor Cooperation is with the INTOSAI Working Group on Environmental Auditing (WGEA) on climate change. As a project under WGEA's climate and biodiversity hub, the first planned activity is to roll out training for developing country SAIs on applying funding to help them build capacities in becoming responsive to climate change. WGEA has also surveyed SAIs that are interested in engaging with mentoring arrangement between more advanced SAI and a beginner SAI on specific environmental topic, including climate, and a pilot on mentoring by peers, is being rolled by IDI's Global Foundations Unit.

Vivi Niemenmaa, Secretary General of the WGEA presented in the IDC meeting's climate panel the WGEA work on climate since 2010, ongoing projects as well as capacity building needs. WGEA audit database reveals that performance audits on climate have so far been conducted by SAIs in Global North. Niemenmaa stressed that environmental and particularly climate area is developing rapidly, and this concerns both the science as well as policies. Combined with the fact that climate change increasingly affects economies and pose existential threats in SIDS, the capacity development needs in SAIs are urgent.

SPOTLIGHT ON CAPACITY BUILDING

Ms. Camilla Fredriksen and Ms. Vivi Niemenmaa

Niemenmaa pointed out that it is not sufficient to look only at the governments' spending on climate. In addition, SAIs should look at the spending having adverse impacts on climate, such as subsidies to fossil fuels.

IDI Senior Manager Camilla Fredriksen confirmed that there has been an increased interest from donors under the Cooperation in supporting SAIs in addressing climate change in audits. From her former experience in working on the topic, she has seen that climate change capacities often go beyond the typical audit techniques, and that lesser resourced SAIs often face hurdles in implementing the audits because of their complexity and technical nature. "It's therefore especially important for donors who wants to support SAIs in these endeavors, which are both timely and relevant in relation to the SDGs, to theme up with the best technical experts in the area, to facilitate results. The collaboration with WGEA will help us ensure this, and bring donors and SAIs closer together, and improve their joint understanding on the impact SAIs can have.

CBC Annual Meeting Focuses on Partnering for Quality Capacity Development

By the INTOSAI Capacity Building Committee

Under a common headline of Partnering for stronger SAIs, and enhanced PFM, the INTOSAI Capacity Building Committee (CBC), INTOSAI-Donor Cooperation (IDC) and IFAC's MOSAIC gathered its members for five days of meetings in Kingston, Jamaica, kindly hosted by SAI Jamaica. The meeting welcomed more than one hundred delegates, including representatives from all INTOSAI regions, INTOSAI strategic goal committees, the General Secretariat and IDI, a great number of heads of SAIs, donor representatives and INTOSAI friends and stakeholders from IFAC, civil society, professional accountancy bodies and others.

Building on a common interest in stronger SAIs and enhanced public financial management and the belief in the great value of strong, diverse partnerships, the synergies between the meetings were clear for organizers and participants alike. The INTOSAI-Donor Cooperation's meeting – which took place first – concluded on several points highly relevant to that of the CBC, many of which carried into the CBC meeting.

SPOTLIGHT ON CAPACITY BUILDING

Lessons learned on peer-to-peer cooperation

The INTOSAI Capacity Building Committee was proud to launch the EU-funded study on peer-to-peer capacity development support to SAIs. The study (available on the CBC website) provides an overview of the conditions that make peer-to-peer cooperation relevant, efficient, effective, sustainable and value-adding for SAIs. The report raised both good practices and constraining factors which provided an interesting point of departure for a high-level panel discussion between SAIs and donor representatives.

Round-table discussions, led by the CBC Peer-to-Peer workstream, allowed participants to consider in more detail good practices, as well as areas for improvement relating to different aspects of peer-to-peer cooperation, including funding of projects. The discussions also led to some suggestions on how to effectively share good practices between both SAIs and donors.

SPOTLIGHT ON CAPACITY BUILDING

Building strong partnerships

Building strong partnerships was a recurring theme throughout the meeting. Participants heard different perspectives of how SAI capacity development can be strengthened through peer partnerships, regional partnerships, and through a diverse ecosystem of partners.

One common denominator for some of these partnerships is the reliance on external (donor) funding by SAIs with limited resources. Linking to issues raised during the IDC-meeting, participants underlined the importance of having predictable, long-term support for the development of the quality and capacity of SAIs' core audit professions and audit professionals, namely quality people and quality audits. The CBC welcomed the IDC agreement to raise awareness of issues relevant to SAI capacity development to explore new funding and funding modalities through leadership outreach.

SAI Kenya shared their experiences of building an ecosystem of strong national partnerships to help increase the impact of the SAI, support the development of the audit profession in Kenya, as well as put focus on transparency and accountability in the public sector. GIZ complemented the picture by sharing various insights on the theory and practice of how the GIZ supports SAIs in such efforts.

SPOTLIGHT ON CAPACITY BUILDING

Competent people, quality audits, SAI results with impact

Intense sessions on quality people, quality management and audit impact followed. SAI South Africa led an interactive session on ways in which SAIs can go about effectively managing auditor competence, an essential foundation for a professional SAI. The session highlighted the value of the newly endorsed ISSAI 150, the two accompanying GUIDS and HR management guide.

