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Emerging IT Technologies for Accounting and Auditing Practice

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Abstract

The IT impact can be noticed in all activity fields of this world, and the audit is no exception from the evolution of this technological trend. ***Motivation****: Given that professionals are progressively pursuing experimentation in working with new technologies, the development of Artificial Intelligence (AI), Blockchain, RPA, Machine Learning through the Deep Learning subset is a particularly interesting case, on which the researcher argues for debate.* ***The objective*** *of the article is to present the latest episode of the new technologies impact that outline the auditor profession, the methods and tools used. The quantitative, applied and technical* ***research method*** *allows the analysis of the emerging technologies impact, completing a previous specialized paper of the same author.* ***The results*** *of this paper propose the integration of AI, Blockchain, RPA, Deep Learning and predictive analytics in financial audit missions. The projections resulted from discussions with auditing and IT specialists from Big Four companies show how the technologies presented in this paper could be applied on concrete cases, facilitating current tasks. Machine Learning and Deep Learning would allow a development for prescriptive analytics, revolutionizing the data analytics process. Both the analysis of the literature and the conducted interviews admit AI as a business solution that contributes to the data analytics in an intelligent way, providing a foundation for the development of RPA.*

Keywords: *AI, Machine Learning, RPA, Blockchain, predictive analytics*

JEL Classification*: M42, O33*

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Introduction

The current state of the research field (i.e. financial audit) highlights the impact of IT towards which, over time, have been controversial hypotheses in the literature. This global influence of IT has undergone a continuous evolution, against which most of the big companies have chosen to follow this technological trend to remain competitive and to ensure transparency in the accounting and auditing professional fields, particularly in the technological era of Blockchain (Fiammetta, 2017; Rooney et al., 2017; Yermack, 2017, Rozario & Thomas, 2019), to maintain investor confidence (Schmitz & Leon, 2019).

A first hypothesis from the ACCA (2019) is supported by the fact that the technology detains the potential to revolutionize the audit, but also at the level of the data analyzes that impose the finality of this process. These analyzes are based on large volumes of data (i.e. Big Data), a phenomenon investigated by me in the article "Innovations in Financial Audit based on Emerging Technologies", published in "Financial Audit" journal, no. 3/2020, at the level of data analysis processes occurring a series of changes generated by the IT impact. This impact can be perceived as an opportunity for auditors; it also includes challenges generated mainly by Blockchain technology (Farcane and Deliu, 2020) and the emergence of smart contracts.

Given that the impact of IT through Artificial Intelligence (AI) techniques develop Big Data, we will analyze the applicability of RPA, Data Analytics, predictive analytics, Machine Learning and Blockchain, in financial audit missions. In addition to the above, we describe the technological influence: RPA contributes to the automation of repetitive and well-documented work processes consisting in the application of AI algorithms, the Blockchain allows, through the properties of transparency and confidentiality of transactions, immediate verification of data change or fraud attempts, Machine Learning, which is a branch of AI allows the development of algorithms to ensure a learning process for computer systems. The research considers (1) how these technologies can be mapped on the stages of financial audit missions, (2) what are their particularities and (3) why the acquisition of modern technical skills is suitable for the audit profession. The term "mapping" is used successively and provides the highlighting of the applicability, impact, transposition, integration or effect that information technology possesses on financial audit.

In our opinion, the quantitative, applied and technical research undertaken contributes to the literature by (1) the extent to which emerging technologies (i.e. AI, RPA, Blockchain, Machine Learning through the Deep Learning subset) are applied to business and auditing, which would involve a conceptual and, why not, technical adjustment, along with (2) the realization of projections aimed at the integration of these technologies in the stages of financial audit missions. These objectives are based on open-ended telephone interviews and numerous subsequent telephone discussions with IT specialists and financial auditors from the Big Four companies. The development of techniques on the applicability of emerging technologies in financial audit is based on the analysis of new algorithms and working techniques belonging to AI and Blockchain technology. Extensive documentation from the literature and discussions on this topic include data sources (i.e. books, websites) with technical explanations, audit technology reports issued by Big Four companies (i.e. KPMG, PwC) or by professional bodies and organizations in financial and IT (i.e. ACCA, ISACA, AICPA). The applicability of these technologies for the practice of the accounting and auditing profession is represented by practical schemes that highlight the technological functionality and algorithms that define the software. Although in Big Four companies, the integration of new technologies is at the stage of development for more extensive and implicitly, more precise analyzes, we hope that the present research will provide the business environment answers to 4 important questions:

1. What will be the technological impact of the application of Blockchain, RPA, AI, Machine Learning and the subset of Deep Learning for the practice of the accounting and auditing profession?
2. How can these emerging technologies be applied at the stages of financial audit missions?
3. What is the working mechanism (of these technological innovations) and what are the algorithms involved in data analysis?
4. Presently, what is the role of the auditor? Given the new technological trends, can we discuss a professionally redefinition or not?

This article contributes by developing work techniques applicable to the stages of the financial audit mission taking into account the impact of new technologies. The main objective of examining the reports issued by Big Four companies and professional bodies is to highlight the emerging technologies that must be understood by auditors. According to current estimates, approximately by 2025, these international companies specializing in audit and consulting services (i.e. Big Four) will hold a substantial share of the audit market (Bhaskar and Flower, 2019). We consider that the examination of these reports represents a solid foundation for the chosen topic, together with applied research at the level of specialized literature and technical documentation (books, websites). This study aims to identify trends, actions and predictions already mentioned in the literature, but which apply to financial audit, as well as factors involved in the analysis processes. The research targets two categories of beneficiaries: young people who want to pursue this profession and auditors.

2. Analysis of the related literature

In era of emerging technologies, auditing is considered an ever-changing profession because technology impacts all areas of this profession (Chan et al., 2018; Schmitz & Leon, 2019). Specialized publications certify the need for knowledge about how these technologies streamline and accelerate economic processes, in order to simplify audit procedures, improve organizational performance and reduce the degree of risk.

To ensure and protect the quality of the audit, it is necessary to improve IT skills (Janvrin and Wood, 2016; Omoteso, 2016), representing actions to be learned (Pathak, 2005; Stanciu, 2015; Chan et al., 2018; Farcane and Deliu, 2020). Financial auditors need to understand new technologies and transpose the knowledge acquired during the audit mission stages, favouring a change in this respect (ISACA 2018, b). Proper training contributes to improving the standard of audit activity (Salijeni et al., 2018), establishing a more controlled environment, increasing quality, the accuracy of results and allocating shorter working time to financial data analysis (PwC, 2019). Developing emotional intelligence in order to establish a closer connection with clients, in addition to acquiring the technical skills of working in coding, cryptography and hashing represent future prospects that should be considered for learning and adaptation.

The audit procedures and tests applied in the financial audit will evolve significantly, starting from the method of sampling historical information to 100% auditing of transactions in real-time or at frequent intervals (i.e. continuous auditing) (Chan et al., 2018; Schmitz & Leon, 2019), verification of audit logs that can be tracked through Hadoop. Complete verifications of transactions are primarily due to the development of ERP systems, then to Cloud technology, IT audit, data processing through SQL, NoSQL and CATT, aspects analyzed by the same author in a previous article "Innovations in financial audit based on emerging technologies".

The present research considers technologies that could be considered by the accounting and auditing profession, such as AI, RPA, Machine Learning through Deep Learning, Blockchain. Technological progress in the audit profession is also due to the potential offered by the ingenious invention, Blockchain, which contributes to improving the quality of audit engagement delivery and achieving the level of reporting required by professional regulators, information users and auditors (Rozario & Thomas, 2019). The high degree of automation of the technology has led to a process of obtaining current, real and relevant data for companies.

The Blockchain allows access to data in real time by reading the nodes (i.e. computers), which keep the latest version of the data. Complexity and sophisticated technology are two fundamental features of Blockchain: asymmetric cryptography characterized by transparency, immutability and distributed systems. Some experts believe that Blockchain offers confidentiality, while others advocate transparency (Fiammetta, 2017; Rooney et al., 2017; Yermack, 2017, Rozario & Thomas, 2019). A person's identity is hidden under a complex cryptography, only the public address being visible.

