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How Data analytics will transform the audit industry in the future and the role of the auditor?

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1) Introduction

In order to better understand what are the stakes linked to the subject of this thesis, it's important to put in place the global context of the topic that is to be found in the **growing digitalization of the world** and thus also of our economies. Indeed, we know for the moment what we can call a **third great wave of economic disruption** and invention that is characterized by major innovations in the information and computer field (CPA, 2016). The rising importance of digital solutions will completely change various aspects of the economy and It's obvious that the future of our industries is to evolve towards the **digitalization** and the various opportunities it can create. Nevertheless, it's also important to understand well what are the challenges and the difficulties it will bring too.

Currently, we are knowing an important acceleration of the progresses in various domains such as **artificial intelligence, robotics, algorithms and Big data** that will completely disrupt the industries. If we take for example figures concerning data (data analytics will represent the main topic of this thesis), we know that by 2020, we will create and copy **as much data as there are stars in the universe**. Concretely, it means that the digital universe will reach 44 trillion gigabytes (which represents 44 zettabytes) in 2020 whereas it represented only 4,4 trillion gigabytes in 2013 (IDC, 2014). This trend in the volume of data used by our society is not yet ready to be slowed down because we can estimate that the volume of data created is expected **to double every 3 years**. (McKinsey & company, 2016). Thus, this rise in the volume of data encouraged the development of programs in the area of data analytics that help companies to take better informed decisions based on various datasets because more and more companies are also using at the same time large amount and various types of data. This involves a change in the way financial statements will be audited in the next few years if these services want to remain useful and relevant for audited companies.

To cut a long story short, the aim of this study is to determine in the context of the **digital revolution** described above how the auditing field will be affected by these changes. First of all, we will try to understand what are the **different types of technologies and data** that can used nowadays in order to improve the overall audit quality. Then, we will try to describe briefly the **technological transformation** known by audit from its beginning to understand how the audit evolved and from where does it come in terms of technology. Thirdly, we will describe how companies can develop data analytics programs and what are their interests to develop that kind of tools.

We will see it exists different ways for companies to develop their tools in function of their size, budget or interest because **the expectations of the stakeholders** change simultaneously towards the auditing field with the evolutions of the technologies. Indeed, stakeholders have a tendency to expect more from the auditors which can lead to a **competition between** firms to develop the best tools and derive a competitive advantage from it. Then, we will try to describe what are the **main advantages** that auditors can derive from data analytics as well as the challenges encountered by all the different actors involved in the audit processes. Firstly, we will tackle this point from **the auditor point** of view by describing the changes arising to the role of the auditor as well as the skills required and the future structure of the audit's teams. Secondly, we will describe how the **audited companies** are dealing with this matter especially from the data security point of view. Thirdly, we will conduct research to understand how the **standard-settlers** are reacting to adapt the standards and the approach they are choosing to deal with the expectations of the various stakeholders regarding the evolution of the standards.

Afterwards, we will describe one possible approach concerning the integration of data analytics possibilities in the audit processes supported by **concrete examples for the following audit procedures** that are audit planning, risk assessment, test of controls and the substantive procedures. The main sources supporting the integration of data analytics into audit comes from a research paper developed in 2018 by the IRE called "Data analytics: The future of audit". Finally, we will try to provide a brief insight on the near future of audit by briefly describing new tools and functionalities coming in the next years such as **artificial intelligence** that expand again further the possibilities to take advantage of Big data and other types of data.

The data used in the context of the thesis come from the **combination of different sources**. Firstly, the main theoretical points are extracted from the **scientific literature** that are known for being reliable sources such as the IRE (institut des réviseurs d'entreprises), the IAASB (International Auditing and Assurance Standards Board), Big 4 companies or the CFFR (center for financial reporting reform). Secondly, some data are **primary data** extracted from the field with direct observations, through informal or semi-conducted interviews with auditors sharing their opinion and/or experience on the topic in 2 Big four companies and one smaller audit firm. Thirdly, **secondary data** are used such as existing surveys or facts from research paper.

Before getting to the heart of the matter, it's important to define and understand some of the concepts that will be extensively used in the context of the thesis.

Big data

The amount of data increased so much in the last years that traditional methods used in the past couldn't follow anymore in order to process all the information's that were created. That's how we arrived to the term "**Big data**" that refers to the enormous **variety and quantity** of Data that is created with an impressive **velocity** (Oracle, 2018). Big data is bigger and more complex than ever and especially when it comes from new types of data sources. Nevertheless, large amount of data does not constitute only problems as it can precisely address a lot of business issues we couldn't have handled a few years ago.

The concept **of Big data** itself is something that appeared recently. We can say it really began in the 1960's and 1970's with the appearance of the first **data centres** and the beginning of the **relational database** (Oracle, 2018). Nevertheless, people only began to really become aware of the importance of this field only in the beginning of the 2000's with the emergence of services such as Facebook, YouTube and many other big digital services known worldwide. Furthermore, it was also the beginning for programs such as **NoSQL and Hadoop**. NoSQL can be described as "an approach to database design that can accommodate a wide variety of data models, including key-value, document, columnar and graph formats" (Rouse, NoSQL (Not Only SQL database), 2011). It constituted an alternative particularly suitable when **confronted with Big datasets**. On the other side, Hadoop is "an open source distributed processing framework that manages data processing and storage for Big data applications running in clustered systems » (Rouse, Hadoop, 2018). It can manage **structured and unstructured** data in the context of data **mining and machine** learning for example.

In our world where all businesses are generating a considerable amount of data with their business processes and operations, we can define this flow of data with **5 essential characteristics** (Oracle, 2018).

1. **Velocity:** It refers to the quickness at which an enormous amount of data is generated, collected and analysed.

2. **Volume:** It refers to the amount of data that is generated each and every second on earth from a multitude type of sources. Collecting such an amount of data constitutes a real challenge.

3. **Value:** This characteristic refers to the intrinsic value of the data that is extracted. When an organization is launching a Big data initiative, it's essential to understand what are the associated benefits but also all the costs when collecting and analysing these data.

4. **Variety:** We can define it as the different types of data we can now collect and analyse. It's interesting to notice that approximately 80 % of the existing data are unstructured. We can find many examples of unstructured data such as E-mails, audios or social medias.

5. **Veracity:** This point refers to the quality and the accuracy of the data that are collected. We mainly think when referring to this point to data coming from social media's where generally there are no controls that are performed. We can conclude without doubt that accumulating data is worthlessness if there is no value behind.

Audit financial statements

It's important to define here what we mean when we are talking about "Financial statement audit" and why it's an interesting and important topic when combined with Data analytics. Each and every company produce in the context of their activities **financial statements** that are providing information's about their financial health and position (PwC, 2016). Consequently, there are many **different stakeholders** that are using these information's for different purposes (See Appendix 1.1). In order to guarantee the trustworthiness and a certain level of confidence in these financial statements, companies are calling an external actor who's called an **auditor**. Thus, the auditor will express its opinion on whether or not the financial statements and the related disclosures are correctly stated. He expresses its opinion mainly on 2 points that are the **financial performances** (linked to the income statement for one given period) and **financial position** (linked to the balance sheet as of one specified date). By this way, the auditor will check one time per year if the financial statements agree with the appropriate GAAP (PwC, 2016) and this contributes to restore trust on the markets.

What's data analytics?

Now, we are going to study concretely the effects of data analytics on the auditing sector through the review of the literature and by aggregating the most important elements of these reviews and interviews conducted with auditors about their own experience on the topic. To start, it's interesting to give a first a general definition of Data analytics.

The IRE (Institut des réviseurs d'entreprises) defines data analytics as "**the process of examining data sets in order to draw conclusions about the information they contain, increasingly with the aid of specialized systems and software**" (IRE, 2018). We can already say that nowadays, data analytics, is commonly used by the auditors in their daily tasks in various situations **from the easiest to the most difficult ones**. In the case of "easy" data analytics, we can mention several basic examples such as the possibility to sort out information's with the help of excel in order to show **Top Ten clients using a revenue criterion** or the possibility to **pair data coming from different sources**. Indeed, we can imagine for example, a pairing between individual fixed assets that are still used in the asset management system with the fixed assets contained in the General ledger (IRE, 2018). In the case of "hard" Data analytics procedures, we have examples such as the **recalculation of the precision of Trade receivables**, or the possibility to perform **a 3-way matching test**. A 3-way matching test can be defined as "a procedure for processing a vendor invoice to ensure that a payment is complete and accurate » (Murphy, 2017). This matching test allows to check if there are no inconsistencies between the **3 most important documents in the context of purchasing processes** that are: Invoice, Purchase Order & order receipts. It's now obvious that this technology will be used more and more in the future by companies in order to take better decisions that rely **on more informed processes**.

As we already depicted in the previous sections, the rising amount of data in the world but also in the overall companies allow a **better analysis of data on a larger scale** by providing a better understanding of it. Consequently, the auditor can theoretically focus on **what's really adding value** and can also give some recommendations based on the analytical tools to the customers. Nevertheless, some questions will still remain difficult to answer as the industry is now entered in a **phase of continuous change**. Indeed, we know that auditors currently use samples to do their tests and we can logically wonder if this approach will have the tendency to disappear to evolve towards a full coverage of the population and all the major changes it implies. This constitutes one of the many other relevant questions that could remain unanswered for a while

given the International auditing and assurance standards boards (IAASB) is actually assessing for the moment until which point do we integrate Data analytics into the international standards of auditing (ISA's) (IRE, 2018). It reveals that this matter is totally **a hot topic for the industry**, and we will only be able for some questions to only produce hypothesis given the uncertainty around this topic. Furthermore, as we previously described, this evolution is unavoidable but it's time **for the profession to be adapted** to the new emerging technologies as the audit tasks did not really evolve fundamentally for many years now

2) Data Analytics applied to Audit

Firstly, what is interesting to notice is that the auditing field did not create data analytics because it's a type of technology already commonly used for other purposes such as **Governance, compliance monitoring systems and risk and control**. Such kind of programs have already been developed by big firms specialized in those technological areas as **SAP and Oracle** (International accounting, auditing & Ethics, 2016). Moreover, some businesses are already using data in the same way as external auditors do and we know that these analyses become more detailed and broader in what concerns risk and performance which could in turn make such that they can cover **the same type of risks as external auditors do**. This will certainly lead to a change in what management could expect in terms of scope from the external auditors and that's why the role of the auditor is now bound to change in the future.

Different type of digital technologies affecting audit

Given the exponential development of data, a lot of companies tried to develop tools in order to transform **this flow of raw data into real added value**. For instance, Machine learning is one possible tool and can be defined as "a set of algorithmic approaches using methods from regressions to neural networks" and it will also play an important role in the interpretation of the data for the future (McKinsey & company, 2016). The **increasing investments** to develop tools (machine learning or analytical tools) and the **increasing amount of data** are two different trends mutually reinforcing each other which stimulates their mutual progresses. Machine learning can be useful because it's as a certain type of artificial intelligence that can "be trained in order to recognize patterns in vast volumes of data that would be impossible for humans to process" (Sun & Vasarhelyi, 2017).

This technology that does not stop to evolve is an effective way to use databases **in order to help auditors to take better decisions** and to evolve towards an automation of some audit procedures. We can mainly differentiate 3 types of machine learning:

1. **Supervised learning**: This type of machine learning is globally the most used and popular. It requires the **direct supervision** of the operations by someone. In supervised learning, the developer will give **labelled data samples** and establish **limits in which the algorithm can work**. So, it requires the developer to provide mainly two things that are the output in order to feed the algorithm and the result wanted. That's why we can say that" **the outcome or output for the given input is known before itself**" (GN, 2018). Based on these information's, the machine should be able to establish **classifications and regressions** with the available data. Finally, the supervised learning is commonly used to perform regressions, predictive models or other popular algorithms such as neural networks, decision trees or Naive Bayes.

2. **Unsupervised learning**: Basically, this type of machine learning is the opposite of the supervised learning approach because it does **not require any control** from the developer and **does not feature any label** on the data (Heidenreich, 2018). So, the algorithm here is provided with unlabelled data but also with the tools required in order to understand the properties of the data. Another important difference with supervised learning is that we **don't know the desired results** whereas on the other side, we knew the result but we just needed to sort out the data (Bilyk, 2018). That's why here we can say that "**the outcome or output for the given inputs is unknown"** (GN, 2018). The main objective of this approach is to establish patterns by using data, generate valuable insights and explore the structure of the information's.

3. **Reinforcement**: This type of machine learning is directly referring to what we can call "machine learning artificial intelligence". Here, the algorithm is trained on a **continuous basis** and works with **trials and fails**. Moreover, the algorithm learns by improving its actions based on its experience and the feedbacks it received in the past.

What is interesting to notice is that currently in the business world, already many firms in various industries are developing technologies based on data such as ERP software's, cloud storage and sensors. This kind of programs allow businesses to **simplify the production and the maintenance of huge data quantity** which in turn stimulates the development of analytical tools in auditing and accounting companies to interpret these data. KPMG's application of IBM Watson program, Kira systems of Deloitte and Helix of EY are examples of machine learning/ Data analytics programs developed by Big 4 companies. What is sure is that deep learning processes are still at the beginning of their life and are not yet deeply implemented in big accounting companies, but they are certainly **the future of the profession**.

Different type of data can be used in the context of data analytics applied to audit

In a few words, we can say the audit industry will **not be spared by this global trend** of digitalization as many other industries and it's sure it will constitute a real **game-changer**. More specifically, data analytics and consequently machine learning will be used more and more to help auditors thanks to its various capabilities. For example, it can analyse many different types of **unstructured data** such as conference audio files, E-mails and social medias to allow the auditors to work in a more effective and smarter way. Ultimately, it will allow them to gain precious time in order to use their **judgement based on larger and deeper databases** (Boillet, 2018).

Furthermore, it adds value to their job as they can formulate better questions for the CFO's, company boards and committees which leads to an **improved accuracy of their work** as it can analyse fully the data and identify earlier exceptions which is more difficult in an exclusively human process. In the figure 1.1 next page, we can see in a visual way **all categories of data** that could be used in order to perform Data analytics procedures and we notice the list comprises a large range of data. These data should be in accordance with **3 main characteristics** that are:

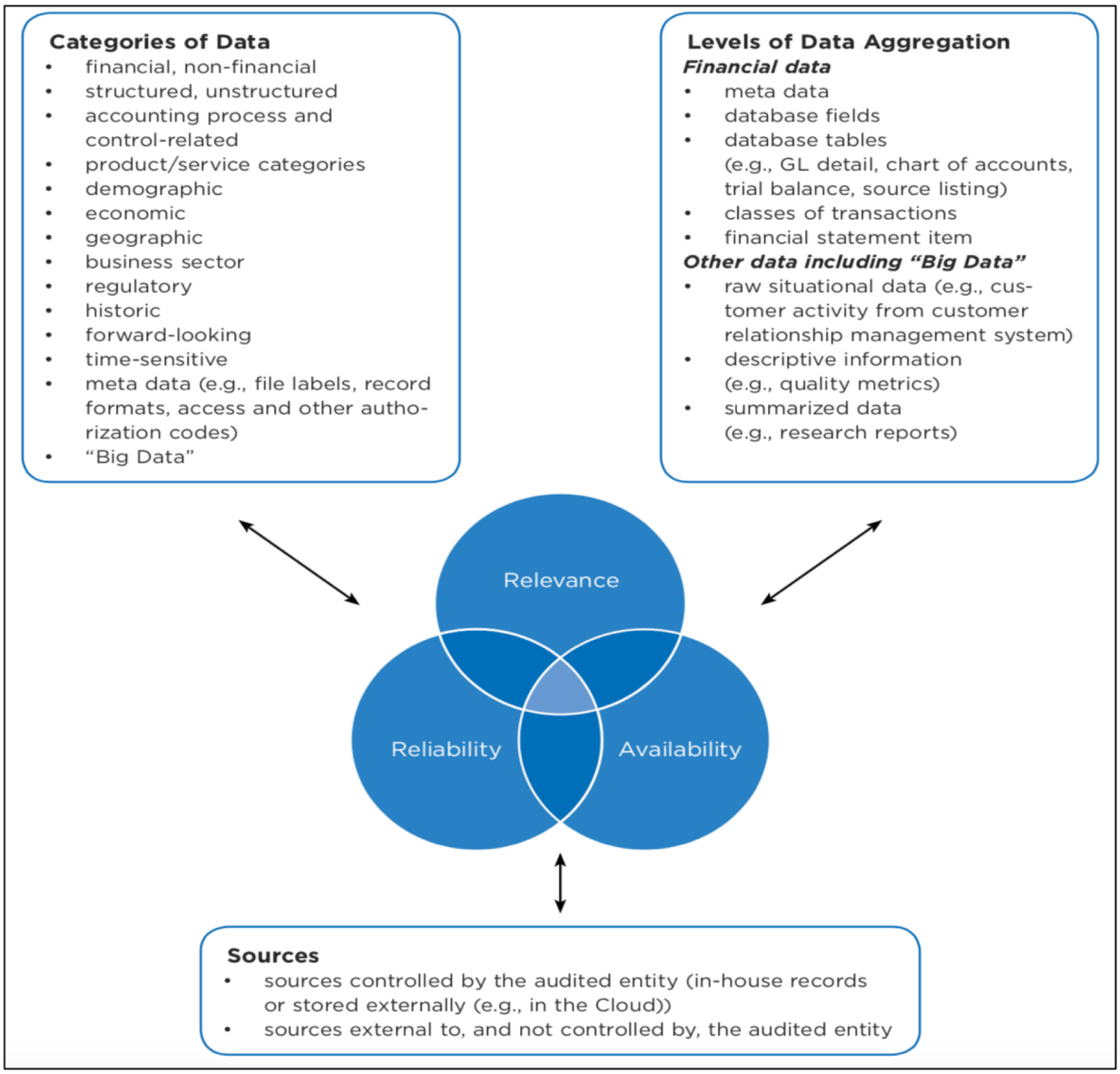
1)**Reliability**: The data have to be accurate and exhaustive in order to support in an effective way the goals of Data analytics.

2)**Availability**: Data that are used in the context of Data analytics procedures should be available in a reasonable timing and optimized from a monetary cost point of view.

3)**Relevance**: Data have to be useful and relevant in order to bring an added value to the audit process and support the objectives of Data analytics.

Each of the 3 criteria above are **essential** characteristics for Data that auditors use in their procedures. It's obvious that in function of the data used, the level of these 3 criteria can vary from **low to high** and inversely. Consequently, the assessment of the auditor can be highly influenced by the type of data he uses. For instance, if we take data that are coming from a system where strict internal controls were performed, it will automatically increase the level of reliability of data that are coming from this system (CPA, 2016).

Figure 1.1: Data attributes that could be considered in an audit data analytics



Source: (CPA, 2016)

Furthermore, if the auditor uses data coming from **external sources** and not from the audited company itself such as websites or social media's, it could also in the same way **increase reliability**. It can be justified by the fact data are less subject to bias created voluntarily or not by the management team of the audited company. Nevertheless, the auditor has also to keep in mind that he does not have everything in his hands to evaluate if the data coming from external sources are provided by systems with a decent level of control (CPA, 2016). Thus, it is the auditor's responsibility to assess the degree of reliability of the data he has by taking into account all the available information's.

It's also important to notice that the criteria of "Reliability" **has not always to be fulfilled before the performance of the Analytical procedures**. Indeed, it can depend on the purpose of the Data Analytics. For example, if the purpose is more **exploratory** and related to a text mining task by scanning contracts with important clauses, we could **not check the reliability** (CPA, 2016). Additionally, we could use Data analytics for a test of controls for example in which the purpose in itself of the task is to check the reliability. In this last case, we don't need either to check the reliability prior to the performance (CPA, 2016).

Major historical evolutions of the auditing sector

In order to better understand the technological evolution of the auditing sector until today, it's useful to remind from where the audit comes from in what concerns technology and the role of the auditors across the time. We can divide a timeline mainly in 5 periods (Lee & Azham, 2008):

1) Before **1840**'s: If we start from the very beginning, auditors favoured an **exhaustive approach** where all the transactions were examined with detailed verifications. Thus, there was still **no sampling** as it's the case now. The main purpose of the auditors was to spot **fraud cases.** Obviously, firms were much less structured than what is now and consequently, no internal controls were performed. The perception of the auditor was also much more different because he was more perceived as a **detective looking for frauds** rather than as a control organization verifying the trustworthiness and fairness of the company's accounts.

2) **1840's-1920's**: During this period, the industrial revolution that started in the UK highly influenced the task of the auditor and brought a substantial evolution

of their role. Indeed, in addition to their role to spot frauds, they had to spot **technical errors and errors of principle**. The error of principle refers to a mistake caused by a wrong recording of an amount in an account instead of another account. Thus, it is not about a mistake in the value itself, but it is a violation of an accounting rule concerning **the classification of the amount in the wrong account.**

3) **1920's-1960's**: From this period, companies became bigger and bigger which justified the need to separate **the ownership function from the management one**. Here again, the auditor function evolved and was meant to ensure the **trustworthiness to the financial statements** drafted by the managers that were intended to the shareholders of the companies. Moreover, audit evolved towards a **sampling approach rather than a full detailed verification** as designed in the first years of auditing. Additionally, at the same time, the concept of **materiality** made its apparition and is still now extensively used and considered as being one of the most important concepts for auditors. The materiality is defined by the corporate financial institute as : "misstatements including omissions, are considered to be **material** if, individually or in the aggregate, they are reasonably expected to influence the economic decisions of users based on the financial statements. Materiality in audit comprises both quantitative and qualitative aspects" (CFI, 2018). Concretely, it's a **threshold** that determines if yes or no an anomaly has to be taken into account by the auditor.

4) **1960's-1990's**: This period can be characterized mainly by the adoption of a **new approach that is the risk-based approach** and an increased complexity of the companies due to their size. This last parameter contributed to considerably **increase the amount of transactions** inside firms and it changed the vision of the auditors because they relied from this moment much more on the internal controls performed in order to initiate their audit processes which allowed them to reduce detailed analysis. From this period, we can also remark an evolution in the role of the auditing task that is now to provide **trustworthiness to non-financial and financial information** given in the annual report of the firms. Moreover, from the 80's, auditors began to rely more and more on analytical tools in their analyses. That's why they also adopted a risk-based approach which is a noticeable evolution. A **risk-based approach** can be defined as a method where the auditor will base his analysis **on the areas where the probability to find mistakes is the highest**. By using this approach, auditors

have to better understand the companies they are analysing and gain further information's about their structure, the industry in which they are present, ... Thus, it's typically relying on **highly diversified sources of information's**.

5) **1990's - …….**: From this period, we can notice the progressive use of **CAAT's programs**. CAAT stands for computer assisted audit techniques and can be defined as a "technology that helps to evaluate controls by extracting and examining relevant data" (Chartered Institute of Internal auditors, 2018). Obviously, programs developed in the 90's have not to be compared with today's programs, but it was already the first important step made by audit towards a **data-driven audit**. Indeed, at the beginning of the CAAT's, auditors could use small scale solutions that allowed to do simple sample selections on the basis of stock volumes for instance (International accounting, auditing & Ethics, 2016) but it has nothing to do with today's capacities.