A session on audit quality facilitated by the Professional Standards Committee and the International Federation of Accountants, underlined the benefits of migrating from a quality control mindset to that of quality management to enhance the credibility of SAI audit work, the confidence of stakeholders and users of SAI audit reports, and their reliance on work done by SAIs, and contribute to overall audit impact.

The UK NAO and IDI then moved the discussion on to tools and approaches to maximize audit impact. Perspectives were shared on the importance of impact-driven audits, robust follow-up systems and strong stakeholder coalitions.

The value of INTOSAI regions

Another recurring theme throughout the meeting was the importance of involving the INTOSAI regions in all SAI capacity development initiatives. From a global perspective, the INTOSAI regions know their membership and can help tailor global support to the needs of their members. With the necessary resources, regions can also play an important role in supporting country level implementation of support.

From a SAI perspective, especially SAIs with limited resources, the regional organization has the advantage of economy of scale and, again with the necessary resources, can support SAIs' journey in implementing INTOSAI principles and standards.

INTOSAI regions shared both their good practices and some challenges in living up to these expectations and ambitions. CAROSAI took the opportunity to partner with the CBC, PASAI, AFROSAI-E, IDI, CIPFA (Chartered Institute of Public Finance and Accountancy) and others in a joint initiative aimed at identifying ways in which the INTOSAI community and INTOSAI partners can support SAIs in small island developing states, as well as SAIs operating in complex and challenged contexts, to adhere to the requirements of the INTOSAI standards to bolster the quality and credibility of their audit outputs.

The value of cooperation with professional accountancy organisations

The CBC Chair and many of its members joined IFAC's MOSAIC as the last meeting of the week to learn about the value of SAIs partnering with in-country and regional professional accountancy organisations in the interest of the professional development of SAI auditors. It was clear that SAIs who partnered with the profession, greatly enhanced their staff's journey to full professionalism.

After the five days of intense meetings, the CBC Chair observed that she was pleased with the week's outcomes and that the CBC had once again managed to give focus and momentum to global SAI capacity development.

All slide and video presentations of the meeting are available at https://www.intosaicbc.org/post-meeting-documentation-2023/

Understand How Disabled People Navigate Through the Residency Path with Optimal Matching

By Robin Kreling, Data Scientist in the Data Analysis and Science Department, Cour Des Comptes, France

The number of people over 50 receiving disability allowances increased by 36% in France between 2011 and 2019. The Court of Accounts wanted to check whether the needs of the populations concerned were being adequately met.

To this end, the Court of Accounts employed an optimal matching technique. This data science technique shows similarities in the succession of events and, thus possible causality between them. By adapting an algorithm derived from genetics, the Court of Accounts verifies possible breaks in the residence and administrative path, depending on the different situations encountered, such as whether or not people have access to specialized care or recognition of disability, and whether or not they receive care at home, etc.

The data scientists' team was particularly inspired by the approach used by the Toulouse University Hospital for a previous survey. This methodology highlights **the value of having a memory of past work and continuity of activity in the team, to capitalise on methods, practices and innovations.** The effort to adjust the algorithm to the data used by the Court in this investigation consisted of choices of calculation method intended to limit the calculation time.

The data was extracted from the digital service platform ViaTrajectoire, which connects people with institutions and helps them manage queues. The available information indicated whether people had open rights for dedicated medical or social care or not. The data was pseudonymised, with different encryption keys for each department.

It should be noted that, as a result of this initial work, **the Court is considering to match this data, with other administrative data for other surveys,** still anonymously, thus capitalising on the knowledge gained from these databases.

An algorithm to confirm and objectify the audit team's intuitions

The optimal matching technique applied to these data consisted of defining a similarity metric between the sequences, i.e. calculating a number giving an indication of the distance between two data sequences: while many changes are needed to transform one given sequence into another, they are considered very dissimilar and remote. If they require little or no changes, they are very close.

This metric is then used to group the sequences into proximity clusters. The grouping in clusters of typology of administrative and residential paths confirmed the intuitions of investigators and refined their understanding of the administrative, care and individual residential paths. For example, 12% of individuals in the 45- to 50-year-old sample are grouped in cluster 2. The persons clustered in this group have an administrative recognition of a disability but do not submit any known application to an institution for a long period of time: these may include persons who refuse the recommended guidance or conduct the recognition procedure as a precautionary measure for future needs for formal assistance. Knowing and quantifying the existence of such precautionary approaches is useful for calculating indicators of the tension of accommodation solutions.

Collaboration between the audit team and data scientists is essential for the success of the audit

Exchanges between the control team and the data scientists of the Data Science and Analysis Department of the Court took place as soon as the feasibility note was drawn up, prior to the initiation of the investigation. This eased collaboration and facilitated the operation of the bases during the investigation. In particular, the audit team had identified very well the databases useful for the investigation. Its exchanges with data scientists were weekly and made it possible to produce indicators requested by the auditors, to point out unanticipated situations (like preponderance of some less visible handicaps) and highlight shortcomings in administrative databases.

