HOW DO BIG DATA AND DATA ANALYTICS IMPACT THE EXTERNAL AUDIT?
– A CRITICAL ANALYSIS

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<tr>
<td>AICPA</td>
<td>American Institute of Certified Public Accountant</td>
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<td>AR</td>
<td>Audit Risk</td>
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<td>CFRR</td>
<td>Centre for Financial Reporting Reform</td>
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<td>CR</td>
<td>Control Risk</td>
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<td>DAWG</td>
<td>Data Analytics Working Group</td>
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<td>DBMS</td>
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<td>Detection Risk</td>
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<td>Exploratory Data Analysis</td>
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<td>IAASB</td>
<td>International Auditing and Assurance Standards Board</td>
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<td>IASB</td>
<td>International Accounting Standards Board</td>
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<td>ICAEW</td>
<td>Institute of Chartered Accountants in England and Wales</td>
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<td>IFAC</td>
<td>International Federation of Accountants</td>
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<td>IFRS</td>
<td>International Financial Reporting Standards</td>
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<td>INTOSAI</td>
<td>International Organisation of Supreme Audit Institutions</td>
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<td>IOSCO</td>
<td>International Organisation of Securities Commissions</td>
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<td>IPE</td>
<td>Information Provided by the Entity</td>
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<td>IR</td>
<td>Inherent Risk</td>
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<td>IRE</td>
<td>Institut des Réviseur d'Entreprises</td>
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<td>ISA</td>
<td>International Standard on Auditing</td>
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<td>JET</td>
<td>Journal Entry Testing</td>
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<td>KPI</td>
<td>Key Performance Indicator</td>
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<td>MGI</td>
<td>McKinsey Global Institute</td>
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<td>RMM</td>
<td>Risk of Material Misstatement</td>
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INTRODUCTION

We live in a world where everything is always changing. The business world is changing through technological evolution. Hence, the way audit is conducted also needs to change to keep pace. Many new technologies and tools exist that can change the way auditing is conducted. This research analyses some of these technologies: Big Data and Data Analytics, and their impact on the external audit. Daily, 2.3 trillion gigabytes of data are generated and the pace is increasing (IBM, 2019a, 2019b). In order to extract valuable information from this data, it needs to be analysed. The technique of analysing data is called Data Analytics (Holmes, 2017).

The current state of research recognises the importance and the advantages of new technologies but often lacks specific applications. Furthermore, few literatures concerning the Belgian and Luxembourg market are available.

The strength of the thesis lies in the diversity of the interview partners. Twelve professionals, from six different audit companies in Belgium and Luxembourg, were interviewed about the use of technology in their company. The diversity is also reflected in the expert opinions as they use different tools and techniques and have different technological maturity.

The problems of the research concern, on the one side, the overload of information. As already explained, more and more data exist and also more and more articles, books, etc. Hence, the useful articles needed to be identified which was a time-consuming task. Furthermore, the various expert opinions have been on the one side valuable insights, but on the other hand difficult to structure due to the variety. The Belgian and Luxembourgish auditors use Big Data and Data Analytics less than expected and the usage in the risk identification and assessment is even smaller than expected. This led to less insight in this aspect of the research.

The aim of this dissertation is to examine the impact that Big Data and Data Analytics has on the external audit. In particular, the influence on the working methods and the audit quality will be discussed. Another important point will be the risk identification and assessment phase of the external audit as it forms the basis for the following audit procedures. Furthermore, further risks are identified and analysed in the course of the audit.

Therefore, the research questions are stated as follows:

➢ Q1: How do Big Data and Data Analytics influence the audit working method?
➢ Q2: What is the impact of Big Data and Data Analytics on the audit quality?
Q3: How is the audit risk identification and assessment phase influenced?
Q4: Which tools and techniques do the Belgian and Luxembourgish auditors use and where do they stand?

The different hypotheses are:

- H1: Applying Big Data and Data Analytics all through the different phases of the external audit leads to more efficiency and effectiveness: less time consuming and less costly.
- H2: The usage of Big Data and Data Analytics enhances the audit quality.
- H3: The usage of Big Data and Data Analytics enhances the identification of possible risks of material misstatement.
- H4: The Belgian and Luxembourgish auditors are lagging behind in their implementation of new technologies.

First, the research methodology will be discussed. Next, the concepts of big data and data analytics will be examined. The notion of audit and risk assessment more specifically will be also be studied. This will build the theoretical basis for the next chapters. The third chapter consists of a literature review. The current state of use of big data and data analytics in audit will be analysed. The advantages and disadvantages, the drivers and barriers are discussed. Furthermore, some implementation models and future prospects are examined. The fourth chapter deals with the empirical research. The results of the interviews are discussed and compared to the literature review. Chapter five deals with the ethical dimensions of the answers provided to the research question. These are data confidentiality and security, and the auditor’s independence. The main ideas are summarised in the conclusion, chapter seven. Moreover, the final maturity model as well as recommendations, further research and limitations are presented.
I. METHODOLOGY

In order to find out how the use of Big Data and Data Analytics influences the audit working methods and the audit quality, a qualitative research was carried out. For this purpose, scientific articles were analysed in the context of the literature review. Subsequently, a case study was carried out. Various experts in this field were interviewed.

In order to gain an overview of the various Big Data and Data Analytics techniques and their use in external audit, scientific articles and books were sought with the help of different databases. Therefore, the database of the library of the University of Liege, Google Scholar, and SSRN have been used. In the context of the literature review, various key words have been used as for example: “Big Data”, “Data Analytics”, “External Audit”, “Audit”, and “Auditing”. Afterwards, a title and a first reading of the abstract or introduction were used as a basis to decide whether they were suitable for the research. Furthermore, it was ensured that the works were scientific. Therefore, the auditors were briefly examined; peer-reviews or citations in other articles were also decisive characteristics. The Mendeley software was used to read and organise the articles. It helped organise the bibliography, highlight in the documents and summarise the texts in a sub window. Furthermore, Excel documents were created, organised by topic, including the summaries of the respective articles. The information retrieved was then categorised based on the structure of the interview guidelines.

To examine the technological maturity of the Belgian and Luxembourgish audit industry, twelve experts were interviewed using semi-structured interviews. Semi-structured interviews were chosen to obtain structured answers but still have the possibility to react to the answers in order to obtain more information. However, this means that the interviewees’ answers depend on their interpretation of the questions. In order to gain a wide range of insights and practical experience, auditors of different ranks and from different audit firms in Belgium and Luxembourg were consulted. The interviews took place in the period between July 1, 2019 and July 26, 2019; either in person at the experts’ offices or another neutral location or by phone. One out of the ten interviews were conducted in a restaurant. Therefore, it is possible that the respondents gave socially desirable answers. Face-to-face interviews were preferred despite the increased expenditure of time, because it increases the likelihood of more detailed answers, facilitates queries and creates a personal atmosphere. Nevertheless, at the request of the experts, two out of the ten interviews were conducted by phone. The interviews were conducted individually or in groups of two, in English or French. Two out of the ten have been conducted in groups of two. Hence, it is possible that interviewees have influenced each other.
Nevertheless, it also allowed them to respond to the other’s statements and thus provide more insight and understanding. The interviews lasted between one and two hours and were partially recorded, depending on the experts’ agreement, in order to better analyse the answers. Notes were taken during. Moreover, five interviewees were additionally recorded with their consent, in order to transcribe the interviews. The other respondents preferred not to be recorded or could not be recorded due to the phone interview. In this case, the interviews can only be retraced with the help of notes. For the analysis of the data, the interviews were first qualitatively coded. In a second step, they were categorised based on the structure of the literature review. Finally, they were compared with the information of the literature review.
II. THEORETICAL FRAMEWORK & CONCEPTS

1. BIG DATA

1.1. What is Big Data?

Before being able to define the concept of “big data”, the term “data” has to be defined. Data is the “factual information (such as measurements or statistics) used as a basis for reasoning, discussion, or calculation”; it is also “information in digital form that can be transmitted or processed” or “information output by a sensing device or organ that includes both useful and irrelevant or redundant information and must be processed to be meaningful” (Data, 2019). This definition already shows that only the analysis of data makes it valuable.

A uniform definition of Big Data does not exist. According to the Merriam-Webster Dictionary, Big Data is “an accumulation of data that is too large and complex for processing by traditional database management tools” (Big data, 2019).

Furthermore, the McKinsey Global Institute\(^1\), an international research and advisory company, defines Big Data as “datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze” (MGI, 2011, p.1). Here, data that cannot be handled by traditional technology is seen as big data.

The analytics company SAS defines Big Data as:

* A term that describes the large volume of data– that inundates a business on a day-to-day basis*. Furthermore, they emphasise the fact that the true value of Big Data lies in the possibility to analyse it and retrieve better decision-making (SAS, 2019).

The international research and advisory company Gartner (2019) defines big data as “high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation”.

Two groups of definitions can be identified. The first one emphasising what can be done thanks to big data and the second one highlighting the characteristics of big data.

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\(^1\) Hereinafter referred to as “MGI”
1.2. The characteristics of Big Data

As already seen in the previous chapter, many authors characterise Big Data on the basis of its attributes. Everyone agrees the characteristics of Big Data all start with the letter “V”. This is the reason why people often speak about the “V’s” of Big Data. What differentiates the authors from each other is the number of attributes they assign to Big Data. Gartner’s definition already identifies the first three attributes: Volume, Velocity and Variety (McAfee, & Brynjolfsson, 2012; Wu, Buyya, & Ramamohanarao, 2016).

**Volume** refers to the scale of data that is gathered and stored. However, it is not possible to fix an amount of data starting from which it can be described as Big Data. This is because the technology is evolving exponentially. Hence, more data can be created and also faster (Holmes, 2017). According to IBM, approximately 2.5 quintillion bytes (2.3 trillion gigabytes) of data are generated daily. Moreover, 40 zettabytes (43 trillion gigabytes) will be generated by 2020. This is three hundred times more than in 2005. (IBM, 2019a)

**Variety** determines the different sources of data. Three types of data sources exist: structured, semi structured and unstructured data. Structured data can be found in spreadsheets or databases and is easy to analyse. Unstructured data is more difficult to analyse but according to IBM (2019a) 90% of the data created nowadays is unstructured. Photos, videos, tweets and other text-processing documents are examples of unstructured data. Traditional analytical tools cannot analyse this type of data. However, identifying key features may enable classification which can add structure to data. Social media posts that use hashtags are an example of semi-structured data. The hashtag can relate the post to a specific topic (Holmes, 2017). Furthermore, data sources can be categorised as external and internal. Data from internal business systems such as production, inventory, sales etc. is defined as internal data. External data sources are characterised by third party systems such as social media, the government, the weather and the financial market (Heilig & Voß, 2017).

The last characteristic of the three “V’s” is velocity (Santos, Teles, Siqueira, & De Oliveira, 2018). **Velocity** describes the speed at which the data is created. According to IBM the rate of global Internet traffic is approximately 50,000 GB per second (IBM, 2019a). Velocity is directly linked to volume because the faster data is created, the more data there is (Holmes, 2017).

Others add a fourth characteristic: **Veracity**, the uncertainty of data, such as illustrated in Appendix 1 and 2. The veracity of a data set determines its reliability (Wu et al., 2016)
A fifth attribute that some authors define is the “Value” of data (Joshi, & Marthandan, 2019). The value of data is defined as valuable information one can get for his or her business needs (Gordon, 2013).

Microsoft adds two more attributes: Variability and Visibility. Variability considers the number of variables that a data set contains, thus its complexity. Visibility concentrates not only on the insight of the data but also on the metadata. Metadata is data about data and allows hindsight, insight and foresight & adequate solutions (Wu et al., 2016).

Defining Data according to its attributes is just one of many ways of defining big data. Other popular definitions describe big data as a new form of technology or an application. Furthermore, big data can be interpreted as a signal or an opportunity to reanalyse archived data with new technologies. Moreover, big data is defined metaphorically as an extension of the human thinking process. Finally, some authors see big data as just a new term for already existing technologies of data analytics (Wu et al., 2016).

The main issue with data and big data, more specifically, is data quality. Analysing bad quality data will not result in good decision making or even be impossible. Greater amounts of data will not compensate bad quality data. Other issues concern the size of data as well as its complexity which makes data storage and analytics even more complicated (Gudivada, 2017).
2. DATA ANALYTICS

2.1. Phases of Data Analytics

The previous chapter has already explained that data is worthless if not properly analysed. Before being able to analyse a data set, a few other steps should be performed.

Runkler (2016) identifies four phases of a data analysis project:

➢ Preparation
➢ Pre-processing
➢ Analysis
➢ Postprocessing

![Diagram of Phases of Data Analysis](image.png)

Figure 1: The four phases of a data analysis project
Source: Following Runkler, 2012, p. 3

Before the analysis, the data needs to be collected and selected and the different steps to make data analysable need to be executed. Finally, the information obtained through the data analysis is interpreted and evaluated for further decision-making.

The preparation and pre-processing phases can be further described through the Data Lifecycle, which consist of the following steps:

➢ Generation
➢ Acquisition
➢ Cleaning
➢ Sampling
➢ Feature extraction
➢ Model development

As described previously, data can be retrieved from internal and external sources. Before acquiring data from external sources, possible data vendors and the data format should be considered. Next, before analysing data, it should be clean. This means data should be free
from any duplicates, outliers and possible conflicts. This allows to create data samples for feature extraction. Numerous methods for data sampling exist and the goal is always to determine the amount of data necessary for statistical significance. The final step then consists in developing a suitable data analytics tool (Gudivada, 2017). Heilig, & Voß (2017) add the data storage phase just before the analysis phase. However, they also state that storage is not possible or necessary for all types of data.

2.2. Definition and functional categories

Analytics is “the method of logical analysis” (Analytics, 2019). Furthermore, analysis is defined as “a detailed examination of anything complex in order to understand its nature or to determine its essential features: a thorough study” (Analysis, 2019).