Indeed, today, it's possible to treat **high amount of data** almost on an industrial scale in addition to the fact **calculations are realized in a very short time-frame**. The technology becomes much more mature now compared to the beginnings because it's not only about the **ability to process things much faster** than before but it's also the fact we can bring additional elements to the risk assessment because we can now integrate **external and non-financial data in it**. Moreover, the maturity of the technology can now be explained by the improved ability **to capture and transfer data**. One of the highest barriers in data analytics is to obtain the data and integrate it in the programs and this difficulty has been reduced significantly in the last years thanks to **the massive adoption of ERP's systems** such as SAP for example that facilitate the extraction of data (International accounting, auditing & Ethics, 2016). Thus, these technology improvements in terms of Big data and analytics can now be considered as an opportunity to **totally redesign the way the audit tasks are performed**.

Development of data analytics tools

Data analytics is already widely known for its capacity to **increase the audit quality** and that's why many large audited companies are willing to know how Data analytics is used to analyse their financial statements. That's why some companies are now taking into consideration Data analytics as a **major criterion in order to choose the auditing company** (International accounting, auditing & Ethics, 2016). So, the quality of Data analytics offering becomes primordial because many clients want to use and to benefit from the analysis provided by analytics that they **cannot easily generate by themselves.** This raises the question of independence between the client and the management. Indeed, Data analytics is in a certain way dependent on the management of the audited company and they want in return to know what has been found with the data provided. But what is found constitutes audit evidences that are **not communicable to management** even if it's thanks to them partly that Data analytics is possible.

Small Companies

The expertise of small firms in Data analytics is **generally more limited** than for the bigger companies. Furthermore, some specialized companies are now trying to provide Data analytics tools to firms that are **compatible with the software providers proprietary audit systems** (International accounting, auditing & Ethics, 2016). Examples of such widely used systems are Kashflow, Xero or Intuit. Another famous example of Data analytics offering is the one proposed by Caseware Analytics. It's designed to help auditors, accountants and professionals in the finance field **to perform data analysis quickly and to improve the quality of audits**. Through this program, Caseware has developed several analytical solutions **specifically designed for the audit use**. Concrete tasks that are performed by this kind of program can be data extraction, transformation or analysis (see the page 30 on "Acquisition of the data"). The advantages brought by these solutions are its abilities to develop the efficiency, to generate new services and to improve the audit quality (International accounting, auditing & Ethics, 2016). Moreover, we can establish the following list containing examples of functionalities that can be performed with the help of third parties' programs to help smaller auditing companies to develop generic but useful data tests (Centre for financial reporting reform, 2017):

- Examination of the segregation of duties
- Trend and probability investigations

- Doubtful keywords in the description of journal entries
- Analysis of unauthorized journal entries
- Duplication of accounting and journal entries (on the basis of the name, the address or the bank account for example)
- Identification of sleeper accounts

Nevertheless, smaller companies **are often reluctant to integrate Data analytics** tools in their processes even if they recognize the efficiency gains and the added quality brought by the technology. Indeed, it would significantly **change their daily routines** and all the challenges that it implies. For example, it requires to retrain/re-skill auditors and to make them learn new tools with an uncertain **timing needed to familiarize them with Data analytics**. Furthermore, the development of customized and optimized tools from a software and hardware point of view requires significant resources that are not always available for smaller structures. All these issues related to the integration and the development of analytics in smaller organisations make them more sceptical.

Medium-size companies

With regard to medium-size companies, it can be a major issue for them to aim auditing larger companies when not having a sufficient level of Data analytics expertise and offering. Such kind of companies can have trouble supporting the investment from a financial point of view in addition to the fact **the return can be low on the short-term**. That's why some medium size companies and bigger ones (through subsidiaries) are **proposing non-audit data analytics solutions and services** such as Data mining or IT consulting to support the implementation of their own Data analytics (International accounting, auditing & Ethics, 2016). Some companies are overall satisfied to provide such king of service by helping management of firms to **build their own management structure** rather than providing controls of their assurance systems through audits.

How to develop data analytics tools?

There are **several different possibilities** to develop Data analytics tools such as firstly creating **coalitions with third parties**. Secondly, companies can **create their own tools either by "starting from nothing"** or by basing **their tools on existing systems**. We can globally assume that all the possibilities are used by the existing companies in function of their budget. Generally, programs are designed to offer the simplest interface as

possible with **the least trainings as possible for the audit teams**. Nevertheless, the development of systems compatible with a multiple amount of accounting platforms requires a **high degree of specialization and expertise**. For example, companies can pay commissions in order to use programs developed by third parties or use their own to analyse data. On the other side, companies can cost their own software in order to decrease their marginal cost to zero (International accounting, auditing & Ethics, 2016). Thus, we can summarize the different alternatives available for companies with the following points:

- **Acquire systems developed by third parties and companies** by paying fees or create cooperation: These 2 options have the advantage to remove difficulties from a technological or expertise point of view.

- **Develop tools internally** either by **starting from nothing** or by completing **existing solutions**. The advantages of these 2 options are that we can develop **tailor-made programs** that respond perfectly to the demands of the audit teams. Moreover, **adjustments** can be easily performed by taking into account remarks from auditors on the field when opting for this solution.

In a few words, data analytics advancements can cause in some cases (mostly smaller companies) **a resistance to change** and companies can be **reluctant to develop their own tools**. Indeed, companies often assess the value of an investment through **a cost-benefit analysis** that can be in the case of data analytics misleading. Costs are in general more easily assessable (cost to develop or buy a tool, cost to train the auditors, …) while the **benefits are not so easily estimable**. For example, the efficiency gains it can bring on the long run or the quality increase in the audit procedures are more difficult to assess. That's why management has often the tendency to give **more importance to cost rather than benefits**. Nevertheless, on average, we can esteem the biggest part of the auditors will follow and evolve with the change by taking as an advantage the growing use of Data in the audited entities. Finally, it's a **matter of life or death** because companies that are not enough equipped in terms of data analytics tools will lose significant number of clients to the profit of companies that are using it to provide better services.

Example of a data analytics tool

EY helix is a concrete example of tool developed by EY within the scope of Data analytics that has been designed to be used **from the smallest to the largest clients of the company.** This tool is now fully integrated to perform tasks in the context of audit procedures. The philosophy of EY while developing this tool can be summarized in one sentence: It's not the tool itself that has to identify problems but it's the auditor who has to understand what the data mean and to evaluate its impact on the audit. The goal of EY with Helix was to make emerging **an analytics-driven methodology** that support auditors to deliver higher quality, deliver more client-relevant audits and to push the level of professional scepticism at a higher level.

The development of EY Helix gave to the company **new possibilities in terms of audit quality** because it allows **to treat bigger amount of data** in order to provide deeper insights over the audited company. Furthermore, it allows to have **a better comprehension of the company's business** and their daily operations. The other major advantage to use this tool for EY is the fact that it has been developed specifically to **satisfy the needs of each and every client** because It's now fully an unavoidable element of the audits.

EY Helix is a tool that is used **globally** by all teams in the world because it is a true audit enhancement through data capture and analytics tools. This allows to directly **increase the value** we take from data. These functionalities can assist the auditors from the risk assessment phase until the execution to cover the whole **operation cycle of the businesses** (EY, 2018). We can highlight several functionalities such as the sales invoicing feature (allowing to check visually which invoices are cleared, and which ones are still open), the effect of credit memos on an organization (analyse how invoices are cleared to check which amounts have been paid through the bank and which ones through credit memos) or the analysis on how the various invoices are settled (analysis of the aging balance that comprises all the accounts receivables ranked by age) to understand which customers have the bigger risks and focus on these ones with specific procedures. In a few words, this helps to enhance the comprehension over the revenues and the account receivables by assisting the auditors to focus their work on the most critical parts. EY Helix is a true competitive advantage mainly thanks to the following elements:

- Availability of the program all around the world and applicable to **various industries and audit areas.**

- Theoretically, it can manage **an unlimited amount of Data** where other software's such as excel are limited in their capacity.
- The functionalities are well integrated in the tool to match as much as possible with the audit methodology and philosophy developed by EY.
- Bigger confidence in the financial reporting by highlighting **unobvious tendencies and trends** in the audited company's data.
- Examination of bigger populations to cover a **bigger part of the organization's operations** and to identify the relevant risks.
- Recognition of **anomalies and exceptions** in the processes of the organizations as well as for the controls.
- Advices given by EY to **help the organisation to enhance their processes**.

This tool developed by EY contains **different functionalities** applicable to different parts of the organisation's financial statements and we can establish the following list for the main features (EY, 2018):

1. **General Ledger analyser:** This functionality allows to perform analysis on the General ledger of the client whatever the size and the quantity of Data to treat. It improves the ability of the auditor to understand the business of the client, the planning, the risk assessment and the quality of the auditing procedures.

2. **Trade payables analyser:** This functionality allows a deeper analysis of the purchases done by the audited company and all their trade payables. It enhances the understanding of the whole purchase-to-pay process from the procurement of the good to the payment.

3. **Inventory analyser:** This functionality is relatively simple as it refers to the feature allowing a better comprehension of the inventory's components. It helps to reach a better efficiency in what concerns the inventory part of the financial statements.

4. **Mortgage Analyzer:** The main goal of this analyser is to provide the auditor with a risk profile evaluation of the client's mortgages. This profile is determined on the basis of different criteria that have different weights in function of the risks identified.

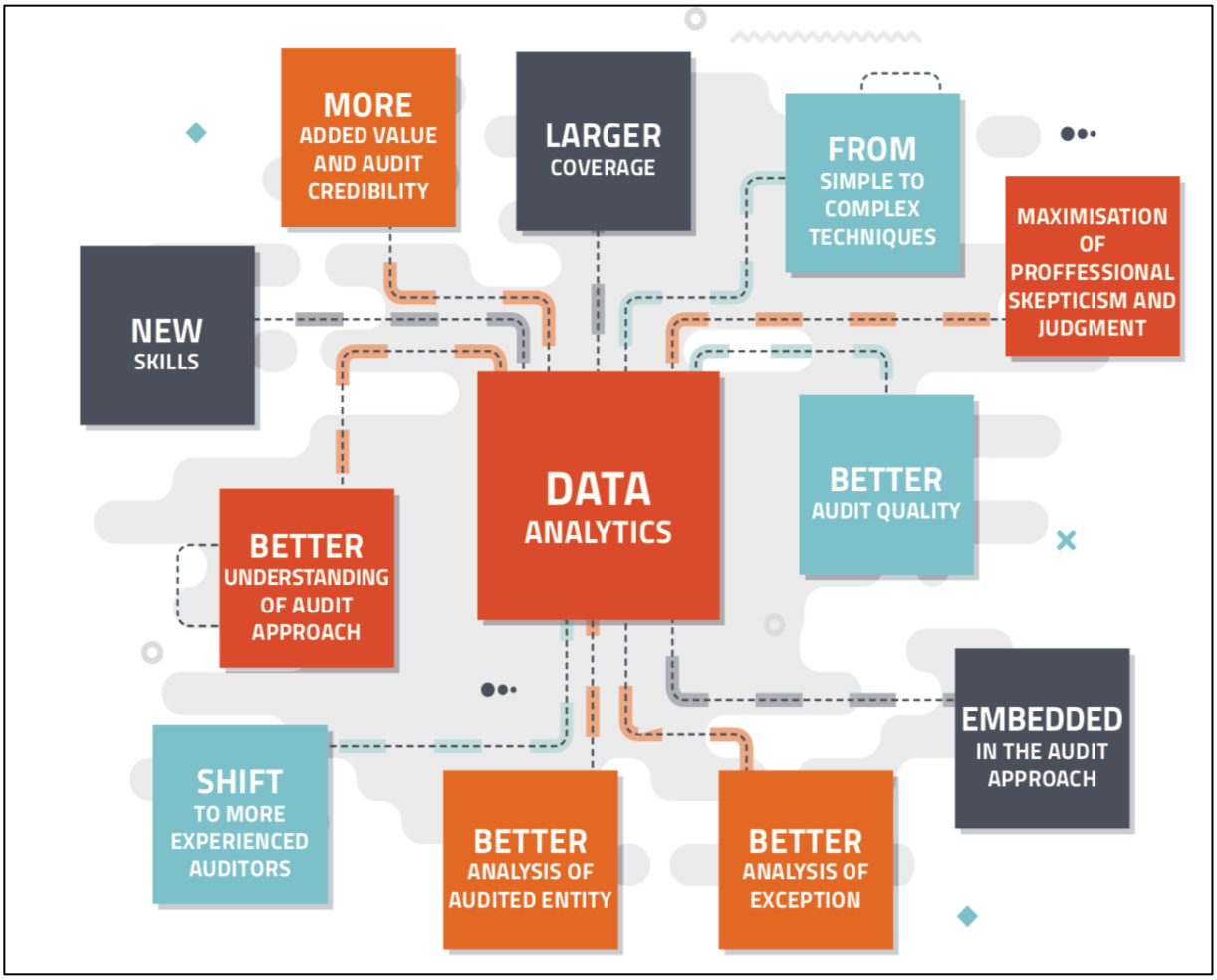
5. **Trade receivables analyser:** This functionality allows a deeper analysis of the revenues collected and all the receivables in order to better understand the order-to-cash cycle. The order-to-cash cycle makes reference to all the steps from the order of the client to the cashing.

6. **Group Scope analyser:** This functionality is designed to assist the auditors concerning the organisation and the presentation of the data influencing the auditing group scoping strategy.

Main Advantages explained

Below, we can find an interesting chart (figure 1.2) summarizing well in a visual way some features related to data analytics and that will be discussed more precisely in the next section:

Figure 1.2: Advantages brought by data analytics



Source: (IRE, 2018)

- **Improvement of the Audit quality**

The financial statements quality can be improved with data analytics and it can be justified by the fact we can test a **bigger part of the population with the aim to achieve 100 % data tested**. By this way, the auditors can benefit from the combination between **quality and value from its use** (IRE, 2018). Moreover, data analytics thanks to the larger population analysis enhances the ability of the auditor to find audit evidences which makes such that we can establish better **risk-based selections for further evaluations** (IAASB, 2017).

Thus, there are several arguments to prove that data analytics tools bring higher standards for the audit area and to sum up which precise elements improve the audit quality, we created the following list that recaps the main elements:

1) Earlier identification of issues

One of the advantage of data analytics is that it allows auditors to **initiate the analysis of the client's data early** in the audit process. Consequently, auditors detect at an early stage what are the audit areas that require more attention. It enables to **put in place specific procedures** tailored to the needs and the risks encountered by the client. Moreover, these evolutions have a direct impact on the ability of the auditor to take a **forward-looking** approach (Centre for financial reporting reform, 2017) in what concerns the detection of exceptions, patterns or fluctuations which enables to focus on the riskier areas. As the auditor will spend more time on these riskier areas, he will perform a better **risk and fraud analysis.**

2) Breadth and speed of the analysis:

An interesting comparison to better understand data analytics could be to draw a parallel with the expression "**finding a needle in a haystack"** (International accounting, auditing & Ethics, 2016). Indeed, current auditing standards are based on the assumption that what is really important now is how you find the needle inside the haystack but now with the rise of data analytics, the haystacks have been reduced which leads to an evolution. Because what will really matter in the future is what you will do with the needles when you found them. It totally illustrates the fact that with this technology, we will be surer in the future to find from where the anomalies come, and the main issue will be **how you solve them**.

Another important advantage concerning data analytics is its ability to give to auditors much more larger data sets in a more rapid way thanks to the recent developments in the interfaces that link the customer to the auditor's systems which **can ease the extraction of data**. These interfaces give the possibility to the auditor as described in the point before to perform audit routines earlier in the risk assessment phase for example rather than later in the substantive procedures (International accounting, auditing & Ethics, 2016).

3)Improved understanding of the organization and its environment

This factor has a big importance because it allows the auditor to perfect its **professional scepticism and judgement.** Indeed, as we previously described, the quantity of data that is being produced increase more and more in addition to the high complexity of these data. Data analytics will allow to the auditor to have a better understanding of the organization he's analysing. This will imply as described in the first point, **a better risk assessment** and answer of the auditor that will lead to an enhanced quality of the audit procedure. Another point to which we would not think about immediately concerns the **attractiveness of the job** itself as a possible career opportunity. Indeed, people are generally attracted by job with a high added value and the fact the **professional scepticism and judgement** will be improved represents a future asset for the auditing field.

- **Improved client service**

4) Visualization feature

This is an important element because it allows to see things **graphically** which can help the auditor to provide the client **with better explanations**. For instance, some types of dashboards could also be useful in order to compare more easily data with previous years or compare results with other businesses. Additionally, it enables to identify **correlations, trends and patterns** in a much faster way than we could have done with data that would have been text based (Financial Reporting Council , 2017). That's why we can mainly differentiate two points in the visualization feature of data analytics.

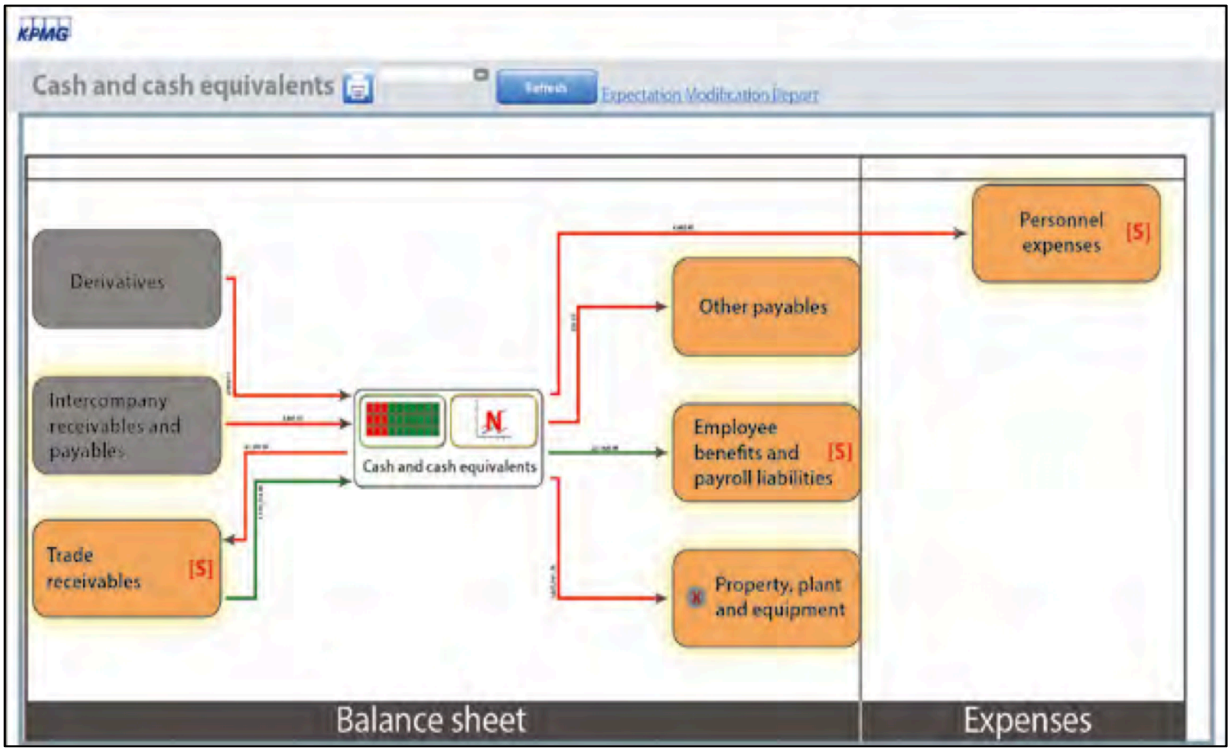
4.1) possible use by non-specialists

It can look like a minor factor, but if we want to make of data analytics a core pillar of the new digital strategy, we have to make it **intuitive**. Moreover, it's also for the common interest because this will decrease t**raining hours needed that the companies have to provide for auditors**. Indeed, some basic but useful functions that are integrated within data analytics tools can be used by auditors **without being an expert in the treatment and the analysis of Data**. Thus, data scientists would not be needed in permanence for all tasks even if the integration of specialists in audit teams will certainly be an advantage for more advanced functionalities.

4.2) Better dialogues between implicated parties

As data analytics will involve more **informed processes** and data, it will allow the auditors to have **real valuable interviews and dialogues** with implicated parties to gain further insights. For instance, we could imagine having dialogue with people responsible for the governance inside the audited firm. Indeed, communication with the client can be **facilitated** when opting for graphics or visual information's as they are generally easier to understand. This argument will also develop the credibility of the audit given the fact it will rely on **more valuable and credible** information's. Moreover, additional valuable information's are also advantageous for audited companies as it will bring them more information's **on their risk assessment and business operations** enabling them to have another point of view on their data they wouldn't have accessed before thanks to visual representations (IAASB, 2017).

Figure 1.3: Illustration of the visualization feature

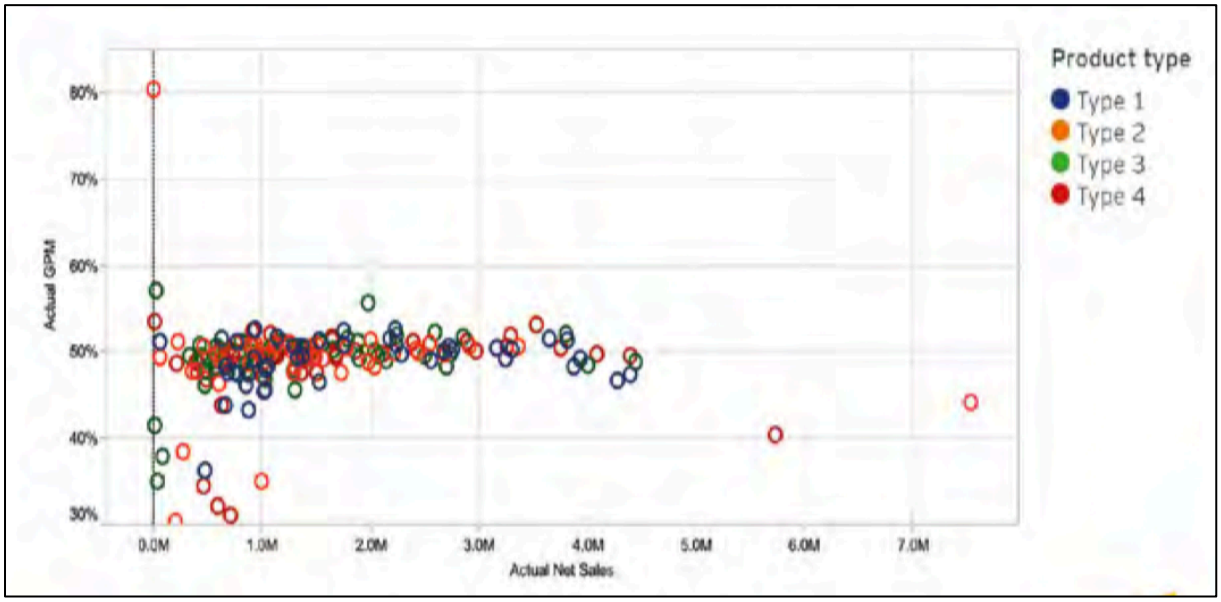


Source: (International accounting, auditing & Ethics, 2016)

On the figure 1.3, we have one example of data analytics program developed by KPMG called "**KPMG's journal flow analysis**" in order to illustrate the argument above of the utilization's ease caused by the visualization feature of this kind of program. Concretely, it's a visual showing accounting entries written in the context of a general ledger of a company.

