The Role of Artificial Intelligence, Machine Learning and Data Analytics in Leveraging the Operations of the Nigeria Customs Service

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Abstract: Customs operations in international supply chain encapsulates complex border management structures, policies, legislation, administrative and operational systems that can best be synchronized, controlled and predicted through emerging, advanced or disruptive technologies, such as Artificial Intelligence (AI), Machine Learning (ML) and Data Analytics (DA). Developed nations like USA, China and other European countries have realized this fact earlier by imbibing the seven International Standards of Trust Digital Repository (TDR), namely: Open Archival Information System Reference Model (OAIS) Compliance, Administrative Responsibility, Organisational Viability, Financial Sustainability, Technological and Procedural Suitability, System Security and Procedural Accountability. This is crucial in optimizing their performance competencies and efficiency in full automation processes. While human resources/capabilities that best fit their customs operations were as well deployed into key areas. In Nigeria too, the introduction of Nigeria Integrated Customs Information System (NICIS) in the customs operation, an ICT infrastructure was a right step in the use of advanced technologies. However, this system lacks 100% automation and harmonization of customs operations and clearing procedures as being obtained in developed countries. Coupled with this are funding challenges, inadequate technologies, non-compliance challenges and among many others.Therefore, this paper employs relevant academic literature sources to critically explore the pragmatic role of AI, ML and DA in leveraging Nigeria customs operations situation presently, and in the nearest future.

Introduction

The increasing waves of advanced technologies like Artificial Intelligence (AI), Machine Learning (ML) and Data Analytics (DA) across the globe considerably have landmark influence on the Nigeria Customs Service (NCS) advancement of their border operation systems and tools in line with international best practices and e-customs project. Advanced technologies come with clear benefits as regards to risk management and profiling, fraud detection and ensuring greater compliance (WTO, 2022). The smart fraud detection, smart fast-track, AI pre-arrival assessment report (PAAR) HS Code search and vehicle identification number (VIN) valuation system are some of the examples of advanced technology systems in the NCS (Saidu, 2022).

Also, the complexities and intricacies of new spectrum of threats with regard to transnational crimes, organized syndicates/criminal networks and other forms of border insecurity issues has considerably led to a gradual shift in the NCS operation processes from the traditional and much cumbersome processes of pre-shipment, documentation and physical inspection of import and export products to more technologically driven and advanced operations (Handbook of Global Customs Automation, 2011; Customs Reforms and Modernisation,2012; Molenaar, 2017; Olomu, Adewumi and Alao, 2018). Consequently, NCS is making remarkable progress in revenue generation, and national security sustenance (Eze, 2018:11; Nwekeaku and Nwukamaka, 2019:44). NCS advanced technology operations thus include intelligence-driven Risk Management (focusing efforts on cargoes and firms most likely to be non-compliant) and the Authorized Economic Operator (AEO) regime (Use of track records and self-policing). These two forms of customs operation make trust, co-operation and minimal intervention, the basis of NCS relations with other stakeholders.

Defining Nigeria Customs Service Current Technology Situation

The introduction of Nigeria Integrated Customs Information System (NICIS) in 2009 paved the way for Nigeria Customs Service use of Advanced Technologies like Artificial Intelligence in operation processes. The system portal enables the development and deployment of a platform that integrates customs operations and other stakeholders. It makes use of advanced technology like Smart-Fraud Detection, Smart Fast-Track, Artificial Intelligence Pre-Arrival Assessment Report (PAAR) HS Code Search and Vehicle Identification Number (VIN) Valuation system, which enhances transparency, predictability and NCS core functions.

NICIS Smart Fraud Detection is an Artificial Intelligence/Machine Learning technology designed to conduct risk assessment activity when it comes to huge number of data in the quickest possible time.

Smart Fast Track is a compliance initiative and a form of the AEO program because it complies with supply chain security standards. The technology uses Artificial intelligence for statistics generation and analytics to ensure compliance in the system thereby filtering compliant traders from defaulters.

Artificial Intelligence Pre-Arrival Assessment Reports HS Code Search assist users of the system responsible for capturing the PAAR Consignment data to look for an appropriate HS Codes based on Item's "Declared Commercial Description of Goods".

VIN Valuation System is a system deployed by the NCS to use AI for the valuation of all Motor vehicles entering the Nigeria approved borders. The system uses AI to allocate the appropriate values and taxes using the VIN/Chassis number using databases from all regions of the world without any form of human interferences.