As shown in Appendix 3 Analytics can be divided into four functional categories (Gartner, 2016; Gudivada, 2017):
- Descriptive analytics
- Diagnostic analytics
- Predictive analytics
- Prescriptive analytics

**Descriptive analytics** examines the historical data and answers the question “What has happened?”. Through analysing historical information, descriptive analytics enables us to learn from the past and examine the possible impact on future results. Companies use descriptive analytics to enhance the performance of their operations. Two common methods of descriptive analytics are (Gudivada, 2017):
- Descriptive Statistics
- Exploratory Data Analysis²

**Descriptive statistics** is a set of tools for quantitative data description including measurement of central tendency and dispersion. Data distribution is an important part of data analytics because it contains all the possible values and their frequency for a variable. To properly understand the distribution of data, various descriptive methods are required. Those descriptive methods include the measurement of central tendency and dispersion, but also graphical representation and interactive visualisation. Interactive visualisation of trends, behaviours and

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² Hereinafter referred to as “EDA”
relationships can be achieved through EDA. EDA consists of three data analysis mechanisms: presentation, exploration and discovery. Visualisation is part of all of those three mechanisms. Presentation aims to familiarize oneself with the dataset. Visual exploration consists of assessing data from various angles, identifying patterns and characterising them quantitatively for decision-making. The aim of this mechanism is therefore to gain insight of the structure of the data and to enable analytical reasoning thanks to visual exploration. Visual exploration is also called visual analytics. The discover mechanisms enables ad hoc analysis which will then help to answer specific research questions (Gudivada, 2017).

**Diagnostic analytics** tries to understand what has been identified during the descriptive analytics. It answers the question “Why has it happened?” through different techniques such as data mining and data warehousing. It uses OLAP’s roll-up and drill-down techniques and can be both exploratory and labour-intensive (Gudivada, 2017).

The **predictive analytics** helps to foresee events and their probability. It answers the question “What will happen?”. Furthermore, it helps implement corrective actions. Predictive analytics are probabilistic in nature and thus use techniques such as decision trees and neural networks. To determine which variable has the highest predictive value, correlation coefficient, scatter plots, and linear regression can be used. The correlation coefficient examines the degree to which two variables are related (Gudivada, 2017).

Lastly, **prescriptive analytics** help make suggestions on how to reach a certain outcome. Through predictive analytics, the problems identified during diagnostic analytics can be tackled. Furthermore, it increases the probability of events foreseen during the predictive analytics. Prescriptive analytics use different simulation techniques to evaluate what-if situations and see which is most probable to occur. Additionally, stochastic optimisation techniques allow to identify ways to obtain better outcomes (Gudivada, 2017).

2.3. Evolution of Data Analytics

The evolution of data analytics over time is shown in Figure 2 (Gudivada, 2017).

![Figure 2: The evolution of data analytics](source)

Source: Following Gudivada, 2017, p.46
The origin of data analytics lies in Database Management Systems\(^3\).

The advantage of **Structured Query Language**\(^4\) Analytics was that, for the first time, computation and data storage are performed in one place. Nevertheless, analysing data in the DBMS is restricted as it cannot integrate external data (Gudivada, 2017).

**Business Analytics** aim to raise business flexibility in regard to changes in the marketplace. Therefore, a repetitive approach is used: First, the former business performance needs to be understood. Next, insights into the business process and its operational activity should be gained. The next step is to forecast the market demand for pre-existing products and services and to identify market opportunities for new ones. The final step consists in providing useful information for decision making. Business analytics methods include business intelligence, data warehousing and data mining (Gudivada, 2017).

**Visual Analytics** merge data analytics with visual and interactive tools, thereby allowing an efficient analysis of large data sets (Gudivada, 2017).

**Big Data Analytics** implies many issues through the use of big data. Those issues include data heterogeneity, complexity, size and quality. However, big data analytics are very successful because of their scalability and performance (Gudivada, 2017).

Finally, **Cognitive Analytics** is a combination of visual analytics and big data analytics (Gudivada, 2017).

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\(^{3}\) Hereinafter referred to as “DBMS”

\(^{4}\) Hereinafter referred to as “SQL”
3. EXTERNAL AUDIT

3.1. Need for auditing

The society needs auditors because there is a need for accountability. The industrial revolution changed the way business is done. Business owners are hiring professional managers to run their firms on a daily basis. The manager can therefore be seen as an agent. The result of this relationship between the owner of the business and the manager is information asymmetry as sown in Appendix 4. The manager has more information regarding the true financial position and the operations’ results than the owner. Moreover, the goals of these two parties do not necessarily coincide and a conflict of interest can result. The manager might not always make decisions based on what is the best for the company but on how he could get the most benefit from. Since the owner does not run the business himself, the manager reports the financial information based on agreed-upon accounting principles. The manager is consequently held accountable to the owner. However, the manager himself is responsible for reporting and the owner cannot directly control this. The manager could therefore possibly manipulate the report, and this is where a need for an auditor comes in (Eilifsen, Messier, Glover, & Prawitt, 2014; Francis, 2018)

Because the amount of business capital rose, the number of potential owners also rose and as a consequence, the need for accountability rose also. The auditor needs to determine whether the report was prepared in accordance with the contract provisions. The verification of financial information adds credibility to the report and reduces the risk that information from management could be misleading or false. There is a need for auditing because they have a valuable role in monitoring the contractual relationship between the company and its stakeholders (Eilifsen, et al., 2014).

The audit of financial statements is thus a key component in the way our economy functions. Auditors are expected to behave according to their professional judgment and sustain professional scepticism in their work (Eilifsen et al., 2014). In the International Standards on Auditing⁵ professional judgement is defined as “the application of relevant training, knowledge and experience, within the context provided by auditing, accounting and ethical standards, in making informed decisions about the courses of action that are appropriate in the circumstances of the audit engagement” (IFAC, 2018c, p.31). Furthermore, professional scepticism is defined as “An attitude that includes a questioning mind, being alert to conditions

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⁵ Hereinafter referred to as “ISA”
which may indicate possible misstatement due to error or fraud, and a critical assessment of evidence” (IFAC, 2018c, p.31).

There are also legal obligations in Belgium and Luxembourg to appoint an external auditor. However, this research does not discuss the different criteria.

3.2. Definition of audit

Audit is “a formal examination of an organisation’s or individual’s accounts or financial situation”. Furthermore, it is “a methodical examination and review” (Audit, 2019).

Different types of audits exist:
- Operational Audit,
- Compliance Audit,
- Financial statement Audit,
- Forensic Audit,
- Internal Audit

Operational audit is an evaluation of the efficiency and the effectiveness of a company’s operations and working methods. The evaluation is thus not limited to accounting but can include many other areas. The aim is to provide management with recommendations on how to improve their operations. The objective of compliance audit is to examine whether the company is acting in accordance with certain procedures, rules or regulations. The findings are reported only to the company’s management and not intended for outside users. Financial statement audit aims to determine if the company’s financial statements are established in accordance with a specific financial reporting framework (Arens, Elder, & Beasley, 2010). Forensic audit targets fraudulent activities (Eilifsen et al., 2014). Internal audit is:

An independent, objective assurance and consulting activity designed to add value and improve an organisation's operations. It helps an organisation accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control, and governance processes. (The Institute of Internal Auditors, 2019).

This work focuses on financial statement audit. From here on, financial statement audit is referred to when using the term audit.
Many authors only make the difference between external and internal audit. The difference lies in the independency or dependency of the auditor.

The Merriam-Webster dictionary defines external audit as an “independent audit” (External Audit, 2019), which is “an audit made by usually professional auditors who are wholly independent of the company where the audit is being made — contrasted with internal audit” (Independent Audit, 2019). External auditors conduct financial statements, compliance, operational and forensic audit (Eilifsen et al., 2014).

Internal Audit is oppositely defined as “a usually continuous examination and verification of books of account conducted by employees of a business — contrasted with independent audit” (Internal audit, 2019).

A widespread definition published by the American Accounting Association says that “Auditing is a systematic process of objectively obtaining and evaluating evidence regarding assertions about economic actions and events to ascertain the degree of correspondence between those assertions and established criteria and communicating the results to interested users” (Silvoso, 1972).

The assertions are defined in the ISA 315 (Revised) as “representations by management, explicit or otherwise, that are embodied in the financial statements, as used by the auditor to consider the different types of potential misstatements that may occur” (IFAC, 2018c, p.280).

The management assertions can be divided into two categories (ISA 315 (Revised)):

- **Assertions about classes of transactions and events, and related disclosures, for the period under audit:**
  - occurrence – transactions and events that have been recorded or disclosed, have occurred, and such transactions and events pertain to the entity.
  - Completeness – all transactions and events that should have been recorded have been recorded, and all related disclosures that should have been included in the financial statements have been included.

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6 At the moment, ISA 315 (Revised) is being revised again. The aim is to adapt the standard to evolving information technology (IFAC, 2019e). However, as the new revised version has not yet been official published, this is not taken into account in this research.
• Accuracy - amounts and other data relating to recorded transactions and events have been recorded appropriately, and related disclosures have been appropriately measured and described.

• Cut-off - transactions and events have been recorded in the correct accounting period.

• Classification - transactions and events have been recorded in the proper accounts.

• Presentation - transactions and events are appropriately aggregated or disaggregated and clearly described, and related disclosures are relevant and understandable in the context of the requirements of the applicable financial reporting framework.

• Assertions about account balances, and related disclosures, at the period end:
  
  o Existence - assets, liabilities, and equity interests exist.
  
  o Rights and obligations - the entity holds or controls the rights to assets, and liabilities are the obligations of the entity.
  
  o Completeness —all assets, liabilities and equity interests that should have been recorded have been recorded, and all related disclosures that should have been included in the financial statements have been included.
  
  o Accuracy, valuation and allocation - assets, liabilities, and equity interests have been included in the financial statements at appropriate amounts and any resulting valuation or allocation adjustments have been appropriately recorded, and related disclosures have been appropriately measured and described.
  
  o Classification - assets, liabilities and equity interests have been recorded in the proper accounts.
  
  o Presentation - assets, liabilities and equity interests are appropriately aggregated or disaggregated and clearly described, and related disclosures are relevant and understandable in the context of the requirements of the applicable financial reporting framework. (IFAC, 2018c, pp. 319-320)

The auditor can use the assertion as stated here or differently, as long as they are all covered. It is therefore allowed to combine the two categories of assertions. For entities in the public sector, additional assertions regarding the compliance with laws or regulations can be added.

The aim of auditing is to “enhance the degree of confidence of intended users in the financial statements” (ISA 200) (IFAC, 2018c, p.77). The auditor gives an opinion on whether the
financial statements comply with an applicable financial reporting framework and whether they give a true and fair view. The auditor collects evidence to reduce the audit risk to an acceptable low level. This enables him to obtain reasonable assurance that the financial statements are free from material misstatements. Two Audit overall objectives exist: (1) obtain reasonable assurance that the financial statements are free from material misstatements and (2) report on the financial statements and on the findings (ISA 200) (IFAC, 2018c). Reasonable assurance is, in the context of audit engagements, and in quality control, defined as “a high, but not absolute, level of assurance” (IFAC, 2018c, p.32). A simplified overview of the financial statement audit process is shown in Appendix 5.

The financial statement audit is built on three fundamental concepts:

➢ Materiality,
➢ Audit Risk, and
➢ Evidence regarding management assertions.

The assessment of materiality and audit risk determines the scope of the audit evidence to be collected. The audit risk will be explained in detail in the following section. The concept of materiality is defined in the ISA 320 as “Misstatements, including omissions, are considered to be material if they, individually or in the aggregate, could reasonably be expected to influence the economic decisions of users taken on the basis of the financial statements” (IFAC, 2018c, p.335). The auditor makes a professional judgement on the size and nature of a misstatement up to which it would not significantly affect the users’ decision (Eilifsen et al., 2014).

The ISA 500 defines audit evidence as “information used by the auditor in coming to the conclusions on which the auditor’s opinion is based. Audit evidence includes both information contained in the accounting records underlying the financial statements and other information” (IFAC, 2018c, p.404). Furthermore, the audit evidence can be delivered by the client himself or by a third-party. The collect audit evidence needs to be sufficiently appropriate so that the auditor can draw reasonable conclusions on which he bases his opinion.

The auditor wants reasonable assurance that the financial statements are not materially misstated. Therefore, he gathers sufficient appropriate audit evidence to reduce audit risk to an acceptable low level, which will then allow him a reasonable conclusion on which he can base his opinion.
The term sufficiency refers to the quantity of audit evidence needed which is influenced by the assessment of risks of material misstatements and the quality of the evidence. The appropriateness refers to the quality, thus the relevance and the reliability of the audit evidence (ISA 500) (IFAC, 2018c).

3.3. Phases of financial statement audit

The end product of the financial statement audit is the auditor’s opinion regardless of whether the financial statements are free from any material misstatements. Therefore, the auditor needs to gather audit evidence to establish and support his opinion. In order to get this information, the auditor first needs to understand the entity he is auditing and its environment, as well as the entity’s business and industry. It is important that the auditor has a good understanding of the client’s risks, how he copes with them and which risks are most likely to become a material misstatement in the financial statements. The auditor then plans the procedures to gather the audit evidence.

The accounting system can be simplified into three stages: internal control, individual transactions and account balances. First, the individual transactions are captured, recorded, and summarized. Next, the entities design and implement controls to ensure those transactions are initiated captured recorded and summarized appropriately. Finally, the individual transactions are grouped into account balances and then the financial statements are formed.

The auditor can collect information in each of the three stages. Evidence regarding ending account balances generally has the highest quality but is also the costliest. Procedures testing whether the internal control over financial transactions is effective gives additional information. If the internal control is effective, this means the transactions are captured and summarized properly, the account balances are thus free from material misstatements (Eilifsen et al., 2014).

The Audit Process can therefore be divided into the following major phases:

- Client Acceptance or Continuance
- Preliminary Engagement Activities
- Plan the Audit
- Consider Internal Control
- Audit Business Procedures and Related Accounts
- Complete the audit
- Evaluate the results and issue audit report
These phases are however iterative and interrelated.

**Client Acceptance or Continuance:** The audit companies are required to have policies and procedures to decide whether to accept a new client and to maintain an old client. This minimizes the probability to enrol in an audit activity with a client with integrity issues.

**Preliminary Engagement Activities:** There are three preliminary engagement activities:
- Determination of the audit team requirements;
- Ensuring compliance with ethical requirements, including independency; and
- Establishing an agreement with client-related services to be performed and the terms of the engagement.

Therefore, the auditor needs to understand entity and its environment as well as the client’s performance measurement and the quality of its internal control. This helps to assess the risk of material misstatement which will then enable the auditor to determine the scope of the audit.

**Plan the Audit:** The audit planning is an important phase as it ensures the effectiveness and the efficiency of the audit. Beforehand, the preliminary assessment of the entity’s business risk and the determination of the materiality need to be done.

**Consider Internal Control:** The entity’s management and the board of directors set up the system of internal control. This shall allow:
- Reliable financial reporting
- Effective and efficient operations
- Compliance with law and regulations

The quality of the internal control has direct influence on the risk assessment and is thus crucial for the auditor.