We can remark through this chart a map showing to the auditors **all the flow of transactions recorded by an organization** and it can help to detect unexpected double entries that are highlighted with the red arrows. Moreover, we can remark that each transaction according to its size has a **different volume** which represents the value of the entry and this enables the auditor to focus on transactions **with higher values and risks**. Then, they can investigate individually each transaction more in detail for the ones that seem to be suspect.

Figure 1.4: Illustration of the visualization feature



Source: (International accounting, auditing & Ethics, 2016)

Another example of the visualization feature of data analytics can be found above in the figure 1.4 within the context of **a revenue analytics** where the auditor tries to assess the profitability level of all the different types of products that are proposed by a company. In what concerns the interpretation of the graphic, we can say that the different colours represent the **different types of products proposed by the company**. These products are split on the chart in function of 2 variables that are the **net sales** and the **GPM** (Gross processing margin that calculates the difference between the revenue brought by the product and all the cost of the raw commodities used to produce the good). This type of analytics supports the auditor in order to better **identify and understand what are the different risk**s concerning the sales, the gross processing margin or the costing proposed by the company. Thus, this graph allows to identify **bizarre trends** in the performance of the products and leads the auditor to ask more precise questions to the company to understand if the bizarre trends are correctly justified. Consequently, it has as a general effect to increase t**he quality of**

the audit as we can specifically design audit procedures in function of the trends that are seen on the graphic.

- **Improved effectiveness**

5)Maximize the efficiency of the human judgement

A concrete example of this argument can be found in **the context of the decreasing time needed for auditors to perform manual analysis**. Types of manual analysis that can be automated will be later specified in the section related to the "integration of data analytics into the audit procedures" (p 73). By this way, they can dedicate more of their time to use **their judgement in order to analyse data**. As previously noticed, this will help them to really focus on the part of their job that is really **adding value**. As data analytics implies a bigger part of automation in the processes, the auditors will be able to target with more precision the **most fundamental parts of their job and the riskier parts of the procedures.** Because beyond the pure time argument as we can do things faster, we can go to the **most essential things more rapidly** rather than spending a lot of time on samples that regularly do not tell so much (International accounting, auditing & Ethics, 2016).

6) Continuous analysis

Data analytics enables the auditor to initiate **testing's more frequently** and to reduce the **time needed between testings**. It creates a major evolution as he does not need any more to focus procedures **around the year-end** (Centre for financial reporting reform, 2017). As the auditor can be engaged in a continuous process of monitoring, he can better manage the identification of the risks as well as the assessment of the controls.

Main limitations explained

In the previous part, we highlighted all the benefits that are brought by data analytics but obviously, we can also notice some **limitations** and we will try now to find some of them by establishing the following list.

1) **Need for auditors to understand and verify the data they are using**

This point specially applies to the **relevance of the data** that are used in the context of the audits. Indeed, the relevance of the data is a very important parameter because when data are not well controlled or not reliable due to for example bad sources, it can **negatively affect** the quality of the audit (IAASB, 2017). On the other hand, even if the auditor assesses that he's dealing with relevant and reliable data that can possibly give further insights for him, he has to be aware that it will not provide all he needs to know on the audited entity (IAASB, 2017). That's why a large majority of interviewed auditors would be in favour of the development of a **new standard precisely describing how to assess the reliability and the trustworthiness of data** from both internal and external sources such as Big data due to their raising importance in the future. This proposition will be discussed more in detail later in the section concerning "the challenges encountered by the regulators" (p48).

2) "Reasonable assurance" provided by data analytics

Obviously, the auditor must try to keep and to exercise permanently its **professional judgement** related to accounting and auditing. And the fact we can possibly test 100 % of a population rather than selecting samplings does not mean that the auditors cannot fail anymore in its judgement and absolutely guarantee **that mistakes will not happen**. Everybody has to keep in mind that we can't provide more than this "reasonable assurance" or at least, the definition of "reasonable assurance" could have evolved in a way to have higher standards with the appearance of data analytics (IAASB, 2017).

3) **No replacement of the professional judgement**

What is also important to remark concerning the financial statements of many organizations is that a significant part of them are based on accounting estimates or qualitative data (IAASB, 2017). Consequently, the assessment of the auditor requires professional judgement to evaluate the **degree of reliability of the organization's**

estimated value. It's sure data analytics enables to develop valuable information's for the auditor that he has to take into account but, the use we do from it requires to **keep its professional judgement and scepticism**. Indeed, one of the issues when referring to data analytics in order to generate audit evidences is that the logic behind data analytics tools such as the algorithms can seem opaque for auditors and there are some risks auditors do not totally understand how the results are obtained (EY, 2015). That's why according to some experienced auditors interviewed, we have to find a **right equilibrium** between counting on analytical tools and exercising professional judgement on the results provided.

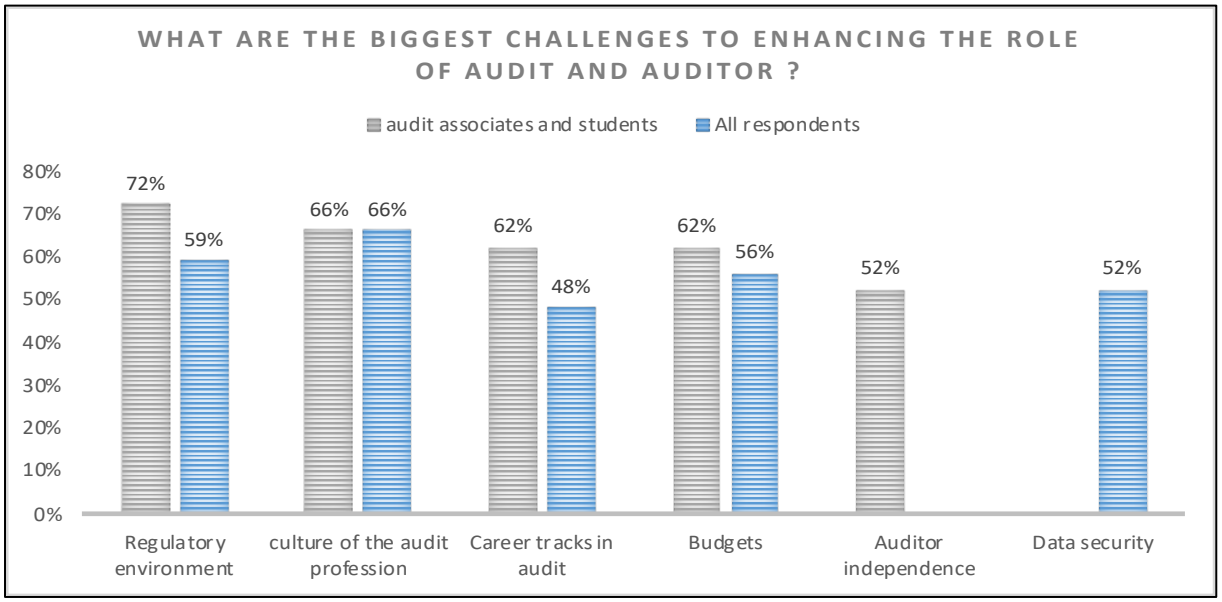
4) Overconfidence in the technology

We already could remark in previous parts that data analytics brings a lot of advantages and the use of this technology can considerably improve the quality of the audit evidences. Nevertheless, prudence should be present for the auditors and the stakeholders in what concerns a possible **excess of confidence** in this kind of technology. Indeed, we always have to keep in mind the limitations of analytics and not think it's an **infallible process** (IAASB, 2017). For example, an auditor would be wrong if he thinks "the results have to be 100 % sure because an analytics programs generated it".

Main challenges and current unanswered questions

As previously described, the development of new technologies using a considerable amount of data will considerably modify the industry and create new opportunities. A survey conducted by Forbes in collaboration with KPMG (in 2015) among different actors close to the auditing industry such as accounting students, audit professionals and academics confirms that **new technologies will have a big impact on auditors and their role within the audit profession** (Forbes, 2015). As showed on the figure 1.5 below, The report really shows interesting figures because it states that **59 % of all the participants esteem the regulatory environment is the biggest challenge to enhancing the role of audit** and that's why a part of this thesis will be dedicated to describe the challenges encountered by the standard-settlers with the technological evolution of the profession (Forbes, 2015). Furthermore, 66 % of the respondents think that **the audit culture needs to change to be able to make a step forward**.

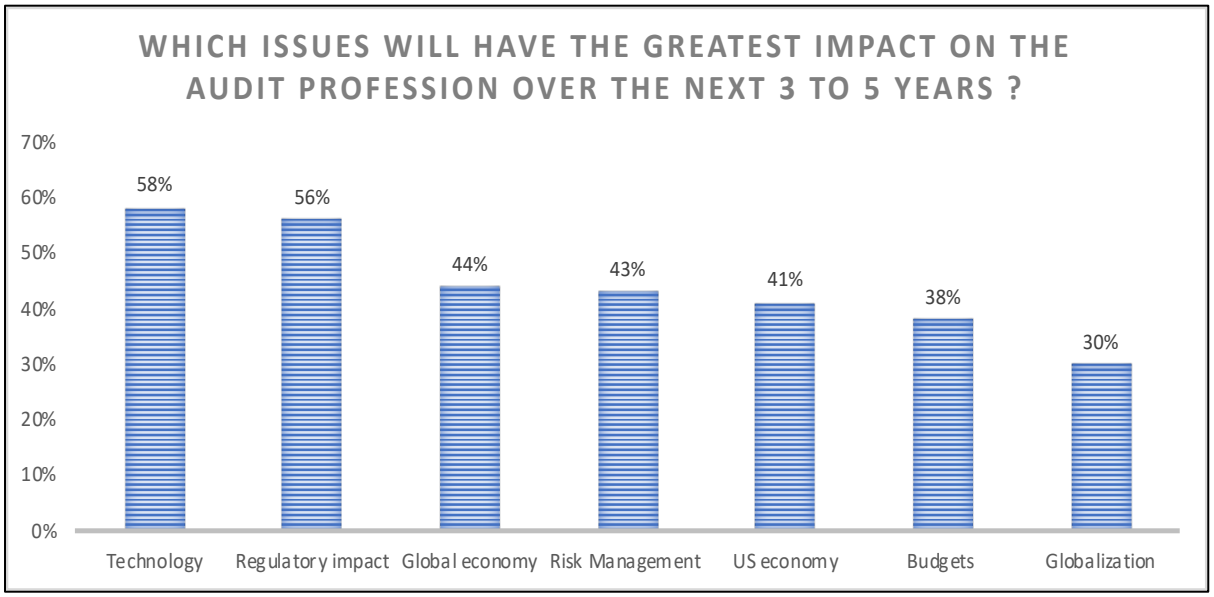
Figure 1.5: Survey indicating the perceived biggest challenges to enhancing the role of the audit and the auditor



Source: (Forbes, 2015)

Furthermore, we can notice another important concern of professionals (52 % of them) on **data security**. This precise point will be discussed in more detail in the next section concerning "audited companies" (p32). Finally, other points such as **budgets** and **auditor independence** are important matters for audit associates and students within the scope of this survey.

Figure 1.6: Survey indicating the perceived biggest factors influencing the audit profession over the next 3 to 5 years

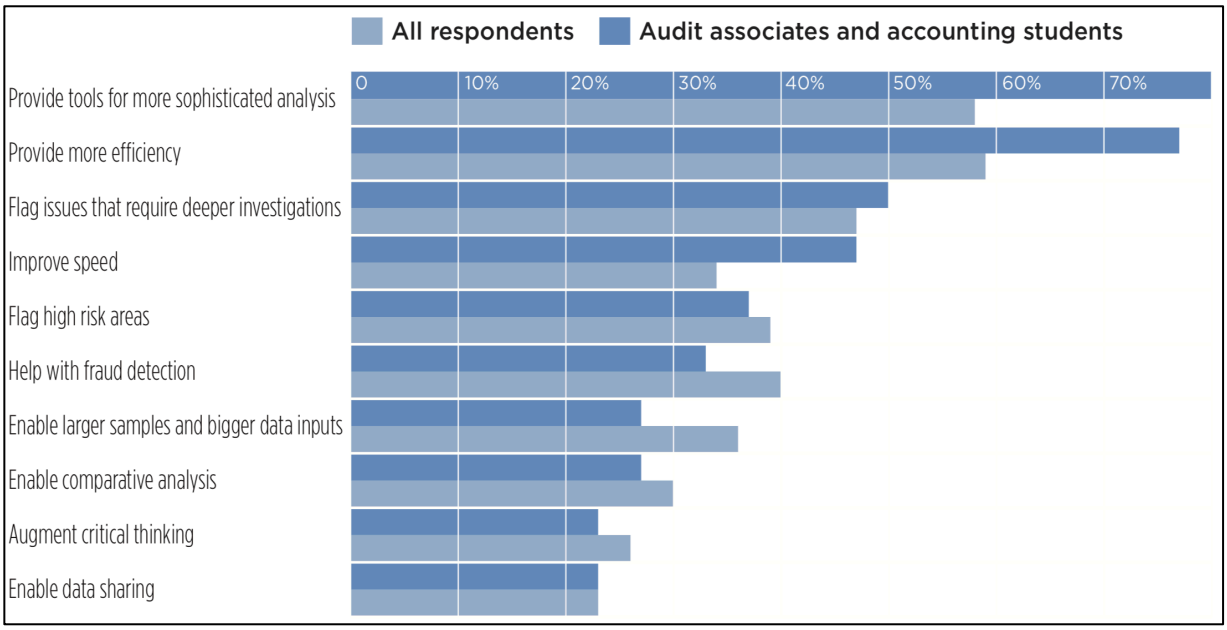


Source: (Forbes, 2015)

As illustrated on the figure 1.6 above, we actually see **technology is actually recognized as the biggest challenge by audit professionals** before other important factors such as the well-known **heaviness of the audit regulatory environment** and before the influence of **the global economy**. That's the whole purpose of this thesis to understand how technology will impact the sector and which changes it will imply concretely for the auditors as it is a major concern for the profession.

The next reflexion within the context of the survey was focused on the impact caused by technology and how auditors evaluated it by responding to the following question: **"What is the impact of Technology on the audit process?"**

Figure 1.7: What is the impact of Technology on the audit process?



Source: (Forbes, 2015)

On the figure 1.7, we can remark a **noticeable difference between the youngest generation of respondents in the survey and the others** because the new generation values much more the fact we can use **new tools allowing to provide more sophisticated analysis** than the oldest generation of auditors. We obtain the same type of answers in what concerns **the extra efficiency it can create**. It really illustrates the difference in the vision and the philosophy because there is a willingness of the young generation of auditors **to use the new available tools in their routines**. Thus, the youngest generation that is generally well aware of all technology advancements and at ease with its utilization is **keen on using it more to provide deeper insights**. Another reason why they are pushing is because it will totally change and even **revolutionise the position of the auditor**. Indeed, junior auditors are often asked to look for

evidences to support audit procedures and they often have to dedicate a significant part of their time to organize the presentation of these evidences with what we call the "**documentation"** step. Technology advancements will allow junior auditors to spend more time on the analysis itself and "lose" less time on "boring" tasks they had to do before being promoted to a higher position. Thanks to that, they have access to most valuable tasks earlier in their professional path. This contributes to make the auditor **profession more attractive to seduce more potential future workers** (Forbes, 2015)**.** This will of the young generation implies also some developments in the skills that are required to be able to react appropriately towards the new challenging situations that can arise. This point will be later discussed in the "change in the skills required from the auditor" section (p37) but we can already mention that a **critical mind** will always be required from auditors and will be even more than ever useful. Indeed, as businesses are becoming more complicated, **a critical mind** will never be replaced by new technologies.

Additionally, this digital phenomenon unlocks never seen opportunities from a data access point of view. Consequently, further controls are **more than ever needed in what concerns the collection and the treatment of data** because data leakage is a particularly important matter given the rising amount of data (Forbes, 2015). Many experts esteem we can compare the current situation in terms of data security with the emergence of the **Sarbanes-Oxley act** that was characterized by a vigorous attention of the investors **towards fraud management** (Forbes, 2015). The Sarbanes Oxley act was precisely aiming to **protect shareholders and investors against fraudulent practices** and accounting mistakes by enhancing the quality of the information's provided by companies. To maintain a good quality of information's, companies were obliged to keep in their record's certain types of documents for a given duration. The targeted documents were mainly activity's documents and electronic mails that had to be kept for five years. Additionally, companies had to take the appropriate measures **to protect their data** through encryption for example when needed (Digital Guardian , 2016).

In the next section, we will split **the challenges** in function of the different actors that are **involved directly** by the changes and evolutions caused by the data analytics implementation in the audit procedures:

1) Audited Companies

Acquisition of the data: accessing client's data

The **extraction of data from the client's system** can be in some cases a challenge for auditors and is sometimes perceived as a difficulty. Bigger companies often have access to the client's system through a **customized account** where they only have an access to **read-only functionalities** and they can download by themselves relevant reports with their own identifier name and identification for example (International accounting, auditing & Ethics, 2016). It's usually considered as an **effective way to collect information's** within the scope of audit procedures. Nevertheless, data capture can be an important barrier for auditors to be able to use analytical tools when they cannot extract data in an effective way (EY, 2015). In some situations, the main reason evoked is the **security matter** because audited companies can be reluctant to give an access to their system when they have **invested massive amount** of money to develop data security solutions. Consequently, the data capture process can be highly difficult for the auditor (EY, 2015).

Furthermore, auditors have sometimes to deal with **multiple different types of systems** within the same organization which complicates the data extraction too as the data capture competency is usually not among the core capabilities present in the audit's team. This situation often implies a waste of time in discussions between the auditor and the audited company to resolve this problem of multiple systems. In one of the surveys launched by the International accounting, auditing and Ethics organization (ICAEW), one of the participants declared he had approximately 450 different client's accounting systems. Nevertheless, sixty percent of the systems are based on common systems such as **Oracle and SAP** that offer interesting possibilities from a core scripting point of view (International accounting, auditing & Ethics, 2016). Currently, data extraction is mainly focused on the general ledger but if the profession wants to benefit from Big data, they will have to deal with sub-ledger information's such as revenues for example (EY, 2015). As consequences, it automatically **expands the amount and the complexity** of data that have to be extracted.

There are **several different manners** to collect information's and data. The method described in the first part of the previous paragraph refers to the method where auditors **extract by themselves data**, but another approach is to use approved data and information's coming from the management. In this specific case, auditors are required to perform an inspection of the data provided and approved by the management. Then, if all seems to be correctly approved and extracted, auditors can

use it to perform their own procedures. What is sure when extracting data is that management has always the **duty to check the integrity and the security of the data** they provide (International accounting, auditing & Ethics, 2016)

So, the consequent amount of time spent by the auditor to map differences between the various systems implies a **scalability** but also an **efficiency** in the offering developed by auditing organizations. The mapping performed by the auditors means that he has to **understand the data he's using** and how **they are articulated** in practice within the audited company (International accounting, auditing & Ethics, 2016). In a few words, he has to articulate them in a way that makes sense. The comprehension of data comprises for example to differentiate the dates when an element has **been initiated, approved or posted** by knowing we could have significant variations between them. This step has not to be underestimated by auditors because it constitutes an important point as it already gives the first foundations and intuitions on the company. One solution to reduce this problem consists in the investment by auditing firms in programs allowing data extraction and having a compatibility with the most used information systems but obviously, the cost of this kind of program can be very high even if they bring a true added value for the auditors (CPA, 2016).

Other solutions can exist for the data extraction step because some firms are specialized **in the software's allowing data extraction**. For example, it is possible to extract and analyse information's by exploiting patented accounting systems that are mostly adopted by SME's. Yet, it does not usually offer a high degree of customization (International accounting, auditing & Ethics, 2016). For an auditor, it exists many different possibilities to treat data and transactions because we can base our analysis for example on **the account, transaction type or the activity code**. The data transformation is also another topic that is essential while extracting data from the client because it's the step that is used in order to **make data useable for the auditor**. One obstacle that can arise from this step is the degree to which data have been **modified and generally simplified** (International accounting, auditing & Ethics, 2016). Indeed, this step implies an attentive work because it can definitely impact the quality of the audit's evidences gathered. Transformation of data often tends to make auditors afraid, but it can be helpful to do it in some situations (International accounting, auditing & Ethics, 2016).

In a few words, auditors may have some difficulties to extract data that are ready to be used due to several reasons. Indeed, when auditors want to use data analytics tools, they can in some situations deal with obsolete, unreliable or uncomplete data.

Furthermore, some companies can use a such wide variety of small software's for their business processes that it becomes difficult for the auditor **to extract useable data in an appropriate format without taking too much time modifying it**. That's why when companies try voluntary to enhance the coherence of their data management for internal reasons, it can also have a significant beneficial outcome for auditors too (CPA, 2016).

Cybersecurity and the data protection of the clients

Obviously, data analytics and other technologies will bring major enhancements in the efficiency and the quality in the job of the auditor. Moreover, we could expect in a near future auditors working in real-time with client's data through continuous auditing, but it raises questions in relation with **the security and the protection of the client's data**. Nevertheless, even if it's clear technology advances such as digitalized documents and the interconnexion between client's platforms and auditing company brings an added value, it exposes also companies to be more easily **subject to cyber-attacks to steal important information's** (Rutgers Carlab, 2017). As consequences following the loss of data due to a potential cyber-attack, it could negatively impact **the stock prices of the audited company** for example in the most extreme cases. Generally, auditors recognize security and confidentiality are among their major concerns and that's why they acknowledge this is a risk that has to **be controlled judiciously** according to many interviewees.

Yet, security should not be perceived as something **that leads to dysfunctionalities** due to exaggerated behaviours such as the fact users would perform their tasks outside the system. Normally, all organizations dealing with the client's data put in place **rule of conducts** to control which kind of data are used and for which purposes. These rules of conducts are largely decided in cooperation with the management. Thus, audit teams are often asked to limit as much as possible the use and the extraction of personal data but it's not always an easy recommendation to apply. Indeed, many audit professionals confess the risk is generally lower when being busy with business to business companies but when it's payday loan companies, this is often more complicated (International accounting, auditing & Ethics, 2016).