However, evidence abounds that NCS in delivering its core functions via these current advanced technology system is being embattled with some key challenges, which include: Inadequate funding, cybercrime, non-compliant traders, insincere declaration by Importers/Agencies valuation (over invoicing, under invoicing description, concealment), integrity issues, lack of trust between the private and public sectors, Inadequate coordination between government agencies, logistics – inadequate cargo handling equipment at Terminals, resistance to change by Stakeholders and Officers, near computer illiteracy of both the officers and stakeholders, payment delay Alert from Inter switch and e-Transact, lack of integrity of Importers/Agents (through false declaration, wrong addresses etc.), inefficient/insufficient infrastructure in Terminals (Nwekeaku and Nwukamaka, 2019:46; Mikuriya and Cantens, 2021; Aisha, et. al. 2022).

Moreover, KPMG (2019) Report survey on the current state of Data Analytics in Nigeria revealed that the biggest investments in Data Analytics capabilities were in the Financial Services and Technology, Media and Telecoms. In other words, public sector was not as keen to invest in Data Analytics. KPMG attributed this problem to the fear that the slim resources of Government will make foray into a seemingly new area difficult to justify in the face of daunting challenges across many other areas of government responsibilities. This opinion contradicts the full maturity requirement of AI technologies in terms of capabilities diversity of Business Analyst, Data Scientist, Software Engineer, Data Engineer and Visualization specialists. Furthermore, there are constraints for customs administrations in Africa in sourcing analytics talent which must be both in-house expertise and external experts.

Likewise, Mohammed and Adamu (2023) assessment of smart government application of technology in Nigeria Customs Service notes the urgent need for NCS to meet up with the trends of global realities and challenges. They indicate the problems of apparent lack of support for better decision-making and collaboration with the citizens in service delivery, intelligent systems, new platforms for communication and collaboration, data collection sharing and analytics, shared services, sensors and ubiquitous computing with reverberating consequences on Customs transformation in Nigeria.

More importantly, NCS current technology systems are yet to meet up with the world class fully automated ICT solutions (*Daily Post*, 2022; Olagunju, 2022; Mohammed and Adamu, 2023).According to Saidu (2022) fully automated ICT solutions can help in:
- ➢ Providing an end-to-end ICT platform to digitalize all customs business processes and procedures,
- ➢ Upgrade and update customs ICT infrastructure to world class
- ➢ Address critical operational challenges and loopholes
- ➢ Modernize all related customs infrastructures, business premises covering the customs Area Commands, Border Stations, Zonal Headquarters and the Customs Headquarters
- ➢ A unified Customs Management System (UCMS)
- ➢ E-Port System
- ➢ Non-Intrusive Inspection (NII) Scanners.
- ➢ Risk Control Center (RCC)
- ➢ Mobile Enforcement
- ➢ Electronic Cargo Tracking System (ECTS).
- ➢ Intelligent Gate (Gate)
- ➢ Excise Automation
- ➢ Paperless Customs (Office Automation System, Human Resource Management, Document Management System and Asset Management System).
- ➢ Infrastructure Upgrades (Customs Data Centre and Customs Network).
- ➢ Marine Deployment
- ➢ Capacity Building

Analysis, Interpretation and Application of Basic Concepts
The three basic concepts for this study are Artificial Intelligence, Machine Learning and Data Analytics. It is important to note that they are highly interwoven since they share mutual benefits.

Artificial Intelligence: AI is a computerized system that exhibits behaviour that is commonly thought of as requiring intelligence thus:
- systems that think like humans (i.e. cognitive architectures)
- systems that act like humans (i.e. automated reasoning, learning)
- systems that think rationally (i.e. inferencing, optimizing)
- systems that act rationally (i.e. intelligent software agents).

Thus, AI can manage the process of who has access to what data and when, ensuring that the appropriate levels of control are in place.

AI is not just one type of technology but rather a broader term covering multiple technologies which include machine learning, deep learning, computer vision, natural language processing and other technologies, used individually or in combination, to add intelligence to applications (WCO/WTO, 2022:69). Hence, any concept relating to AI, ML and DA largely implies AI technologies.