**Audit Business Procedures and Related Accounts:** The audit is generally organised through categorising the financial statement accounts according to the business process that is mainly influencing them. Next, the audit procedures to the accounts are performed to minimize the risk of material misstatement. For most audit engagements, this is the most time-consuming phase of the audit process.

**Complete the audit:** After the auditor has obtained all of the audit evidence, he evaluates their sufficiency and if necessary, gathers additional evidence. In this phase, other issues are also
addressed as for example subsequent events or lawsuits which can affect the financial statements.

Evaluate the results and issue the audit report: the final phase of the audit process consists of examining the results and choosing the appropriate audit opinion (Eilifsen et al., 2014). According to the ISA 700 (Revised) the auditor should:
(a) form an opinion on the financial statements based on an evaluation of the conclusions drawn from the audit evidence obtained; and
(b) express that opinion clearly through a written report.

Four types of audit opinions exist:

- Clean or unmodified opinion
- Modified opinion
  - Qualified opinion
  - Adverse opinion
  - Disclaimer of opinion

**Clean or unmodified opinion:** It is defined in the ISA 700 (Revised) as “The opinion expressed by the auditor when the auditor concludes that the financial statements are prepared, in all material respects, in accordance with the applicable financial reporting framework” (IFAC. 2018c, p.40).

If the auditor cannot gather sufficient appropriate evidence to conclude that the financial statements as a whole are free from material misstatements or if he concludes that the financial statements as a whole are not free from material misstatement, the auditor shall express a modified opinion (ISA 705 (Revised)) (IFAC, 2018c).

**Qualified Opinion:** The auditor cannot give a clean opinion but nor, based on the effect of any deficiency, uncertainty or limitation in the scope of the audit, an adverse opinion or a disclaimer of opinion. The motives for the qualified opinion and its impact on the financial statement need to be disclosed to the audit report (Nkoa, 2015).

**Adverse Opinion:** The effect of efficiency has such an important impact on the company’s financial statement that the auditor cannot express a qualified opinion. The impact on the financial statement is so important that the auditor needs to express an adverse opinion to raise the reader’s awareness on the incomplete and misleading nature of the financial statements.
Again, the motives and its impact on the financial statements need to be disclosed to the audit report (Nkoa, 2015).

**Disclaimer of Opinion:** The effect of a limitation or uncertainty in the scope of the audit is so important that the auditor cannot express an opinion on the financial statements. The nature of the limitation and the uncertainty have to be clearly indicated in the report (Nkoa, 2015).

3.4. Audit regulators

The audit environment is regulated by several organisations which impact the exercise of audit. The International Federation of Accountants\(^7\) is the global organisation for the accountancy profession (Eilifsen et al., 2014). The IFAC’s mission is to “serve the public interest and strengthens the accountancy profession by:

- Supporting the development of high-quality international standards;
- Promoting the adoption and implementation of these standards;
- Building the capacity of professional accountancy organisations; and
- Speaking out on public interest issue” (IFAC, 2019a, p.2).

Moreover, the IFAC supports the different international standard setting boards in the development of their international standards. The International Auditing and Assurance Standards Board\(^8\) is an independent standard setting board which issues standards for auditing, quality control, review and other assurance related services. One of those standards is for example the International Standards on Auditing (ISA) (IFAC, 2019b). The IAASB has issued 36 ISAs (IFAC, 2019d). As the standards often use general terms, the auditor has to apply his professional judgement regarding the given circumstances of the engagement (Eilifsen et al., 2014).

The International Ethics Standard Board for Accountants\(^9\) sets ethics standards and other requirements for professional accountants all over the world. The IESBA’s most important activity is the development of the Code of Ethics for Professional Accountants (IFAC, 2019c).

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\(^7\) Hereinafter referred to as “IFAC”

\(^8\) Hereinafter referred to as “IAASB”

\(^9\) Hereinafter referred to as “IESBA”
The International Accounting Standards Board\textsuperscript{10} is an independent standard setting body developing and issuing the International Financial Reporting Standards\textsuperscript{11}. Furthermore, they also approve interpretations of the IFRS (IFRS, 2017).

The International Organisation of Securities Commissions\textsuperscript{12} is the standard setter for the securities market worldwide (IOSCO, 2019).

The International Organisation of Supreme Audit Institutions\textsuperscript{13} is the central association of the external government auditors (INTOSAI, 2006).

Independence of the auditor and ethical behaviour are crucial for the audit sector. The audit function meets the need for accountability of the financial statements. Therefore, the auditor has to be independent of the entity being audited. This allows an unimpaired assessment and opinion (Eilifsen et al., 2014). The International Code of Ethics for Professional Accountants lists the five fundamental principles of ethics for the audit function:

- **Integrity:** to be straightforward and honest in all professional and business relationships.
- **Objectivity:** not to compromise professional or business judgments because of bias, conflicts of interest or undue influence of others.
- **Professional Competence and Due Care:**
  - Attain and maintain professional knowledge and skill at the level required to ensure that a client or employing organisation receives competent professional service, based on current technical and professional standards and relevant legislation; and
  - Act diligently and in accordance with applicable technical and professional standards.
- **Confidentiality:** to respect the confidentiality of information acquired as a result of professional and business relationships.
- **Professional Behavior:** to comply with relevant laws and regulations and avoid any conduct that the professional accountant knows or should know that might discredit the profession (IFAC, 2018a, p.18).

\textsuperscript{10} Hereinafter referred to as “IASB”
\textsuperscript{11} Hereinafter referred to as “IFRS”
\textsuperscript{12} Hereinafter referred to as “IOSCO”
\textsuperscript{13} Hereinafter referred to as “INTOSAI”
4. RISK ASSESSMENT

The audit risk \(^{14}\) is defined in the ISA 200 as “the risk that the auditor expresses an inappropriate audit opinion when the financial statements are materially misstated. Audit risk is a function of the risks of material misstatement\(^ {15}\) and detection risk\(^ {16}\)” (IFAC, 2018c, p.80). The audit risk does not consider the risk that the auditor might express a modified opinion when the financial statements do not contain any material misstatements.

The Audit Risk Model is thus:

\[
AR = DR \times RMM.
\]

Moreover, the ISA 200 defines detection risk as “the risk that the procedures performed by the auditor to reduce audit risk to an acceptably low level will not detect a misstatement that exists and that could be material, either individually or when aggregated with other misstatements” (IFAC, 2018c, p.80). The detection risk refers to the scope of audit procedures. It is thus influenced by the effectiveness of an audit procedure and how the auditor performs the procedure.

The Risk of material misstatement is defined as “the risk that the financial statements are materially misstated prior to audit” (IFAC, 2018c, p.82). The risk of material misstatement is also called the entity risk because it is independent of the audit. It includes two factors:

(i) Inherent risk\(^ {17}\), which is defined as “the susceptibility of an assertion about a class of transaction, account balance or disclosure to a misstatement that could be material, either individually or when aggregated with other misstatements, before consideration of any related controls” (IFAC, 2018c, p.82). External circumstances which increase the business risk can influence the inherent risk.

(ii) Control risk\(^ {18}\), which is defined as:

\[
\text{The risk that a misstatement that could occur in an assertion about a class of transaction, account balance or disclosure and that could be material, either individually or when aggregated with other misstatements, will not be prevented, or}
\]

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\(^{14}\) Hereinafter referred to as “AR”

\(^{15}\) Hereinafter referred to as “RMM”

\(^{16}\) Hereinafter referred to as “DR”

\(^{17}\) Hereinafter referred to as “IR”

\(^{18}\) Hereinafter referred to as “CR”
detected and corrected, on a timely basis by the entity’s internal control (IFAC, 2018c, p.82).

The control risk depends thus on the effectiveness of the internal control.

The Audit Risk Model is then determined as follows:

\[ \text{AR} = \text{DR} \times \text{IR} \times \text{CR} \]

However, the assessment of the audit risk is based on professional judgement and not on precise measurement. The risk of material misstatement and the detection risk can be reduced but never eliminated as an inherent limitation of the internal control exists (IFAC, 2018c). The standard offers the possibility to assess the combined risk of material misstatement or to assess the inherent risk and the control risk separately. Furthermore, the assessment can be quantitative or non-quantitative.

The risk of material misstatement can occur on two levels:

(i) Overall financial statement level

(ii) Assertion level for classes of transactions, account balances, and disclosures

The overall financial statement level includes risks of material misstatement relating to the whole financial statements and can affect many assertions at the same time (ISA 200) (IFAC, 2018c). Risks of material misstatement at the financial statement level represent conditions that can possibly increase the risks of material misstatements at the assertion level. Moreover, they play a special role in the auditor’s consideration of risks originating from fraud. Risks at the financial statement level are often the result of an insufficient control environment (ISA 315 (Revised)) (IFAC, 2018c).

The risks of material misstatement at the assertion level determines the scope of the audit procedures (ISA 200 & ISA 315 (Revised)) (IFAC, 2018c).

The objective of the auditor as stated in the ISA 315 (Revised) is:

To identify and assess the risks of material misstatement, whether due to fraud or error, at the financial statement and assertion levels, through understanding the entity and its environment, including the entity’s internal control, thereby providing a basis for designing and implementing responses to the assessed risks of material misstatement (IFAC, 2018c, p.280).
The Risk Assessment Procedures are defined as:

*The audit procedures performed to obtain an understanding of the entity and its environment, including the entity’s internal control, to identify and assess the risks of material misstatement, whether due to fraud or error, at the financial statement and assertion levels* (IFAC, 2018c, p. 280).

This means that the risk assessment procedures are the basis for the identification and assessment of the risk of material misstatement. However, these are not sufficient appropriate audit evidence to be the basis of the audit opinion (ISA 315 (Revised)) (IFAC, 2018c).

Many methods to assess the risk of material misstatement exist (ISA 315 (Revised)) (IFAC, 2018c):

➢ Questioning management, appropriate individuals of the internal audit function and other people within the entity
➢ Analytical procedures
➢ Observation & inspection

The information obtained through the risk assessment procedure is used as audit evidence for the risk assessment. Risk assessment sets the scope of the audit procedures that need to be executed. To identify and assess the risks of material misstatement, the auditor first identifies the risks. This is achieved by apprehending the entity and its environment. Next, the identified risks are assessed and the auditor evaluates their impact on the financial statements as a whole and at the assertion level. Finally, the probability of the misstatements and whether the magnitude could be material are examined. Appendix 6 shows the non-exhaustive list of Conditions and Events That May Indicate Risk of Material Misstatement of ISA 315 (Revised) (IFAC, 2018c).

The auditor applies his professional scepticism in accordance with ISA 200 when identifying the risk at the financial statements level. Moreover, to identify and assess risks at the assertion level, materiality and audit risks are examined in accordance with ISA 320. The materiality is determined through professional judgement, which is influenced by the estimation of the financial reporting needs of the users of financial statements (ISA 315 (Revised)) (IFAC, 2018c).

Furthermore, information obtained during the client acceptance or continuing process can be relevant for the risk assessment process. Information from other engagements for the same
entity, as well as previous experience and relevant changes should also be considered. The risk assessment procedure calls for a correct understanding of the entity and its environment. This also includes the internal control. Based on auditor’s judgement the relevant internal controls related to financial reporting are identified. Concerns about the auditability of financial statements can be the result of the auditor’s comprehension of internal control. When assessing the risk, the auditor can determine the controls to prevent, detect or correct material misstatements in specific assertions. It is important to comprehend those controls in order to relate them to assertions. Many controls used simultaneously are often needed to address a risk. The controls can affect an assertion directly or indirectly (ISA 315 (Revised)) (IFAC, 2018c).

The identified and assessed risks can both be risks due to error and risks due to fraud. Specific responsibilities relating to fraud are stated in ISA 240 (ISA 315 (Revised)) (IFAC, 2018c). The auditor also needs to determine whether the identified risk is a significant risk. A significant risk is defined as “an identified and assessed risk of material misstatement that, in the auditor’s judgment, requires special audit consideration” (IFAC, 2018c, p.281). Significant Risk generally concerns significant non-routine transactions, which are unusual because of their size or their nature, or judgmental matters with significant measurement uncertainty. The risks of material misstatement can thus be greater for judgmental matters that need accounting estimates (ISA 315 (Revised)) (IFAC, 2018c).

Once the risks are identified and assessed, the auditor will design and implement appropriate responses to obtain sufficient and appropriate audit evidence in accordance with ISA 330.
III. CURRENT STATUS OF THE RESEARCH

The sources used are mainly scientific sources, either published by an audit standard oversight or regulation board, in a scientific or academic journal, peer reviewed, etc. Moreover, current sources have been used to reflect the state of the art. Many of the sources used come from the US. The US is often more technologically advanced than Europe, Belgium and Luxembourg more specifically. Nevertheless, these sources are very valuable as they show tendencies on how Big Data and Data Analytics can be used in the future in Belgium and Luxembourg.

1. Big Data and Data Analytics in External Audit

In traditional audit, it is mainly accounting data that is analysed. Therefore, in auditing, the term Big Data is composed of the financial transactions and account balances but more importantly the related data which is not directly linked to the entity’s accounting (Byrnes, Criste, Stewart, & Vasarhelyi, 2014). Big Data and Data analytics allow to analyse not only the client’s accounting data (transactions) but also the meta data from key business processes (Ramlukan, 2015). Non-financial information is becoming more valuable and the focus is on predictive and future-oriented data instead of historical information (CFRR, 2017). The auditors can combine their analysis with internal and external data (O’Donnell, 2015). Facilitator of Big Data usage by auditors: emerging technologies and the large number of tools that exist (Alles, 2015). However, the audit industry is lagging behind, and Big Data possibilities are not fully exploited (Gepp, Linnenluecke, O’Neill, & Smith, 2018).

The usage of Data Analytics is nothing new in audit. However, what is new is the amount of data, the new Data Analytics tools and techniques, and the speed at which the analyses are done (O’Donnel, 2015). As O’Donnell (2015, p. 28), KPMG International’s head of data & analytics – audit, writes: “It is an evolution, not a revolution”.

2. Drivers of using Big Data and Data Analytics in External Audit

Historically, the auditors only slowly adapt to technological changes. Alles hypothesised that the auditors will only begin to use Big Data if it is perceived as a threat to their profession (Alles, 2015).