An interesting report performed by PwC in 2016 showed that between 2014 and 2015, the number of detected cyberattacks significantly **expanded by 38 % which really demonstrates the importance of this topic** nowadays. Given the importance of this topic and its potential damageable consequences on the stock prices of companies,

both internal and external auditors should value more this aspect with the aim of protecting the assets of organisations and also the interests of their own clients.

Nevertheless, it's clear that it will certainly imply an increase in **the costs included to perform an audit** as it would require for the auditors more efforts and attention to **preserve the data of their clients**. Thus, the use of data analytics within the scope of financial audit exposes companies to cyberattacks (including data leaks) that require special attention especially from a data **verification and validation** point of view. Solutions in order to tackle this problem can be to invest more money for companies on hiring qualified manpower able to put in place security procedures to protect data and give advices to auditors on how to properly extract and secure data they use (Rutgers Carlab, 2017). For example, trainings could help auditors to teach them **how to use secured platforms** to extract data and to limit their demands to what Is really necessary in what concerns sensitive data about employee. Thus, the development of such solutions requires companies to develop strict internal policies in collaboration with auditors, data security professionals but also audited firms to limit as much as possible the security risks (Rutgers Carlab, 2017).

In a few words, some audited companies are reluctant to let auditors have access to their system. Obviously, all companies want to keep their integrity for their data and that's why some of them have reservations when auditors use their data by fear of data corruption for example or data breaches (CPA, 2016). As consequences, the auditing companies have to take **all the necessary measures to maintain the confidence** between all parties involved in the audit processes.

2) Auditors

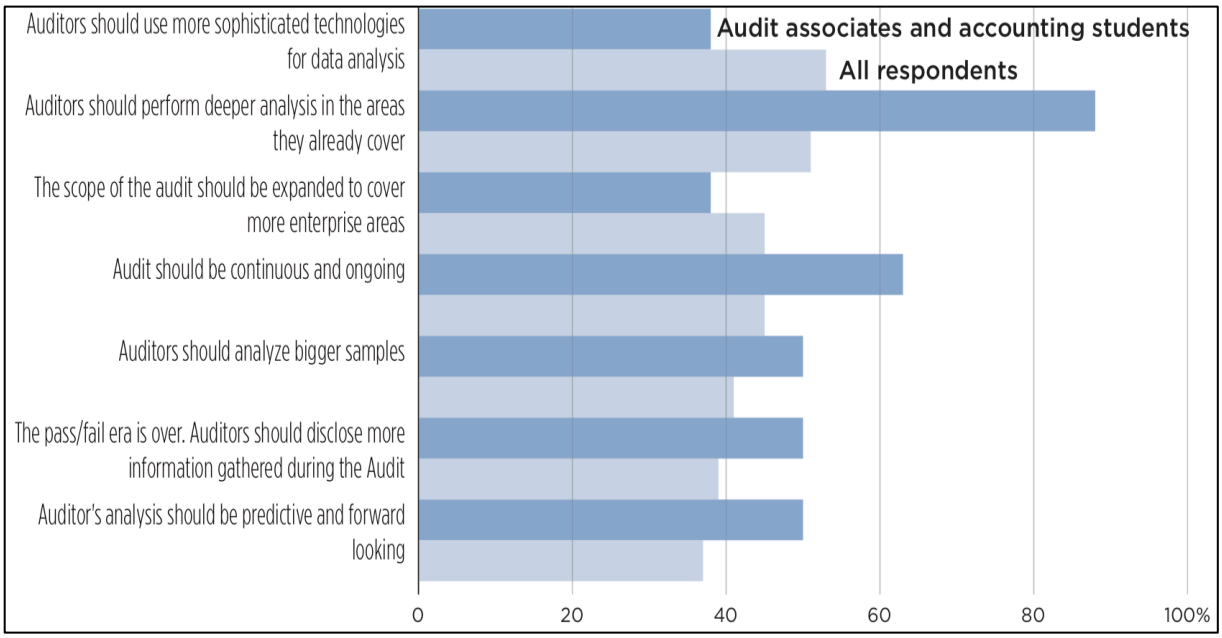
The rising amount of data and the increasing capacity to process it will revolutionize audit and provoke fast changes as never before. From this point of view, we understand that data analytics will play an important role in order to enhance the breadth and the quality of the audits. Consequently, auditors will have to integrate **technological skills in their nature** (Forbes, 2015).

Change in the role of the auditor

In the context where organisations use more and more data analytics in their operations, auditors need to evolve as well to keep up pace with changes because it will imply the **emergence of new sorts of risk assessments and controls** according to

many interviewees. Consequently, auditors need to respond to these changes by increasing the fulfilment of client's requirements as the expectation of the various stakeholders increase too. To be able to provide larger services, it requires according to the survey showed on the figure 1.8 below, to **use more sophisticated technologies** for data analysis and to **perform deeper analysis in the areas they already cover** (Forbes, 2015). That's why we can imagine now a situation where audit would go beyond what's foreseen in the traditional audit approach and **expand the scope of audit** by providing new innovative services to the clients. Indeed, auditors will work more than ever with data and it would be a normal advancement for them as long as the independence is not threatened. We can imagine several types of new procedures included in the auditor's mission from **advisory to consulting tasks**.

Figure 1.8: How should the role of the auditor evolve?



Source: (Forbes, 2015)

We can establish the following list of new tasks that could be performed by auditors that go beyond its traditional role (Centre for financial reporting reform, 2017):

- **Identification and prevention of fraud** and extension of the auditor's role towards the forensics field. Forensics refers to investigations conducted on the field of accounting and auditing to analyse the finances of some businesses. These investigations can be used in the context of legal disputes. Demand for auditors to perform fraud detection will increase in the coming years due to the evolution of the society too where we have a **deterioration of the ethical**

values. Forensics skills will be needed to unpick businesses similarly to due diligences practices (ICAS, 2016).

- **Integrated or sustainability report:** With all the information's available for the auditor through data analytics, we could imagine the auditors helping to draft a sustainability report aiming to present the impact of a company's business from an environmental and social point of view. Indeed, the evolution of the society could also lead to new expectations **in terms of sustainability from stakeholders**. Stakeholders could expect an assurance that a company Is effectively citizenship responsible (from a social and environmental point of view). Nevertheless, there is still a major barrier concerning the regulations and the possible litigations arising from the assurance of that kind of activities.

- **Identification of revenue losses, leaks** and other parts of the business where the company could improve its generation of revenue.

- **Advising organizations on their business operations** and the way they are dealing with cost management for example.

- **Use of predictive models:** The fact auditors could use predictive models will directly imply an enhancement of the forecasting's performed thanks to the huge amount of data available.

- **Deeper insights on risk management:** Data analytics could help auditors to provide better recommendations for companies to identify and manage their risks.

- **Real-time monitoring of controls:** The society Is evolving too through what we can call" an instant culture" and that's why audit could provide in the future real-time financial information's rather than annual reports. For example, it could allow investors or shareholders to have directly reliable information's on the company.

- **Consulting in the field of compliance and tax**

As mentioned above, we can imagine extensions in the role of the auditor in order to provide the client with a greater security and a diminished risk but it's essential to keep in mind that an auditor has to keep its **independence** in the processes. According to interviewed auditors, we never have too much information's on a client and the more information's they have, the more they can provide an accurate assurance to the stakeholders around the company. Nevertheless, the auditor has to make sure he does not intervene directly in the processes of the company at the risk of "corrupting" its own work and procedures.

Additionally, the results of the previous question are clearly indicating there is a different perception in function of the auditor's level of seniority. Indeed, when looking to the chart related to accounting students and audit associates, we remark we have a significant part (more than 80 %) thinking that audit **should perform deeper analysis in the areas they already cover** (Forbes, 2015). On the other side, the trend is largely less significant when looking at the chart related to all participants.

If we look at another proposition comprised in the survey, we notice another difference between generations with regard **to the pass/fail analysis of audit reports**. Indeed, another perspective is adopted by young auditing starters (more than 50 % of them) where we should not only limit to the pass/fail view **but rather adopt a predictive perspective**. Again, we have a significant difference with more experienced professionals where only 39 % of them share this point of view (Forbes, 2015).

What we can conclude from this part of the survey is that we notice **technology** is really an important factor that many professionals are now taking more and more into account in the processes. Indeed, students and young starters in the job seem to be persuaded that in the future the **audit breadth will be enlarged**. Many examples of expansion in auditor's tasks could be imagined such as fraud detection or the analysis of the data integrity (Forbes, 2015). Nevertheless, an extension in the role and the breadth of the auditor will certainly not change from one day to the next because it will require **adaptations in the mentalities but also in the standards**. Besides, many professionals esteem the auditor really benefits from such a particular situation that we can assess there is currently **an underutilization of what they could be reporting**. We have to imagine in the future an auditor doing analysis allowing him to give **deeper and larger advices to its clients**.

However, it's important to keep in mind that **technology only remains a tool** that is available, but the core quality is to develop **its critical mind**. Critical mind is an essential state of mind to **conduct deeper analysis**. The survey developed by Forbes is very interesting because it discusses with professionals from all seniorities the main challenges and elements impacting this digital revolution. As described before, first results from this report indicate that **58 % of the respondents perceive technology as the biggest impacting factor for audit in the future** and so most of them are aware of the changes it will bring on the profession and the skills required. For 80 % of the interrogated professional's starters, the main advantage coming from technological evolutions is that it will give **more means to provide deeper examinations**. Moreover, 59 % of all the respondents esteem the greatest value will come from **the gain brought from an efficiency point of view**. One of the conclusions drawn by this report is that the vision towards the evolution of the future is significantly different from one generation to another.

Thus, auditors can bring more added value by concentrating their efforts to use their **critical mind and professional scepticism** to Interpret the increasing amount of data they have in their possession. It would be a mistake for the auditor to focus too much on the data extraction and individual tools. Indeed, the purpose of data analytics is to upgrade the auditor's capacities on another level by deepening its effects. The rise of data analytics tools is a true opportunity for the sector because **audit needs do more** according to many professionals. Rightly, it's one of the interesting results coming from the Forbes survey because It states that 93 % of the participants esteem that the **audit has to provide deeper insights and to do more for the clients** (Forbes, 2015). Nevertheless, if the profession wants to reach such a level of completeness, it needs to evolve on many points. It does not just involve the technological capacities but also points such as the **profession's culture or skills required**. The evolution in the audit profession is not a real debate because 83 % of students and audit associate's workers agree with the idea that they are ready and open to changes as they perceive audit as a permanent enhancement. This brings us to the next point concerning the evolution in the skills required from the auditors.

Change in the skills required from the auditors

Some other key points were drawn from the survey in what concerns **future skills required for auditors** and we can notice that a lot of professionals begin becoming aware of the necessity to evolve. **Proactivity** is a character trait that will become essential for auditors in the auditing field according to professionals because it's a

requirement for many improvements. Indeed, proactivity will help to provide more insights for 50 %, more quality for 48 % and more value for 41 % of the interviewees (Forbes, 2015).

From a skill point of view, 3 skills appear to be very important for the respondents in what concerns future auditors because 52 % of the overall participants esteem **experience in the industry of the client**, **investigative financial skills** and **critical thinking** will be prominent skills (Forbes, 2015). The combination of these 3 skills mentioned before is critical because it's essential to combine each of them in a team to have a complementary mix. Indeed, the **industry's experience** is mostly brought by the oldest members of the team through their accumulated experience and expertise developed with the years of practice. On the other side, **the analytical and technological know-how** should be brought by the younger generation. Obviously, the experience in an industry requires many years given the complexity of some organizations and that's why the ideal is to work with teams including different level of seniorities. This diversity will allow more experienced auditors to transmit their knowledges on the industries while they can also learn from the technological know-how of the less experienced ones. The combination of the analytical and technological mindset can make reference to many different qualities. But, according to interviewees, it's above all being able to have a **problem-solving approach**. It requires to understand a problem, analyse and dissect the problem in order to find the right solution. Moreover, **analytical mindset** refers to the abilities of an auditor to collect information's, analyse the information's and to take the appropriate decisions in function of the information's he has. This analytical mindset can be trained almost every day by an auditor as he exercises it to detect trends in dataset, when trying to interpret data and information's, when brainstorming with other members of the team, when adding new data in an existing dataset or when taking decisions influenced by several different possibilities. Thus, the new auditor is not only able to use data analytics tools, but it goes beyond with the needed mindset to understand the whole processes. Obviously, the future auditor will also be able to deal with the **collection of data.** As the amount of data used will increase more and more, it will be critical for auditors to **process and manipulate dataset**. That's why many professionals suggest including in auditing studies data analytics and software's courses in academic programs.

Another important quality for the future auditor will be to maintain a **curiosity state of mind** and this quality has already to be developed during the studies. So, it's in part the responsibility of the academic world to support the development of this quality.

Indeed, what is essential to understand while performing an audit of a company is that we target a **holistic approach** (Forbes, 2015) where we try to figure out how all the different parts of the business are working together. This approach necessitates a **curiosity and critical state of mind** rather than a "separatist" approach where we always have the tendency to separate everything without doing enough links between the different parts. Moreover, some interviewees also highlighted the necessity for an auditor to demonstrate **adaptability**. Indeed, technological evolutions in the auditing field will not stop and will even accelerate with the rising importance of artificial intelligence for example. So, auditors have to be ready to adapt themselves because an audit career represents according to many professionals a **career full of changes and learning.**

By speaking with professionals on the field, they also communicate the necessity to recruit future auditors that are **eager to learn** and learn **relatively quickly**. It's clear that **statistical and mathematical** skills will be determining to allow the auditor to efficiently exercise its **judgement** given the complexity of some of the model's that auditors have to process. From the moment audit will depend on large volumes of data, **statistics** will become more than ever useful in order to process and verify data with the aim of improving the quality of the audit procedures. For example, statistics will be useful to perform correlations coefficients to check the reliability of the data. This coefficient could be used for example to establish a threshold allowing to detect anomalies through KPI's (JICPA, 2016).

Nevertheless, it's certain that auditors will definitely have to possess their traditional skills in terms of accounting or finance that are traditionally learned through the academic process, but companies will need to complement that with "more modern" skills. Thus, future auditors have to be more **tech and computer-navvy** now than what they were a few years ago but also, they have also to conserve their traditional competencies. For instance, the **ability to handle data** will be essential because most of the companies are now using information's system from accounting to sales management. It's essential because the auditor has to understand the data that are contained in these systems and how to extract them (type of format needed for example). That's why it's important for companies to train their auditors to handle data in practice through trainings and experience on the field (JICPA, 2016).

Furthermore, these changes in the skills required influence the recruitment processes of companies that are for the moment wondering which kind of recruits they want, and which kind of profile associated. Indeed, it exist different possibilities such as giving

the priority to current auditors by training them to new technologies or recruit people already familiarized in the technological field. Several other complementary questions can be asked such as: Do we recruit people confident with graphics because they have already expertise in it or do we look in priority to people having an analytical mindset (International accounting, auditing & Ethics, 2016). Moreover, which combination of people I search is also an important question as well as the type of specialists auditing companies is hiring because we can wonder if we need people only to "understand" the models or people able to question the statistical models we have behind. Finally, we can rise a question concerning the type of trainings that is provided by wondering if we still continue to train generalists or if we begin to train **specialists**. To answer to these questions, we can already mention that generally auditing companies are not fundamentally changing the type of profile and qualities they are looking for in comparison with the last decade. Nevertheless, it's incontestable that they changed the **mix of skills** they are looking in the teams by acknowledging the growing necessity to employ **data specialists** (International accounting, auditing & Ethics, 2016).

As explained more in detail later in the "change in the structure of the audit's team" section (p43), IT auditor's profile will be more and more Integrated in the engagement teams. Nevertheless, if all the auditors are now familiar to work with spreadsheets in excel for example, they are still not enough qualified in what concerns **IT skills**. That's why all audit professionals interviewed are pushing for **trainings** or **continuous development opportunities** to make this change. The goal of these trainings is teaching auditors how to effectively use new digital tools, how to analyse and present the outcomes coming from analytical tools, how to transform these outcomes into audit evidences and how to turn these evidences into conclusions. Continuous development is an interesting tool because it allows to have an **on-going process** of development that helps to acquire new type of skills that we can gain in a formal and informal way. It's a process where in a first time, we experience, we learn and after we can apply (Jobs.uk, 2009). Additionally, it's often suggested to improve the **relations and the collaboration** between the academic world (universities but also other educational institutions) and the professionals to teach the realities of the field because it's sometimes noted that there is an important gap between both worlds.

Concrete example of academic program combining theoretical learning with practical experience

One possible example to illustrate how we could improve the courses given in universities can be found with the project called "**KPMG master of accounting with**

data and analytics program" launched by KPMG in 2019. This project aims to develop accountants and auditors in the data age and combines the teaching expertise of some business schools in the USA with specific courses designed by KPMG geared towards technology and analytics through practical courses supervised by professionals bringing their field experience (KPMG , 2019). Indeed, this program has been designed to provide future auditors with the **hard skills** needed from an accounting point of view but also with the **soft skills** required to adapt to the rapidly-changing environment.

As emphasized in the previous section, the auditors have to be trained to develop their **analytical spirit and critical thinking** and that's exactly what this program is aiming. Moreover, through practical courses and real-life cases, the academic program develops other skills required according to KPMG to become an auditor of the future. They cite specifically **communication and interpersonal skills** as being essential additional requirements (Forbes, 2018). Communication skill refers to the ability of the auditor to clearly communicate messages and ideas orally in the context of interviews with the client, meetings or presentations (Forbes, 2018). On the other side, interpersonal skill refers to the ability of an auditor to communicate with the different clients in various type of situations and be able to understand the point of view of the client in order to have a better comprehension of its actions because an auditor is before all someone that listens (Forbes, 2018).

The program that is designed in collaboration with partners universities is foreseen to have in a first phase, the classes (practical and theoretical) with various topics such as data analysis and visualisation, statistical decision making, auditing with automated procedures or auditing through information systems (KPMG , 2019). In the second phase, it's foreseen to have an internship that allows to have immediately an experience on the field. In the final phase, almost all students will be hired by the company thanks to the quality and the rigour of the training adapted to the current and future needs of the labour market (KPMG , 2019).

Specialization of the profession and off-shoring

For their biggest majority, trainings were mainly focused until now on giving general auditing trainings by teaching everybody to know a bit of everything, but many companies are now reflecting on the necessity to change this philosophy. Indeed, audit professionals emit remark that we saw a specialization of many professions in the last decades and audit could follow this trend equally. So, teaching to every auditor a bit of

everything could be something of the past and it could evolve towards a **specialization of the profession**.

Furthermore, data analytics could have an unexpected effect on the demand of the auditing companies for young auditors here in Belgium. Indeed, with the rise of data analytics, the demand for qualified graduates just coming out of school will be lowered due to the fact less "mundane" tasks will have to be performed (International accounting, auditing & Ethics, 2016). Indeed, we notice a kind of **outsourcing** and **off-shoring** of the remaining routine tasks outside Belgium by a manpower less qualified but that are specifically trained to use Data analytics programs for these kind tasks. As they are specialized in this field, they can do these tasks in a more efficient way we can do because they are now used to process information's within the context of routine tasks. It's usually reserved to **low-risk tasks** as dealing with bank confirmations, repetitive task when adding up accounts, … Nevertheless, this practice comprises also some disadvantages (ICAS, 2016). Firstly, auditors do not exactly know how the processes are managed abroad from a quality or time point of view in addition to **confidentiality or data security** issues. The main advantage for junior auditors is that they will spend more of their time on tasks that really add value and require more **judgemental skills**. Yet, there is often a certain "pre-conception" towards the junior's auditor job that is still not totally ready to be changed because a lot of people are still thinking that the youngest have to do the "dirty work" because this is by this way they can learn too (International accounting, auditing & Ethics, 2016). The main justification of companies for the off-shoring is often that it is not efficient to allocate routine tasks such as bank confirmations or check on inventory records to qualified workers here in Belgium. That's why that kind of tasks can be now performed by workers having a lower degree of qualification and it really became a strength for specialized centres located in other countries. This practice could be expanded in the future to data analytics tasks (International accounting, auditing & Ethics, 2016).

To summarize, the evolution of audit practices could raise some problems in what concerns the **development of the auditor's competencies**. Data analytics will imply more and more to deal with the collection of data from different sources of dataset (financial/non-financial, internal/external). This will require new skills from the auditors in the field of **IT** especially. Furthermore, an **analytical spirit** will be necessary to take the right decisions in various situations. For example, the auditor will have to decide what are the most relevant information's in the dataset, what type of data does he have to prioritize, which tools to use in which context and also how to communicate and present appropriately the outcomes (CPA, 2016). These requirements in terms of

skills have to be developed by the auditing companies because it's their responsibility to educate their staffs from all seniorities to make them at ease with the latest technological advancements. Nevertheless, all companies do not have the same capacities and that's why from this point of view **larger companies will have a significant advantage**. Finally, we can conclude that if auditors want to take full benefits of the existing techniques, they will have to improve their knowledges in IT through trainings in companies or specific courses already included in the academic programs which is still not the case in Belgium.

Change in the structure of the audit teams

The growing use of data analytics tools will have also unavoidable consequences on the audit engagement and more specifically on the structure of the audit engagement teams (Rutgers Carlab, 2017). Indeed, **skilled centralized resources** should be more and more integrated in the teams (Rutgers Carlab, 2017). Skilled centralized resources are for example **data scientists** that could bring an added value to the current teams. We can already assume that skilled centralized resources are already being use from time to time in order to develop and analyse results from data analytics tools. Nevertheless, with the increasing use of this kind of tools, most of companies could have **a lack of qualified** workers in this field (Rutgers Carlab, 2017).

That's why many analysts esteem companies should hire right now more **data specialists** to complete their teams as the requirements for their expertise will not cease to expand. Basically, this new structure in the engagement teams (from junior auditors to partners comprising seniors and managers) will enhance cooperation between audit professionals and data scientists to ensure a smooth transition towards the integration of data analytics tools in the audit procedures.

Thus, it's primordial for companies to integrate data specialists in the audit teams but as previously mentioned in the "change in the skills required from the auditors" section, it remains vital for them to train auditors to maintain their **critical mind and professional scepticism**. Indeed, these critical skills remain highly important when examining outcomes generated by data analytics tools. Moreover, the increasing use of data analytics implies sometimes bigger difficulties for the auditors in the interpretation of the data (Rutgers Carlab, 2017). Consequently, auditors are now more than ever in a situation where they have to exercise their professional scepticism and critical mind because some surveys show auditors have the tendency to take for granted what is performed by specialists (Rutgers Carlab, 2017). Ultimately, auditors

have a sort of biased vision of the work of specialists and may have too much confidence in the capacity of specialists to identify and evaluate risks in a sector that becomes more complicated and where auditors do not own enough expertise to question what is performed by other people.