AI makes use of different applications in various areas from voiced-directed personal assistants and chat bots such as Siri, Alexa and Xiaoice in service industries, diagnosis improvement in health care, behavioural algorithms, Robots, to digital assistant support in telecommunication. The digital assistant apps can be used in tracking criminal activities. Digital personal assistants have modern features of mobile phones operating systems and computers, it can be used for tasks such as online search, recommendations, voice interpretation among others. Automated personal data banks – database housing digital information (images, fingerprints, insurance details, and vehicle registration, etc.) are maintained using AI tools. This is a huge source of reference data for government security departments and agencies in tracking criminals (Okwor, 2022).

Hence, NCS like many other organizations will share the following benefits if AI technologies is fully integrated into its operations:
- Time and money savings made possible by process and task automation.
- Productivity improvements and new operational efficiencies.
- The ability to speed up security decisions and improve experiences based on deeper, faster insights.

Machine Learning: ML therefore is a subset if AI that provides computers with the ability to learn without being explicitly programmed. Arthur Samuel Coined the term in 1959 characterizing it as, the office to look out for without being unequivocally programmed (Mc Clelland, 2019).
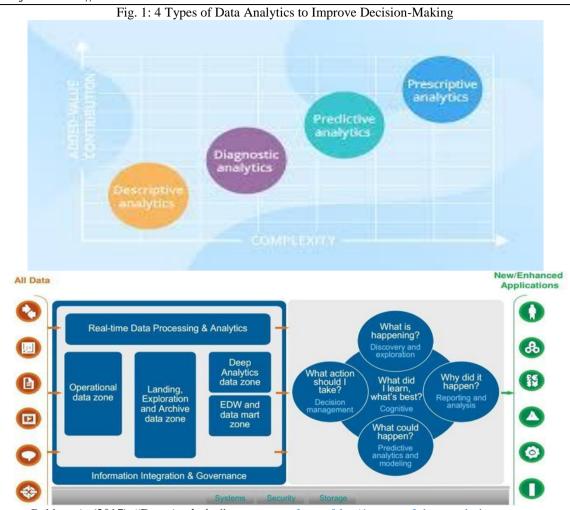
It is about algorithms that can extract information automatically without online human guidance. The algorithms allow to learn from and make predictions on data. The emphasis is often on prototyping those algorithms for production mode and the design of systems that update themselves. It is also the process of using mathematical models to predict outcomes versus relying on a set of instructions. This is made possible by identifying patterns within data, building an analytical model, and using it to make predictions and decisions. Machine learning bears similarity to human learning process such that increased experience amount to accuracy (WCO/WTO, 2022:69).

Okwor (2022) defines ML by asserting that many of the computational techniques relating to AI are actually from a field called machine learning, this may be depicted since the set of techniques and apparatuses that allow computers to think by making scientific algorithms upheld amassed information. Furthermore, deep learning is one method for machine learning and it is improved deep learning that recently led to big advances in Artificial Intelligence (AI).

ML has profound advantages for Customs operations in terms of:
- The ability to analyze and interpret data volumes, recognize patterns from them and create decision-making bases in much faster and accurate way.
- Machine learning algorithms can develop predictive compliance models that become more accurate as they learn from data. These models can forecast compliance issues thus enabling Customs to address them before they escalate (Oguejiofor, et. al., 2023).

Data Analytics: DA in this study simply implies the adoption of latest digital technologies in establishing connection between data and effective decision making within an organization. It also has four major approaches (see fig. 1), namely: Descriptive (what has happened/what is happening now); Diagnostic (why it happened); Predictive (What might happen); and Prescriptive (What should be done) (World Customs Organization Practitioner's Handbook, 2018:3-4; European Commission Report, 2016:22).

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Fig. 1: 4 Types of Data Analytics to Improve Decision-Making

Source: Bekker, A. (2017). "Data Analytics". www.scnsoft.com/blog/4-types-of-data-analytics
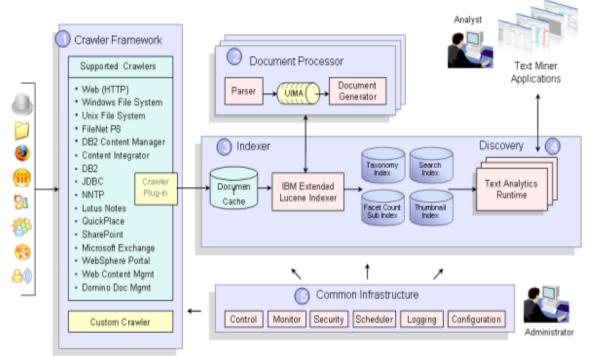
Thus, the core objectives of data analytics according to WCO's BACUDA (Band of Customs Data Analysts) Project (2020) include:
- Fraud detection track (Risk profiling of fraud by machine learning)
- Customs valuation track (unit price analysis and mirror trade analysis based on market data or trade statistics data)
- Customs management track (Developing business intelligence indicators for members e.g. forecasting customs revenue, time release study)