**Client:** “The most likely driver of the use of Big Data by auditors is client use of Big Data” (Alles, 2015, p. 442). This means that auditors are not using Big Data because they necessarily see the added value but because they feel like they have to because of their clients (Alles, 2015). Even small clients are becoming more digitalised and their managements are appreciating the benefits of using Data Analytics. Hence, they will expect auditors to use those techniques.
The market and technological advancement are also demanding that the audit companies use those techniques. The clients demand deeper insight and expect them to keep up with the changes (O’Donnell, 2015). The clients have higher expectations and demand changes in the audit approach. The organisations expect the auditors to be more future oriented, to analyse larger volumes of data, carry-out in-depth analysis and extend the audit scope. The clients also expect auditors to have a more holistic view of the client’s business and environment. They demand for valuable insight and recommendations (Forbes Insights, 2017). “The better auditors are the ones who can translate their findings into actionable information for the organization” (Stansbury, as cited in Forbes Insights, 2017). The three major skills that organisations expect from their auditors are technology, communication and critical thinking (Forbes Insights, 2017).

**Stakeholder’s expectation:** Audit companies are investing in Big Data and Data Analytics techniques to respond to shareholder’s expectations (CFRR, 2017). At the moment, the organisations are issuing audited financial statements only once a year. Nevertheless, it is possible for them to generate financial statements more frequently. Hence, stakeholders’ expectations can evolve in the same direction, to have more frequent audited financial statements up to real-time audited financial statements (Byrnes et al., 2014; CFRR, 2017).

**Competitors:** finally, a last driver for audit cabinets to apply Big Data and Data Analytics techniques is to differentiate themselves from their competitors (CFRR, 2017).

### 3. Data Analytics tools and techniques used in audit

<table>
<thead>
<tr>
<th>Audit 1.0</th>
<th>Audit 2.0</th>
<th>Audit 3.0</th>
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<tbody>
<tr>
<td>Manual audit</td>
<td>IT audit</td>
<td>Inclusion of Big Data in audit analytics</td>
<td>Semi- and progressive automation of audit</td>
</tr>
</tbody>
</table>

**Figure 3: The generations of audit**

Source: Following Dai, & Vasarhelyi, 2016, p.2

Some examples of commonly used tools are Excel Analytics, ACL – IDEA Caseware, and software that use regression analysis (IRE, 2018a).

Data Analytics can be divided into exploratory and confirmatory analytics. The first one is most valuable in the planning and risk assessment phase. The second one is mostly used to produce
substantive assurance regarding management’s assertions. However, there is no clear
distinction between the two of them and the auditors often use combinations (Byrnes et al.,
2014).

Many different analytical procedures and data analytical tools exist. A survey from Appeblau,
Kogan and Vasarhelyi (2018) identified and categorised them:

- **Audit Examination:** transaction tests and ratio analysis, sampling, confirmations and
  reperformance, and CAATS;
- **Unsupervised:** clustering models, text mining models, visualisation, process mining
  (discovery models);
- **Supervised:** process mining (optimisation), support vector machines, artificial neural
  networks, genetic algorithms, expert systems and decision aids, C4.5 statistical
  classifiers, bagging and boosting models, bayesian theory and bayesian belief
  networks, dempster-shafer theory models, probability theory models;
- **Regression:** log regression, linear regression, time series regression, auto regressive
  integrated moving average, univariate and multivariate regression analysis;
- **Other Statistics:** multi-criteria decision aid, benford’s law, descriptive statistics,
  structural models, analytical hierarchy processes, complementary hypothesis
  evaluations, monte carlo study and simulation (Appelbaum, Kogan, & Vasarhelyi,
  2017b, p.9)

The Audit Examination techniques are all diagnostic and descriptive in their nature.
Nevertheless, those are general techniques which are already used for many years, this is why
they will not be further investigated. The unsupervised analytical procedures can all be
classified as descriptive analytics. Th supervised, regression and other statistical procedures
instead have more predictive and prescriptive orientation.

The most common ones will be explained in more detail:

- **Clustering** (Appelbaum, Kogan, & Vasarhelyi, 2018; CFRR, 2017; IAASB, 2015a): It
  is “the task of grouping a set of objects in such a way that objects in the same group are
  more similar to each other than to those in other groups” (Appelbaum et al., 2018,
  Appendix). It is a tool “to detect groups of similar events and identify outliers” (IAASB,
  2015a, p.15)
- **Predictive analytics** (Appelbaum et al., 2018; CFRR, 2017; IAASB, 2015a): “Time
  series extrapolation and cross-sectional analytics can be used to predict results”
  (IAASB, 2015a, p.10)
➢ **Text mining** (Alles, 2015; Appelbaum et al., 2018): “deriving high quality information from words or texts” (Appelbaum et al., 2018, Appendix). Text mining can be used to examine for example minutes or contracts (Alles, 2015).


➢ **Artificial Neural Networks** (Alles, 2015; Appelbaum et al., 2018): It is a “computational model based on the structure and functions of biological neural networks” (Appelbaum et al., 2018, Appendix).

➢ **Visualization** (Appelbaum et al., 2018; CFRR, 2017): Visualization is a Data Analytics technique “to represent data or processes with images, charts, or graphs” (Appelbaum et al., 2018, Appendix).

➢ **Probability Theory Models** (Appelbaum et al., 2018; CFRR, 2017): “What if” scenarios are used to discover new possibilities and to analyse large populations (CFRR, 2017). Probability Theory is a “mathematical theory for modelling events or phenomenon under conditions of uncertainty, used in insurance and other fields requiring statistical forecasting” (Appelbaum et al., 2018, Appendix).

The auditors can apply most of those Data Analytics techniques in various audit phases (Appelbaum et al., 2018).

4. **Effect on the working methods**

   Big Data and Data Analytics allow to “rethink the way in which an audit is done” (Ramlukan, 2015, p.15). The audit needs to adapt to the stakeholders’ expectation and demand to receive information in a timely manner. Up until now, the technology has been used to automatise and improve traditional procedures, but the technical opportunities are not fully exploited. The new technologies can transform the audit (Byrnes et al., 2014). The auditors can now work everywhere and at any time. Moreover, the audit is not bounded to one local team, but individual competencies can be leveraged globally. Thanks to cloud computing, the procedures can be dismantled into separate tasks and be executed more effectively (Byrnes et al., 2014). Furthermore, the workload can be spread over the whole year, reducing the amount of work during the “busy season”, which also enhances audit quality (Byrnes et al., 2014). Finally, Data
Analytics can be helpful to evaluate whether the authorised person has performed the transaction and whether segregation of duties is respected (O’Donnell, 2015). The use of technology in audit allows to either obtain the same level of assurance at a lower cost or obtain a higher level of assurance at the same cost. The focus is mostly on reducing the cost and maintain the same level of assurance. However, maintaining the costs and enhancing the assurance is also beneficial (Byrnes et al., 2014). Nevertheless, the human component will not be fully eliminated but their productivity will be boosted. The human component will always be necessary for professional judgement (CFRR, 2017).

Potential opportunities for Big Data and Data Analytics in audit are (Cao, Chychyla, & Stewart, 2015 and Byrnes et al., 2014):

- Identify and evaluate the risks linked to client acceptance or continuance
- Identify and evaluate the risks of material misstatement because of fraud and investigating for fraud
- Understand the client and its environment
- Execution of substantive analytical procedures responding to the evaluation of the risk of material misstatement
- Support the auditor’s conclusion

As this work focuses mainly on the impact of Big Data and Data Analytics on the risk assessment phase of external audit, this will be discussed in more detail in the following section.

5. Risk identification and assessment

As will be outlined in the advantages, the usage of Big Data and Data Analytics enhances the risk identification and assessment (AICPA, 2018; CFRR, 2017; IAASB, 2015a; IFAC, 2016; IRE, 2018a). Thanks to data-driven risk indicators, the risk identification and assessment procedure is more accessible for updates, makes it easier to respond to changes; this can help in analysing the cause of the risk (Coderre, 2015). The areas of audit risk can be identified and evaluated earlier thanks to the possibility of analysing larger populations (IFAC 2016). Data-driven risk indicators used in the planning phase of audit make it possible to concentrate the audit procedures on specific risk matters. Furthermore, it enables continuous risk assessment (Coderre, 2015).

The initial tendencies of automated financial statement audit are already present in the planning stage. In the first planning phase, the preliminary risk assessment takes place. This forms the basis for the client acceptance or continuance. The risk that can be assessed during this phase is called the “order risk”. The assessment of order risk is based on economic, industry/sector
and other business data that may already exist. The order risk will then, in further processes, become part of the inherent risk.

The tools used during this phase are decision making support tools to quantitatively evaluate qualitative data. This means Data Analytics is used to evaluate Big Data from the controlling environment (Zaeh, 2018).

In the second planning phase, a specific risk assessment is conducted. This means, that client specific risk limitations are identified and evaluated. The aim is to have an audit detail test strategy which is adapted to the client’s characteristics. To do so, a plausibility assessment is conducted to identify possible risk areas. The tools used are Artificial Intelligence and Data Analytics for quantitative assessment of qualitative data. The aim of this second planning phase is to have a detailed risk assessment and audit of the client’s internal control system. This will make it possible to identify and assess the control risk (Zaeh, 2018).

Before the implementation of Big Data and Data Analytics, the auditors focused on financial reporting related internal control systems. Now, a broader approach is needed, continuous monitoring. More and more booking details are created and also more automatically. This means that there is less human intervention which results in improved reliance on data integrity. However, continuous monitoring of the functionality and the effectiveness of the internal control system is necessary (Zaeh, 2018).

The usage of Data Analytics in the risk assessment phase of the external audit allows to:

➢ "Identify the type and volume of the transactions,
➢ Map the core business processes
➢ Match the transactions with expected patterns
➢ Check the seasonality of the transactions
➢ Map the evolution of the KPI’s” (IRE, 2018a, p.6)

6. Advantages of using Big Data and Data Analytics

There are multiple advantages to using Big Data and Data Analytics techniques in External Audit. The most common ones are explained in this section.

Larger populations: By using Data Analytics, the auditors can analyse larger populations and focus to only test the outliers or anomalies. This also contributes to better audit evidence collection and more pertinent samples (Byrnes et al., 2014; Cao et al., 2015; CFRR, 2017; IAASB, 2015a; IFAC, 2016; O’Donnell, 2015; Ramlukan, 2015). Consequently, few errors could be accepted. However, analysing larger amounts of data can also lead to more false
positives. This can be overcome through the application of statistics and other methods determining “exceptional exceptions” (Byrnes et al., 2014).

**Improves auditors’ performance & focus on risky areas:** Using Data Analytics allows to boost the performance of the auditors. Time for manual and repetitive work can be saved and therefore used for more judgemental or fundamental tasks. The auditor can thus focus on the outliers and more complex and risky parts of the audit (Appelbaum, Kogan, & Vasarhelyi, 2017a; Byrnes et al., 2014; Cao et al., 2015; CFRR, 2017; IFAC, 2016; IRE, 2018a; O’Donnell, 2015; Ramlukan, 2015). This leads to tailor-made audit approach (Ramlukan, 2015). The speed at which the analysis is done can be increased (O’Donnell, 2015). The usage of Big Data and Data Analytics enhances the potential for detecting material misstatements (AICPA, 2018). Furthermore, the procedures can be performed more frequently, leading to continuous auditing and controlling the client’s system in real-time which enhances the risk and control assessment and results in more relevant audit reporting (Byrnes et al., 2014; Cao et al., 2015; CFRR, 2017). Finally, Big Data makes it possible to identify correlations. This information is more valuable than only identifying the cause (Byrnes et al., 2014; Cao et al., 2015).

**Enhanced understanding of the client’s business and environment:** The auditor can assess larger populations in a timely manner which allows him to have a better comprehension of the client’s business and his environment. The auditor has a better understanding of and insight into the client’s operations, risks and controls (AICPA, 2018; Cao et al., 2015; CFRR, 2017; IFAC, 2016; O’Donnell, 2015). Thanks to this, issues can be spotted earlier which allows responsive actions in a timely manner (Byrnes et al., 2014; CFRR, 2017). Additionally, complex organisational structures and account relationships can be visualised. This enhances the auditor’s understanding and makes real-time assessment of transactions possible (Byrnes et al., 2014; O’Donnell, 2015). Hence, the auditor can better identify relationships and deviations, combine information and gain additional insights which improves the professional judgement and scepticism (Byrnes et al., 2014; IFAC, 2016). Moreover, the better understanding of the client’s business and its environment improves the risk assessment and the auditor’s reaction (AICPA, 2018; CFRR, 2017; IAASB, 2015a; IFAC, 2016; IRE, 2018a). The improved understanding of the client’s business can provide valuable information for the client himself and the service provided to the client can be improved (CFRR, 2017; IFAC, 2016). Hence, the usage of Data Analytics in the external audit can also provide added value for the client (CFRR, 2017).
Enhances the client relationship: Additionally, the usage of Big Data and Data Analytics also has a positive impact on the client relationship as it improves the communication with those charges with governance and provides more reliable information (AICPA, 2018; IRE, 2018a). The possibility to visualise the results of the Data Analytics can also have a positive impact on the communication with the client. The client can see the benefits of analysing data and can see his data from a different perspective (CFRR, 2017).

Enhances auditor credibility: Finally, the credibility of the audit is increased through the added value, improved service and enhanced client relationship (IRE, 2018a).

Enhanced audit quality: Moreover, the usage of Audit Data Analytics can improve the audit quality. The client data can be analysed at an earlier stage which allows to identify and evaluate risky areas earlier. Thanks to this, the audit plan can be tailored to the specific client and risks and is thus more relevant (CFRR, 2017).

7. Effect on audit quality

“Data Analytics is a key element in the strategy to improve audit quality” (IRE, 2018a, p.2). According to the Data Analytics Working Group19, “the quality of a financial statement audit can be enhanced by the use of data analytics” (IFAC, 2016, p. 7). Also, the Chief Financial Officers interviewed by Forbes Insights (2017) confirm that technology enhances audit quality.

The reasons for the higher audit quality are already explained in the previous section, discussing the advantages. Most important are the added value (IRE, 2018a) and the data quality (ICAEW, 2016). Data analytics can improve the audit quality mainly because of the quality of the analyses and the judgements the auditors can retrieve from it. The value lies in the audit evidence generated through the analytics. There are different reasons why Data Analytics can enhance the audit quality: (1) possibility to graphically visualize the results, (2) high level of development, (3) user-friendliness, (4) scope and velocity (ICAEW, 2016).