The Blockchain includes transactions instituted from various parts of the network, each transaction being verified in order to confirm or deny its validity. Through Data Mining, the essence of Blockchain technology consists of clustering (grouping) algorithms, logic models, neural networks and anomaly detection algorithms (Klous & Wielaard, 2016), adding new transactions to existing ones, the trading process remaining decentralized. The Blockchain network is not owned by a central authority, being characterized by accessibility and transparency of information (Fiammetta, 2017; Rooney et al., 2017; Yermack, 2017, Rozario & Thomas, 2019), without allowing changes in

data. While a person's real identity is encrypted, transactions are accessed with private keys and their encryption with public keys. By a simple search of the company's address, the transactions in which it was employed can be visualized, which "forces" a representation according to reality. Blockchain integration would be very helpful in the financial sector, due to the impossibility of modifying the data from the "blocks", once introduced in the Blockchain network.

This level of transparency would add an additional level of accountability, along with operational efficiency and decentralization. At the same time, it would eliminate the existence of intermediaries and costs necessary to validate transactions, the Blockchain facilitating access to customer data, helping to increase efficiency, effectiveness (Rozario & Thomas, 2019), by reducing the duration, complexity and cost of the audit mission. Given the presence of smart contracts, which characterize the Blockchain, auditors can rely on the documents underlying the resulting transactions.

Although the existence of software with a certain degree of decision-making intelligence and even predictive behavior is well known (Kuenkaikaew, 2013), AI applications are not so widespread as to create a challenge in financial audit, given the significant potential for revolutionizing this profession. AI is considered an umbrella term for a group of technologies that can be combined in a different way. Human like intelligence is predictable to appear in a period of 5 to 10 years (Johnson, 2018), drastically reducing the workforce (ISACA, 2019 b). In auditing, AI tends to evolve and acquire emotional intelligence. Most experts believe that AI has progressed a lot in recent years, but it is not possible to claim an approach to this stage (Johnson, 2018).

It is well known that, in addition to automating processes belonging to AI, analytical procedures and audit tests are undertaken that are analyzed through Data Analytics (AICPA, 2015; Vasarhelyi, 2017; ISACA, 2018). Data Analytics concerns the entire methodology and not certain stages of the analysis process, being considered a multidisciplinary field. In Big Four companies, monthly comparisons are performed with the previous year (in case of more complex analyzes), for the chart of accounts used by the company. Analytical Review, from the audit planning stage, consists in studying, comparing and verifying variations between accounts, the correlation between financial information (e.g. balance sheet information, profit and loss account, treasury statement, accounting policies and explanatory notes) and non-financial (e.g. information about business model, main risks or information on key performance indicators). Whether significant variations are found by the auditor, more information is discussed with the client.

Predictive analytics is a type of advanced data analysis, based on information technology modeling techniques, Data Mining business processes and management, Machine Learning, AI. Historical data are combined with rules, algorithms and occasionally with external data, to determine the future outcome of an event or the probability of an occurring situation (Chan et al., 2018). At the predictive analytics base is the diagnostic and descriptive analytics, found in most business analyzes. The descriptive analytics looks at the past performance of the organization after examining the historical data, providing a foundation for understanding future performance. The next stage is the predictive analytics, which aims to make estimates of future developments. Anticipating the requirements of the business environment, using Machine Learning and processing natural language through AI, the learning algorithm is responsible for discovering and predicting models. The last process of data analysis is the prescriptive analytics that uses optimization algorithms, suggesting possible results, stating reliable recommendations/actions based on predictions and implications for each decision option.

According to PwC (2019), in 2-3 years the potential of Data Analytics, RPA and AI technologies will be observed. Significant potential is expected in the adoption of AI through Machine Learning, in the sense that patterns and exceptions for financial audit tests will be identified, ways of assessing the company's risk. Machine Learning and traditional statistical analysis are similar in many ways, but they are different in the execution process. While statistical analysis is based on the theory of probabilities and its distributions, Machine Learning is designed for the purpose of examining data, which is based on a combination of mathematical equations that can best predict a result. Thus, Machine Learning is recommended for a wide range of business problems (and not only), involving functions of classification, linear regression and multi-cluster analysis. Starting with 2020, the future tends towards the development of intelligent modules incorporated by AI, the progress in a technological audit knows a period of slow development and late appearance (AICPA, 2015).

The pace at which things are evolving is slower than estimated a few years ago (ISACA, 2018 a).

RPA is an automation form with business processes based on robots and AI. RPA automates repetitive, manual work tasks that would require access from various sources (e.g. from the SAP IT system, Excel, client-auditor platform or SharePoint), removing human intervention (ACCA, 2019). The flexibility of the software is conferred by imitating human interaction with the computer system, having the ability to learn almost any standard process or rule-based activity. This is done by following some steps according to certain rules, executed in a very short time, compared to the time required for a person. The software can run through steps in the process of extracting and comparing data in order to analyze the changes in SAP with the changes provided by the customer. The software can automate activities that involve copying and transposing information between the database and tools (e.g. Excel), reviewing bank reconciliations, checking the correctness of accounting balances from account statements with accounting balances. These checks follow a certain procedure and assume a large part of the time allocated to audit missions, while being prone to human error. Integrating RPA into financial audit missions would prove to be an intelligent and extremely useful work technique (Gartner, 2019).

3. Research methodology

The IT impact debated in the literature, in addition to open telephone interviews with an IT specialist (59 minutes) and two financial auditors (139 minutes), employees of Big Four companies, allowed the development of the technology-financial audit intercorrelation. The interviewees have two years of experience in the field of auditing and following numerous telephone conversations with them, in addition to the interviews, allowed the application of technical concepts of the scheme type in a current context.

By the term intercorrelation we appreciate the reciprocal link between IT and audit, more precisely, the impact of IT in financial audit missions, but also the way in which IT departments develop software to determine those methods and procedures that minimize audit risk.

The research begins with rigorous documentation on the effect of AI, RPA, Blockchain, Machine Learning for the practice of financial audit. Through an online search, specialist reports issued by professional bodies in accounting and scientific articles indexed in international databases have been considered: Emerald Group Publishing, JSTOR, Scopus, Web of Science, Springer Science + Business Media, ScienceDirect, ProQuest, Elsevier, but also the American Accounting Association website, the Research Gate social network, Financial Audit Magazine, Semantic Scholar and Google Scholar search engines. The search was conducted based on keywords in both Romanian and English language, such as: "audit and technology", "artificial intelligence in audit, "predictive analytics in audit", "challenges in the audit profession", "impact of Blockchain in the auditing", "RPA adoption in the audit". Relevant research from 2013-2019 was included focusing on the impact of these new information technologies in the financial audit. The inclusion of articles and publications was done after a carefully reading of the content, representing the way of selection. This study did not include all the research aimed at the impact of information technology in the audit, the aim of the authors being to ensure the theoretical understanding of these technological concepts to apply the concepts and theories in a real context.

Following the conducted interviews, the way of working and the applicability of these technologies are detailed, based on logical schemes, key algorithms that compose and develop the present industrial revolution 4.0. Through an applied, technical and quantitative research, graphic structures are outlined regarding the application of technological concepts in a practical, real context (i.e. the impact of IT on the stages of the financial audit mission), representing the center of interest of this paper. These schematic information flows highlight the applicability of new emerging technologies at the stages of financial audit missions.

4. Results and discussions

4.1. Emerging IT Technologies – Blockchain, Data Mining, RPA, Artificial Intelligence and Deep Learning

Although it is well known that technology is evolving day by day, AI applications are not so widespread as to create a challenge in financial auditing, given the significant potential of revolutionizing this profession. In

Table no. 1 are mentioned publications aiming technological influences, followed by debates and applicable projections (where applicable) of new technologies on the stages of financial audit missions.