Data Analytics Tools: Data analytics has three basic tools which can be analyzed as follows:
- **Predictive Analytics:** Predictive Analytics requires models to analyze the data and provide insights relative to the evolution of observable patterns. This generally involves the formation of algorithms and their operationalization in dedicated data analytics software.
- **Cognitive Computing:** Cognitive computing is the use of artificial intelligence, often through the use of artificial neural networks, to stimulate human thought processes, and allow for machine learning using self-learning algorithms, node-based models, or a combination of both. Cognitive computing therefore imitates human learning within the scope set up by the programmers.
- **Statistical Programming languages:** R and Python are the most popular statistical programming languages, followed by Java. Java is more often used to build the structure and the interface of programmes such that the code may be ported easily to any platform that support Java, rather than to process statistics. Also, among these languages, R is the only "true" statistical programming language; both Java and Python were built and are used for more general purposes such as web and game programming.

Theoretical Framework for the Study and Application

Source: Hudlicka, E. www.researchgate.net/figure/SAMPLE-Cognitive-Architecture-Modeling-Decision-Making-Integrated-within-a-Testbed_fig2_238270023/download

The above framework signifies that AI technologies comes in many forms with varying functional capabilities, each form reflects underlying expertise and characteristics of the domain which propels the form that can forge a generic architecture for cognitive computing (Gudivada, et. al., 2016). Implementation of such an architecture requires a platform with the following characteristics: Infrastructure for data cleaning, transformations, and fusion; a set of both deterministic and probabilistic algorithms for computing analytics; a learning component powered by a domain cognitive model; an array of machine learning frameworks for hypothesis generation, evidence gathering, and scoring hypotheses; a high-performance computing system with scalability, performance, and elasticity (Gudivada, et. al., 2016).

However, to realize above architecture characteristics to perform tasks more accurately and efficiently, WCO/WTO (2022:67) has enumerated basic requirements as follows:

- There must be strong ethical principles combined with robust compliance and legal framework.
- There is need for clear and authoritative guidance on how AI technologies can be used.
- There must be a shared responsibility between the public and private sectors.
- There is need to create awareness of how the technology works and what the rules around its use are.
- There is need to ensure effective compliance of the provisions governing the applications of AI-based information and determinations.
- There must be access to robust and transparent redress mechanisms to ensure the integrity and ongoing improvement of AI processes

Interpretatively, if the above requirement are well acknowledged by NCS in building its AI technologies Architecture, challenges with regards to trust, compliance and integrity will be sufficiently addressed.

Prospects of AI Technologies in Customs Operations

AI, ML and DA have huge prospects in customs cross-border operations due to the enormous volumes of data generated from people and goods moving across borders. AI technologies enable access to more information and data intelligence by Customs there by encouraging faster decision-making in areas of risk management in the cross-border movement of both people and goods. AI technologies have the possibility of

efficiently interpreting and ingesting this vast and ever-increasing amount of data thereby making it easy to identify risk characteristics via AI tracking tools.

The implementation of AI technologies have the possibilities of enhancing Customs operation by tailoring basic tools for use in Customs and border management. These tools include:

Automation and Streamlining: One of the significant contribution of AI technologies to Customs operation is via its Automation tools and software streamline compliance tasks in reducing the burden of manual processes. For instance, compliance management software can automate data collection, reporting, and document management, making it easier for organizations to comply with regulatory requirements (Hamdani, et. al., 2021).

Revenue Collection Models: RCMs ensure that appropriate duties and taxes are collected at the border.

Products' Classification via Harmonized System (HS): AI technologies enabled Harmonized System (HS) which simplifies matters for users and enables greater compliance and certainty for both Customs and the private sector.

Customs Audits: AI technologies can be used for auditing to identify anomalies easily thereby enabling Customs auditors to focus on areas of non-compliance.

Real-Time Monitoring and Alerts: This AI tool provides Customs with a continuous view of their compliance status. The system has ability of detecting deviations from regulatory norms in real time and trigger alerts for immediate action.