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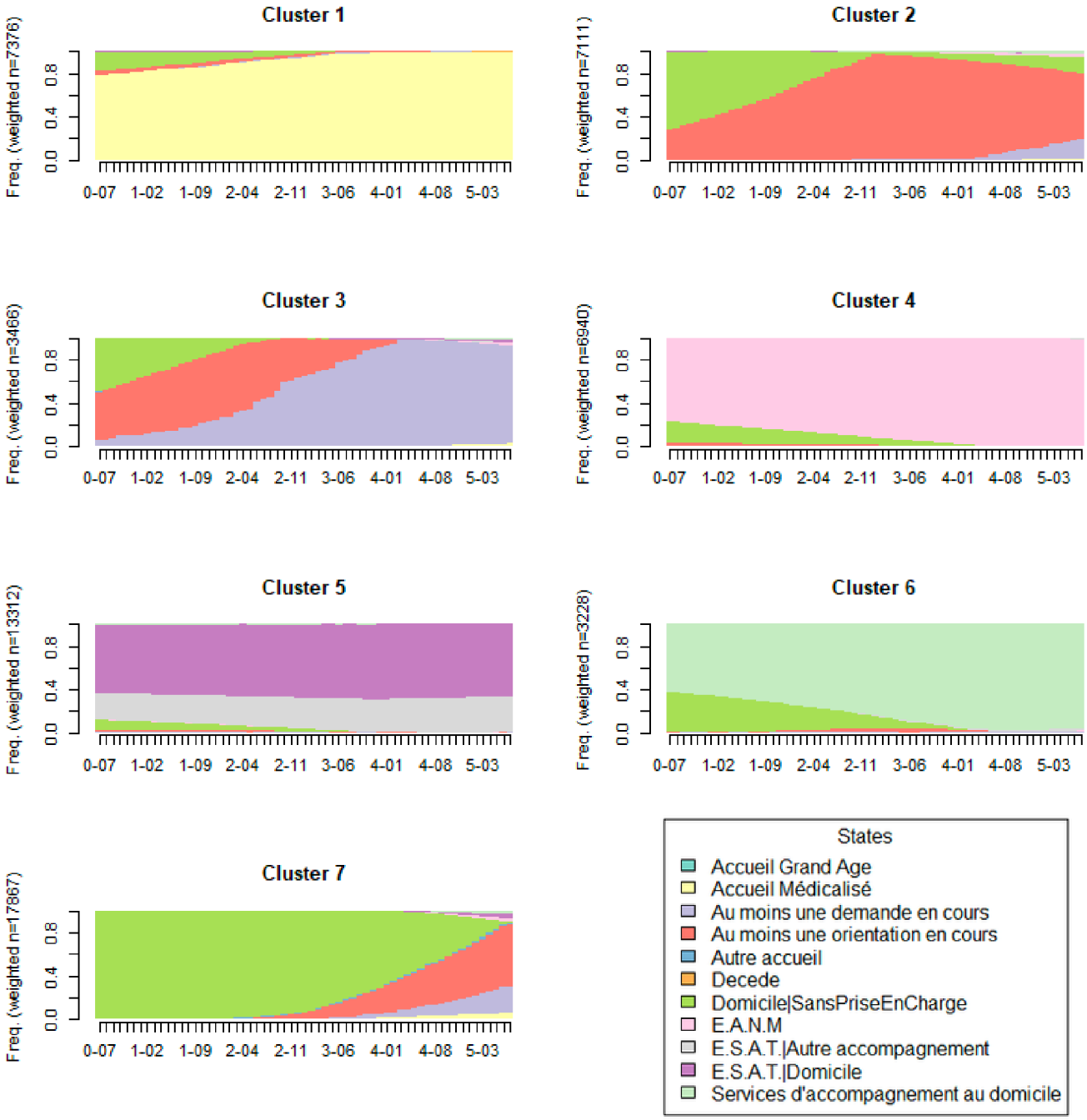
SPOTLIGHT ON DIVERSITY, EQUITY AND INCLUSION



Reading graphs: in X-axis, the months and years (sequences of 5 years complete, from 0-01 to 5-12); in Y-axis: the proportion of cluster observations, which ranges from 0 to 1. Each cluster has a different size (the size is indicated by “Freq. (weighted n=[number]”. For example, cluster 6, we see that nearly 60% of the 3,228 people in this cluster do not experience any changes in their situation over a period of 5 years.

Source: Adobe Stock Images, Marina

In this respect, it is important to stress that the audit of the data itself contributes to the audit of the steering of the public policy in question: these shortcomings, identified by the data scientists, gave rise to explicit recommendations in the report published in September 2023, which can be accessed in French here.

The resulting database is indeed very recent, but will be useful for future investigations into disability and dependency. Over time, its historical depth will increase and represent longer and more representative sequences of a life course. It will also allow causal analysis of the effects of future reforms of public policies on autonomy and inclusion of people with disabilities.

Robin Kreling, Data Scientist in the Data Analysis and Science Department

To go further:

Contact Court Data Science and Analysis Department.

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