That's why the traditional audit teams will now be **changing** and be replaced due to the multiple new skills required among auditors to face the new digital challenges because It's now clear as explained earlier that the most mundane part of the jobs will be either **off-shored** or **replaced** by IT systems. The necessity to deal with **increasingly complexities** in the various businesses combined with the need to provide **wider services** will automatically create a requirement to have **different profiles** in a team with different expertise's and skills. The complexification of the activities can be explained by a growing internationalization of the business. This could lead to a new philosophy for the auditors following the strategy **"Think global, Act local"** (ICAS, 2016). This growing complexity could in the future create situations where businesses organization will exceed the capacities of the traditional auditor. That's why each and every team will be composed by different members having each **specialist skills** in different areas.

For example, we could imagine a team with a profile specialized in auditing and having general expertise in business surrounded by profiles specialized in data analytics, a precise type of industry, valuation, fraud, governance, … (Appendix 1.2) Nevertheless, it's clear that a cohesion will be needed to allow teams to work correctly and that's why a change in the organizations cultures will be needed and this requires much more **relationship business skills** to be able to collaborate with different assurance providers. Consequently, we could imagine in the future companies training specialists to become auditors rather than auditing companies training auditors to become specialists (ICAS, 2016).

3) Regulators

The fact Big data will be used increasingly among companies will have a certain impact on the effectiveness and efficiency of firms to better satisfy the expectations of the stakeholders (CPA, 2016). Currently, the auditing regulation requires from the auditors to understand sufficiently the whole environment around the audited company. The understanding of the company comprises **the industry**, **the news** around the company but also all the **risks** associated to the operations. It's highly important to identify these risks because it could possibly cause material misstatement in the accounting of the

audited company. Nevertheless, the adoption of dig data by many firms will also certainly modify how firms will perceive their business and all the risks linked to their activity (CPA, 2016). For instance, we can imagine a company working with Big data active in the retail sector. This retail company will benefit from this use of Big data because it allows them to develop more efficient processes in order to better design and sharpen their buying processes. It will automatically decrease the risk for the retail company to buy goods that will be difficultly sold or definitely thrown.

So, it's clear with this example that the rise of Big data will imply **significant evolutions in the business models of companies**. Consequently, the link with audit regulations is clear because it will in turn provoke a change on the assumptions that are currently in force in the accounting field and also on the estimates used while auditing a company (CPA, 2016). Nevertheless, the integration of data analytics in the regulations will not be an easy task **due to several reasons**. Firstly, it would require enhancing the relations between the regulators and the auditors that were not always optimal (CPA, 2016). Secondly, auditors and regulators are currently dealing with standards that have never been designed to integrate the data analytics approach in it. This really shows that it remains a lot of work before obtaining standards in phase with the reality of the field. In fact, it's a kind of new situation that is known for the moment and that requires a positive attitude from all parties to aim a real improvement of the audit standards.

Moreover, we can say there is a kind of dual feeling coming from the regulators because from one hand, they do not want to discourage professionals to develop new tools through innovations with data analytics for example. But, on the other hand, they have to be attentive before definitively adopting new standards because they have to **take into consideration the continuous remarks** emitted by the different types of stakeholders involved in audit and also to make the appropriate connections with the educating standards and the professional ethics (Centre for financial reporting reform, 2017).

It's now time to get to the heart of the subject to pinpoint which aspects concretely of the international standards of auditing (ISA) will be affected with the rise of data analytics tools. Firstly, it's important to understand that the actual standards are based on a **risk-based approach** with the integration of data analytics in the audit procedures (Centre for financial reporting reform, 2017). It means that it highlights mainly the comprehension of the internal controls and when it is necessary, it advocates to test these internal controls to assess if they are performed correctly by the audited organization.

ISA 520: Analytical procedures

To begin, we can analyse how data analytics will impact **ISA 520** which deals with **analytical procedures (**it refers to the operations performed to understand the business of a firm and to analyse plausible relationships between both non-financial and financial data to check if there are any inconsistencies in the financial information's**)** and it describes how the auditor can perform these analytical procedures in the context of **substantive procedures (**it refers to all procedures performed in order to obtain proofs and evidences that it does not exist any material misstatements in the financial accounts of a company during an audit). Furthermore, it enacts the responsibility of the auditor as he has to use analytical procedure **close to the end of the audit** when it's time for the auditor to draw a general conclusion on the financial statements (Centre for financial reporting reform, 2017). This example is a concrete standard that was designed at the beginning for the use of commuter assisted audit techniques (CAAT's) but as they were designed a relatively long time ago, they are not up-to-date with the latest technological evolutions.

That's why concerning **ISA 520**, many professionals are convinced by the use of predictive analytics in complement to more traditional analytical procedures. **Predictive analytics** is different because it uses data coming from different sources. From one side, we have data coming from internal sources of the company and on the other side, we have data coming from unusual sources (mostly external data). For example, if we take the audit of a retail company, predictive analytics could lead to take information's such as the weather or the geo-localization to determine more precise expectations on a **continuous** basis. That's why some professionals advise the proposition to study the integration of predictive analytics in the **ISA 520** which is not the case for the moment (Rutgers Carlab, 2017). Indeed, developments in predictive analytics allow now to predict and avoid anomalies to happen because it's a new approach that is **forward-looking** rather than being past-looking. Another important feature of predictive analytics could be that we can assess **the validity of any transactions before it actually occurs** and if needed, to take the appropriate measures and controls to prevent it (Goh, 2017). This is enabled by the fact that a comparison is performed between a pre-established normative model and the transactions. Thus, new standards have to take this new phenomenon into consideration because it will become a common tool as companies are now generating and stocking huge amount of data and also by the fact that they are using ERP's system that facilitate the task of the auditor to develop these models because they have theoretically an access to these data without any limitation.

General IT controls in the internal controls

Another important matter that will influence the action of the regulators concerns the **general IT controls** that are performed within the audit context. General IT controls are essential and especially when the whole profession is turning towards a **data-driven audit** because when auditors are using data analytics tools they are highly dependent on the data that are provided by the accounting systems (Rutgers Carlab, 2017). Obviously, it's not always easy for an auditor to have a sufficient level of comprehension towards IT specialists that are performing controls. That's why researchers advised the IAASB to introduce in the guiding rules new technologies and methodologies that could help the auditors in order to carry out validation of automated controls (Rutgers Carlab, 2017). For example**, the process mining** technology could be one possible solution to help auditors. In a few words, process mining can be defined as a process that "leverages the digital event logs in your company's existing IT systems to create a visual reconstruction of the business processes in your organization" (Grossbaier, 2018). Concretely, process mining is finding in the company's dataset digital tracks that are automatically recorded and it allows to reconstitute processes inside the company such as order-to-cash, purchase-to-pay or production processes.

This example of technology can be highly useful to visualize **how processes are really working on a daily basis** inside a company. Thus, process mining could be used to assess the efficiency of the internal controls in financial reporting. Another example of the usefulness of this tool can be found in the context of segregation of duties to check potential risks and inefficiencies in the context of internal controls. That's why the possibility to use process mining technologies should be included in the ISA 330 as discussed in the next point.

ISA 330: Nature and extent of controls

As consequences to the use of solutions such as process mining or equivalent processes, The IAASB should think to upgrade the **ISA 330** that is dealing with the "nature and extent of controls" (Rutgers Carlab, 2017). Indeed, **ISA 330** should now include a recommendation to perform efficiency testings of controls or segregation of duties through these tools. Indeed, badly performed IT controls can have significant consequences on the accounting information systems (Rutgers Carlab, 2017). In a few words, external auditors should better understand their IT environment and it is justified by the fact an auditor can't rely on data provided by the audited company

without understanding if they are correctly controlled, reliable and secured. This is what leads to the following major potential evolution in the IAS concerning the **data integrity and reliability**.

ISA 500: Data integrity & reliability

ISA 500 is another standard that will require the attention of the international auditing and assurance standards boards (IAASB) as it deals with the topic of the **data reliability and integrity**. Indeed, this standard requires from the auditor to check if the information's used in the context of the audit procedures **are reliable**. In the case where most of the data used by the auditor are internal, he has to assess firstly the reliability. Secondly, he has to take care of the accuracy and the completeness of the information's through the acquisition of audit evidences and thirdly, assess if the information's are adequately accurate and precise to meet its objectives. Thus, the IAASB is precise and strict on how to perform controls for **internal data** but there are not enough guiding rules when the source of the data are external to the company such as Big data comprising **social media's or RFID** (Rutgers Carlab, 2017). Moreover, auditors don't have standards in order to judge the provenance reliability of this data. Indeed, external data will be in the future a true complement to the traditional data and that's why it should me more regulated and be fully considered as an audit evidence. For example, customer's tweets can be a relevant indicator of the customer's financial condition or its acceptance towards the products of the company (Rutgers Carlab, 2017).

The use of the customer's tweets within audit procedures have to be subject to many criteria in order to be relevant. Indeed, the auditor needs to analyse for example if the tweets are reflecting the positions of true customers with no intention to harm intentionally the audited company or being sure that the used text mining app is working correctly. In the actual situation where there is no clear rule on the use of external data, it leads to circumstances where auditors are hesitating to use data coming Big data sources which is contributing to slow down the audit efficiency whereas the original goal was of improving the audit efficiency by providing a higher level of reasonable assurance. Moreover, we can imagine the use of Big data in various industries and especially, in **higher risk business cycles and industries** where it could be a great complement by taking into consideration the higher computational and financial costs (Rutgers Carlab, 2017). That's why the IAASB should additionally according to audit professionals set up recommendations describing which kind of industries and cycles can benefit the most from the use of Big data through practical

cases. Finally, the IAASB should also determine which kind of evidence is brought by Big data analytics because it exists currently a hierarchy based on the value of the evidences where third-parties evidences are better ranked than management interrogations for example but it's still not the case for analytical evidences (EY, 2015). Without this classification for analytical evidences, auditors will be less inclined to use analytics in their procedures.

ISA 530: Audit Sampling

Another matter concerns the **evaluation of the exceptions.** Indeed, under the current traditional approach that is risk-based, the auditor that identifies exceptions from its samples (**ISA 530**) has to extrapolate these exceptions to assess its impact on the financial statements. However, with data analytics, auditors have the opportunity to test a wider part of the population (almost 100% in some cases) and to estimate with more precision the importance of the errors. That's why some doubts are emitted on the real value brought by the quantity of work performed by an auditor when analysing outliers to determine if they are in fact simple exceptions (IAASB, 2017). Consequently, it's often perceived as being useless and ineffective to test all identified outliers. To settle this problem, researchers emitted the idea to develop **filters** that would take into account different types of criteria (from quantitative to qualitative criteria) to identify data that can be characterized as exceptions representing a higher risk due to the transaction or the processes involved (Rutgers Carlab, 2017).

The objectivation in the identification of the exceptions (included in the substantive analytical step) could be based on non-conventional criteria adaptable in function of the industry or the type of company involved. For example, we could use a square-footage criterion to identify the precision in the revenue linked to a real-estate company's inventory (Rutgers Carlab, 2017). Nevertheless, it is still on the auditor's accountability to choose the right criteria in function of different parameters because one set of criteria could not fit all types of companies.

Audit opinion

A revision in what concerns the **audit opinion** could be performed too. Indeed, the auditors as explained previously are more and more pushing to use new technologies in their daily job in order to provide better services and meet in a more efficient way the needs of the stakeholders (Rutgers Carlab, 2017). This philosophy leads also to evolutions in what concerns the **traditional audit opinion**. Currently, the opinion of

the auditor is reflecting its position in a given point of time that is in some way **static** but it's now evolving towards an opinion that becomes **more continuous**. That's why the notion of static opinion could become something of the past. Indeed, under the current model that is static, the opinion of the auditor could not be relevant anymore due to the time needed between the emission of the opinion and the closing of the financial statements that can be counted in weeks or months (Rutgers Carlab, 2017). This gap in the time needed affects also the different stakeholders that could receive an "obsolete" opinion of the financial accounts. Today, all the data and information's that are recorded in the enterprise resource planning programs (ERP) are in some way more dynamic and enable to track all the business operations of a company. This could be used in the future in order to provide real-time auditing through what we can call **continuous auditing**. That's why continuous auditing will require some adaptations in the standards that are currently in application.

Impact of continuous auditing on ISA 500 & ISA 530

Continuous auditing could have a real effect on the **sampling-based approach** that is currently in vigour. As previously described, ERP systems allow to treat high amount of data and this leads to a **future obsolescence of the sampling-based** approach. Currently, the **ISA 500** makes just a small reference to a full population examination in the context where the whole population is composed of small items having a large value. Nevertheless, it's clear that today's technologies allow to extend this reference and to test the full population which has as an impact to increase the audit quality. The advantage of continuous auditing is that it can be applied to different types of analytics that are used such as **prescriptive** and **predictive** (Rutgers Carlab, 2017). The use of continuous auditing should be better framed too to determine when it brings a true added value and determine when the benefits of doing so exceeds the costs. For example, continuous auditing can be used to test populations of any size and any risk in the context of substantive analytical procedures or test of details. That's why the standards ISA **500 and ISA 530** should be modified to determine how and when to use continuous auditing and how to deal with the full coverage of the population.

Indeed, when we have a full coverage of the population, the **sample risk** is normally eradicated. The sample risk can be explained as the risk arising from the possibility that the conclusion of the auditor would be different in function of the fact another sampling would be selected or the full population would have been tested. This can be due to different factors such as the **bad selection** of a sample or due to a too little selection size that has as effect to misrepresent the whole population. Nevertheless,

some doubts can be expressed on the assumption that all the other risks are completely eradicated. For instance, in some situations, the auditor could miss to detect material misstatements contained in the documents he's analysing. This would have as an effect to make the full coverage of the population less useful and in some way feeble. The solution to counteract this kind of situation can be to always motivate auditors, as often highlighted in this thesis, to use their **critical mind and professional scepticism** whatever the type of audit approach that is used (from traditional to continuous methods). That's why the new standards should really take into account that factor and foster auditors to make use of this mindset to avoid missing material misstatements (Rutgers Carlab, 2017).

ISA 315: Identifying and assessing the risks of material misstatement through understanding the entity and its environment

Another matter concerns the **risk assessment analysis.** Indeed, there is an uncertainty concerning the nature of the audit evidences get from data analytics tools originally generated for risk assessment procedures (IAASB, 2017). For the moment, it is still enacted that evidences get from the risk assessment phase do not have enough weight to be considered as audit evidences allowing the auditor to emit an opinion as there is no expectation of results (IAASB, 2017). Nevertheless, we can assume that when we are using data analytics in the context of **risk assessment** to provide evidences, we could use it also for other purposes but for the moment it is impossible (Rutgers Carlab, 2017). For instance, evidences get from data analytics cannot be used for substantive analytical procedures and this is justified by the fact there is no expectation of results when the auditor initiated the process.

In fact, there is currently a separation in the categorization between **risk assessment procedures and the response activities** (Rutgers Carlab, 2017). Nevertheless, we can consider it's a major point of evolution that must be thought and adapted in a way to change the current structure of the audit procedures. For instance, it can be done by allowing auditors to use data analytics jointly for risk assessment, test of controls and substantive procedures. Analytics is usually used in the context of **risk assessment** (including procedures to identify the risks of misstatements) with the aim of providing an understanding of the entity and its environment as described in the **ISA 315**. Moreover, it could bring a true added value to use data analytics simultaneously to generate audit evidences as one of the property of analytics **is to examine a full population.** As the risk assessment procedures are enhanced, the risks can be identified earlier, and this justifies a modification of the **ISA 315** (Rutgers Carlab, 2017).

Predictive analytics will also play an important role here in the years to come as it enables to check the existence, completeness and accuracy in the whole population (Rutgers Carlab, 2017). Thus, the IAASB should think on the possibility **to substitute current analytical procedures** as predictive analytics can do it too. The key point here remains to find a solution concerning the reliability of non-conventional external data. At last, it will be also important to determine through clear rules how to utilize predictive analytics as it can be used **for multiple purposes** such as test of controls, risk assessment and substantive analytical procedures simultaneously (Rutgers Carlab, 2017).

ISA 540: Auditing accounting estimates

Finally, it's also interesting to mention that the IAASB already started to do some modifications in the standards under the recommendation of professionals and we can take as an example the **ISA 540**. The modification of this standard aimed at the modernization in what concerns the understanding of the **accounting estimates**. Indeed, accounting estimates are not always easy to understand due to the fact they are often based **on complex processes** especially in the banking or insurance industry (IAASB, 2017). Accounting estimates can be defined as an approximation used for some financial statements elements in which we cannot measure the exact value due to the uncertainty to value it. There are mainly 2 possible reasons: 1) the value is depending on future events 2) because we cannot aggregate correctly data coming from past events. It's usually from the responsibility of the management to do the estimates in function of subjective and objective criteria.

In fact, the estimates are most of the time based on large amount of data and previously under the **ISA 540**, the auditor had to understand all the process needed to calculate the estimates as well as all the controls of the systems that are generating the estimates. More precisely, it was enacted that "ISA 540 requires the auditor to obtain an understanding of how management makes the accounting estimates, and an understanding of the data on which they are based" and "ISA 540 requires the auditor to obtain an understanding of the relevant controls around the accounting estimate » (IAASB, 2017). These rules have been adapted in order to allow officially the use of data analytics tools given the fact accounting estimates are often based on large amount of data and the auditor can be usefully helped by new technologies in order to better manage the risks linked with data sources (IAASB, 2017).

Philosophy of the IAASB with regard to the adaptation of the standards

It's interesting to notice that the IAASB launched at the end of 2016 a list of International auditing standards (IAS) that were according to them susceptible to change with the rise of data analytics. They were asking to various stakeholders to share their experience in what concerns the potential changes in this list. The list comprises IAS's not analysed in this thesis such as: **ISA 240** dealing with the auditor's responsibilities to fraud in an audit financial statement, **ISA 320** dealing with the materiality in planning and performing an audit. Moreover, the list comprises also other ISA's already treated in this thesis such as **ISA 330** dealing with the auditor's procedures in response to assessed risks, **ISA 500** relating to audit's evidence and **ISA 520** dealing with audit sampling. In function of the remarks emitted by the professionals among with auditing companies of all sizes, investors, audit national authorities and others, they will adapt the standards to meet the new needs of the stakeholders with the aim of improving the audit quality.

This is an interesting initiative coming from the IAASB because there is also sometimes a feeling of the auditors that it exists a kind of **disconnect** between the authorities and the field in what concerns the evolution of the profession (IAASB, 2018). That's why sometimes audits firms can be reluctant to totally integrate data analytics in their operations as there are different point of views inside the authorities to assess if the current standards are met when using these tools. To illustrate that matter, it can happen that auditors are in reality having a coverage of the full population thanks to the last technological advancements, but they are obliged at the same time to take some samples on the population to be sure to comply with the current standards. That's why on conclusion, we can say there is a need for the **authorities to hear more than ever the recommendations** coming from the auditors that are busy on a daily basis with the audit procedures (IAASB, 2018).

Other Important recommendations coming from auditors concern the necessity to develop standards that remain **principles-based** (IAASB, 2018). It allows to keep a certain **flexibility** in the tasks of the auditor that is absolutely necessary in an environment where everything can change very fast. Moreover, the proposition to develop **practical guidance** in addition to standards appears to be also an interesting way to adapt to the current world. Indeed, current standards are not totally encouraging or discouraging the use of data analytics but it's sure that the option to always try updating permanently standards may not be the right solution anymore. That's why auditors would now opt for a **non-authoritative approach** where standards

would rather be based and illustrated with real-life cases that can be developed more rapidly than theoretical and authoritative rules. The risk to develop new standards too rapidly is to discourage innovations in addition to the fact it is almost impossible to update permanently all the required standards without impacting the quality. Thus, the key in the development of "real-life standards" is to foster the cooperation between the different actors involved and try to keep **technological neutral** standards allowing to adapt and accommodate standards rapidly (IAASB, 2018).

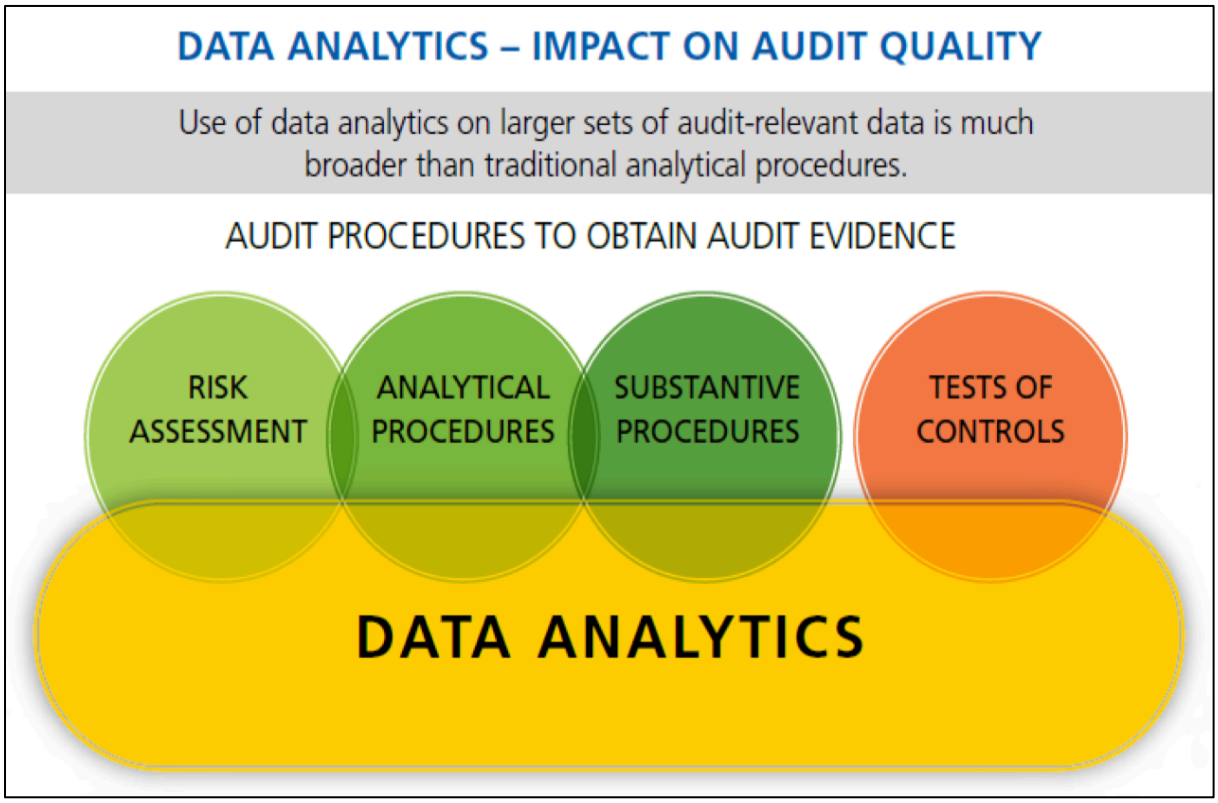
How to integrate data analytics in the audit approach?