Risk-Based Targeting: AI technologies have the potential of improving risk-based targeting of commercial shipments. AI technologies as well provide and analyse data during shipment inspections using augmented/mixed-reality glasses in detecting contraband and counterfeit goods. Besides, data would be available in real time, enabling officers to make quicker determinations, thereby increasing the number of inspections, accuracy and volume of goods that could be reviewed.

X-ray Scanners: Through the use of X-ray scanners to analyse container images, cargo inspection efficiency can be enhanced.

Logistics Monitoring: Especially in Customs warehouses and bonded areas to boost control efficiency.

Data Analytics and Risk Assessment: Data analytics tools are instrument in assessing risks (Ayusha, et. al., 2023). Customs as well as any organizations can identify patterns and anomalies indicating potential risks by analyzing vast datasets. Predictive analytics can help forecast regulatory changes and their potential impact on Customs operation thereby enabling proactive risk mitigation.

Visual Search and Facial Recognition Technology: Through visual search and facial recognition technology, high-risk passengers and vehicles and among others are identified at the border. This can be further expanded to create intelligent analytics to predict future outcome, facilitating better risk management and preparedness.

Chatbots and Robots: The implementation of chatbots in government agencies can greatly enhance communication between the government, companies and citizens using natural language. Of importance, a chatbot could serve as a channel for access to Customs in situations where certain services could be delivered more efficiently and cost effectively. Chatbots can rapidly capture and manage large volumes of user requests and sort through information and databases to deliver results to the user. Thus, routine communication can be automated, questions answered and recommendations made, which would free up officers to focus on higher-value work. The types of government services provided could be transformed and government operations optimized. Predictive analytics for the management of services and assets could be used to forecast and measure levels of usage. While more effective compliance could be attained in reporting and in collection of taxes and duties. Similarly, the use of enquiry robots at the border for passengers encourages better service provision due to their efficient ability to think and act rationally than what human can do.

Self-payment Service: This is achieved through the development of relevant mobile apps at the border, among others which provides Customs duty self-payment services.

Possible Challenges of AI Technologies in Customs Operations
Despite innumerable benefits of AI Technologies in enhancing Customs operations towards efficiency and effectiveness in role delivery, there are some possible challenges that must be given adequate attention for the full realization of AI technologies prospects in Customs operations.

The Question of Building Technical Trust: AI technologies deal with science and algorithms with considerable advantage on the technical side. People who are completely unaware of those algorithms and technology that lies behind the working of AI technologies will find it difficult to know its workability, core concepts and dynamism. This therefore raises the question of technical trust with humans in spite of its benefits and prospects especially in terms of speed and efficiency in Customs task delivery

AI Science Skills Shortage: This is another possible challenge considering the vast science skills and knowledge needed to maximized output from AI technologies. It could as well be demanding on human occupation and there could be urgency of changing the scope of human occupation to professions that would be must grounded in computing science, data analytics, visualization among others.

AI Technologies Investment Demands: There is no gainsaying that AI technologies like Artificial Intelligence, Machine Learning and Data Analytics requires huge investments in terms of building human resources capabilities and adopting efficient software models for Customs operation. This can also be demanding for government and NCS.

Software Malfunction: It is important to consider the possibility of Software malfunctioning for no innovation or human is idealize (Okwor, 2022). Programmes installation or machine equipment can crash. Unlike human tasks that can be regularly followed, it is difficult to understand what actually went wrong when a programme or computer equipment crashes. In such case, there would be difficulty of shifting blame to machines or understand the root/cause of such crash.

The Question of AI Technologies superseding every Customs Task: This could as well generate possible challenges for Customs operations in the future based on the conception that AI Technologies cannot handled every Customs task but rather boost and promote efficiency and effectiveness in the Customs operations.

Higher Expectations: AI technologies globally have high expectations in terms of service delivery, speed, capabilities, and efficiency. Anything short of this can weakened people expectation and high rate of the AI technologies. This fact spread across every concerned areas of AI technologies implementation and care must be taken to avert the possibility of this challenge.

Means of Achieving AI Technologies in Customs Operations in Nigeria

To realize the potential role of AI technologies in levering Customs operations in Nigeria, the following must be strictly considered as they also serve as means of overcoming possible challenges of AI technologies in Customs operations.

Adoption of Intelligent Software Applications and Tools: This is crucial for successful integration of AI technologies. Hence, Software developers must understand Custom's objectives and design applications to suit their needs. Pre-built Software services such as vision, speech, language, knowledge and search functions can be leveraged and tailored for specific use or custom software applications, and algorithms can be built for specialized use.