Table no. 1. Technology research on Data Mining, Deep Learning, AI, Blockchain, RPA, influencing financial audit

Technology type	Research year	Influence on financial audit	Article name	Author
Data Mining	2015	- The call to Data Mining and Big Data allows the identification and extraction of data needed for the benchmarking process.	Considerations regarding financial audit in the Big Data era	Stanciu, V.
Deep Learning	2015	- Predictive analysis, through Deep Learning, would help in increasing the accuracy of the techniques used in the audit missions.	Consequences of Big Data and formalization on accounting and auditing standards	Krahel & Titera
AI	2016	- In order to be applicable, AI will always need critical thinking from the auditor.	We are Big Data	Klous & Wielaard
Deep Learning	2018	- Through the implementation of software applications, Deep Learning could help in selecting data attributes to predict or detect fraud risk.	Audit Risk Alert: General Accounting and Auditing Developments 2018/19	AICPA & CIMA
Blockchain	2018	- The auditor profession will become more IT-oriented. - The new responsibilities in the audit will be to verify and ensure the correct implementation of the Blockchain. - Blockchain will enable task automation and real-time information analysis. - Due to the immutability property of the data, transactions written in Blockchain blocks cannot be altered. - The authenticity and validity of the transactions are guaranteed.	Impacts of Blockchain on the Auditing Profession	ISACA Journal
Blockchain	2018	- The implementation of the Blockchain will allow a complete analysis of the data, exceeding the method by sampling, increasing the level of assurance and improving the quality of the audit.	Impacts of Blockchain on the Auditing Profession	ISACA Journal
Blockchain	2019	- Blockchain is not considered a passing trend but will contribute to the paradigm shift in accounting and auditing, through the emergence of smart contracts.	Accounting and Auditing at the Time of Blockchain Technology: A Research Agenda	Schmitz & Leon, 2019
Blockchain	2019	- The key words underlying the Blockchain effect for the areas of accounting and auditing are: governance, transparency, trust, smart contracts, continuous audit.	Reengineering the Audit with Blockchain and Smart Contracts	Rozario & Thomas, 2019
RPA	2019	- The audit will face automation of many processes, also requiring the RPA implementation.	Why Audit Leaders Need to Adopt RPA	Gartner

Source: Author processing

Table no. 1 briefly presents the emerging technologies belonging to the industrial revolution 4.0. The research of these synthesized publications is the eagerness of the authors to find credible purposes, which following the methodological application, allow the fulfillment of the objectives of this study stated in the introduction.

The Data Mining process is a combination of several data processing techniques. In order to understand the concepts that define this technology and its potential, Data Mining allows manual selection of data and their processing in order to obtain information that helps to understand and visualize situations (e.g. erroneous accounting records, discrepancy between computer system existing data and data provided by the customer). By understanding and applying predictive analytics, could be highlighted the complexity of data that has the ability to create scenarios or patterns that are extremely useful for financial auditors.

Deep Learning, a subset of Machine Learning (ML) is based on artificial neural networks that allow the processing, transmission and "learning" of the computer system about work processes that human beings know and have transposed to this technology, mimicking how the human brain works. With Deep Learning help, by selecting and processing data, a series of algorithms try to identify the connections underlying the prediction or detection of fraud risk, based on data analysis models and situations/examples/scenarios already outlined by the auditor.

The auditors' orientation on IT in order to acquire more advanced technical work skills than at present is based on the Blockchain and RPA concepts knowledge. When auditing the Blockchain, auditors can be sure of the validity and authenticity of transactions, according to ISACA Journal (2018). Through the emergence of smart contracts, the Blockchain will contribute to the paradigm shift in accounting and auditing, the key words that define this technology are: transparency, trust, governance and the ability to conduct an ongoing audit, helping to improve audit quality. The verifiability of the authenticity of the transactions is already ensured, the auditor focusing on financial aspects aimed at deep human judgment and professional skepticism.

From the RPA implementation point of view, auditors can automate work processes that follow a certain routine, both in the planning phase and during execution phase of the audit plan. For RPA, the following (standard) work processes can be considered: collection of audit evidence, preparation and standardization of activities, processing and merging of data captured from several sources. The final result (of these stages) automated would consist of a single document that the auditors will verify and analyze. Workloads that have been previously processed with Microsoft Excel and CaseWare IDEA (tools used primarily in the Big Four) can be automated through RPA (Moffitt et al., 2019; Gartner, 2019).

By presenting these publications, we want these technological influences to substantiate the understanding and applicability of new information technologies, which will be technically outlined in the next section.

4.1.1. Robotic Process Automation (RPA) in financial audit

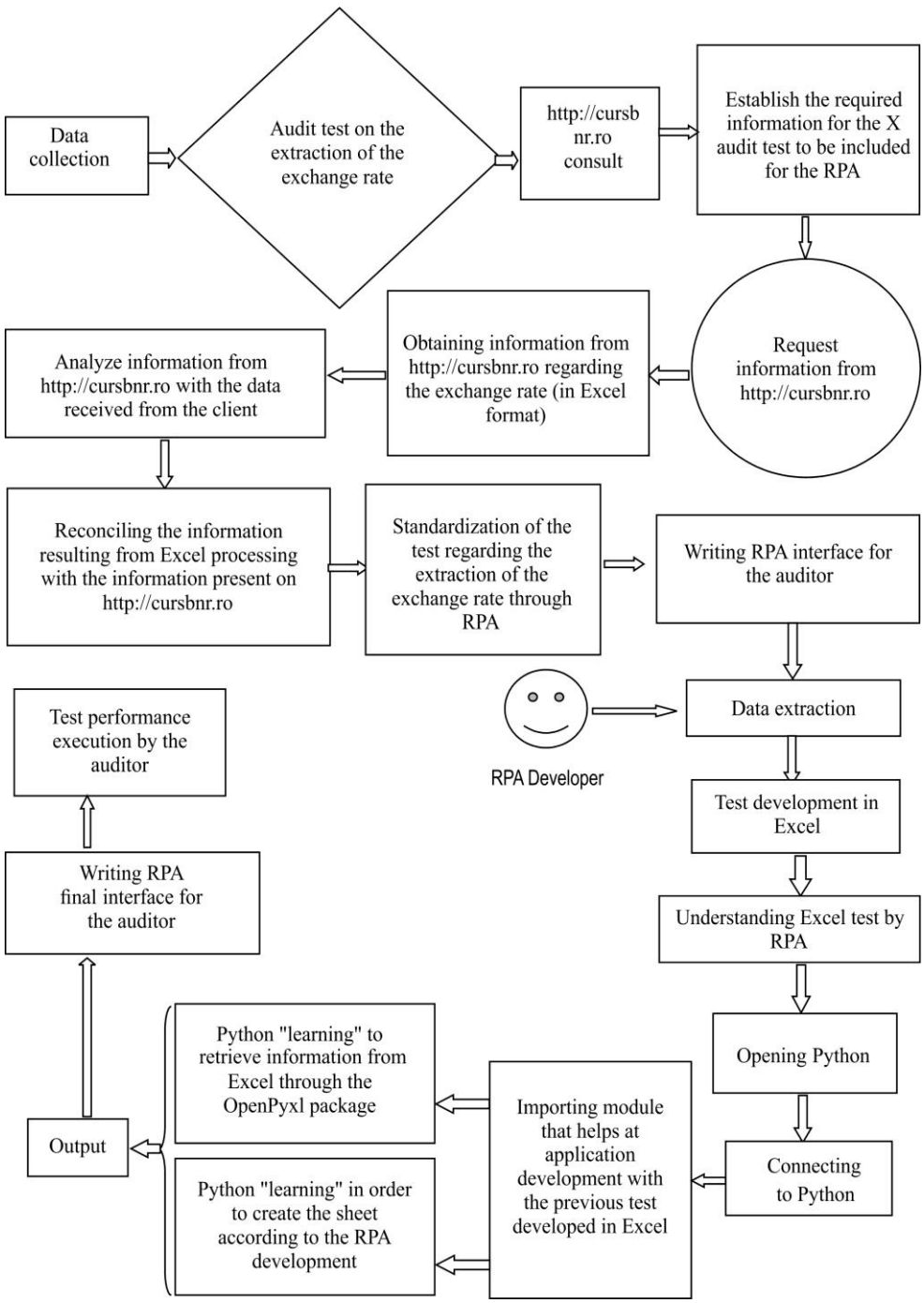
Following the interviews conducted with IT and audit specialists, we have detailed below the working through Robotic Process Automation. RPA automates standard steps in audit engagements and targets changes to the traditional data analysis process, such as: collecting and preparing audit data, copying and transposing information between the database/software (e.g. SAP) and tools (e.g. Microsoft Excel), organizing them on several selection criteria, integrating manual notes, running basic tests using Microsoft Excel. For the implementation of the RPA, audit departments should identify those parts of the audit process that can be mapped through the RPA. Knowing the answers to the following questions can lead to the adoption of RPA in audit firms:

1. *Is it the same repetitive process followed, each time?*
2. *Given that audit work requires human judgment, what would be the rules and probabilities that would cover the entire automation process?*
3. *Are the data resulting from the audit analysis saved in the same directory, each time? Is it there a field name and an identical location in the system?*

If the answer is yes to all three questions, then the audit activity could be automated through the RPA. If the rules of automation cannot be precisely defined and according to the above questions, (most) indicated would be that this task (i.e. processing data) be brought to the attention of the auditor and not (yet) to act for RPA adoption. This form of technological automation is intended to improve manual tasks (Gartner, 2019). There is an efficiency in the RPA-Audit relationship when the RPA could automatically transpose repetitive and structured work activities, based on well-known and

already tested rules, which follow the same working procedure every time and allow execution in a format that could be automatically read, as presented in ***Figure no. 1***.

Figure no. 1. Automation of an audit test on the extraction of the exchange rate through the Python programming language performed by RPA



Source: Personal approach

Taking as an example a client who works with foreign currency, RPA can help in extraction of exchange rate from the NBR website (i.e. National Bank of Romania), for extended periods of time (e.g. months or even years). By writing a specific code in Python, which results in an application that automates the verification of the exchange rate from the NBR website with the client's account sheets, the exchange rates used are compared with those presented on *http://cursbnr.ro*.

Automation of the "Exchange rate extraction audit test" begins with the collection of necessary data to obtain the final result (i.e. what data and what data sources are needed to verify the exchange rate). After establishing the audit test and consulting, in the first instance, the web address *http://cursbnr.ro*, the RPA specialist establishes the information necessary for the test type, after a prior discussion with the auditor, in order to establish the ways in which the information will be obtained. The next step in the automation process is to request the information from *http://cursbnr.ro* and to obtain it for a period of one year in Excel format. Obtaining information is realised by running queries that aim to import the exchange rate into Microsoft Excel, for a certain period (one year).

After obtaining the information, the resulting data are analyzed and compared with those received from the customer. In this stage, the two sources are reconciled (the data obtained in Microsoft Excel from *http://cursbnr.ro* with the data provided by the client). By standardizing this audit test, we understand the establishment and application of a standard for the analysis of imported data, for longer (several years) or shorter (several months) periods of time. In order to execute the software by the auditor, which is the final result, it is necessary to write an interface that ensures the execution. The development of the audit test in Excel is conditioned by the writing of the interface and the extraction of data by the RPA specialist. By opening and connecting to Python (i.e. programming language) it is ensured the import of the module developed for the software/computer application that "teaches" Python to take the information from Excel through the OpenPyxl package (i.e. working tool in Python) in order to create sheets which include the development of this test, designed by the RPA specialist. Once the test is automated, Python will help write the final RPA interface that will be executed by the auditor.

The RPA projection can be applied in the same way to automate a set of tests required by the auditor, such as: FAR – Fixed Asset Register, FIFO – First Input First Out, bank reconciliations, transmission of automatic e-mails in correspondence with banks, suppliers or customers for balance confirmations, comparison and reconciliation of the Journal Register with the Balance Sheet, revenue audit tests, completion of operations extracted from the audit process with invoice data (or other data), VAT tests, completion of declaration 300. Specifying the type of audit test in a Big Four allows the RPA department to establish the necessary information to automate that test or that part of the audit work.

Another automated task through RPA is to compare the data received (most of the time) in Microsoft Excel with the financial statements of the audited company. Through the verification process, the RPA department ensures that there are no differences between the balances of the income and expenditure accounts reported at the end of the year (N) and the initial balances at the beginning of the year (N+1). Are automated checks through RPA for the movements during the year in order to check original, supporting documents, which certify the registration of those movements in the account sheets. The automation of audit tests allows the verification of more information, which for the auditor are time consuming. By verifying the reason for the movements recorded in the account statements and the original document, electronic documents should be suitable for electronic processing, otherwise limits to automation might arise.

Following the example section that can be automated by RPA, another type of audit test is performed in Big Four companies, namely the Cut-Off test. The auditors request from the client the sales and purchase logs from December and January of the following audited year. In this regard, the invoices from that period are

selected, to verify the registration according to the reality of the reported period. The auditor pursues the correct recognition of the income, more precisely if it was recognized in the correct year, the reported income. The Cut-Off test is already automated in Big Four and consists of documenting invoices, by introducing the invoice database received from the client in MUS (Monetary Unit Sampling), a tool used in IDEA Audit Software. Running this tool extracts the selections that the auditor must verify. In the case of this type of test, human intervention might be necessary, considering that there might be invoices issued in January N + 1, but attesting a transaction of year N. The transaction will not be reflected in January N + 1, but will be highlighted in accounting on 31.12.N. Such decisions take into account contractual clauses that might or might not be included in the working algorithms.

TOM (Table of Movement) is another type of audit test that can be automated through RPA, for all sections: verification of fixed assets (for the purpose of observing additions, transfers, respectively outputs of fixed assets), routine checks applied to the provision accounts or equity to verify the movements in the level of capital accounts. Another type of audit test that exists in the Big Four is BAD DEBTS, which starts from the 411 account details. By RPA is calculated the number of days in which the money was received from clients, by dividing by time periods: between 0 and 90 days, 90 and 180 days, 180 and 270 days, over 270 days. The total amount overall periods should confirm the final balance of account 411 from the balance sheet. At the same time, the impairment loss recording is also verified, by executing a script in Python which verifies the 491 account. In practice, the audit tests presented above are based on complex formulas in Excel, which are automated by RPA, by the Python programming language.

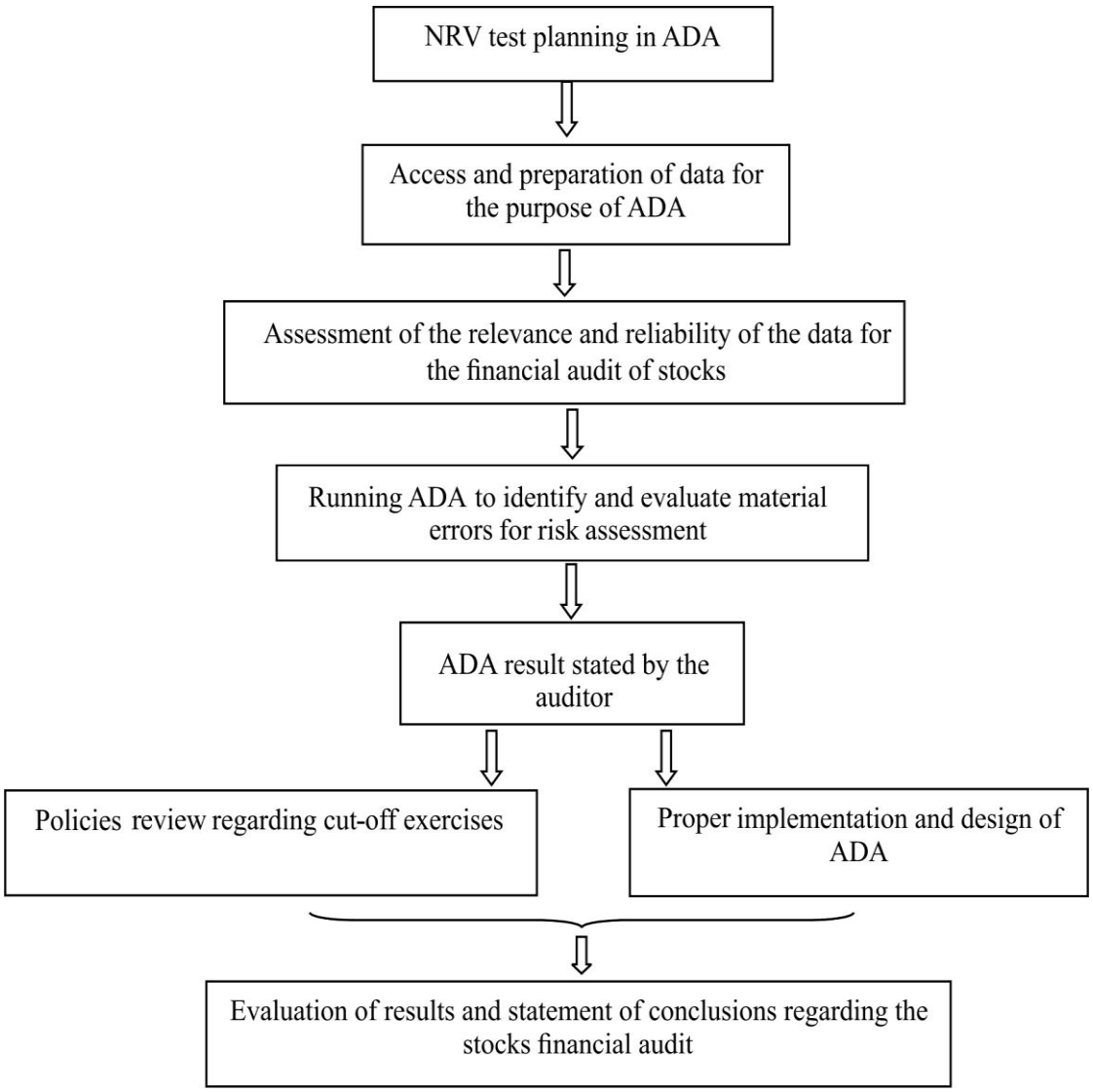
4.1.2. Data Analytics in financial audit