It's now time to talk about the **integration** of data analytics in the different audit procedures and we can already mention that data analytics should be embedded in audit by following the methodology recommended by the ISA (IRE, 2018). That's why we will see in the following section how data analytics can be integrated in each of the different audit phases existing and described below (IRE, 2018):

1. Audit Planning
2. Performing Test of controls
3. Performing substantive procedures
4. Evaluation of the results

It's important to notice that the approach developed below is mainly inspired by the research paper conducted by the institut des réviseurs d'entreprises (IRE) called "Data analytics: the future of audit" in which some complements are brought by bringing examples and data coming from the field in addition to literature complements. As showed visually on the figure 2.1 below, data analytics will have a significant effect on the four main different audit procedures: **risk assessment, analytical procedures, substantive procedures and test of controls**. We will explain more precisely in the following chapter how concretely data analytics can be embedded with the aim of obtaining a better audit quality.

Figure 2.1: Impact of data analytics on the audit quality



Source: (IRE, 2018)

We can mainly differentiate 2 roles that data analytics can fulfil because it can be either **exploratory** which is more related to the audit planning phase or performed within the scope of **audit procedures** such as test of controls or substantive procedures (IRE, 2018).

The exploratory role of data Analytics

The exploratory role is often abbreviated under the name "EDA" which means **Exploratory data analysis**. In a few words, EDA is the more often used with a graphic or a visual representation in order to display the most important and relevant features in a data set (Information technology Laboratory, 2018) . This representation enables the auditor to know where he will have to spend the most of his time with audit procedures because it highlights areas which are the riskier. We refer to this method often in the **risk assessment phase** or in the audit **planning phase** where the auditor tries to establish a global strategy in order to perform the audit and to understand the client. Additionally, It's the occasion for the auditor to perform a first and preliminary analysis of the data he has to in order to have a first global idea on the audited company (IRE, 2018).

To have a first understanding of these data in the context of the **planning phase**, several questions need to be asked. Here is below a set of examples of questions that are useful to fulfil this task (IRE, 2018):

- What are showing data? and do they pinpoint something? (For example, trends or patterns recognized in data)
- Can we already detect any risk of fraud thanks to the data?
- What are the sections of the audit that appear to be the riskier?
- Are some models or methodologies more appropriate to perform some specifically designed analytical procedures?

In the context of the **risk assessment phase**, EDA can be used to give first insights over the following elements (IRE, 2018):

- **Provide an understanding of the company and its environment**: Auditors have to possess enough comprehension of the client in order to spot potential risks of material misstatements. Indeed, it enables to put in the light transactions and accounts that have the highest likelihood to contain material misstatements (Information technology Laboratory, 2018).

- **Evaluate and recognize the risks** to encounter some types of material misstatements

- **Put in place procedures** that are fitting the identified risks previously.

As described above, one of the biggest advantages bringing data analytics in the context of this phase it that it enables the auditor to put in place made-to-measure procedures and methodologies. Indeed, data analytics can provide important information's on the population such as amounts/volumes of transactions, sharing between credits & debits and the transaction's timing (IRE, 2018). So, it can be used from one side to improve the quality of the risk assessment phase but also on the other side to improve the auditor's comprehension of the population itself.

Data analytics in the audit planning phase

Data analytics is already currently favoured by auditors when initiating the planning phase. But, before beginning the real procedures, it's essential for the auditor to be aware of the possibilities he has in terms of functionalities from data analytics. Obviously, the more business processes inside the audited companies are based on information systems, the more functionalities the auditor will have with data analytics (IRE, 2018). That's why it's often the case bigger companies offer more data analytics possibilities than smaller ones because they rely much more on information systems. Several examples of questions can be raised to demonstrate how the auditor has to proceed when dealing with data analytics in this phase (IRE, 2018):

- Which tools does the auditor own to perform procedures?
- What sort of data analytics can be used to analyse the audited company?
- What is the degree of availability of data concerning the transactions?
- What is the degree to which business processes are recorded in an information system?

Then, it's essential for the auditor to assess the quality of the data available in the General Ledger. Indeed, the general ledger which comprises the record-booking system of credit and debit accounts must be verified to assess the truthfulness and the completeness of the information's for the audited period. Again, several questions need to be asked by the auditor to carry out this task. It can be done through interviews for example:

- What is strictness degree of the controls performed by the company in order to ensure the truthfulness and the completeness of the data?

Following this first question, some inquiries should be made to obtain more details from the client (IRE, 2018):

- Who inside the audited company can have access to the data in the information system and the authorization to operate modification in the system?
- Try to examine data provided by the client by reconciling data from a subsystem with the general ledger.

Data analytics in the risk assessment phase

In this audit phase, the emphasis is put on a **preliminary examination** of the general ledger. Moreover, the purpose of this action is to put the light on the most important **flows of transactions** existing inside the company. If the work is well performed by the auditor, it should help him in order to have better insights on the identified risks and the available functionalities of data analytics for the rest of the audit (IRE, 2018). Consequently, it will also enable to have a better accuracy **in the approach towards the risk**. So, data analytics can be useful in this step to provide a first view on the following items (IRE, 2018):

- **Visual representation** of important key performance indicators for the audited company. Examples could be the inventory turnover or the account payable turnover.

- **Identification of the seasonality** in the transactions. For example, sales could be subject to seasonality because at each and every calendar date in the year, the company experiences the same type of changes that are regular and predictable.

- The **nature** and the **total size** of the transactions.

- **Visual representation** of the core processes which can help the auditor to have a better understanding of the audited company.

The audit procedure role of data analytics

Here, we are now talking about **another way to use** data analytics with a completely different structure that is much more methodical and involves more mathematics and statistics in the processes (IRE, 2018). Moreover, data analytics can be used interestingly in order to complement the following audit procedures:

- Test of details
- Test of controls
- Substantive analytical procedures

In this part, we will develop more in detail how data analytics can be integrated in the audit procedures. Some of the procedures will be illustrated with examples of real-life cases extracted with the help of EY Helix.

Tests of controls

In this procedure, the auditor is involved in order to test and assess the **efficiency of the controls** performed by the client. Theoretically, each and every company should have put in place systems having a sufficient level of control but here it's the duty of the auditor to check if they are efficient **to avoid the occurrence of material misstatements due to data**. Depending on the results of this assessment, the auditor will be able to decide if he will rely or not on the control's system of the client to perform its audit procedures. If it appears that the control's system is pretty weak, the auditor will be obliged to use much more substantive tests which has an automatic effect to make the audit much more expensive for the client (Bragg, Tests of controls, 2018). We have **different types of test of controls** that can be classified as below:

1. **Reperformance**: In the context of this control, the auditor could take the decision to launch independently new transactions with the aim of assessing which controls are in place and evaluate their effectiveness.

2. **Inspection**: Here, auditors could verify some business documents to look at different signs indicating controls have been realized by the audited company. These signs can be review marks, signatures, … If the inspection approach is favoured to perform the test of controls, the auditor will mainly take into consideration a sample of documents that are linked to transactions that happened during the year. This will help to test the reliability of the controls for the transactions concerning the reporting year (Bragg, Tests of controls, 2018). In a few words, it is an inspection of the data used to check if they are working as initially planned.

3. **Observation:** Here, the auditor could have the possibility to **look at business processes in "real-time"** and to have a special attention dedicated to the controls performed. In a few words, the auditor looks how the processes are working in real-time while employees inside the company are performing the controls. For example, It can be applied to basic controls such an inventory counting (Bragg, 2018).

If the auditor finds mistakes in the controls, the first reflex in general is to increase the size of the samples and to perform other testings. Following the expansion of the sample, there are 2 possible outcomes: if new errors appear, we will have to consider there is a systematic error in the system which leads to an inefficiency or if the errors seem to be isolated, we can consider they are insignificant to evaluate the system . Thus, we can develop the following list of examples detailing concretely how data analytics can help in the context of test of controls (IRE, 2018):

- Examination of possible **modifications in the user's access right list** during the reporting year.

- Examination of the **limits of credits** for all the different clients of the audited entity in order to check if it exists any surpassing of the pre-defined limit.

- **Segregation of duties** in order to cash cycle: Here, the main purpose of data analytics is to check if some combinations of tasks have not been performed by only one and unique person which can be inappropriate when we are dealing with critical combination of tasks that require different approvals from different persons (Gehrke, 2018). In order to perform such kind of task, the starting point can be the licenses given to each user determining who has the authorizations to perform certain tasks. So, data analytics enables to detect the following segregation of duties anomalies in the context of sales transactions: Creation of false clients and initialization of orders for them, Creation of sales documents and initiation of an erroneous invoice or initiation of a payment for a credit that is not existing, …

- **Examination of all the payments** made for invoices during the reporting period by detailing for example the timing of the payment, the presence of an approval or an approval by the appropriate person.

Substantive analytical procedures

In this procedure, auditors are involved in order to verify the existence of potential anomalies in the records of the clients. Once anomalies are detected, further examinations will be needed. Thus, the procedure consists in the comparison between **operational and financial information's** (Bragg, 2018). In other words, the auditor tries to check financial information's with the help of plausible relationships by using both financial and non- financial information's. The main purpose of this procedure is to check if previous **relationships** that were applicable in the past are still in line with the relationships of the audited period. Logically, relationships should stay in the same range over time. If it's not the case, it could mean financial records were not correctly managed. It can come from different reasons such as mistakes or frauds in the reporting of the activities. Below, we can find a list containing examples of substantive analytical procedures (Bragg, 2018). The first type of substantive analytical procedures we can find are **ratio's analysis** in which we try to perform comparisons between relationships with financial or non-financial information's through benchmarks and by understanding their evolution across time.

- **DSO or Day sales outstanding's**: it calculates the average number of days needed for a company to collect the payments after a sale. So, we establish a direct relationship between sales and receivables which should be in line with historical data unless there were changes in the policy of the company such as evolution in the way the company collects money, change in the customer profile or simply a change in the credit policy (Bragg, 2018).

- **Bad debt ratio**: A bad debt means that it is a financial loss for the company because it relates to a payment that the customer of the audited company will not pay. Logically, this ratio should move in the same proportion as sales do and if it's not the case, it could mean the management team does not recognize correctly bad debts. In other words, it's a kind of trend analysis that is conducted (Bragg, 2018).

- **Current ratio**: The goal is always, as described above, to compare the ratios with the past reporting periods. Here, the current ratio refers to the capacity of the organization to pay its short-term bills. Another way to see it is to compare the current amount of assets with the current amount of liabilities. It should be stable over the reporting periods unless the company changed its guidelines in terms of inventory, account receivables and payables (Bragg, 2018).

Application of data analytics to substantive analytical procedures

Data analytics can be applied to this procedure through a **regression analysis.** It means that we try to establish and examine relationships between variables in the data and bring to light eventual divergences between the recorded amounts by the audited company and our established expectations (IRE, 2018). In the following section, we will establish some examples on how we can apply data analytics to substantive analytical procedures with some illustrations of real-life cases.

1) Reasonableness testing

The first example of substantive analytical procedure concerns **predictive models**. Predictive models are using relationships between different relevant variables for audit that can be sorted in function they are dependent or independent variables within the model. **Reasonableness testing** is a concrete type of predictive model that can be used in the context of substantive analytical procedures and can be defined a test analysing accounts or changes in the accounts between the reporting periods. That type of testing requires from the auditor to establish models that are used to emit expectations on the accounts based on financial and non-financial information's or both (ACCA, 2017). Data analytics can concretely help by analysing and then, proposing hypotheses on the relationships between the concerned variables. The example we can take concerns the **reasonableness** of the wages that can be tested by using the following formula:

Figure 2.2: Example of a reasonableness test with predictive analytics

$$PredictedWages(Year\ 2) = ActualWages(Year\ 1) \times (1 + InflationRate)\frac{\#\ Employees(Year\ 2)}{\#\ Employees(Year\ 1)}$$

Source: (AICPA, 2015)

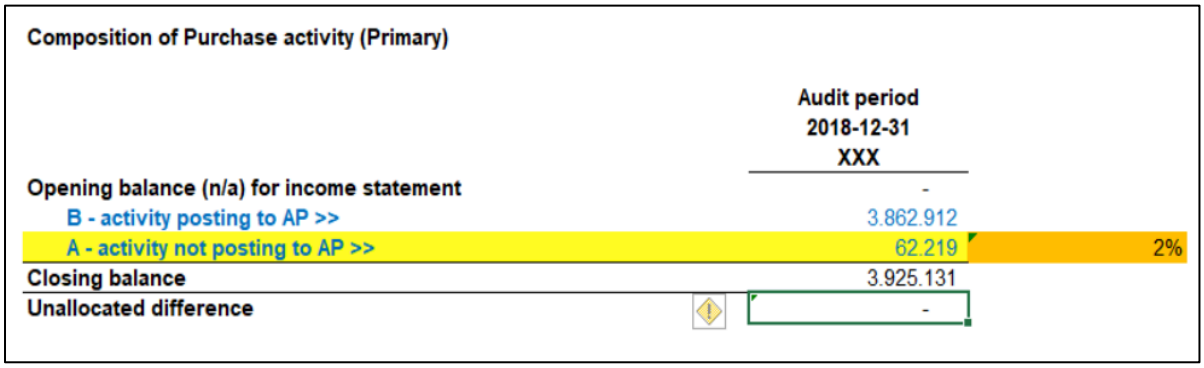
The **reasonableness** of the model showed above in the figure 2.2 has to be assessed by the auditor himself. Nevertheless, we can say that if the whole composition of the employees inside the company remains the same across 2 years and that the inflation rate remains a relevant variable in order to calculate the evolution of the salaries, then we can conclude there should not be a huge difference between the predictive model and the recorded total wages of the current year. If it arises that the composition of the employees changes or that it exists differences in the evolution of the employee's salaries, then the model could be completed to be as close as possible to the reality of the company.

Additionally, similar models can be applied to estimate the total sales of tradeable goods if it exists data that are trustworthy and useable concerning the prices and the quantities. Obviously, the reliability of this kind of models depends highly on the quality and the availability of the data. Models can also be much more complex than the example described above because we can, for instance, integrate stochastic variables to take into account random variations (AICPA, 2015).

2) 2-way correlation

In the following figures, we will try to establish relationships between some chosen variables. This test is called **2-way correlation** and is used in our first example to perform firstly a pairing between **purchases and account payable** (AP).

Figure 2.3: 2-way correlation (account payable-purchases)



Composition of Purchase activity (Primary)

	Audit period 2018-12-31 XXX	
Opening balance (n/a) for income statement	-	
B - activity posting to AP >>	3.862.912	
A - activity not posting to AP >>	62.219	2%
Closing balance	3.925.131	
Unallocated difference	-	

Source: (EY,2019)

We can remark from the figure 2.3 that the relationship between purchases and account payables is not equal to 100 %. It means a small portion of purchases (which represents 2 %) is not related to account payable. It appears in the case of the company above that the rest was linked to inventory and goods issued as showed on the figure 2.4 below:

Figure 2.4: Complement 2-way correlation (account payable-purchase)

	201801	201802	201803	201804	201805	201806	201807
inventory	(1.686)	(886)	(1.737)	(4.797)	(2.637)	(2.618)	(3.15
Assets TOTAL	(1.686)	(886)	(1.737)	(4.797)	(2.637)	(2.618)	(3.15
cost of sales	1.686	886	1.737	4.797	2.637	2.618	3.15
Expenses TOTAL	1.686	886	1.737	4.797	2.637	2.618	3.15
Purchase activity by Source	**201801**	**201802**	**201803**	**201804**	**201805**	**201806**	**201807**
PR (PR)	-	-	-	-	2	5	-
SV (SV)	-	-	-	-	-	-	-
WA (WA) (Goods exit)	1.686	878	1.737	4.797	2.636	2.613	3.15
WL (WL)	-	9	-	-	-	-	-
TOTAL	1.686	886	1.737	4.797	2.637	2.618	3.15

Source: (EY,2019)

Another example of 2-way correlation can be found in the figure 2.5 below:

Figure 2.5: 2-way correlation (Sales-account receivable)

Composition of Sales activity (Primary)	
	Audit period 2018-12-31 XXX
Opening balance (n/a) for income statement	-
B - activity posting to AR >>	(6.577.818)
A - activity not posting to AR >>	-
Closing balance	(6.577.818)
Unallocated difference	-

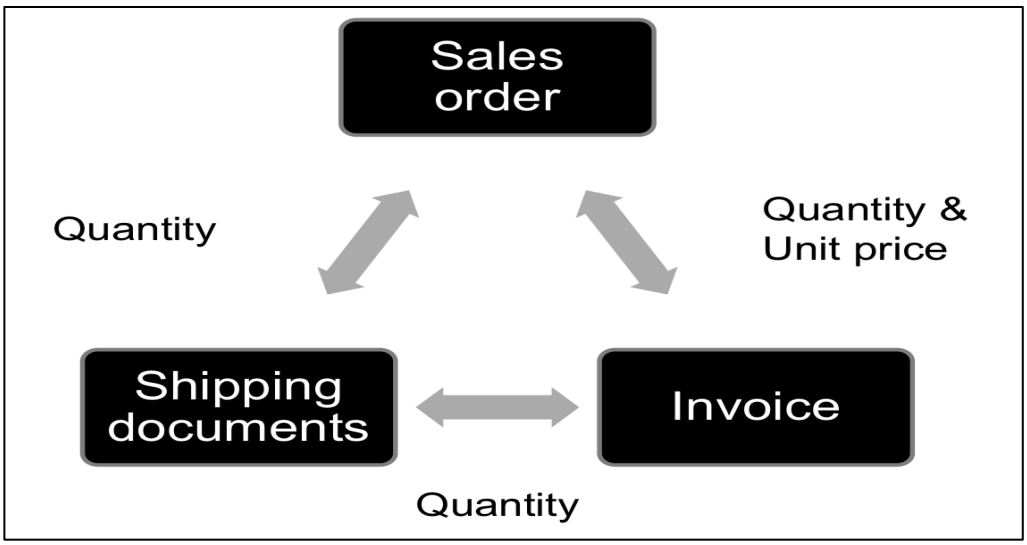
Source: (EY,2019)

We can remark on the figure 2.5 above representing the relationship between sales and account receivables (AR) that the pairing is equal to 100 %. By this way, we can conclude that no issues can be found as the relation is perfect here.

3) 3-way match procedure in the context of order to cash:

Data analytics can be an interesting tool in this case because it can help to identify any difference (in price or quantity) between the data coming from the client invoice detail that is needed to record the revenue with the appropriate sales order and the delivery notes that are recorded in the ERP system of the company (IRE, 2018). That's why we talk about a 3-way matching.

Figure 2.6: Illustration of the 3-way match procedure



Source: (Miklos, 2017)

Thus, the primary goal of the 3-way matching is to generate audit evidences confirming the existence and the accuracy of the revenues (Miklos, 2017). We can take a simple example to illustrate how data analytics can help in the context of a 3-way match procedure with the case of a fictional company having a revenue equal to 120 000 000 €. This revenue is generated by 720 000 different transactions. If the 3-way procedure is performed with a data analytics tool, we could obtain for example the following results:

Figure 2.7: Example of a 3-way match procedure

	Amount (€)	%	Number of transactions	%
No differences	115 750 000	96,5	690 000	95,8
Outliers:				
Quantity differences	1 500 000	1,25	19 750	2,7
Pricing differences	2 750 000	2,3	10 250	1,4

Source: (Miklos, 2017)

We can notice through this example some differences in prices and quantities. Thus, if the overall materiality for the fictional company is equal to 1 000 000 €, the auditors will have to perform further investigations in order to confirm the existence of the revenues.

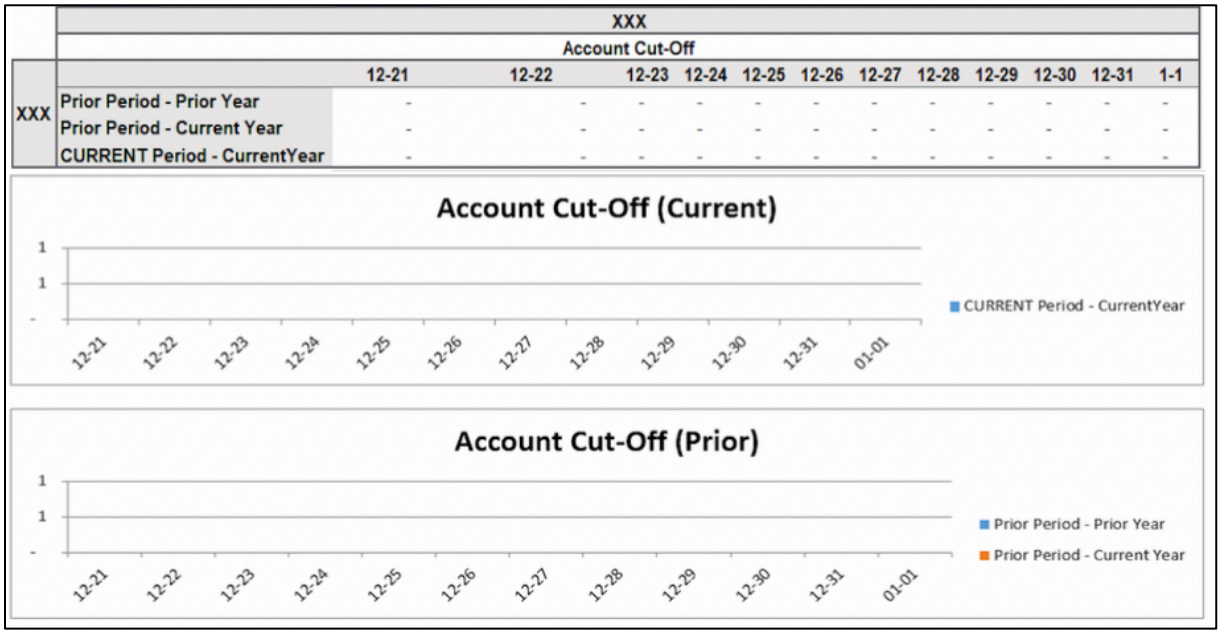
4) Analysis of payments made after period-end

Data analytics can be highly interesting in this test because it enables to classify cash payments that were recorded between the end of the reporting period and the extraction date (IRE, 2018). The classification can be performed on the basis of 2 date criteria: the first one on which we can base the examination of the payment is the date of delivery written on the related invoice or the related delivery note. The second option is to base the analysis on the foreseen delivery date written normally on the purchase order. We use one of the two solution to determine to which period is linked the liability by investigating if the cash payment is linked to a delivery date before or after the reporting period. Thus, it enables to check if the liability was initially correctly recorded in the appropriate period by the audited company (IRE, 2018).

5) Cut-off analysis

Cut-off analysis is usually used to test transactions that are near to a closing period-end because this period can result in a higher risk for the auditor to encounter fraud due to the pressure to meet targets for example. Thus, this test helps to check if transactions were recorded within the correct reporting period (Bragg, 2018).