Data Management Capabilities: Expertise in data cataloguing and data warehousing are mandatory to effectively manage as well as extract value out of Customs and trade data. Data mesh is a democratized approach to managing data from various clouds where various domains operationalize their own data, encompassing data, technology, processes, and organization. Rather than looking at data as one huge repository, data mesh considers the decomposition of independent data products. Confidential computing allows customs authorities to isolate sensitive data while it is being processed, and to secure financial data, protect traders information, run machine learning processes on sensitive information, or perform algorithms on encrypted data sets from multiple sources.

Analytical Competencies: Data analytics application requires a variety of skill sets such as those of data analyst, data scientist, business analyst, quantitative analyst, statistician, econometrician and data-visualization specialist, which are to be called data experts.

Data scientists are the core of any data analytics team. Products develop by the team are built on the insights and trends they discover from data. They use programming tools like Python or proprietary tools for data cleaning, data exploration, model building and performance improvement. They work closely with data engineers for data availability and deliver their models to software engineers who integrates them into user applications in a seamless end-to-end workflow.

Business Analysts are professionals that understand the performance metrics used across the business and can identify business problems that can be addressed with data analytics capabilities. They understand the business side of data and analytics applications and work on driving revenue from products developed by the software engineers.

Data Engineers transform data from existing systems. They are familiar with technologies like SOL, Hadoop, Spark, etc. Data extracted by these engineers are made available to data scientists for exploratory data analysis and model building, as well as to the visualization experts for storytelling and visual presentations.

Software Engineers are typically software programmers. They work with object-oriented programming languages and development technologies like Java, JavaScript, C#, C + + and Git. They expose machine learning models built by data scientists as an end-point in web and mobile applications that clients can use.

Visualization experts are professionals who are skilled in building automated dashboards and creating data visualizations. They are familiar with BI tools like Tableau and Qlik. The data used by these professionals needs to be extracted by a data engineer from existing databases.
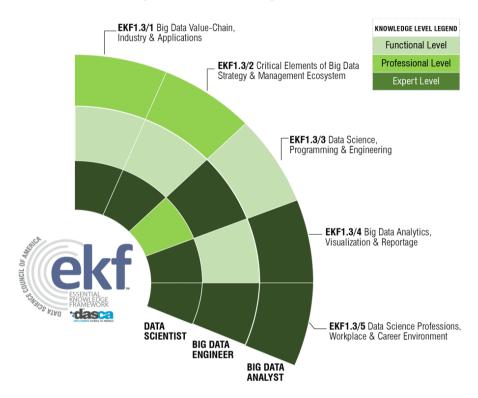
Fig. 4: Essential Knowledge Framework

AI Technologies Implementation Models for Customs Operations: Cases from Advanced Countries

The implementation of AI technologies for Customs operations is achievable considering basic pragmatic models criteria from advanced countries in Europe like Netherlands, America, China, Japan, and among others. Scholars like Chebotareva, et. al., (2021), Dumbrava (2021), Engstrom, Ho, Sharkey and Cuellar (2020) have explored the effectiveness of 'Innovative Approach Model' of AI technologies in these advanced countries.

Innovative Approach Model of AI technologies focus on the issues of legal regulation and development of legislation on robotics and the use of Artificial Intelligence technologies. However, this model can only be realized through the activities of Customs domestic scientists (Markova, Martynova, Zykov, 2020; Chebotareva, et. al., 2021). For the thorough understanding of legal basis for the application of artificial intelligence technologies of world powers, documents like Roadmap for the Development of Robotics in Europe "Robotics 2020" and Declaration on Cooperation in the Field of Artificial Intelligence must be critically studied to understand the fundamentals of Innovative Approach Model of world powers.