Data Analytics is a process that allows the discovery, application, interpretation, simultaneous communication of statistics in order to quantify the company's performance, obtaining descriptive (i.e. quantitative summary of a data set), predictive (i.e. estimates of future developments) and prescriptive analytics (i.e. recommendations based on Machine Learning technology). Data Analytics is based on complex algorithms, extensive calculation methods in the mathematics, computer science, statistics field, but also predefined models, which based on keywords extract the information required by the user. The transition of data through a verification mechanism based on mathematical algorithms aims to test the validity of transactions. Despite the advantages offered, Data Analytics (Cockcroft et al., 2018) is late adopted by auditors.

Do not confuse Data Analytics with Data Analysis. Data Analysis refers to the process of examining, data processing, in order to extract useful information. Data Analytics is a complex term, a science in a complete data management, which includes not only data analysis, but also their collection, organization, storage, processing using methods along with various working techniques. Data Analytics contributes both to decision-making by analyzing past data (i.e. descriptive or diagnostic analytics) and enunciating predictions (i.e. predictive analytics), recommendations based on predictions obtained, future actions for each forecast decision option (i.e. prescriptive analytics). In audit missions, predictive analytics, especially prescriptive analytics are at an early stage and are starting to be implemented, step by step, by large companies.

Data Analytics is frequently used in audit tests because it allows several types of tests to be performed such as auditing stocks (e.g. finished products, commodities, raw materials and materials, work in progress), the auditor tracking the value used for evaluation in the balance sheet, inventories being presented at cost or net realizable value (NRV). This test also verifies the existence of adjustments for the depreciation of stocks. Taking stock auditing as an example, we will map the NRV test on a platform of Big Four companies, ADA (Audit Data Analytics), a general platform that is not designed on a certain type of client or on a certain type of audit test, starting from the scheme presented in ***Figure no. 2***.

Figure no. 2. Performing NRV test in ADA



Source: Personal Approach

The NRV test can be performed both in the planning stage of the audit mission and at the detail tests level. During the planning stage it is possible to identify the nature and composition of the stocks, the way to obtain the balance stock (through the computer system, for example SAP). It is also possible to identify and assess the risks in order to address them, found in the stage of accessing and preparing data for ADA purposes. The purpose of ADA is to verify (primarily) the internal control system, purpose which apply to control tests. In this way, the knowledge of the client is achieved by fulfilling audit objectives, such as: completeness, accuracy, existence, evaluation, separation of exercises, rights and obligations of the company, presentation and highlighting of inventories in the balance sheet. In this stage, the degree of relevance and reliability of the analyzed data is evaluated, more precisely to what extent the ADA platform can evaluate these inventory characteristics.

Running the ADA allows the identification and assessment of material errors required for risk analysis. In this respect, analytical procedures can be adopted, moreover, used both in the planning stage and during the audit mission, depending on the degree of knowledge of the client (e.g. for a new client, the NRV test through ADA could be conducted at the beginning of the audit engagement or for a client whose audit has been performed for several consecutive years, this test may be conducted during the financial audit engagement, when there are certain question marks). These procedures can be useful in identifying unexpected variations, analyzing discrepancies, using specific indicators, such as: stock turnover rate, analysis of monthly fluctuations, comparisons with previous periods and similar companies. In the detailed tests, the financial auditor determines the result, how to measure inventories in the balance sheet (e.g. at the minimum between realizable value and cost), using costing methods (e.g. FIFO, weighted average cost, average cost) and by checking invoices issued by suppliers, the cost calculation or the post-calculation operation. Detailed tests include: inventories of third parties that need to be inventoried, inventories of third parties that should be excluded and reconciliation of financial evidences with financial statements.

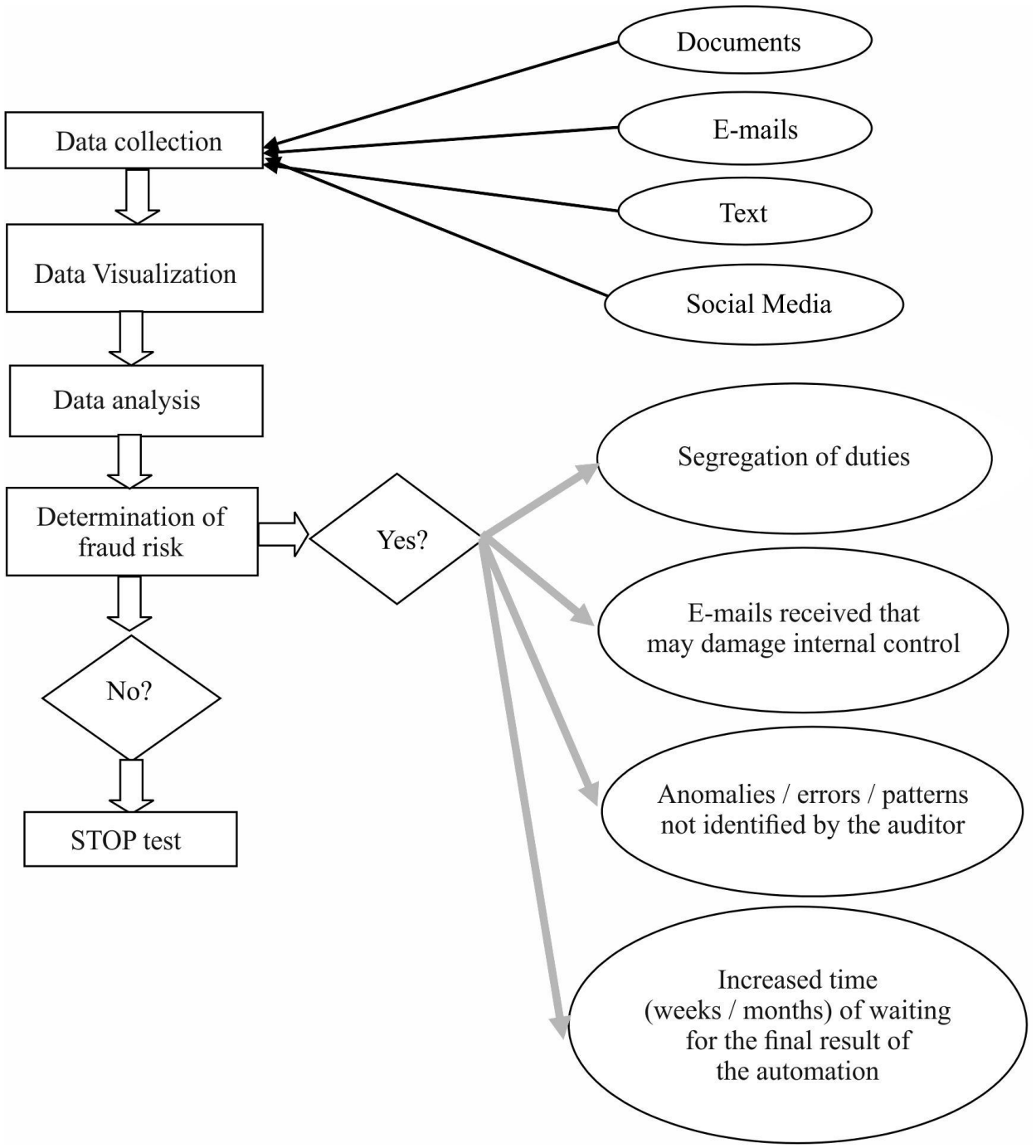
If the results obtained after running the ADA for the NRV test do not conform to the original underlying accounting documents, auditors may review policies regarding the cut-off exercices. These are done by checking the accounting of the last or first entries, respectively exits, from NIR/shipment notice to invoice, from invoice to NIR/shipment notice or of the degree of implementation and design corresponding to ADA. Following the verification of these results, the financial auditor evaluates the results and states a series of conclusions regarding the degree of fulfillment/non-fulfillment of the financial audit of the stocks. Failure to meet the objectives of the NRV test conducted in the ADA may be due to: failure to identify the risk present in previous transactions, changes in risk assessment, lack of organizational procedures that require the implementation of more effective controls on the presentation, highlighting and valuation of stocks.