8. Disadvantages of using Big Data and Data Analytics

Understanding of data: To perform a good analysis, the auditor needs to have a good understanding of the data (IFAC, 2016). Moreover, the auditors’ education should include how to use the new tools and how the outcome can create audit evidence. They also need to be trained to be able to use the data adequately, to know which data they need, which analytics to perform to receive a certain result, draw conclusions and get valuable insight (CFRR, 2017; 2019). Hereinafter referred to as “DAWG“
Ramlukan, 2015). This is a conceptual challenge as the data is used differently in the traditional audit methods (IFAC, 2016).

Data security and privacy: One major challenge the audit companies have to confront is the data security (Forbes Insights, 2017). Another significant impairment of using Big Data and Data Analytics in audit are issues regarding privacy (IFAC, 2016; Ramlukan, 2015). These are also legal and regulatory challenges identified by the IFAC (2016).

Black box: Data Analytics and Big Data need to be applied vigilantly in order to not overvalue the technology (IFAC, 2016). The auditors risk being in a “black box” when they rely on these audit evidences. They need to find an equilibrium between professional judgment and relying on the results of Data Analytics (Ramlukan, 2015).

Appropriate level of work: An additional challenge identified by the IFAC’s DAWG is the appropriate level of work effort for exceptions. The question is whether a certain percentage of outliers or anomalies will be expected after testing 100% of the population, as only reasonable assurance is required (IFAC, 2016). This is also something national standard setters are concerned about (IFAC, 2018b).

Timing: A study published in the “Journal of Information Systems” shows that significant patterns in Big Data visualizations can only be identified if the auditors have formed expectations drawn from the outcome of analytical procedures beforehand. Hence, having a decision framework to develop expectations is advantageous. The timing of Big Data evaluation also influences other factors. If the Big Data patterns conflict with other audit evidence, the auditor will be more concerned about potential misstatements and probably increase the budgeted audit hours. It is thus better to examine Big Data visualisations after initial hypothesis are formed and relevant patterns can be more readily detected to produce valuable findings. The study shows it is probable that auditors will fail to identify relevant patterns if they have not built expectations regarding what is important to the decision context beforehand (Rose, Rose, Sanderson, & Thibodeau, 2017).

Higher number of exceptions: The possibility to test larger populations also involves a higher probability to have a larger number of exceptions (IRE, 2018a).

Large volume of data: Another challenge of implementing Data Analytics into audit is the high amount of information (IAASB, 2015a).
9. Barriers of using Big Data and Data Analytics in audit

Skills: Implementing Big Data and Data Analytics techniques requires investments in human capital. This can be a barrier especially for smaller auditing companies. The professional accountancy organisations should support them through providing education, raising awareness about the benefits, developing tools and guidance, research and recommend hard- and software (CFRR, 2017). There are many data science applications that exist that auditors can implement. Nevertheless, they need to learn how to use them or be supported by specialists. The auditors need to be able to measure the information Therefore, they will need additional education in information technology, statistics and modelling (Byrnes et al., 2014; Cao, et al., 2015; CFRR, 2017; IAASB, 2015a; IFAC, 2016). This also something the regulators, oversight bodies and standard setters, as well as the audit firms, especially the smaller ones, are concerned about (IFAC, 2018b). If the auditors can use Big Data tools provided by the market, which are easy-to-use, this can save costs and it won’t be necessary to engage specialists and the training could be limited. Otherwise, engaging specialists can be seen as an obstacle because those who want to use Big Data to increase profit are willing to pay more than those who only want to use it for compliance, such as audit (Alles, 2015).

Data Acquisition: Another significant impairment for implementing Big Data and Data Analytics into audit is the data collection (IAASB, 2015a; IFAC, 2016; Ramlukan, 2015). Data gathering is problematic because of multiple reasons. First of all, the clients have invested a lot to protect their data and are therefore often unwilling to share the data with the auditor. Furthermore, many different accounting systems exist and often also different systems within one company which complicates the data extraction as it requires the necessary skills and knowledge. Additionally, the auditors need more and more data for their analysis which hampers the extraction (Ramlukan, 2015; see also IFAC, 2018b). Furthermore, the acquisition of the data can be very time-consuming. This is because the data format is important for the analysis, and because the information system differs from one client to another which presents another barrier (IRE, 2018a). Also, regulators, oversight bodies and standards setters are concerned by data acquisition (IFAC, 2018b).

Investment: One main barrier, the audit companies have to confront is the budget (Forbes Insights, 2017: IFAAC, 2016). The introduction of Big Data and Data Analytics techniques also requires investments in technologies. This can be a barrier especially for smaller auditing companies. The professional accountancy organisations can support them through developing tools and guidance, research and recommend hard- and software. The smaller audit companies
can alternatively use third party tools to analyse data or third-party database tools (CFRR, 2017).

**Standards, regulators and oversight body:** The major challenges the audit companies have to confront are the regulatory environment (Forbes Insights, 2017; IFAC, 2016). The absence of references to Data Analytics in the ISAs can be seen as a barrier. Moreover, it leads to the opinion, that using Data Analytics does not reduces the procedures required by the ISAs (IFAC, 2016). The audit companies are also concerned about regulators and oversight bodies, because if they have little or no experience in the new technologies themselves, how are they going to inspect audit files which used Data Analytics. Furthermore, there is also uncertainty about the documentation requirements. At the moment, the auditors need to include the characteristics of their samples and tests, but when using Big Data and Data Analytics, do they have to document all data used and details of the procedures performed (IFAC, 2018b)?

**Qualitative and appropriate data:** The data which is analysed needs to be of high quality appropriate and relevant for audit to be able to produce qualitative and relevant audit evidence. The Information Provided by the Entity\(^{20}\) needs to be accurate and compete (IFAC, 2016). National standards setters, regulators and oversight bodies are also recognising the impact of the data quality and reliability (IFAC, 2018b).

**Paradigm shift:** A successful implementation of Big Data and Data Analytics in audit involves a change of paradigm. The experienced auditors are used to a certain way of thinking and working. However, a change in their mindset needs to happen for successful introduction and usage of the new techniques (Cao, et al., 2015).

10. Limitations

**Audit evidence:** The auditors have difficulties to use the audit evidence resulting from Data Analytics in the contemporary audit evidence model. The nature of the audit evidence in the current audit approach is not clear (IAASB, 2015a; IFAC, 2016). They encounter complication to create audit evidence responding to the risks previously identified (Ramlukan, 2015).

**Reasonable assurance:** Even if the auditor can test 100% of the population, he cannot provide more than reasonable assurance. This is because the auditor always needs to apply professional judgements and scepticism. This is even more true when analysing accounting estimates and qualitative information (IFAC, 2016).

\(^{20}\) Hereinafter referred to as “IPE”
11. Implementation and maturity models

Different models for successful implementation of Big Data and Data Analytics in accounting and auditing exist. Some of them will be explained hereinafter. They will serve as a basis for the final maturity model of this thesis.

Murthy & Geerts (2017) have developed a model to integrate structured external Big Data with accounting system elements. They have developed a three-step-approach. First, five appropriate Big Data sources are identified: website logs, social media, location/existence sensor logs, communication repositories, and intranet/extranet logs. Those are related to the different phases of business transactions. The second step consists of extracting the information. Finally, in the last step, the information generated from the external sources is used for decision-making.

Langhein, Kiesow, Strobel, & Thomas, (2018) identify the audit procedures suitable for Data Analytics. As shown in Appendix 7, it is appropriate to use Data Analytics in the “Risk Identification” process of financial statement audit. Furthermore, they present eight critical success factors which are crucial for the digitalisation of the audit industry:

- Transparent potential benefits
- Quality of the audit result
- Degree of automation
- Collaboration of the companies
- Independence of seasonal fluctuations
- Consulting and audit expertise
- Independence of the auditors
- Data protection and security

Tang, & Karim, (2017) have determined four steps to integrate Big Data into audit. The first one consists in combining traditional data and big data. Secondly, a talent training procedure needs to be developed. Efficient use of Big Data in the audit procedures requires competent auditors to manage the data. Next, the audit companies need to acquire appropriate Big Data tools. Finally, the last step consists in adapting the auditing standards.

Appelbaum, Kogan, & Vasarhelyi (2017a) provide a step-by-step approach for applying Data Analytics.
Here, the first step consists in understanding the different components of a business cycle. This will allow to select the data and understand the risks that are involved. Next, it has to be decided which data needs to be extracted. Furthermore, the auditor has to completely understand the data to apply the best analytical procedure possible. The fourth step includes identifying the main characteristics of the data and its statistical parameters. Data visualisation will allow to identify the related assertions and where Data Analytics is the most advantageous. The data quality, integrity and accuracy also need to be evaluated. In the final step the identified outliers and anomalies are examined (Appelbaum, et al., 2017a).
Gartner (2018) has also published a Maturity Model for Data and Analytics.

![Maturity Model for Data and Analytics](image)

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12. Future prospects

According to the DAWG, supervised machine learning and cognitive computing will probably be used in the future. Other examples they give are (IAASB, 2015b):

- Continuous Control Monitoring
- Continuity Equations
- Process Mining in Auditing
- Exceptional exceptions
- Evidence from Big Data
- Audit Data Standard
- Visualization for continuous assurance monitoring

Davenport, & Raphael (2017) don’t see a future for fully automated auditing but they think that cognitive technologies can bring additional value to the audit. They also present a five-step approach to transform tasks towards cognitive technology:

![Five step approach to cognitive technology](image)
According to Ramlukan (2015) however, the future of audit is having intelligent audit software inserted into the client’s system which will stream the results in real-time to the auditor.

Auditors are not yet aware of the full potential of Big Data and Data Analytics. Some recommendations to promote the adoption are (Byrnes et al., 2014):

- Encourage the research in universities, audit cabinets and consortiums.
- Provide guidance and adapt the audit standards to encourage auditors to efficient use of the new technologies.
- Encourage the collaboration with different specialist who have the necessary skills.

The potential of all these new technologies can go beyond financial statement audit. As the use of Big Data and Data Analytics provide greater insight the audit companies can offer additional services. However, they have to need to maintain the independence of the auditors which could become complicated. The auditors will spend more time analysing the client’s result and can provide added value to the client through greater insight (CFRR, 2017).

13. Standards

The audit environment is dictated by the standards. The opinions regarding the ISAs vary.

In 2015, the IAASB founded the DAWG. The aim of this group is to advise the IAASB regarding technological evolutions and their most effective reaction in the public interest. Furthermore, the DWAG has also investigated the different Data Analytics techniques and their effect on audit (IFAC, 2016).

The ISAs are neither a constraint nor encourage them to use Big Data in the external audit. (Alles, 2015, CFRR, 2017, IFAC 2016). Alles (2015) even sees them as a facilitator of using Big Data in the external audit. According to the IRE (2018a), Data Analytics is already integrated in the ISA audit approach. Nevertheless, some are requiring more: the standards and regulations should encourage auditors to optimal use of technologies (Byrnes et al., 2014). Through using new technologies for which no strong framework in the standards exists also brings additional risks to be second guessed. This can discourage the auditors to use those new technologies. Moreover, the audit oversight authorities’ risk to evolve in different directions (IFAC, 2016).

The IFAC sees opportunities to revise the standards because they “were written in a completely different technological era” (IFAC, 2016, p. 9). The standards do cover the possibility to use technology in audit but the concept of CAATs is becoming outdated (CFRR, 2017). Since then,
there have been enormous changes in the client’s businesses and technology. The ISAs should support improved audit quality and be appropriate to the changing audit environment (IFAC, 2016).

However, the ISAs also need to be applicable regardless of the circumstances. The use of Data Analytics is still at an early stage and changing the standards too early could be counterproductive (IFAC, 2016, 2018b, CFRR, 2017). Hence, the standards should remain principle based because that provides flexibility. Furthermore, professional scepticism remains essential when using Data Analytics (IFAC, 2018b). At the moment, the audit standards are established in the perspective of a risk audit approach. Hence, practical guidance could be a short-term solution. (IFAC, 2018b, CFRR, 2017)

Ramlukan (2015) divides the problems regarding the auditing standards and regulations into four categories. First the substantive analytical procedures, where the auditors using Data Analytics do not necessarily establish expectations. Hence, there is uncertainty concerning audit evidence resulting from Data Analytics. Secondly, validating the data used for analytics is complicated as some standards exist but there are still limitations up to which extent the auditors can collect audit evidence from Data Analytics. Next, it is not sure where in the hierarchy of evidence the audit evidence from analytics is located. Finally, there is concern regarding the degree of precision required form Data Analytics.
IV. **EMPIRICAL RESEARCH**

For the empirical part of this thesis, twelve professionals from Belgian and Luxembourghish audit companies have been interviewed. In order to gain as many ideas as possible and to analyse different points of view, interview partners of different ranks and from companies of different sizes were selected. However, the research does not cover smaller auditing firms. The interviewees are mostly active in auditing, but risk managers who support the financial auditors in Information Technology and Data Analysis were also interviewed. A detailed list of the interview partners can be found in Appendix 8. The names of the interviewees and the companies they work for are not disclosed because they expressed their personal opinion and not necessarily the auditing company’s official opinion.

The interviews were conducted in person or by phone, in French and English, and lasted one to two hours. The interview guide used can be found in Appendix 9. Additional questions are enclosed in Appendix 10. These questions were prepared to get more detailed and precise answers, and also more certainty if something was not clear. The transcription of the interviews can be found in Appendix 11.

1. **Big Data and Data Analytics in External Audit**

As already explained in the literature review, most of the data is accounting data and historical data. The auditors mainly analyse what has happened in the past. Most data used in audit is extracted from the client’s information system. The auditors sometimes also use third-party data such as correspondent banks or suppliers for example. This is because “for each record at the client side, there exists a record on third-party side” (Anonymous, personal communication, July 9, 2019). The auditors are then going to compare them. Good quality analysis obviously requires qualitative and truthful information. The audit team needs thus to challenge the data. Nevertheless, it is often the case that auditors rely more on third-party data. Here Data Analytics is not yet applied.

Data used in external audit is mostly structured. In some cases, depending on the client’s operations and information system, unstructured data can also be analysed. However, in contrast to what could be seen in the literature review, this is rather the exception. Structured data is often easier to analyse, this is why auditors prefer to work with structured data. Moreover, most client systems provide structured data. Therefore, it can be questioned whether the auditors are really treating Big Data, as the concept is not only related to the volume.
Nevertheless, some audit firms have projects where investigating how unstructured data can be used in audit, especially in risk identification and analysis. There are also some investigations on a global level, how unstructured data can be transformed into structured data.