From these two documents, it was discovered that the modern practice of using AI technologies for Customs operation of European countries can be traced to 2018, in a pilot project called "iBorderCtrl". This project is an innovative project that introduced the use of machines with "artificial intelligence" at border checkpoints (Chebotareva, et. al., 2021; Dumbrava, 2021). The work of the "iBorderCtrl" system is divided into two directions. At the initial stage, documentary control is carried out – loading a scanned image of a passport, visa. Then, while passing through passport control, the person crossing the border, using artificial intelligence, a robot, is asked questions for customs purposes using a web camera. The robot reads facial expressions, reveals involuntary facial expressions that appear when trying to hide or suppress emotions. If the Artificial intelligence provides information on the existence of grounds indicating the likelihood of a person violating customs rules, then the procedure for passing biometric identification is not excluded. Thus, the initial functions are performed by artificial intelligence, but under the supervision of a person – a customs inspector. The undoubted advantage of using artificial intelligence technology in the customs business of European countries is that, on the one hand,

this technology acts a "virtual" lie detector, on the other, an intelligent "processor" of information about persons crossing the customs border.

In China, the application of AI technologies took two levels of regulation – national and local. This regulation can be found in China strategic documents – The Global State Development Program "Made in China-2025" which contains plans for the development of the robotic industry, as well as the plan for the Development of New Generation Artificial Intelligence Technologies. In China, there are five checkpoints using artificial intelligence, where the time for the release of risk-free goods has been significantly reduced. This development stimulates favourable conditions for the movement of goods across the customs border. Furthermore, China employ the service of well-known Chinese AI technologies integrators such as Huawei and Nuctech to develop an "intelligent customs infrastructure". China's customs also use an innovative model of an intelligent checkpoint. At the border with the Hong Kong Special Administrative Region, there is a 'smart' automobile customs post "Huanggang" of the Shenzhen Customs, in the ports of Guargdong province robots are used as "customs officials".

More importantly, as a result of global automation of customs operations using artificial intelligence technologies, favourable conditions for the movement of goods and vehicles across state (customs) borders have been identified. In Netherlands for instance, in the port of Rotterdam at checkpoints, almost a full range of cargo operations is provided by robots, while the role of a customs inspector is performed by two to three people. In Japan, an automated information system for interdepartmental interaction is actively used, which is integrated with the information subsystems of absolutely all government agencies.

Conclusion

The increasing pace of advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML) and Data Analytics (DA) indubitably offer best solutions to the inherent challenges and lapses in the Nigeria Customs Service (NCS) operations. This is much feasible considering what obtains in advanced countries across the globe. Indeed, AI, ML and DA are form of AI technologies that demonstrate the shifting trend of both global realities and comparative advantages in the international supply chain that every organizations, agencies and government must embrace. Of importance is the bigger access to data information and intelligence for effective decision making beyond human reasoning capacity and possibility of AI technologies tools in enhancing Customs operations in key areas, namely; risk assessment, revenue collection and compliance. Although AI technologies has some possible challenges, its implementation legislation standards, benefits and prospects sufficiently outweigh them if fully imbibe. Thus, with right investment in human capabilities especially in the area of data management and Analytics as well as AI technologies software that best suite Customs operation in Nigeria, AI technologies is a reliable leverage for Nigeria Customs Service in the nearest future.

Recommendations

By and large, this paper based on numerous ideas and positive deductions from the reviewed academic literatures on the role of artificial intelligence, machine learning and data analytics in leveraging the operations of the Nigeria Customs Service recommends thus:

❖ There is a need for Nigerian government and Nigeria Customs Service to invest massively in Customs human resource capabilities. Especially, the position and indispensable activities of customs domestic scientist in fully integrating AI technologies innovative model approach. This can be achieved through professional training of capable customs officers in the AI strategic planning institutions of advanced countries with successfully AI technologies innovative models or template.

❖ There is also a need to incorporate pragmatic approach of 'Science of AI technologies' in Nigeria Customs Service training institutions. If possible, this can be set aside as a course curriculum with teaching professional expertise in this area, in relevant customs academic institutions in Nigeria. In this way, the possibility of amassing future AI technologies scientists can be realized.

❖ The NCS should implement AI technologies driven checkpoints through the use of human assistant robots in the future. Such development will provide solutions to inherent customs operational challenges at the checkpoints due to the ability to robots to easily detect issues relating to non-compliances and fraud beyond ability of any human.

❖ Similarly, it is necessary for AI technologies driven checkpoints to adhere strictly to the principle of a "single point of receipt" of preliminary information for various controlling entities at the checkpoint. To achieve this, it is important to establish the processes of integration and convergence of a single information system of an intelligent checkpoint with software for technical means of customs control.

❖ It has become necessary for NCS to research into the role of Customs AI technologies Integrator. This will help in profoundly understanding their activities thus making it easier to employ them in integrating 'Intelligent Customs Infrastructure" just as being obtained in more advanced countries.

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