Data Analytics tools aim to analyze revenue trends by region and type of product, invoices and payments confirmations, verifications of segregation of duties for users involved in transaction processing, analysis of Key Performance Indicators (KPIs), forecasting economic and financial trends. These tools allow the direct interaction of the auditor with the client's system in order to analyze 100% of the transactions, through queries performed on each operation, detecting the existing risk more easily and quickly. Data Analytics is valuable in performing risk and fraud analysis activities, and could be perceived as an innovation in financial audit, which contributes to the quality and efficiency of services provided. For example, access to dashboard situations (e.g. graphical visualization, forecasted trends) allows easier observation on business models, facilitating the immediate identification of anomalies.

Risk management and fraud investigation represents another advantage of Data Analytics. Data Analytics tools process the huge amount of data (i.e. Big Data) that exists in companies around the world. Audit software leads to an integrated decision process aimed at preventing risk, but also its management. ***Figure no. 3*** shows a schematic analysis in the detection of fraud that could be applied when executing the detailed tests.

Any investigation is based on data collection in order to examine the current state of data. In order to detect fraud, it is necessary to collect this data and view it. The data analyzed by the auditors in the detailed tests applied aim to establish the risk of fraud. Whether such a risk is found, the financial auditors shall examine its possible causes. These may be due to: the insufficient degree allocated to ensuring the principle of separation of functions between employees of the company and even globally (in the case of Big Four companies). It can also be listed: the existence of e-mails that were received and contributed to the prejudice of internal control, by the installation from the user, in an unconscious way, of malicious software that allowed the attackers to infiltrate to the secret information, anomalies/errors/patterns not yet identified by the auditor, increased waiting time (weeks/months) for the final result of the automation.

Figure no. 3. Fraud detection scheme in the financial audit through BDA



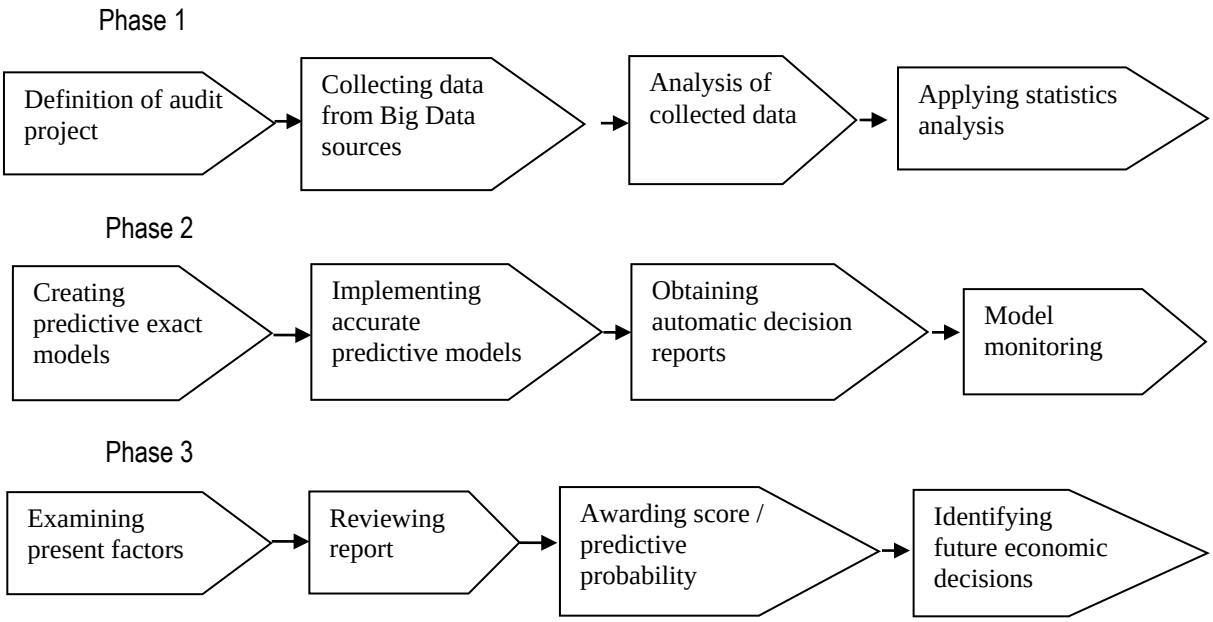
Source: Personal Approach

4.1.3. Predictive analytics in financial audit

Predictive Analytics is the second phase of the data analytics process (the first being descriptive analytics), which consists in the application of analysis techniques that combine rules, algorithms and external data to state some probabilities of a situation or outcome occurring.

At the predictive analytics level, three interconnected phases can be observed. The preliminary stage includes the documentation about the objectives of the audited entity, verifying the compliance of the accounting principles and the control procedures. In the next stage, within the planning of the audit mission, the definition, elaboration of the audit project and collection of data from Big Data sources are presented (phase no. 1). For the execution stage of a financial audit mission, we find the data analysis, the application of statistics and algorithms on the collected data (***Figure no. 4***).

Figure no. 4. Phases of the predictive analysis process mapped in a financial audit mission



Source: Personal Approach

The predictive analysis process begins with the definition of the audit project (i.e. what is the purpose, what are the objectives pursued in the audit mission), data collection (i.e. preparation of data obtained from several sources), analysis of collected data (i.e. completion of verification processes and processing, observations resulting from the identification of corrections on incorrect records, data modeling), applied statistical analysis (i.e. application of audit work algorithms and techniques). The second phase is represented by the creation of exact predictive models that contribute to the implementation of the predictive model in the decision-making process. The implementation of these models is followed by obtaining automatic decision reports. Monitoring the model is a necessary step in examining its performance and continuity of application. The objective of the last phase consists of examining the predictive report, in order to supervise the activity carried out during the financial audit mission and to enunciate future economic decisions for the audited company.