Figure 2.8: Example of a cut-off analysis



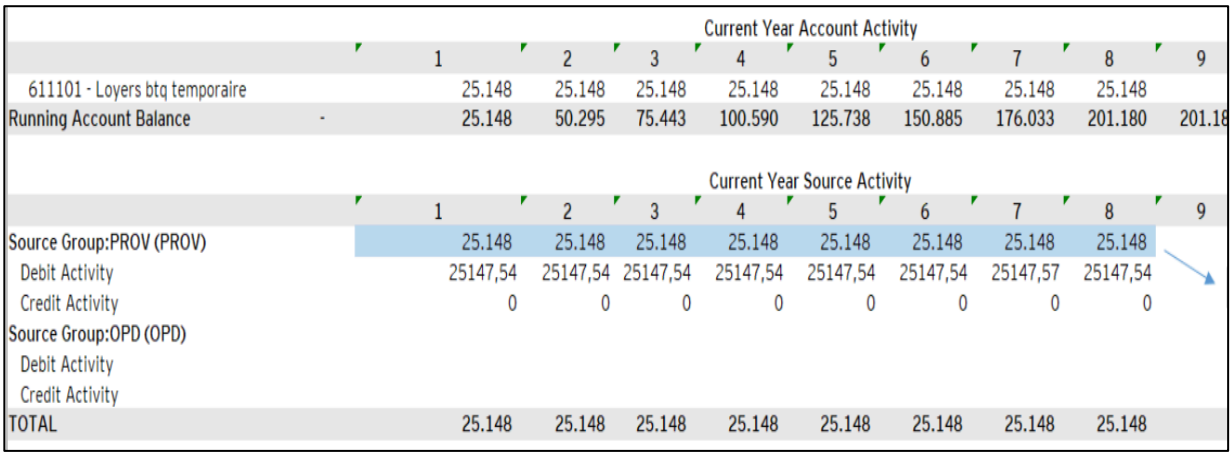
Source: (EY,2019)

The figure 2.8 demonstrates that there Is **no cut-off issue** because no material entries were recorded in the system near a closing period-end for the case of the audited company above. If there would have been material entries in the graph, the auditor should have performed further investigations to check if these entries were correctly recorded in the appropriate period.

6) Completeness test:

This test aims to assess if all transactions or events are booked correctly in the accounting records/financial statements of the audited company (Bragg, 2018). The example represented on the figure 2.9 below illustrates how we can perform a completeness test with data Analytics tools. In the case of the company below, we test the completeness of a **temporary shop rent** that has been used for 8 months to replace the usual shop during the restoration works. To carry out this task, the auditor needs to have the rental contract to know the monthly pre-defined amount between parties and the duration of the contract. In our case, we can effectively remark with the help of the data analytics tool that the transactions are well charged each month for a duration of 8 months as written in the contract. Moreover, the amount of 25.148 euros is well charged each month. As additional evidences, the auditor can check the existence of these payments by taking a look at the bank statements related to the period of the payment. In our case, we can conclude that everything is recorded without any issue.

Figure 2.9: Example of a completeness test



Current Year Account Activity

	1	2	3	4	5	6	7	8	9
611101 - Loyers btq temporaire	25.148	25.148	25.148	25.148	25.148	25.148	25.148	25.148	
Running Account Balance -	25.148	50.295	75.443	100.590	125.738	150.885	176.033	201.180	201.18

Current Year Source Activity

	1	2	3	4	5	6	7	8	9
Source Group:PROV (PROV)	25.148	25.148	25.148	25.148	25.148	25.148	25.148	25.148	
Debit Activity	25147,54	25147,54	25147,54	25147,54	25147,54	25147,54	25147,57	25147,54	
Credit Activity	0	0	0	0	0	0	0	0	
Source Group:OPD (OPD)									
Debit Activity									
Credit Activity									
TOTAL	25.148	25.148	25.148	25.148	25.148	25.148	25.148	25.148	

Source: (EY,2019)

7)Inventory subledger data analysis: The goal of data analytics in the context of this procedure is to perform some tests concerning the inventory subledger. There are many examples of this step, but we can list some of them such as the analysis of the costing method or by taking a look at the balance as per year-end (IRE, 2018).

8) Transaction flow verification: The goal of this verification is to check if the booking sequences are in accordance with the processes originally illustrated and foreseen in the risk assessment step (IRE, 2018).

Test of details

In this procedure, the auditor is looking for proofs that all the balances, disclosures and underlying transactions that are linked with the financial statements of the customer are exact (Bragg, 2018). Data analytics can have mainly 2 functions within the scope of test of details:

- **Reconciliations and roll forward:** The first usefulness of data analytics in this procedure is its ability to roll forward data easily. Roll forward can be defined as "the systematic establishment of a new accounting periods balances by using (rolling forward) prior accounting period data" (VentureLine, 2018). On the other side, reconciliation enables to match and analyse information's that are coming from different data's sources (IRE, 2018).

- **Recalculations:** Another interesting feature of data analytics is its ability to reperform and recalculate items for a full population and not only a sample which consequently expands the value of the audit (IRE, 2018). An example of recalculation could be found with the examination of the **prepaid expense**

account. A prepaid expense relates to an asset where payments are carried out in the balance sheet of this year but where the good will be received in a later future. In this case, the auditor could examine and recalculate all the assets related to these prepaid expenses that are comprised in the final prepaid expense balance (Bragg, 2018).

Other miscellaneous procedures

1) Journal entry (JE) testing:

in this step, data analytics can be useful in order to detect and **avoid potential risk of management override of controls** (IRE, 2018). The objectives of this step are explained in ISA 240 that describes it as the responsibility of the auditor to make sure the financial statements are free of material misstatements due to **intentional frauds or mistakes**. Moreover, according to ISA 240, the auditor should keep its professional scepticism by being aware that audit procedures covering the errors could not be efficient enough to fully cover the risk of fraud. Fraud is defined as an "act by one or more individuals among management, those charged with governance, employees, or third parties, involving the use of deception to obtain an unjust or illegal advantage » (CPA, 2015). So, it's the role of the auditor to establish procedures and to detect material misstatements. Several steps can be required to perform such kind of procedures (CPA, 2015):

I. **Understanding of the business processes of the audited company and the information system**. The understanding of the firm can be done through the investigation of the controls used in the context of unexpected transactions, standard & non-standard journal entries. This step is an important one because it enables to target areas where the risk is the highest for the management to **record inappropriate entries or to do some manipulations**. Several reasons can explain why some people inside companies could be tempted to manipulate accounting recordings such as: satisfy artificially to debt requirements, to give a good image of the company to third parties or to maximise personal gains through salaries or bonuses for example (CPA, 2015). Several other questions can be raised in this step such as: who is authorized to record/review the booking of financial entries and adjustments? Are there situations where the management asked for an access to record transactions? How are established the entries (manually or automatically)? Does it exist any segregation of duties between the IT and the accounting personnel?

II. **Examination of unexpected activities** that are linked to journal entries. The main purpose of this step is to bring additional information's to the ones brought in the first step. Example of questions that could be asked here are: Are there any changes in the way transactions were recorded? Were the employees asked to record transactions without any appropriate documentation linked to it? (CPA, 2015)

III. **Selection of journal entries having possibly an inappropriate characteristic** in order to test them. Some criteria are relevant to do a good selection such as the existence of internal goals and targets that have to be reached. This can influence how journal entries are recorded (CPA, 2015). Normally, the selection should allow the auditor to identify frauds that are typically characterized by journal entries recording made by individuals who are not allowed to do that, transactions not enough documented (often at the end of the year), journal entries containing round number, records and reviews performed by the same person. Moreover, the auditor should pay more attention to accounts that are especially subject to frauds due to their natural complexity, big estimated amounts comprised in the account, previous misstatements in past years or presence of intercompany transactions. Typically, data analytics can help to perform this selection and identify frauds (CPA, 2015).

Figure 2.10: round numbers identification in the journal entry

	EUR	
Round numbers (T:1000)(S:NA)	JE count	JE line count
111	62	111
000	1412	3478
999	90	166

Source: (EY,2019)

As shown on the figure 2.10 above, we notice that data analytics programs can automatically identify journal entries which contain round numbers. In some cases, this could potentially be a sign of fraud. Thus, the auditor should normally investigate all journal entries found by the program that are material to assess if they could have an inappropriate nature.

IV. **Perform an appropriateness test of the journal entries selection** that has been chosen in the previous step. In this step, the auditor is examining the description of the selected journal entries identified before. So, the purpose is to analyse the supporting document linked with the underlying journal entry to see if it supports it correctly (CPA, 2015). Several questions can be asked in this step such as: Are JE's reviewed by the right person? Is there documentation supporting all JE's? Why some supporting documents are not the original ones? Can the JE be justified by relevant business processes of the company? Is there any alteration of the supporting documents(CPA, 2015)?

Figure 2.11: Identified phrases in the description of the journal entry

	EUR		Total	
Identified phrases (T:140000)(S:headerline)	JE count	JE line count	JE count	JE line count
cash	6	12	6	12
fraud	0	0	0	0
email	0	0	0	0
percent	0	0	0	0
per	120	795	120	795

Source: (EY,2019)

For example, we can use data analytics to have directly access to a description of all journal entries which enables to search for key identified words that can have an importance within the scope of the audit. As shown on the figure 2.11 above, we can notice there is no entries mentioning "fraud" in their description which is already a first good sign. Nevertheless, we remark other entries containing "Cash" in their description which is not abnormal, but it can be relevant for the auditor to check more precisely what is behind the description for the higher transactions.

V. **Documentation of the results obtained through the different steps**. Thus, the aim of this step is to summarize the whole processes performed by the auditor and to support it with the documentation associated. Several other elements can be part of this step such as: presentation of the examinations performed with more details, results over the inappropriate adjustments of journal entries, perception of the auditor on the controls put in place by the audited company to avoid inappropriate bookings or a description of the employees interviewed with a detail of their main answers to the questions asked by the auditor.

One of the additional tests that can be realized in the context of Journal entries testing is to check if it exists **unbalanced journal entries**. In other words, we check if the total of credits is equal to the total of debits and if it's not the case, it means we have an unbalanced journal entry. Data analytics allows to check this condition of balanced journal entries easily as shown in the figure 2.12 below, we can see there are no unbalancing entries as the total is 0 in addition to other complementary information's displayed such as the amount of lines in the Trial balance (691) and in the journal entries (350 374).

Figure 2.12: Analysis of unbalanced journal entries

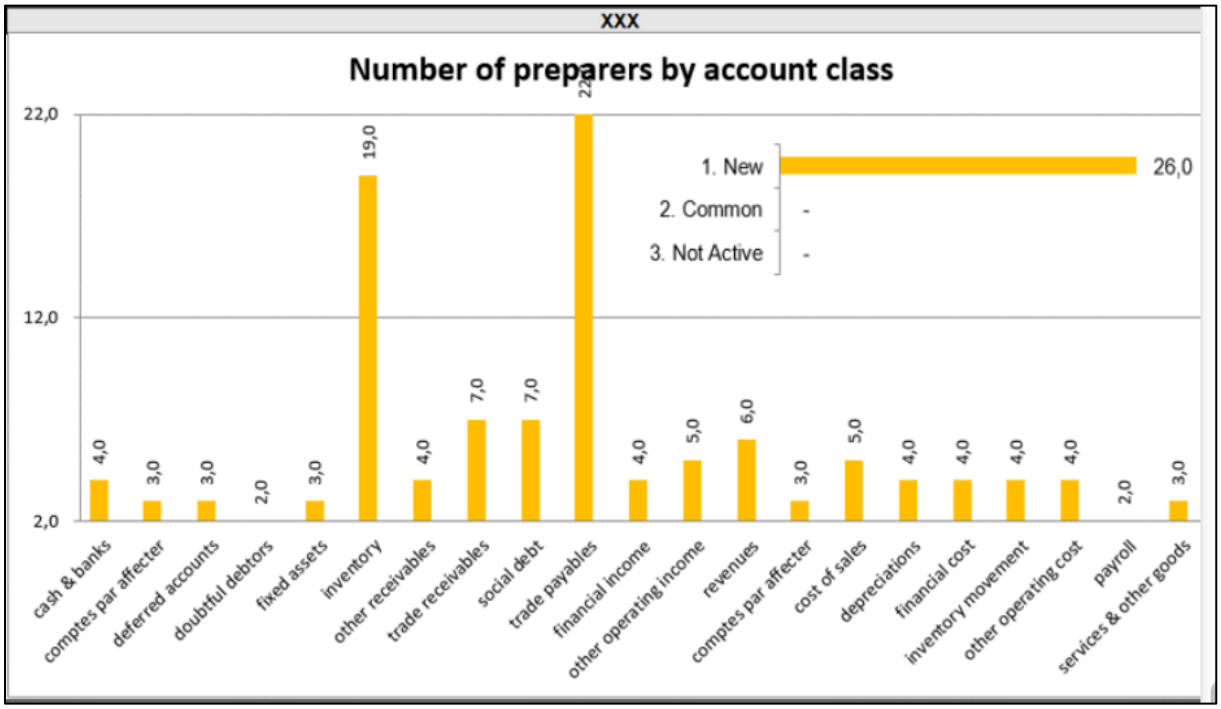
		EUR	
Control totals			
Journal entries		Actual	Control
Line item count:		350.374	
Amount:		-	
Trial balance		Actual	Control
Line item count:		691	
GL beginning balance:		-	
GL ending balance:		-	

	EUR		
Unbalanced journal entries by difference amount	<=.01	>.01	Total
Count of JEs	-	-	0
Percent	0,0%	0,0%	0,0%

Source: (EY,2019)

Another type of test, showed below on the figure 2.13, can be conducted in this procedure and is called "Segregation of duties and preparer map" that has been extracted from EY Helix. This test enables to analyse who booked journal entries for the company in which account and to investigate the evolution in the amount of people who have been authorized to operate such kind of entries. In the case of the company below, we can notice that there was a total of 26 new people doing JE entries in 2018 as there were 26 new preparer ID's in the company's ERP.

Figure 2.13: Segregation of duties-Preparer map



Source: (EY,2019)

Furthermore, we can also analyse the details of the accounts in which we have the highest number of preparer's ID or journal entries lines. The accounts that have the highest number of preparers are commercial debts (22 users) and inventory (19 users) this year. The trade receivables account and social debts have 7 preparers. The following accounts have all between 4 and 6 users: Cash & banks, financial income, revenues, cost of sales & other income. All the other accounts have only 1-3 users (Equity, other debts and social fees, PPE). Thus, accounts in which a lot of people were Involved are the ones in which the risk of fraud is the highest and where further investigations are the most needed. In the case presented above, it can be perceived as an issue that such a high number of people can record commercial debts and inventory.

However, the detail of the accounts indicated that a majority of the journal entries were recorded automatically for both accounts which diminishes the risk of fraud as there is no human intervention to influence the reporting. For the inventory, it seems logical that a lot of people can keep records of stock (including workers). For the commercial debt account, we notice that all the recordings were carried out by accountants which reveals that there is no problem of segregation of duties. Indeed, a detail of each account can be generated to see which users performed which transactions (appendix 1.3) in the section "activity". As explained above, these controls

enable the auditor to guarantee an adequate segregation of duties with management and consequently reduce the risk of fraud.

2) Automation of manual procedures

Finally, the last noticeable feature of data analytics in the context of audit procedures is its ability to perform automatically manual procedures that are tiresome and takes a lot of time for the auditor (IRE, 2018). It enables auditors, as described in the "advantage" part, to focus on the most adding value tasks. Here Is a list of examples of tasks performed usually manually by auditors and that will be more and more automated in the future with new digital tools (Vasarhelyi, Deep Learning and the Future of Auditing, 2017):

- Paperwork processing
- Contracts review
- Inventory checking
- Automatization of substantive manual procedures such as confirmations and examinations
- Drafting of auditing reports

Data Analytics: Absolute assurance?

We saw in previous sections the advantages, disadvantages, challenges and how to implement data analytics in the audit procedures. In this section, it's now time to answer to another question: Is data analytics an absolute assurance? Firstly, it is important to keep in mind that the main purpose of the auditor is to be sure financial statements do not contain material misstatements. Indeed, the auditor has to be able to guarantee a good level of reasonable assurance and minimize as much as possible the global auditing risk on the financial statements. The mathematical conception of the previous sentence can be illustrated in the following way: if the auditor guarantees 5 percent of audit risk then automatically, the degree of reasonable assurance will be equal to 95 percent (IRE, 2018). Consequently, when the auditor will be facing misstatements and deviations, he always has to remember he has to provide this reasonable assurance and exercise its professional judgement on the deviations and misstatements detected by data analytics programs. Based on this simple assumption, we can already conclude that even with data analytics, audit will not provide an absolute assurance to audited companies (IRE, 2018).

3) What's next?

The aim of this section is to provide a brief overview with the future digital technologies that fill follow and complement data analytics tools. Thus, in this section, we will describe briefly how these technologies will impact audit.

Artificial intelligence

As described at the beginning of the thesis, data analytics is in some way the first step of the digital revolution as **artificial intelligence** applications are currently being developed by the biggest auditing firms. One of the main characteristics of artificial intelligence is its capacity to **perform some aspects of the human intelligence** by using a set of new technologies such as machine learning, data mining, speech and image recognition as well as sentiment analysis (Boillet, 2018). Nevertheless, tasks that can be perceived as relatively easy for the human brain such as recognizing different forms on a picture can be also relatively complex to process for automated systems. Indeed, it requires for the machine to **convert all these forms into a computer-readable** format and to analyse it pixels by pixels (Vasarhelyi, 2017).

Artificial neural networks are relatively new systems that were enabled thanks to the huge advancements in the power of the computers and the data storage capacities (Vasarhelyi, 2017). Thus, **deep neural networks** are now able to analyse huge amount of data and learn from these data. Consequently, the systems can identify trends and patterns and sort data in function of pre-defined categories. Obviously, deep neural networks need to be trained in order to **maximise their effectiveness** and minimize errors by analysing huge amount of data from various sources. Once the **neural networks** are correctly trained, there is a true possible gain in efficiency for auditors. For example, it is possible for neural networks to identify much faster than humans trends and patterns without any external intervention in addition to the fact it requires less processing steps in comparison with traditional data mining approaches (Sun & Vasarhelyi, 2017).

Deep learning can be very interesting in the context of the Big data analysis as it is able to analyse Big data with an effectiveness that humans cannot reach. **Semi-structured and unstructured** Big data can bring relevant complements of information's on different aspects of the company such as the products and services sold by the client or their operations (Vasarhelyi, 2017). It constitutes a real advantage because it minimizes the dependence of the auditor on data provided by the client. Thus, **data**

mining in the context of Big data will bring a true added value in order to add critical information's helping to better understand the audited company and especially in the **risk assessment** phase.

Nevertheless, as it exists major barriers for the auditor to interpret manually the vast amount of data existing that can be structured or unstructured, there is a need to develop **deep learning** applications to process the data and be able to use them in the audit procedures. Moreover, the automation of some mundane tasks performed by the auditor will directly improve the audit quality and help the auditor to better support its judgements (Vasarhelyi, 2017). Indeed, deep learning can analyse various types of data such as **text, images or speech** which enables the auditor to focus on other tasks. Concrete tasks that can be automated concern mainly **substantive tasks** such as confirmations and examinations (Sun & Vasarhelyi, 2017). We are now going to establish a list of data sources that can be used in the context of deep learning applications applied to audit.

Image and Video recognition

In the future, we can imagine automating tasks with deep learning we wouldn't have thought a few years ago. Indeed, Deep learning applications can now **analyse videos recorded from a drone** to count the inventory that is owned by a company. For instance, it is possible to recognize from the drone the different models and the quantities of products that are warehoused. Thus, **inventory check** is one possible application but it's possible to treat other types of data such as interviews and conference records with the aim of inspecting or observing (Sun & Vasarhelyi, 2017).

Speech Recognition

Auditors make often use of interviews in order to obtain additional information's on the audited company and develop audit evidences. For example, they can be interested to have interviews with employees, management responsible or internal auditors. Deep learning can play an interesting role here as it is possible to analyse **how the answers of the interviewees are given** and what type of language is used. Indeed, we can say that sometimes the way the interviewee responds can be as important as the answer itself because it could **reveal an attempt of dishonesty** (Vasarhelyi, 2017). Concretely, Deep learning could through speech recognition applications detect hesitation and latencies in the words used potentially indicating frauds such as "Maybe", "could" or "perhaps". Thus, this functionality can assist auditors to **detect**

potential frauds in oral conversations that could be less easily found without Deep learning even with specific training's provided to detect that kind of attempts.

Speech recognition applications are also able **to write on real-time** what is said word by words by the interviewee and without being influenced by the accent of the person or eventual background noises. This retranscription of the text can be also complemented **by an analysis of the emotion** expressed by the interviewee or other relevant factors possibly influencing the audit evidences. In a few words, speech recognitions applications could be used in the context of interviews, various types of calls or presentations with the aim of inquiring possible attempts of hesitations by employees inside the audited company (Sun & Vasarhelyi, 2017).

Text recognition

Obviously, a company is emitting an enormous amount of data in their daily operations which complicates the work of the auditor especially when dealing with multiple written documents from different sources. Indeed, auditors have to deal with contracts such as **lease contracts, management discussion analysis, social medias texts or press releases**. Text analysis can be performed by deep learning applications as it Is possible to categorize parts of the text by classifying them in function of the needs of the auditor (Vasarhelyi, 2017). For example, Deep learning could analyse a huge amount of lease contracts in a much shorter timeframe than humans by **extracting the most relevant information's** on the contracts. For instance, it can extract the different clauses written in the contract, the beginning date for the lease, the payments, the renewal and termination options. This enables to bring a higher efficiency and accuracy compared with human capabilities as Deep learning algorithms are able to analyse much more contracts (Vasarhelyi, 2017).

While performing these multiple analysis, artificial intelligence is trained to **detect the cognitive patterns** and to replicate more and more these patterns to be close of the human judgements which contributes to make the efficiency of deep learning better and better (Sun & Vasarhelyi, 2017). Thus, artificial intelligence enables auditors to work in a more intelligent way as they can use **their human judgement to examine bigger datasets**. Consequently, auditors can better interact and ask more precise questions to interviewees in the audited company. All these processes contribute to make the audit more accurate and to provide an overall added-value. Moreover, new developments in artificial intelligence will enable Machine learning to have predictive features. Indeed, through the analysis of past data, artificial intelligence will be able to

predict **the occurrence of future events and risks**. In the future, machine learning will be complemented to **develop fraud detection models** to calculate more precisely the risk to encounter material misstatements in the financial statements of a company which in turn will definitely enhance the audit quality. This trend will confirm the evolution of audit from a **past-looking point of view to a forward-looking approach** (Vasarhelyi, 2017)**.**

Finally, it's also to be noticed that the social medias will play an increasingly important role in the auditing field in the future thanks to deep learning and this will bring additional insights for the auditor. For example, IBM already developed Watson which is able to extract **from social medias relevant information for the audit in function of keywords** or **certain subjects**. Moreover, It can extract data from various sources such as Twitter, Facebook, YouTube or Amazon and articulate the collected information's coming from million interactions **visually** in order to provide data concerning opinion, demographical or geographical aspects (Vasarhelyi, 2017). Concretely, it is possible for the application to process and sort data provided by the customers of the audited company on their opinion or feeling on the last products they launched. By this way, the auditors can see if there is a majority of positive or negative feelings. Thus, this procedure is entirely automated and allows to transform qualitative data that would have necessitated a great effort to perform manually into quantitative data that can be more easily integrated into audit procedures and be used as evidences. It constitutes another evolution in the future in comparison with the traditional audit approach. In a few words, we can say artificial intelligence will enable in the context of data analytics to provide better insights for auditors that will work as a companion to complement the human judgement of the auditor.