The use of non-accounting data is client-dependent. In the telecom-sector, the hours per user or hours per destination could be interesting. In the hotel sector it could be the level of occupancy. Nevertheless, the non-accounting data always needs to be corroborated with accounting data.

2. Driver of using Big Data and Data Analytics in External Audit

The clients’ data has already been analysed in external audit for many years. What has changed now is that there is more and more data and not necessarily only accounting data. Moreover, the hardware and the tools are becoming more powerful.

Client: In contrary to the literature review, most Belgian and Luxembourgish auditors do not agree to having introduced the new technologies because they felt pressure from the client. There is no pressure to use some specific tools but there is pressure to be the most efficient in their audit. Hence, to reduce the audit cost for the client. Using Big Data and Data Analytics is one way to do so, because it gives access to a large volume of information and allows to perform process mining. Some add that the clients, even the smallest ones, are becoming more digital and hence it is only a logical consequence but not really pressure.

Competitors: Moreover, in accordance with the literature review, the auditors want to set themselves apart from their competitors. This is why they have to explain how they are going to use Big Data and Data Analytics in their request for proposal and how this will be valuable for the client.

Advantages: Nevertheless, most auditors state that the main reason for using these new technologies is because the audit companies see the advantages for themselves and the possibility to enhance the audit quality. They understand the significance it has or can have in their work.

3. Data Analytics tools and techniques used in audit

The tools and analytics used depend on the client and the manager. The manager has an overview of the engagement and knows what is relevant. The Belgian and Luxembourgish auditors use external tools but also develop them themselves to be more flexible. The most frequently mentioned external tool is Caseware Analytics IDEA which is supposed to be more powerful as Excel as more lines can be treated and multiple filters can be applied at once.
The audit examination techniques identified in the literature review are also used by the Belgian and Luxembourghish auditors. The most frequently cited example is the Journal Entry Testing, which will be explained in more detail in the next section. Further descriptive Analytics are used to determine tendencies and patterns, and to identify outliers and exceptions. Descriptive Analytics is especially used at the beginning of technologies’ implementation. Clustering is used to identify correlations and verify whether they are casual. Diagnostic Analytics are applied to understand why outliers exist, and to identify their root cause. Additionally, data integrity can be verified.

Furthermore, as already identified in the literature review, the auditors can use Data Analytics techniques to visualise data. The information that can be retrieved from visualisations makes the data relevant. “Visualisation and data relevance go together” (Anonymous, personal communication, July 9, 2019). Patterns and exceptions can be identified and then the auditor can focus and filter on these specific areas. Hence, the auditor can go further in the investigation. Use in data quality and integrity test allows to understand the data better.

The ability to visualise is also advantageous in documentation to show the risky areas and explain why and which transactions have been focused on. The graphs are then integrated in the working papers which facilitates the understanding of the auditor’s decisions and working steps.

Some Belgian and Luxembourghish audit companies use Data Analytics to show their results to the client. The client likes to know the audit approach, why the auditors are investigating certain things and why they are focussing on certain transactions. It facilitates the communication with the client and to explain what the auditor wants to do, which data he needs, etc. Then the client can give more appropriate information than the auditor would maybe have asked for. This allows to save time. Of course, the client could try to give “bad quality” data or try to hide something but then it is the auditors’ responsibility to test data quality and integrity. It is also used to ask the client information.

Some software and Business Intelligence tools generate visual representations of the results. They have integrated dashboards where the statistical quality of the data is presented. This includes missing fields, missing account numbers, missing account descriptions, etc. Moreover, it is more visual and thus more understandable. Nevertheless, some audit firms fear that they are not yet well-advanced in this field. Then, they are going to observe the client’s dashboard.

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21 Hereinafter referred to as “JET”
and Key Performance Indicator\textsuperscript{22} to understand how those are built and to check the quality of the KPI’s to see if they can be relevant for audit.

Some process and text mining techniques are also used. The process mining techniques are explained in the following section. Text mining is used to identify publications on the client in the “Moniteur Belge” for example. Here robots and artificial intelligence are used to identify and analyse the results. Nevertheless, this kind of application is rather an exception and not yet applied by many audit firms.

As many Belgian and Luxembourgish audit firms are only starting to implement Big Data and Data Analytics, predictive analytics are less applied. The application is limited because auditing is linked to historical accounts and the auditors do not always have the necessary data. Some auditors only apply it to non-accounting data to determine how this will be reflected in the accounting data and determine the correlations. Others use predictive analytics for sales forecast and to detect trends. Another example is risk assessment during the interim audit to foresee possible risks at year end. For the substantive analytical procedures, the trends and evolutions are analysed and compared to the current data. It is used for example when analysing margins, to see if they are in line with the trends and evolution of the client’s operations. Nevertheless, its use can be questioned when the auditors can test 100% of the transactions at the end of the year. Prescriptive Analytics such as artificial neural networks are not used yet by the Belgian or Luxembourgish auditors.

A possibility of Data Analytics using not only accounting data is benchmarking. This is a controversy topic as will be explained hereinafter and only used by few audit firms and only under specific circumstances. Benchmarking requires Big Data to be able to compare the client’s performance to its competitors. Benchmarking is possible if the data is delivered by the client or is publicly available. Moreover, whether or not benchmarking can be done depends on the client’s business and the client’s size. There are clients who, even if operating in the same industry, have different activities, hence it is more difficult to compare them. Furthermore, the valuation rules can differ from one company to another. The way of calculating the margins can also vary. This complicates the comparison.

\textsuperscript{22} Hereinafter referred to as “KPI”
The information on multinational companies is publicly available as they are listed on stock exchange. Multinational companies are active all over the world. It is important to use benchmarking to understand their business and related risks.

Most often, the auditor’s do not collect the data by themselves as it is time consuming. The data can be provided from the global group level. Or the consulting department does some benchmarking based on statistical data. They analyse the market to discover the trends of the industry, which is then sent as a newsletter to the auditors.

The auditors cannot compare the data from different clients within the company due to confidentiality rules. Moreover, it is not the auditors’ mission to do so. Anonymising the data is a possibility but difficult to implement. The data may be not sufficiently anonymised. Then, the source can be identified, and the data reconstructed. When the data is anonymised too much, then it can become unanalysable. The strength of the data lies in the possibility to link them. If this is not possible, then it loses all its interest. Some audit firms have projects regarding a centralised server, where all the data is anonymised, so they can do some benchmarking. Nevertheless, there is the concept of Chinese Wall and confidentiality clauses. The auditors are not allowed to share the information with other audit teams within the same audit company or outside of it.

4. Effect on the working methods

Before using Data Analytics in audit, the auditors used samples and the probability of identifying some mistakes was reduced. Testing 100% of the transactions allows to discover all the outliers and anomalies. Hence, the audit is moving from a sample-based approach to an exception-based approach. Moreover, the auditors can focus on the complex and risky areas which is more relevant. Additionally, the usage of Big Data and Data Analytics leads to more upstream work: The auditors analyse the transactions before testing them. They anticipate during the risk assessment which leads to a lower work charge for the substantive procedures.

Data Analytics is also used for JET, which is the most common application of Big Data and Data Analytics. In the JET test, the entries recorded and their counterbalance, the entries posted on weekends, who posted the transaction, etc. is checked. Moreover, the auditors can identify duplicates. To do so, the auditors have to apply multiple filters, which can be time consuming and complicated in Excel. The Data Analytics tools allow to perform all filters at once and in a shorter amount of time. Furthermore, Data Analytics allows to immediately identify which
transactions have been recorded automatically and hence do not need be investigated if the internal control system works properly.

Another Data Analytics procedure is the process mining which is used to verify whether the internal control system works as described and the controls are working properly. Before, the auditors determined a representative sample of the transactions to verify whether the internal control system was working correctly. Now, process mining allows to test 100% of the transactions. Moreover, when the client’s employees are posting the transactions, depending on the information system, it can generate logs. Hence, the system records who has posted which transaction and at what time. Based on this, the auditors can verify whether the employee was authorised to post these transactions or whether it follows the theoretical flow. The auditors will verify who has posted which transactions, which accounts have been moved. Furthermore, they will also check the cancellations and authorisations. This also allows to verify the segregation of duties.

Some Data Analytical procedures are also used to perform recalculations, for example for depreciation. This was already possible before but now it can be done much faster and easier. Now the auditors can access a whole population and retrieve data from different databases, recalculating them to see if they match. Moreover, the auditors can forecast the revenue at year end during the third quarter of the financial year. Nevertheless, it has to be questioned whether this is useful when they can test 100% at the end of the year.

Some audit firms have competency centres. There, they use a special program, which has been developed globally, to analyse the data which cannot be treated with Excel. The system can, up till now, not be used by the external auditors but by computer scientists or engineers. The competency centre sends a list of which data they need and which format to the client. The data analysis is performed by the competency centre’s staff. Afterwards, the local team receives the reports they requested. However, only one or few of these centres exist per audit group. Hence, their working hours need to be divided among the different members. Moreover, it requires a lot of organisation, as they need to receive the data on time to be able to perform the reports on time.

Part of the audit firms also have a so-called “shared service centre”. These are located in different countries worldwide, so that they can take advantage of the time difference. There they can send data, tell them which analysis or tests should be done and the next day when they get back to work, they receive the results. Of course, this is not only advantageous as bad communication can lead to unintended results.
Furthermore, the auditors request to receive the sales general ledger. If the client is in retail or a distribution business, the auditor can analyse the sales by month, geographical sector, etc. Trends can be detected and be compared with the prior year. The margins can also be analysed which allows to foresee the next months. This is even more interesting for the managements’ KPI. Data Analytics can also be used for accounts receivable, inventory, and sales to perform trend analysis.

5. Risk identification and assessment

In contrast with what could be identified in the literature review, most of the Belgian and Luxembourgish auditors state that the usage of Big Data ad Data Analytics in the risk assessment phase is still in its infancy and is limited. Moreover, some auditors think that the impact on this audit phase will remain limited, also in the future. This is because it requires professional judgement, and the auditor’s skills and understanding of the client’s business and environment. Hence, there will also always be the possibility of human error. Nevertheless, artificial intelligence can be used to monitor social networks and press articles for example to identify risks. Some audit companies are currently investigating whether it is possible to use non-structured, third-party data during the risk identification. This is because “the real risk is not the one you already know and you can follow; it is the one you do not know yet” (Anonymous, personal communication, July 26, 2019).

The audit firms follow a risk-based approach as per ISAs. The risk identification and assessment are executed at two levels: (1) at financial statement level and (2) at assertion level (ISA 315 (Revised) (IFAC, 2018c). Continuous risk assessment is crucial. All along the engagement, new risks are identified. Nevertheless, the auditors can still make mistakes during the risk assessment phase because it requires professional judgement, but if this is done correctly, he can identify all the outliers.

During the risk identification and assessment at financial statement level, the risk regarding those charged with governance is, among others, analysed. This is done before deciding whether the audit firm accepts a client. To do so, some Belgian and Luxembourgish companies use so-called “blacklists”. These are international databases for example, containing information about managing directors who have already “gone bankrupt, committed fraud or money laundering” (Anonymous, personal communication, July 25, 2019). There are some public databases which are freely accessible, but there are also some chargeable databases which are often more powerful and contain more information.
An appropriate risk assessment at assertion level requires for example a good understanding of the client’s operations and environment, the income and data sources. Data Analytics makes this more visible and understandable. “The management assertions for the period under audit are: occurrence, completeness, accuracy, cut-off, classification, and presentation. The assertions at the period end are: existence, rights and obligations, completeness, accuracy, valuation, and allocation, classification, and presentation” (ISA 315 (Revised) (IFAC, 2018c, pp.319-320). To cover the management’s assertion accuracy, the auditors perform recalculation. Recalculations allow to have assurance on accuracy, assurance on existence can be covered through verifying for example the authorisations, etc.

Thanks to the usage of Big Data and Data Analytics, populations and sub-populations can be identified more easily. The auditors can group the transactions for example, according to low or high risk or according to the payment delay. Besides, correlations between those groups can be analysed.

After analysing the client’s business and his environment, the auditors use standardised questionnaires for the risk identification. Depending on the answers they give, the risks will be identified automatically. Nevertheless, the auditors still need to apply their professional judgement to ensure that the automatically identified risks are really present.

Data Analytics tools also allow to identify all the opening operations and to analyse them. This is helpful to identify possible risks of management override. Before, this was done manually, hence the auditors could have missed some opening operations or not see the connections.

6. Advantages of using Big Data and Data Analytics

The advantages identified during the literature review and by the Belgian and Luxembourgish auditors are:

- Larger populations
- Improvement of auditor’s performance and focus on risky areas
- Positive impact on audit quality

Additional advantages identified by the Belgian and Luxembourgish auditors are:

Improved risk identification: The risk identification and assessment can be customised to the specific client and circumstances. As the outliers can be identified, the risks for certain accounts can be reduced. Furthermore, the auditors can focus their work on the risky areas.
**Added value for the client:** The clients prefer the auditors who work like this as they analyse all the transactions. Moreover, the client can also benefit from additional insight. The auditors explain, while presenting their results, how Data Analytics has been used which leads to higher interest from the client in these new technologies. Furthermore, there is also the delivery of the added value. The auditors are hired to certify the accounts. The clients expect more than this. They expect the auditors to communicate the results of the procedures in more detail and also those issues, which do not lead to certification problems. Data Analytics allows to do so. Nevertheless, this also raises the question of why the auditors should do so if they are not paid for it.

**Flexibility:** Moreover, applying Big Data and Data Analytics in the external audit allows to have different perspectives and detect trends. The auditors can have a more comprehensive and flexible approach. Once data is gathered, a variety of analyses and tests can be done.

**Documentation:** The usage of Big Data and Data Analytics is also beneficial for the documentation, as the auditors could for example extract a history of what has been done during the audit, which can be included in the audit report. Furthermore, visualisations and graphs will enhance the comprehension of the audit documentation.

**Client’s internal control:** The usage of Data Analytics in audit also forces the client to have sufficient internal control. Insufficient control can lead to bad data quality and then the data cannot be analysed.

7. **Effect on audit quality**

**Time:** The audit firms which have just started to implement the new technologies do not see time savings yet. However, once everything is implemented, it saves time. Once the auditor knows what he has to look for, he can work faster. Nevertheless, it can take time to transform the data if it is not in a correct format. Furthermore, the auditors need to spend less time on substantive procedures, as they will have to perform less. The auditors can now focus on the outliers and risky areas and do not need to do random checks on things that are working perfectly. However, what needs to be tested also depends on the threshold. Additionally, many tests that were previously performed manually, can now be automated. Hence, it saves time because the software and tools are more powerful.