Predictive analytics cannot guarantee 100% accuracy in the predicted results. Audit tests applied in an audit mission help auditor create predictive models that allow the recognition of trends not previously identifiable or the likelihood of a situation occurring (e.g. the risk of fraud). Because it is based on other approach than Data Mining, predictive analytics determines a likely outcome of faster

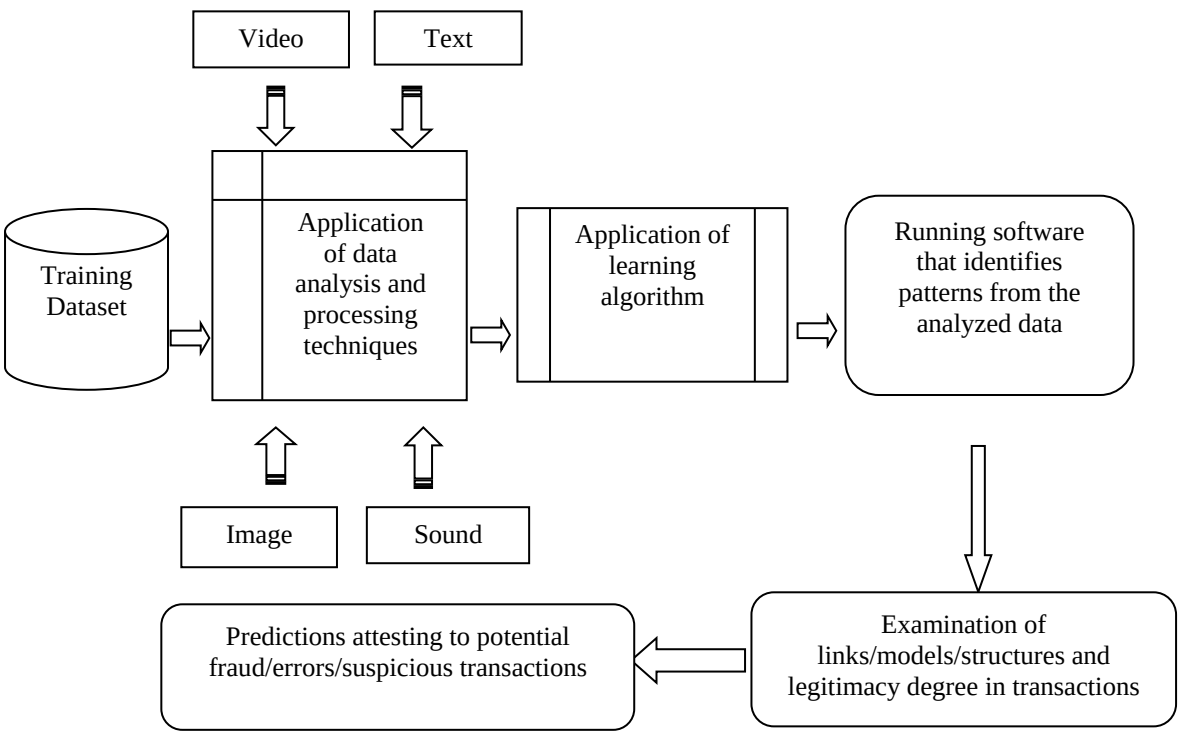
data processing and a greater focus on predictive statement than on descriptive analytics. The application of statistical techniques consisting in predictive modeling and the application of Machine Learning technology contributes to the appearance of the last phase of business analytics, namely prescriptive analytics (eng. Prescriptive Analytics). Being the most current level of data analytics, prescriptive analytics allows access to viable solutions to business problems. This type of analytics assesses the expected impact generated by future implementations, at the changes data level or implications regarding each stated option decision.

4.1.4. Machine Learning in financial audit

Machine Learning represent the most challenging area of AI, given that, over time, there have been resistances for attempts to fully automate workloads, which are currently performed with both software and human intervention help. Machine Learning is based on analytical models, it is designed to automate work tasks, which in most cases require to go through detailed and time-consuming processes. Machine Learning is supported by the existence of the available data sets and the evolution of computing capacity.

Data analysis and identification of patterns previously defined by the auditor are embodied in the analysis patterns. The models are processed by a machine learning algorithm through a software "capable" of solving various audit processes (e.g. at the level of substantive procedures to obtain sufficient and adequate evidence, which is divided into analytical tests or detailed tests). Through an iterative approach, Machine Learning makes machine learning possible. Due to the collection of examples that are specific to a correct output for a certain input, computer systems "learn" to make predictions that attest to potential situations of fraud, the occurrence of errors or suspicious transactions. The Machine Learning functionality is based on the application of a learning algorithm on processed and analyzed data in order to obtain the most accurate predictions (***Figure no. 5***).

Figure no. 5. Machine Learning functionality to detect potential fraud



Source: Personal Approach

Machine Learning functionality becomes useful starting with the existence of training dataset that are followed by examining the links, models, structures, degree of legitimacy of transactions, resulting from the application of data analysis and processing techniques (e.g. video, text, image, sound). Applying the learning algorithm to the data already processed allows the running of the machine learning software, which recognizes those categories of examples (patterns previously created by the auditor) and labels those transactions that enclose a potential risk of fraud. This type of algorithm is defined by learning without supervision, contributing to the formulation of predictions about the activity of the audited client, in this case, the resulting predictions attest to the fraud risk, generated by the identification of suspicious transactions or accounting errors.

Machine Learning functionality becomes useful starting with the existence of training dataset that are followed by examining the links, models, structures, degree of transactions legitimacy, resulting from the application of data analysis and processing techniques (e.g. video, text, image, sound). Applying the learning algorithm to the data already processed allows the running of the machine learning software, which recognizes those categories of examples (patterns previously created by the auditor) and labels those transactions that possess a potential risk of fraud. This type of algorithm is defined by learning without supervision, contributing to the formulation of predictions about the audited client activity, in this case, the resulting predictions attest to the risk of fraud, generated by the identification of suspicious transactions or accounting errors.

Even if the data based on the application of analysis and processing techniques change, machine learning systems will follow the same path, by training the machine learning algorithm (e.g. recognition of inappropriate accounting formulas for the type of operation, recognition of acquisitions, transfers, additions, scrapping that presents exorbitant amounts compared to the original accounting documents) on new data, the system being able to label the new entries. In this way, those transactions that do not comply with reality will be identified, contributing to the design of those models that do not fully correspond to those previously stated by the auditor.