4) Conclusion

To conclude, data analytics will completely revolutionize the auditing industry from many points of views. As depicted in this thesis, this revolution will predominantly bring major enhancements for the audit quality, but it also contains major challenges that have to be addressed in the future to fully benefit from this technological advancement. The major benefits brought by data analytics can be summarized by a larger testing of the population, earlier identification of the main risks areas, better visualization of the results and increase in the auditor's focus. Consequently, all these benefits gathered together will have as a general effect to improve the audit quality, enhance the client service and to bring at a higher level the effectiveness of the auditor.

It's also to be noticed that a large majority of the professionals are now aware of the technological impact on audit and want to embrace this change by expanding their role in order to fully benefit from the opportunities brought by data analytics. Indeed, according to recent surveys, audit professionals want now to go deeper in the areas they already cover in addition of covering areas they never approached before. That's why more and more, auditors will go beyond the traditional auditing framework. Several new services were described in the thesis and could be in the future performed by auditors such as fraud detection through forensics specialization, integration of sustainability reporting or performing consulting activities to improve business operations. Nevertheless, in order to fully succeed in this transition, a true change in the skills of the new auditors will be required as it's generally perceived that new auditors applying in this field do not enough IT capabilities according to a majority of interviewees. Several approaches were discussed within the context of this thesis in order to fill the gap existing between the skills required in the companies and what is taught in the business schools. One of the possible solutions is to develop cooperation between auditing companies and the higher education to give courses closer to the reality of the new skills needed by the auditors that could then be completed by training's or continuous learning processes inside the companies. Thus, a re-skilling will be needed in order to reach a better analytical approach, problem-solving mindset as well as increased judgemental, statistical and IT skills which will be essential. This mix of skills that is required for the auditors of the future is currently lacking on the market which illustrates the necessity to train more seriously auditors to these evolutions.

Furthermore, the re-skilling is not the sole problem identified for auditing companies as it exists some concerns with the extraction of the data coming from the audited company or the security matter on how to protect these data efficiently. Indeed, the

huge amount of data generated by companies constitutes a true added value for auditors but also a challenge in what concerns their security because both internal and external auditors should value more this aspect with the aim of protecting the assets of organisations and also the interests of their own clients.

Moreover, several questions were asked concerning the evolutions of the standards and one of the questions raised in this thesis was to know if the international standards developed by the IAASB were adapting as fast as the evolution of the technologies. On this question, we can conclude that the standards are not evolving at a fast pace and it's a kind of willingness of the IAASB. This strategy is predominantly understood by the professionals that have specific requirements in what concerns the standards because they consider it should not be changed too rapidly to avoid a rushing behaviour leading to badly-designed rules. As described in this thesis, they are mainly attached to a collaborative approach between professionals and standards-settlers with the aim of finding a consensus on the best approach to adapt standards. Professionals are mainly asking for practical guidance with standards remaining flexible in order to be adaptable to the fast-changing environment. Furthermore, they emphasize the necessity to establish non-authoritative standards promoting the use by the auditors of their professional scepticism and judgement to be able to take the best from the possibilities of data analytics. Nevertheless, we tried in this thesis to target the most relevant international standards that could be subject to modifications by the IAASB in the following years and this mainly concerns ISA 315 (identification and evaluation of risks to meet material misstatements), ISA 330 (nature & extent of controls), ISA 500 (Data reliability & integrity), ISA 520 (Analytical procedures), ISA 530 (evaluation of exceptions) and ISA 540 (accounting estimates).

Finally, we tried through concrete examples to describe a possible way to implement data analytics into the different audit phases that are audit planning, risk assessment, test of controls and the substantive procedures. We saw the true possibilities and the value it brings for the auditor but it's essential to remember that data analytics does not constitute an absolute assurance for the auditor. Indeed, the auditor has always to remain critical towards the reliability of the data he's using. Moreover, professional scepticism and judgement are essential to perform audit especially when it concerns the assessment of qualitative or accounting estimates that can remain tricky even with the use of data analytics tools.

5) Critical analysis and limits of the thesis

This thesis also contains some limitations. Indeed, even if the main results of this thesis were obtained through a combination of research conducted with scientific literature and interviews with professionals on the field, only a limited number of interviews were performed. Consequently, the results may not reflect entirely the whole situation and opinion of the profession. That's why we could have missed some elements concerning the impact of data analytics on audit. Moreover, the main interviews and elements of this thesis were conducted in the context of big audit firms, but it could be relevant to conduct further research with smaller actors which may not perceive this evolution in the same way as bigger companies in the industry.

Additionally, the angle chosen for this thesis was more theoretical oriented in order to better understand the main advantages, challenges and functionalities of data analytics but further research could be conducted in order to quantify the real gain in terms of effectiveness (time, money, …) in each of the different audit phases needed by companies. This type of research is still lacking in the scientific literature but requires more means and deeper knowledge on the topic to conduct effectively research.

Finally, we described possible standards affected by data analytics and some of the expectations of professionals towards the regulators but it is not 100 % sure that the IAASB will take all these remarks into consideration and only the years to come will indicate us how international standards will really evolve and at which pace due to the fast changes in the auditing industry. Thus, it could be interesting to follow the attitude and the decisions of the IAASB in the coming years. Moreover, the topic still contains some unanswered questions given it is a hot topic knowing almost every day new evolutions which offers almost continuously new possibilities in terms of research and development thanks to the advancements in domains such as machine learning and artificial intelligence.

6) Bibliography

ACCA. (2017). *Analytical procedures*. Retrieved from ACCA: https://www.accaglobal.com/in/en/student/exam-support-resources/professional-exams-study-resources/p7/technical-articles/analytical-procedures.html

Accounting, Financial & Tax. (2017). *7 Major Phases of Audit*. Retrieved from Accounting, Financial & Tax: http://accounting-financial-tax.com/2009/09/7-major-phases-of-audit-of-financial-statements/

AICPA. (2015). *Audit Analytics & continuous auditing* . Retrieved from AICPA: https://www.aicpa.org/interestareas/frc/assuranceadvisoryservices/downloadabledocuments/auditanalytics_lookingtowardfuture.pdf

Bilyk, V. (2018). *4 TYPES OF MACHINE LEARNING ALGORITHMS*. Retrieved from The App Solution: https://theappsolutions.com/blog/development/machine-learning-algorithm-types/

Boillet, J. (2018). *How artificial intelligence will transform the audit*. Retrieved from EY: https://www.ey.com/en_gl/assurance/how-artificial-intelligence-will-transform-the-audit

Bragg, S. (2018). *Analytical procedures*. Retrieved from https://www.accountingtools.com/articles/analytical-procedures.html

Bragg, S. (2018). *Tests of controls*. Retrieved from Accounting Tools: https://www.accountingtools.com/articles/what-are-tests-of-controls.html

Bragg, S. (2018). *Tests of details*. Retrieved from Accounting Tools: https://www.accountingtools.com/articles/2017/5/15/tests-of-details

Centre for financial reporting reform. (2017). *Audit Data Analytics: Opportunities and tips*. Retrieved from CFRR: http://siteresources.worldbank.org/EXTCENFINREPREF/Resources/4152117-1427109489814/SMPs_spreads_digital.pdf

CFI. (2018). *What is Audit Materiality?* Retrieved from CFI: https://corporatefinanceinstitute.com/resources/knowledge/accounting/audit-materiality/

Chartered Institute of Internal auditors. (2018). *Computer assisted audit techniques (CAATs)*. Retrieved from Chartered Institute of Internal auditors: https://www.iia.org.uk/resources/delivering-internal-audit/computer-assisted-audit-techniques-caats/?downloadPdf=true

CPA. (2015). *Implementation Tool for Auditors*. Retrieved from CPA: https://www.cpacanada.ca/-/media/site/business-and-accounting-resources/docs/implementation-tool-testing-journal-entries-and-other-adjustments-responding-to-the-risk-of-management-override-of-controls-may-2015.pdf?la=en&hash=3C27B4C969669E97FB88B37FD1B42

CPA. (2016). *Audit Data Analytics Alert*. Retrieved from CPA: https://www.cpacanada.ca/en/business-and-accounting-resources/audit-and-assurance/canadian-auditing-standards-cas/publications/audit-data-analytics-alert-pace-of-change

Digital Guardian . (2016). *QU'EST-CE QUE LA CONFORMITÉ SOX ?* Retrieved from Digital Guardian: https://digitalguardian.com/fr/blog/what-sox-compliance

EY. (2015). *How big data and analytics are transforming the audit*. Retrieved from EY: https://www.ey.com/en_gl/assurance/how-big-data-and-analytics-are-transforming-the-audit

EY. (2018). *Leading-edge digital technology powering the EY audit*. Retrieved from EY: https://cdn.ey.com/echannel/gl/en/services/assurance/digital-audit/EY-Digital-Audit-v4.pdf

Financial Reporting Council . (2017). *AUDIT QUALITY THEMATIC REVIEW*. Retrieved from FRC: https://www.frc.org.uk/getattachment/4fd19a18-1beb-4959-8737-ae2dca80af67/AQTR_Audit-Data-Analytics-Jan-2017.pdf

Forbes. (2015). *A focus on change* . Retrieved from Forbes : https://images.forbes.com/forbesinsights/StudyPDFs/KPMG-AFocusOnChange-REPORT.pdf

Forbes. (2018). *Five Skills Auditors Need To Succeed Today*. Retrieved from Forbes: https://www.forbes.com/sites/insights-kpmg/2018/07/16/five-skills-auditors-need-to-succeed-today/#2ab914702356

Gehrke, N. (2018). *Digitization of auditing SAP Order-to-Cash Processes*. Retrieved from Zapliance: https://www.zapliance.com/en/blog/auditing-real-sod-in-order-to-cash

GN, C. K. (2018). *Machine Learning Types and Algorithms*. Retrieved from Towards Data science: https://towardsdatascience.com/machine-learning-types-and-algorithms-d8b79545a6ec

Goh, C. (2017). *The predictive audit: Why prevention is better than a cure*. Retrieved from CEO Magazine: https://www.theceomagazine.com/business/innovation-technology/data-mining-data-analytics-enable-predictive-auditing/

Grossbaier, C. (2018). *Process Mining and Internal Audit: A Match Made in Heaven?* Retrieved from Celonis: https://www.celonis.com/blog/process-mining-and-internal-audit-a-match-made-in-heaven

Heidenreich, H. (2018). *What are the types of machine learning?* Retrieved from Towards data science: https://towardsdatascience.com/what-are-the-types-of-machine-learning-e2b9e5d1756f

IAASB. (2017). *Exploring the Growing Use of Technology in the Audit, with a Focus on Data Analytics*. Retrieved from IFAC: http://www.ifac.org/system/files/publications/files/IAASB-Data-Analytics-WG-Publication-Aug-25-2016-for-comms-9.1.16.pdf

IAASB. (2018). *Exploring the Growing Use of Technology in the Audit, with a Focus on Data Analytics*. Retrieved from IAASB: https://www.ifac.org/system/files/publications/files/Data-Analytics-Feedback-Statement.pdf

ICAS. (2016). *THE CAPABILITY AND COMPETENCY REQUIREMENTS OF AUDITORS IN TODAY'S COMPLEX GLOBAL BUSINESS ENVIRONMENT*. Retrieved from https://www.icas.com/__data/assets/pdf_file/0003/239457/The-capability-and-competency-requirements-of-auditors-in-todays-complex-global-business-environment.pdf: https://www.icas.com/__data/assets/pdf_file/0003/239457/The-capability-and-competency-requirements-of-auditors-in-todays-complex-global-business-environment.pdf

IDC. (2014, April). *The digital universe of opportunities: Rich data and the increasing value of the internet of things.* Retrieved from IDC: https://www.emc.com/leadership/digital-universe/2014iview/index.htm

IFAC. (2009). *INTERNATIONAL STANDARD ON AUDITING 450*. Retrieved from IFAC: http://www.ifac.org/system/files/downloads/a021-2010-iaasb-handbook-isa-450.pdf

Information technology Laboratory. (2018). *What is EDA?* Retrieved from NIST: https://www.itl.nist.gov/div898/handbook/eda/section1/eda11.htm

International accounting, auditing & Ethics. (2016). *Data analytics for external auditors*. Retrieved from ICAEW: https://www.icaew.com/-/media/corporate/files/technical/iaa/tecpln14726-iaae-data-analytics---web-version.ashx

IRE. (2018, january 12). *Data analytics: The future of audit.* Retrieved from IRE: https://www.ibr-ire.be/fr/publications/series_actuelles/brochures/generalites/Documents/Brochure-data-analytics-2018.pdf

JICPA. (2016). *The Outlook for IT-Based Auditing: Approaches to Next Generation Audit*. Retrieved from JICPA: https://jicpa.or.jp/specialized_field/files/0-10-48-2-20160726.pdf

Jobs.uk. (2009). *What is Continuing Professional Development (CPD)?* Retrieved from Jobs.uk: https://www.jobs.ac.uk/careers-advice/managing-your-career/1318/what-is-continuing-professional-development-cpd

KPMG . (2019). *KPMG Master of Accounting with Data and Analytics Program*. Retrieved from KPMG Campus: https://kpmgcampus.com/portal/32/assets/files/KPMGMastersBrochure.pdf

Lee, T., & Azham, M. (2008). The evolution of auditing: An analysis of the historical development. *Journal of Modern Accounting and Auditing*.

McKinsey & company. (2016, December). *THE AGE OF ANALYTICS: COMPETING IN A DATA-DRIVEN WORLD.* Retrieved from Mckinsey: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Analytics/Our%20Insights/The%20age%20of%20analytics%20Competing%20in%20a%20data%20driven%20world/MGI-The-Age-of-Analytics-Full-report.ashx

Miklos, V. (2017). *Audit Data analytics*. Retrieved from PCAOB: https://pcaobus.org/News/Events/Documents/05242017-SAG-meeting/presenter-slides-Vasarhelyi.pdf

Murphy, K. (2017). *The 3-Way Matching Process & Concept*. Retrieved from Purchase Control: https://www.purchasecontrol.com/uk/blog/what-is-3-way-matching/

Oracle. (2018). *What Is Big Data?* Retrieved from Oracle : https://www.oracle.com/big-data/guide/what-is-big-data.html

PwC. (2016). *Understanding a financial statement audit*. Retrieved from Pwc: https://www.pwc.com/im/en/services/Assurance/pwc-understanding-financial-statement-audit.pdf

Rouse, M. (2011). *NoSQL (Not Only SQL database)*. Retrieved from Search Data Management: https://searchdatamanagement.techtarget.com/definition/NoSQL-Not-Only-SQL

Rouse, M. (2018). *Hadoop*. Retrieved from Search Data Management : https://searchdatamanagement.techtarget.com/definition/Hadoop

Rutgers Carlab. (2017). *comments on the IAASB Data Analytics Working Group Consultation Paper*. Retrieved from Rutgers Carlab: https://www.ifac.org/system/files/publications/exposure-drafts/comments/IAASBComment_Final2-15-17.pdf

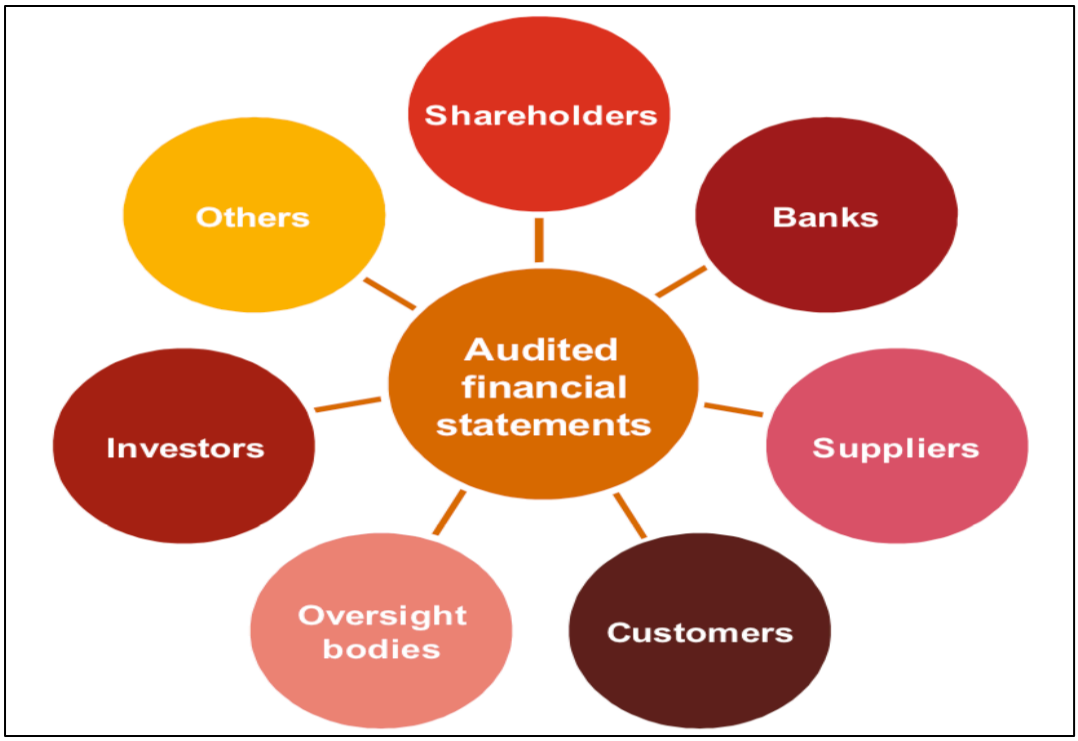
Sun, T., & Vasarhelyi, M. (2017). *Deep Learning and the Future of Auditing*. Retrieved from cpa journal : https://www.cpajournal.com/2017/06/19/deep-learning-future-auditing/

Vasarhelyi, M. A., & Ting, S. (2018). Embracing Textual Data Analytics in Auditing with Deep Learning. *The International Journal of Digital Accounting Research*.

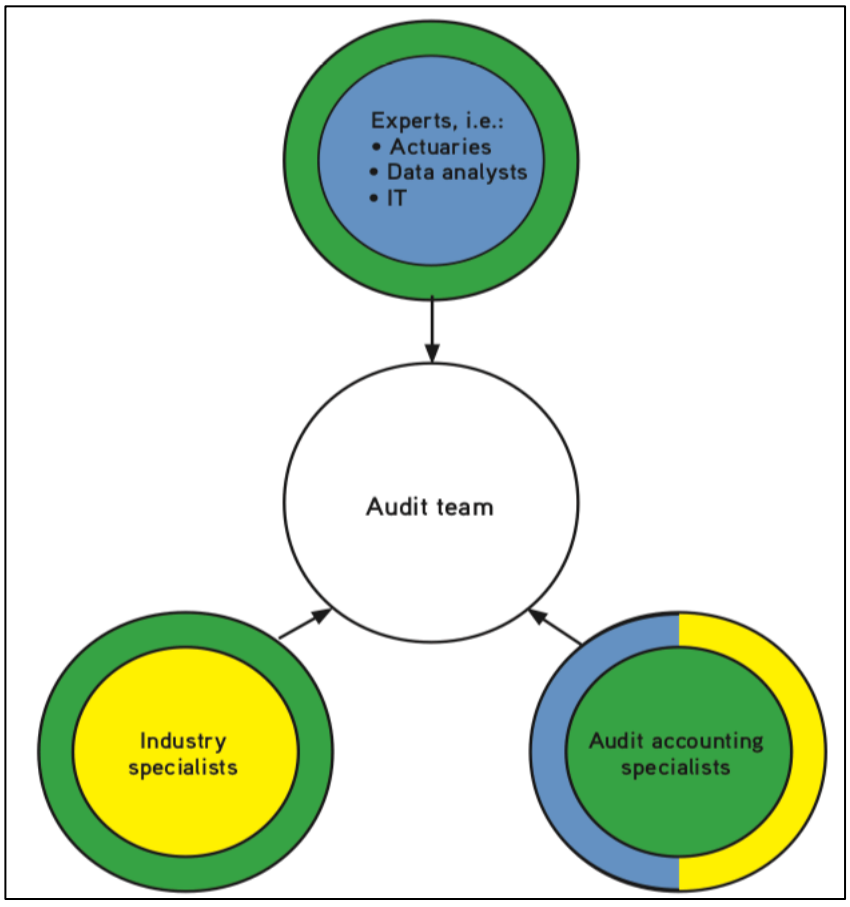
VentureLine. (2018). *Roll Forward Definition*. Retrieved from VentureLine: https://www.ventureline.com/accounting-glossary/R/roll-forward-definition/

7) Appendices

Appendix 1.1: Stakeholders around an audited company (PwC, 2016)



Appendix 1.2: Composition of future audit teams (ICAS, 2016)



Appendix 1.3: Preparer map (EY,2019)

	Account Type	Account Class	PY Entries Preparer	CY Amount	CY Debit	CY Credit
Activi	Assets	cash & banks		479.531	32.751.251	(32.271.720)
Activi	Assets	comptes par affecter		(116.756)	162.714	(279.470)
Activi	Assets	deferred accounts		(400)	12.501	(12.902)
Activi	Assets	doubtful debtors		-	8.000	(8.000)
Activi	Assets	fixed assets		3.545	123.140	(119.595)
Activi	Assets	inventory		13.689	163.305	(149.616)
Activi	Assets	other receivables		4.810	1.261.013	(1.256.203)
Activi	Assets	trade receivables		(100.555)	8.506.812	(8.607.367)
Activi	Liabilitie	social debt		(2.487)	4.155.682	(4.158.169)
Activi	Liabilitie	trade payables		(81.497)	7.125.830	(7.207.328)
Activi	Revenue	financial income		(405)	-	(405)
Activi	Revenue	other operating income		(78.580)	75	(78.655)
Activi	Revenue	revenues		(6.577.818)	136.003	(6.713.821)
Activi	Expense	comptes par affecter		116.756	119.595	(2.839)
Activi	Expense	cost of sales		3.925.131	4.125.320	(200.189)
Activi	Expense	depreciations		119.595	119.828	(233)
Activi	Expense	financial cost		9.924	12.103	(2.179)
Activi	Expense	inventory movement		75.810	81.923	(6.113)
Activi	Expense	other operating cost		4.142	4.752	(610)
Activi	Expense	payroll		672.224	838.614	(166.390)
Activi	Expense	services & other goods		1.533.344	1.627.975	(94.631)