Nevertheless, in some audit companies, some part of the work is sent to so-called service centres. If the communications with those centres is not good enough, the outcome will not be correct and hence the gain in time will be lost. The same counts for automated processes where
bugs can occur. It is thus not necessarily a time saving but the workload is distributed differently. When the implementation is completely finished, it reduces the overall workload.

Besides, the auditors will need to spend less time performing the tests but in contrary, the time to develop the software and tools will increase.

**Cost:** In the beginning, the introduction of Big data and Data Analytics will cost a lot because many investments need to be done. The audit companies are still investing a lot of money in the development of the software and tools and also for the training. The bigger audit firms can afford the initial investment. In the long term, the audit cost decreases because the hours spent per client decreases. Moreover, the auditors will save time spent on some procedures which will reduce the audit costs.

Nevertheless, the way of calculating the audit cost might not be suitable anymore. At the moment, the audit cost is calculated according to the number of employees working on it and how much these cost per hour. It is thus an hourly rate. If the process is more and more automated and less humans are working on the audit, then the technology cost will become more important and should also be included in the audit cost.

**Efficiency & effectiveness:** The increase in efficiency cannot be measured yet as many things are still in development and many investments have to be made. In the long term, applying Big Data and Data Analytics increases the efficiency and the audit work is more effective thanks to reduced costs and the time saved. The auditors can focus on the more complex and riskier areas which increases the efficiency. Additionally, the relevance of the audit work is also increased.

Nevertheless, depending on the client, it is not efficient to use all the tools, for example if these require a high volume of data but the client’s business does not generate enough transactions. Hence, the cost-benefit ratio needs to be kept in mind.

**Quality:** The personal opinion of most of the auditors is that the usage of Big Data and Data Analytics enhances the audit quality. Nevertheless, they think that for most of the others in the industry, the opinions are still divergent. The audit quality is enhanced because, as already explained in the advantages, using Big Data and Data Analytics leads to improved insight and better audit evidence. Moreover, the whole volume of transactions can be tested. The auditors can focus on the more complex and risky areas and it increases the probability of finding errors. Through technological advances, the data quality is improved which in turn improves the audit quality. Finally, relevance of the audit work and the assurance is also increased.
objective is of course to increase the audit quality. Nevertheless, the audit quality is increased only if the auditors receive good quality and the tests and analyses are performed correctly.

8. Disadvantages of using Big Data and Data Analytics

**Fragmentation:** If the data extraction is fragmented for example by month or by quarter, it can be time consuming to reassemble the data. Especially if the data is organised differently from one fragment to another.

**Client relationship:** Another disadvantage is that some auditors feel that the client relationship suffers from the technological evolution. The auditors are communicating more and more by email or phone instead of face-to-face meetings. Moreover, some auditors feel like it gets more difficult to understand the client’s operations and environment if the auditors are not “on the field”.

**Teamwork:** Through the application of Big Data and Data Analytics, the work is more fragmented. Hence, there’s a chance of less communication within the teams and less teamwork.

**Data quality:** A successful analysis requires integer and accurate data, otherwise the result is not useful.

**Necessity of materiality:** At the moment, there is a risk-based approach and Big Data leads to testing 100% of the transactions. A possible outcome could be that 95% of the transactions follow the norm and 5% are anomalies. Then, the auditor needs to analyse these abnormal transactions. Nevertheless, if the value of this 5% is within the acceptable margin of error then the question is whether it is still necessary to test them. Big Data can have an impact on materiality and raise the question if it is still necessary to define the materiality if the totality of transactions is tested.

9. Barriers of using Big Data and Data Analytics in audit

The main barriers already identified in the scientific literature on which the Belgian and Luxembourghish auditors agree are:

- Data acquisition
- Auditor’s skills
- Auditor’s mindset
- Investment
- Data quality
Standards, regulators and oversight body: The auditor’s opinions about whether the standards are seen as a barrier are divided. This will be discussed in a later section.

Client’s competencies: One additional barrier identified by the auditors are the client’s competencies. The data extraction can be executed by the auditor or by the client himself. In this case, the client also needs to understand the data to extract the relevant information. Furthermore, when the client collects the data himself, employees with good IT skills who understand the information system are required.

10. Data integrity, quality and complexity

The main problems concern the data extractions and the data quality. Some clients have less known information systems which complicates the data collection. The data quality depends on the data extraction. Sometimes the auditors need to transform the data to be able to use it. For some tools, they need data in a specific format, then they have specific guidelines.

The auditors need to ensure the data integrity and accuracy. This includes the right period, debit and credit net to zero, journal entries net to zero, compare general ledger to final balance, etc.

There are three methods to ensure data quality:

1. Reconcile the client’s data with reliable third-party data
2. If the data extraction is performed by the client, the auditors can sit in and check if the extraction is done correctly, nothing manipulated or deleted, …
3. Test the client’s internal control system to verify the data in the system is accurate

11. Implementation and maturity models

The implementation of Big Data and Data Analytics is a continuous and iterative process which will not happen from one day to another. Nevertheless, some steps and critical success factors can be identified.

The first step in successful implementation of Big Data and Data Analytics in external audit is the awareness. The auditors need to realise how important it is and which effects it can have on their way of working and the audit quality.

Next, they have to invest in the necessary hardware and software, the audit, Big Data and Data Analytics tools. These can be developed internally, co-developed with other companies or for some tools even bought from external providers. The informaticians and engineers can start with the development of the tools and software, but the auditors are the ones who will be using
them afterwards, hence they should be involved in the development. This is a continuous and iterative process. The development of hardware and software follows the general digitalisation and technological revolution.

At the same time, the audit staff needs to be trained as it is a new way of working with new tools, a new approach. They need to be trained on how to use the software or tools and how to extract the data from the client in an appropriate format. The auditors need to understand how Data Analytics work. They need to know which output they want and how to get it.

The auditors also need vocational training regarding data literacy. This is something some audit firms have been struggling with. In fact, data literacy is the ability to understand the data, to interpret it, to draw conclusions. The training shall confront people and make them aware of certain elements to which they have to pay attention, which are questions that the auditors should ask themselves or the client, etc.

Furthermore, a change in mindsets needs to happen. “It is necessary to demonstrate how the tool can help the auditors and demonstrate how it works with practical and concrete examples” (Anonymous, personal communication, July 9, 2019).

It also needs to be ensured that the auditors can extract the data from the client and which data they can get, which format, etc. This will influence the analysis and tests that can be conducted later on. The data extraction depends on the client’s information system. Hence, a successful data extraction requires a deep understanding of the client’s operations, his environment and his information system to understand where the data they need is stored.

After the data collection, the quality of the data must be ensured. The auditor needs to verify the data integrity and accuracy. To extract the appropriate data, the auditors need to know which tests he wants to perform beforehand, which output he wants to have and which kind of reports he wants to get.

Finally, the data is uploaded into the auditing and Data analytics tools to test and analyse it.

At the beginning of their introduction of Big Data and Data Analytics, the audit firms start implementing it on some of the clients they found the most appropriate and roll it out on more clients afterwards.

Some critical success factors for an effective implementation have been identified by the Belgian and Luxembourghish auditors. First of all, a deep understanding of the client’s business and his information system is crucial for appropriate data gathering. Next data literate auditors
enhance the effectiveness of the analysis. Finally, the initial resistance to adopt the new way of working needs to be overcome.

12. Future prospects

In the near future, two or three years from now, not a lot will have changed. Big Data and Data Analytics will be used even more in external audit and more dynamically. It will also become more visual and there will be more tools on the market and the technological maturity will rise. There will be more flows of information and the audit approach will become more drilled down and more exception-oriented. “The usage of Data Analytics is not a revolution but an evolution of audit; the usage of artificial intelligence will be a revolution” (Anonymous, personal communication, July 9, 2019).

In the longer term, the audit approach and nature will change. Stakeholders do not want to wait six months to receive the audited financial statements. Furthermore, the audit’s frequency is also susceptible to change. It’s going to be more like anticipations and continuous certification. Most of the Belgian and Luxembourgish auditors agree that the audit will evolve to continuous auditing. One possibility is to implement the audit tool or software directly into the clients’ information system. This way, the auditor can see if it is an outlier or in the norm immediately after a transaction is recorded. Some audit firms already have projects to develop such Artificial Intelligence tools which can be uploaded into the client’s system and then immediately extract all the necessary data. This will reduce the interim step between data extraction and uploading into the audit system. Hence, the risk that the data is not extracted correctly, or parts are missing is reduced. Nevertheless, some fear that some clients will not accept this as there will be difficulties regarding the security and some clients are very reluctant to share the data. There are also some legal limitations regarding data security and leaks. The client does not want to mitigate the auditor’s risk additionally to his own. A lot of political discussion with the client will take place. However, there will also be added value for the clients as they will need to spend less time on data extraction, looking for matching data etc. Furthermore, the data transparency will increase.

Another possibility is that one of client’s information system providers will develop a tool or feature for the auditors which will be implemented in the client system. It is not done yet, at least not in Belgium, but it is a possibility. This system could then be treated like an external expert. Of course, the information system’s auditors need to audit the tool and provide the necessary certificates, but then it can be used just like every other external expert information.
Another possibility is that the audit reports will be produced by robots. Robots do not make any mistakes and can work 24 hours per day, seven days a week; hence, they are more efficient. In more and more audit firms, part of the work will be done by robots and humans will intervene only when professional judgement is required. Nevertheless, this human intervention for professional judgement will always be necessary, also because the machines or robots can only do what human tell them to do.

Therefore, there is a high potential but some auditors fear that as long as the regulations and standards do not change, the auditors cannot take full advantage of its potential. The usage is thus limited. Moreover, there needs to be a change in the auditor’s mindset. They are trying to change the way audit is done nowadays but it is a long process. Finally, the client’s ERP systems also need to evolve to enable structured data extraction.

13. Standards

Auditors’ opinion on the standards are divided. Some see them as a barrier, others do not. Some think the standards must be adapted to the technological evolution, other think that it is still too early to do so. Next, the auditor’s justifications for their point view will be outlined.

The auditors who are convinced that the standards are not a barrier for the usage of Big Data and Data Analytics justify it as follows. First of all, “the ISAs are a general framework” (Anonymous, personal communication, July 16, 2019). This means they provide only guidance but do not prohibit the usage of Data Analytics techniques. Some auditors say that “they are not aware of any text passage which prohibits the use of Big Data or Data Analytics” (Anonymous, personal communication, July 9, 2019). Next, they do not see a problem for using Big Data and Data Analytics as long as the reasoning is well documented and no matter which other auditor would come to the same conclusion. Therefore, the reasoning needs to be detailed and proven with facts, figures and graphs. Big Data and Data Analytics facilitate the creation of those graphs and provide the figures. In the future, the standards will have to change but it is still too early to do so because first there needs to happen a change in mindset and it also needs to be envisaged how smaller audit firms cope with the new technology and the associated costs.

The auditors who take the view that the standards are a hurdle, explain it as follows. The possibilities of applying Big Data and Data Analytics in external audit are fully consistent with the ISAs. First, according to the ISAs, the auditors have to do both; test the internal control system and perform substantive procedures. Through the usage of Big Data and Data Analytics,
the auditors would test 100% of both; they would do too much work. Secondly, the ISAs are based on the risk assessment approach. Normally, the auditors don’t need to test everything. The usage of Big Data however will lead to testing 100% of the transactions. Big Data leads to perform work that goes beyond what the standards require. The issue is that testing both will lead to doing too much work because Big Data allows to test 100% but only test one, and this gives assurance on the faithful image of the financial statements, is not in line with the standards. Hence, the auditors are not convinced that the ISAs allow to gain assurance from Big Data and Data Analytics. There’s a lot of potential to change the way of how audit is conducted but as long as the standard setter and regulator do not react to it, the usage of Big Data and Data Analytics will be limited. Therefore, a possible solution could be to organise meetings to demonstrate to the members of the standard setting board what Data Analytics allows to do but also what cannot be done. They need to involve people who understand the issues, capabilities and limitations of the tool and can explain them.

14. Client’s extent of responsibility

The auditors can only apply Data Analytics if they get the data from the client. Furthermore, the structure of the data depends on the client’s information system.

“The client responsibility is to keep the records available in their system” (Anonymous, personal communication, July 19, 2019) and to make sure the data is of good quality. This is called IPE; the client is responsible in sharing the data and ensuring it is integer and accurate. It is the auditor’s responsibility to say which data he needs and in which format. The auditor also needs to verify the data integrity and accuracy. This task will become more difficult when the data volume increases. The role of the client has not necessarily changed a lot. What has changed is the data reliability, because if the data used for the analysis is wrong, the whole conclusion will be wrong. Moreover, when the extracted data is not integer or accurate, the client will need to rerun the data extraction. This can be very time consuming.

The “perfect” client has the general IT controls. This includes, among others, access management, a history of data changes and manipulations. Furthermore, the ideal client would verify the data consistency and integrity before sharing it with the client. Finally, he would also delete the data lines which are not useful for the auditor.

Data extraction: Whether the client or the auditor extracts the data depends on the client’s choice. Tools to extract the data immediately from the client exist but most of the time, the
clients extract the data themselves. There are multiple means to transfer the data, these depend again on the client’s choice.

Reluctance to deliver data: It is in the commercial relationship that the client has to deliver all the information that he asks for to the auditor. However, the clients have installed costly security programs to protect their data, therefore they are more reluctant to share their data. Whether or not the clients agree to provide the data depends on their willingness and ability.

A minority of the audit companies include, in their general terms and conditions, that they only accept the client if he agrees to give access to all of his data. Even if it is only the case for a minority of the auditors at the moment, they think that it will evolve more in this direction because they need the data to perform their analysis. If a client refuses to share his data, this could be seen a sign that he is hiding something. Some clients, especially the small and medium family businesses, do not have the information systems to extract the necessary data. The auditors should then educate the client and explain to him the added value this can have for him.

ERP systems: Many different ERP systems exist. The most well-known are SAP, AX, and ORACLE. Less familiar information systems or using multiple systems which interact with each other can complicate the data extraction. Nevertheless, the auditor cannot tell the client which system to use, he can only make recommendations as for example to include a process for data traceability.

Advantageous but not necessary: Some clients generate some kind of management report where they analyse the general ledger. This can be helpful for the auditor’s risk assessment. Furthermore, if the data analysis is not done by the local audit team, they need to be planned in advance when the data will be received and when the results need to be available. This can only be done when the client is well organised.