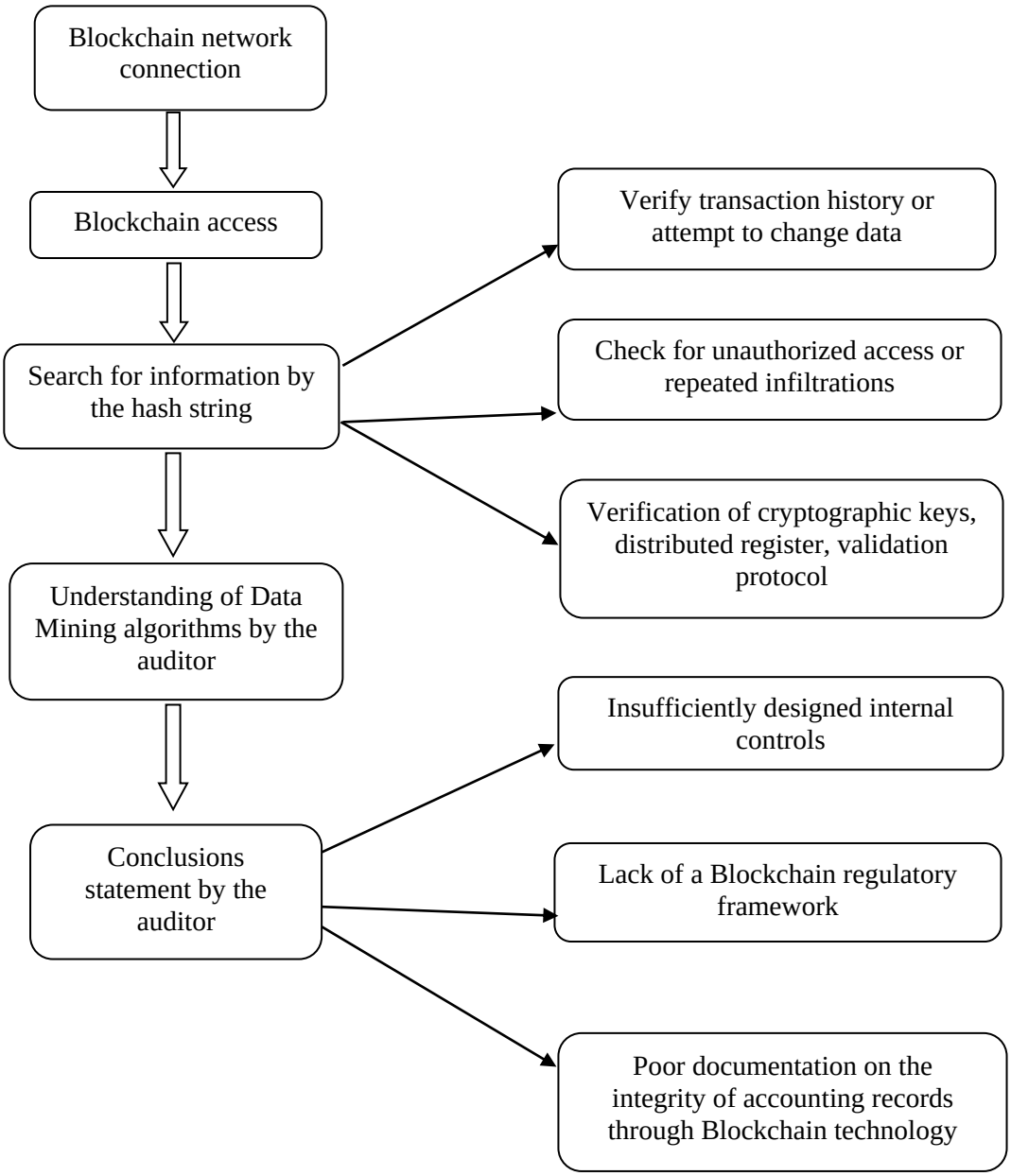
4.1.5. Blockchain in financial audit

Blockchain technology is considered a decentralized digital registry, a distributed and constantly updated database, an algorithm that includes encrypted transactions, keeping records in "blocks". Once initiated, encrypted transactions cannot be changed without modifying previous transactions. The blockchain is defined by the cryptographic hash function, an irreversible function which for the financial audit presents an advantage due to the alteration of the "blocks". Due to the authorized access granted to the participants in the transactions, the audited data can be considered secure for verification. Due to the cryptographic security identified at the level of transactions (by time and date), auditors can easily identify anomalies, possible data errors or failed access attempts. The development and integration of controls for the audit of Blockchain technology would represent the next level in testing the integrity of data and the progress of this activity sector.

Example: By automating a process that aims to sell goods, can be identified several stages that make up a complex flow (drawing up and signing contracts between parties, issuing and paying invoices, issuing and receiving goods, paying and concluding transactions). The fulfilment of the stages is guaranteed, the transactions being concluded on the intelligent contracts' basis (the computer performing actions as a human being).

We know details about the Blockchain network, about the fact that the information is contained in a shared database and continuously reconciled. We design the necessary steps to connect, access, search for information, in order to audit a client using Blockchain technology, an audit that led to a case of embezzlement. The applicability of this projection, conducted in the detail tests stage, can be observed in ***Figure no. 6***.

Figure no. 6. Auditing the Blockchain network to discover a case of embezzlement



Source: Personal approach

The Blockchain can be defined as a collection of interconnected nodes. The nodes are represented by individual computers that receive data from the participants who customize the received data, being available for access. Therefore, by accessing the information, details regarding the transactions concluded between the participants can be consulted, the Blockchain being characterized by a special type of

network called "peer-to-peer", which distributes the work tasks between the participants (peers), downloading data from any connected "peer". Access to the Blockchain is through private keys. In the example above, to discover a case of embezzlement, we will start by looking for information by the hash string that targets suspicious transactions. The verification of the transaction history can include: repeated infiltrations, attempts to change the data, checks on the synergy of the three technologies that contribute to the immutability of the data in the Blockchain, namely: cryptographic keys, distributed register and validation protocol.

Following the discovery of a case of embezzlement, the auditor needs to understand the Data Mining algorithms, in order to state conclusions, from various causes, such as: the existence of an insufficiently designed internal controls by the company using the Blockchain, lack of regulation and the presence of legal constraints, poor documentation on the integrity of accounting through Blockchain technology.

During financial audit missions, auditors may detect hacker attempts to access blocks to change the data. A slight change in the data would result in a drastic change in them, due to the hash functions, which will be immediately noticed by the auditors. Any change in block 3 will change the hash in block 2, which would lead to changes in block 1 and so on, due to the irreversible function that underlies Blockchain. An experiment was undertaken by Ahmad et al. (2019), where existing audit logs were used to verify the BlockTrail prototype in the Blockchain network. The level of correctness and consistency of this network was checked.

5. Conclusions

This research highlighted the mechanism and applicability of RPA, Machine Learning artificial intelligence technologies, the development of tools and fraud detection through Data Analytics, the applicability of predictive analytics, Blockchain network auditing to discover a case of embezzlement.

Through the RPA projection, an automated process was detailed that aimed at the automatic extraction of the exchange rate for a client who works in foreign currency. The RPA automation of this type of test is based on the affirmative answer to three detailed questions in the application part of this paper. The RPA projection, which is based on several stages of analysis and processing, aimed to verify the correctness of the exchange rate used by the client, compared to the NBR website. The final result is represented by the direct execution of the auditor, with a direct effect in the efficiency of the working time. The conclusion of this research is that an automation by RPA in the financial audit would considerably minimize human errors, and the verifications that auditors would perform after receiving the data processed by RPA would be insignificant.

By understanding emerging technologies, auditors will acquire new working skills (i.e. advanced technique in data analytics, prescriptive and prospective approaches, performance in financial audit missions, knowledge of Data Mining algorithms). Audit firms should consider prescriptive analytics, which are based on Machine Learning technology, by exploring descriptive and predictive analytics. For example, auditors could make recommendations to reduce the fraud rate over the next 2 years. The research detailed how Machine Learning can contribute to the detection of a potential fraud, through a technical scheme, applied in a real context, supporting the integration of this technology for the practice of the audit profession.

Through our research, we believe that the development of Data Analytics positively impacts the practical field of auditors. Data Analytics would significantly improve the quality of these missions, by analyzing large data sets (Big Data), applying statistics on complete information and conducting predictive and prescriptive analyzes, in order to "capture" all the possibilities of analysis and economy forecasting.

Performing the NRV test on a platform owned by Big Four companies, ADA (Eng. Audit Data Analytics) represents a type of test that can be applied both in the audit planning stage and in the detail tests. This test also verified the existence of adjustments for the depreciation of stocks, the nature and composition of stocks, how to obtain the balance of stocks (through the computer system, for example SAP). The purpose of the ADA was to verify the customer's internal control system.

By implementing special Blockchain technology, the financial sector dispose an excellent form of security between transactions, due to the existence of smart contracts, which certify the transfer of data between participants. For the financial audit, the Blockchain assures auditors about the transparency and impossibility of modifying already concluded

transactions, due to the property of immutability of the data. We observed the audit of Blockchain technology, which following the auditors' verifications identified the occurrence of a case of embezzlement, by identifying attempts to steal information, failed access attempts, repeated infiltrations, attempts to change data and state conclusions that are due to various considerations.

Taking into account new technological trends, we can discuss a professional redefinition of the role of financial audit, given that audit tests could be performed with the software help in few minutes, to the detriment of a long analysis time. In order to complement the predictive performance of Deep Learning algorithms underlying audit automation, we believe it is important that auditors strive to understand the concepts of AI, predictive and prescriptive data analysis, and develop advanced working skills with Machine Learning, RPA and Blockchain emerging technologies.

5.1. Research limitations

The limitations of this research consist of a limited number of discussions with audit and IT specialists from Big Four companies. At the same time, the analyzed literature includes debates mainly in accounting and financial audit. In this study, no documentation was performed in other financial fields, such as: business expertise, internal audit, enterprise evaluation, financial reporting. All these limitations are in fact areas of expertise that could be deepened in future IT impact research.

5.2. Future research directions

The effect of AI, RPA, Blockchain and Machine Learning could also be seen from the perspective of financial reporting, providing the question "To what extent international financial reporting standards will change as to provide a conceptual framework appropriate to these technologies?". Will be necessary to adopt a specific Blockchain or RPA standard? Should the creation of new roles with new tasks (IT Auditor, Expert Statistician, Advanced IT Analysis Specialist, Researchers in Data Analytics, as well as specialists in the management of International Audit Procedures and Standards – ISA) be considered?

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