Added value for the client: The clients are also moving in the same direction because they need to manage their risks. The clients’ board of directors and management are also aware of the importance and possibilities of Big Data and Data Analytics.

15. Differences regarding client industry

One of the main barriers is the data acquisition, which depends mainly on the client’s information system and how technically advanced the client is. This is according to the
interview partners, not directly sector related but depends on other factors. Firstly, the size of the client is important. A large volume of transactions and a high number of customers leads to an increased use of digitalised systems. A lot of transactions can be found in retail for example, telecommunication, electricity, pharmaceutical sector; besides, large groups and global players necessarily have more transactions. Nevertheless, the companies’ operations can be very advanced in technology but not necessarily in their accounting system. Some add the predictability of transactions as another differentiator. Some activities are more volatile, hence less predictable than others. The demand is influenced by many different factors and therefore, predictive analytics will be more difficult to apply. The maturity and organisation of the client also plays an important role. Furthermore, it depends on the data criticality for the client. The financial sector is often more digitalised and the data is critical. The construction sector has less experience in Big Data for example.
V. ETHICS

In this chapter, how the research thesis addresses the ethical dimensions of the answers provided to the research question will be examined. First of all, the terms “Ethics” and “Business Ethics” will be defined. Next, the different ethical theories will be demonstrated. Finally, the link between those ethical theories and the research question will be discussed.

The Merriam Webster dictionary defines ethics as:

_The discipline dealing with what is good and bad and with moral duty and obligation; the principles of conduct governing an individual or a group; a guiding philosophy; or a consciousness of moral importance; a set of moral issues or aspects (such as rightness) (Ethic, 2019)._ 

In her course on Business Ethics, Xhauflair defines ethics as “a set of (axiological) principles that are challenged by one or more social actors performing a particular action in a particular situation”. It is opposed to morality, deontology and law. Morality is defined as “a set of (deontological) principles that take the form of general and universal obligations regardless of the particularity of a situation/specificity of an action”; deontology as “a set of (deontological) principles that frame particular social actors in the performance of their professional activity”; and law as “a set of rules that legally sanction (public body) certain fellow-citizens practices” (Xhauflair, 2018, p.19). These concepts all have something in common: they deal with ethical values and principles.

“_Business Ethics can be understood as the study of the ethical aspects of activities including, and relating to, the purposeful exchange of goods and services. This includes their production, distribution, marketing, sale, and consumption_” (Moriarty, 2008, as cited in Xhauflair, 2018, p.26). Business Ethics can be divided into descriptive Business Ethics and normative Business Ethics. Descriptive Business Ethics is defined as “_Social scientists ... approach the study of business ethics descriptively. They try to understand things as they are_” (Xhauflair, 2018, p.28). Normative Business Ethics are “_considered only as a normative enterprise, business ethics... draws from a variety of disciplines, including ethics, political philosophy, economics, psychology, law, and public policy. In this perspective, most of the examinations are variants on the fundamental question_” (Xhauflair, 2018, p.28). These normative questions are divided into three levels. The micro level relates to the individual conduct. The mid-level refers to the operations, strategy and management structure of all kinds of organisations. Finally, the macro level concerns the markets and regulators.
Xauflair explains in her course on Business Ethics that ethics is a sophisticated term. There are various ways to standardise it and it is complicated to define something as ethical or fair.

There are two ethical theories: Consequentialism (Utilitarianism) and Non-consequentialism (Deontology). Consequentialism is represented by the authors Jeremy Bentham, John Stuart Mill, and Henry Sidgwick. The principle is to maximize the utility and is hence outcome-outcome. They consider “an action or rule of action is moral if and only if its consequences result in a higher increase of well-being than any other action or rule of action for the concerned community” (Billier, 2014, as cited in Xauflair, 2018, p.134).

The non-consequentialism is represented by Immanuel Kant, W. D. Ross, Nagel, and Rawls. Here, the principle is to comply with moral standards, hence it is duty-oriented. It is the “science of duties, moral methods or approaches structured around the principle and idea of « duty »” (Xauflair, 2018).

Applying Big Data and Data Analytics in audit is in itself not an ethical problem. Nevertheless, there can be concerns regarding data privacy, security and the auditor’s independence. At the moment, the Belgian and Luxembourghish auditors are mainly treating accounting data. Nevertheless, this is confidential data which needs to be stored in a secure place where it cannot be accessed by unauthorised people. Moreover, the data cannot be shared with people external to the audit team. The development and implementation of these new technologies is just in its infancy. However, when more and more data is extracted and used for the auditor’s analysis, the importance of these ethical problems will increase.

The auditors need to have access to the client’s data to be able to perform effective Data Analytics. Therefore, they also have to physically store the client-sensitive data. This can lead to problems regarding confidentiality and independence which should be addressed together with the IESBA (IFAC, 2016).

1. Data confidentiality and security:

The major ethical problem when applying Big Data and Data Analytics in the external audit is the data confidentiality and the privacy of the people. Individuals’ privacy and data protection need to be ensured. Some ethical rules already exist that apply to external auditors. These are rules on deontology and professional secrecy and can be found for example in the IEASBA Handbook of the International Code of Ethics for Professional Accountants. Nevertheless, some national rules also exist.
Analysing social media data for the purpose of external auditing is not seen as a possible solution in Belgium and Luxembourg. First of all, there is legislation on data protection as for example the EU General Data Protection Regulation\textsuperscript{23}. If it would be possible, then sociologists need to be consulted to analyse people’s behaviour. This is not something which is considered in external audit at the moment.

The clients are concerned about the confidentiality of the data they are sharing with the auditors, especially since the GDPR legislation. GDPR is a law on the protection of personal data. If the files extracted from the client contain the name, birthday, salary, etc. this could be a GDPR related problem. However, sometimes the auditors need personal information to check for example if the information stated on the bank account is in accordance with the supplier, etc. There is disagreement in the auditing industry wherever or not the GDPR legislation impacts the external auditor. Some say the auditors are somewhat exempted from the GDPR and they have the right to receive the information. Moreover, they are bound to professional secrecy and have to ensure the data is not going to be shared outside of the audit team.

Others think that there is not yet a fundamental ethical problem regarding the use of information in external audit. This is because they mainly treat accounting data and only a few personal data. All the non-accounting data are only indicators on how they could affect the accounting. Additionally, the data can be anonymised for natural persons. The current code of ethics is thus still relevant and GDPR does not have an important impact on the external audit profession. The auditors only use few data where a person could be identified and most of the data is anonymised. For example, only the employee’s identification number is shared but not the name.

Another common opinion is that auditors should ensure to collect only the data they need and not useless data. One of the difficulties is hence to be sure which data is needed for the Data Analytics in the context of external audit.

According to the communication 2018/13 issued by the Belgian Board of the Institute of Registered Auditors (Institut des Réviseurs d'Entreprises\textsuperscript{24}), it is important to distinguish between auditors acting as a data controller or as a data processor. The auditor’s responsibilities and obligations regarding personal data depend on this categorisation. External auditors are in

\textsuperscript{23} Hereinafter referred to as “GDPR”

\textsuperscript{24} Hereinafter referred to as “IRE”
most cases considered as data controllers. This means that they can determine the purposes and means of data processing themselves. However, the external auditor is not allowed to conclude subcontracts. Moreover, he must have a confidentiality policy, clarifying his guarantees and obligations, and release it to his clients. External auditors are considered as data processors for example for agreed-upon procedures. The auditor is then processing the personal data simply on behalf of his client. The data processor must follow the data controller’s instructions and cannot freely decide how to use the personal data (IRE, 2018b).

Furthermore, the audit companies need to have security systems to ensure the safety of the client’s data. This has always been the case but nowadays, it is getting easier but also riskier. Due to the increased usage of Big Data and Data Analytics, more and more data will be collected by the auditors. Moreover, the composition of the audit team may change because more technical skills will be required. Therefore, more people will need to have access to the audit file and thus the data. The internal control on file access will increase. There needs to be control procedures to ensure there is no breach of confidentiality or conflict of interest.

Besides, the data cannot be disclosed to anyone outside the audit team. If the auditor wants to publish articles, they need to anonymise the data or only publish the results of the analysis.

2. Independence
The usage of Big Data and Data Analytics in external can also affect the auditor’s independence. The independence is defined in ISA 200 as follows:

*The auditor’s independence from the entity safeguards the auditor’s ability to form an audit opinion without being affected by influences that might compromise that opinion. Independence enhances the auditor’s ability to act with integrity, to be objective and to maintain an attitude of professional scepticism* (IFAC, 2018c, p.90).

The IESBA differentiates independence of mind and independence in appearance. Independence of mind is the ability to draw conclusions by maintaining an unimpaired professional judgement. Independence in appearance is to avoid any situation which could be considered as impairing the auditor's independence. The auditor’s independence is linked to his objectivity, integrity and professional scepticism.

When the auditor gets more and more insight, the client will get to know this insight as well. Nevertheless, the auditor needs to be independent from his client. When getting more and more insight into the client’s business and environment, the auditor risks knowing too much about
the client which can compromise his independency (Tang, & Karim, 2017). The usage of Data Analytics in audit also lead to auditors concentrating more and more on testing non-accounting data. Hence, the auditors tend to perform more non-audit services (Earley, 2015). Some Belgian and Luxembourgish auditors also expressed concern that the rules, especially with regard to independence, are becoming increasingly stricter. Hence there are more and more things they are not allowed to do. The auditors fear that this could lead at some point to complete separations from the other consulting and assurance departments in a way that they need to be in completely different organisations, different structures. However, the auditors need more and more technological skills, increasing help from experts. Hence the complete separation can lead to financing problems and difficulties training the staff appropriately.

O’Donnell (2015) on the contrary thinks that the auditor’s independence is not jeopardised through the new insight. Applying Big Data and Data Analytics can improve audit quality and provide new insights and still allows auditors to be in line with independence standards.
VI. CONCLUSION

This dissertation analysed how Big Data and Data Analytics influence the external audit. The study has shown that many new and fewer new technologies exist, but audit firms are only at an early stage with regards to implementing them. Most audit firms have only just become aware of the potential, especially in Belgium and Luxembourg. Therefore, the full impact is still uncertain.

The aim of the study was to find an answer to the following research questions:

➢ Q1: How do Big Data and Data Analytics influence the audit working method?
➢ Q2: What is the impact of Big Data and Data Analytics on the audit quality?
➢ Q3: How is the audit risk identification and assessment phase influenced? Which audit risks can be identified?
➢ Q4: Which tools and techniques do the Belgian and Luxembourgish auditors use and where do they stand?

The objective was partially achieved. Concerning research question Q1, after successful implementation, the workload can be spread over a longer period and is distributed differently along the audit phases. More work charge is focused during the planning and risk identification and assessment phases which leads to less work charge during the substantive procedures. The initial investments for hardware, software and training are high. In the long-term, audit costs are supposed to decline, but the definition of audit cost is questioned.

The audit quality can be enhanced when qualitative analyses generates audit evidence based on high quality data. Hence, the hypothesis H2 “The usage of Big Data and Data Analytics enhances the audit quality” is validated as long as the data quality can be ensured. The impact on effectiveness and efficiency is still uncertain as there is still a lot of development. The techniques and tools used need to be adapted depending on the client’s need and provided data. Therefore, the hypothesis H1 “Applying Big Data and Data Analytics all through the different phases of the external audit leads to more efficiency and effectiveness: less time consuming and less costly.”, cannot be validated.

The use of new technologies improves the risk identification and assessment as the risk can be identified earlier. Furthermore, it allows more responsiveness and focus on the risky and complex areas in the later phases of audit. Hypothesis H3 “The usage of Big Data and Data Analytics enhances the identification of possible risks of material misstatement.”, is validated.
The Belgian and Luxembourgish audit industry has just started implementing the technologies. Some techniques are not used yet due to less technological advancement, high investment and different regulations compared to the US. Therefore, the hypothesis H4 “The Belgian and Luxembourgish auditors are lagging behind in their implementation of new technologies.”, is true for some aspects of the technology. Nevertheless, the awareness and willingness to invest in technology is present.

To outline the current and potential impact of Big Data and Data Analytics on the external audit, a maturity model has been created. This model includes the most common techniques used in audit and gives one potential way how they can be incorporated. Nevertheless, this is not an exhaustive list and it can vary depending on the audit firm’s size and client base.

The results of this research are linked to the investigations of various international, mainly American, researchers. The study provides new insight on the use of Big Data and Data Analytics techniques in the Belgian and Luxembourgish audit industry.
This master thesis does not aim to create an algorithm or to examine which are the most useful techniques but only introduces the most common ones.

The dissertation is subject to some limitations. First of all, due to the semi-structured nature of the interviews, the respondents’ answers depend on their interpretation of the questions. Furthermore, experts in the field of audit Big Data and Data Analytics have been interviewed. Hence, they are more favourable regarding these technologies and may not represent the general opinion of the audit industry. Nevertheless, their knowledge in both fields audit and technology and especially the usage of these technologies in audit have been very valuable for this research.

Further research could look at the implementation of Big Data and Data Analytics in audit from the clients’ perspective. The clients play a big role mainly due to the data extraction and it would be interesting to have their point of view. Moreover, further investigation is also possible with regards to the influence of the technologies on the internal audit and internal control of the entities. These are also identifying and analysing the risks the entities are exposed to and treat it from a different perspective. In view of the rapid changes and further technological development, it may be useful to investigate the influence of other technologies such as artificial intelligence and blockchain.
REFERENCES


**REGISTER OF REFERENCES**

This register contains the references stated previously and indicates where they have been used in this dissertation.

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ATTACHMENTS

APPENDIX 1: IBM: THE FOUR V’s OF BIG DATA

APPENDIX 2: EXTRACTING BUSINESS VALUE FROM THE 4 V’s OF BIG DATA

APPENDIX 3: THE FOUR FUNCTIONAL CATEGORIES OF ANALYTICS

Source: Gartner, 2016, p.10
APPENDIX 4: INFORMATION ASYMMETRY AND CONFLICT OF INTEREST BETWEEN THE OWNER AND THE MANAGER

Source: Francis, 2018, p.20
APPENDIX 5: OVERVIEW OF THE FINANCIAL STATEMENT AUDIT PROCESS

Source: Francis, 2018, p. 31
APPENDIX 6: INTERNATIONAL STANDARD ON AUDITING 315: CONDITIONS AND EVENTS THAT MAY INDICATE RISKS OF MATERIAL MISSTAMENT

Non-exhaustive list stated in ISA 315 (Revised):

- Operations in regions that are economically unstable, for example, countries with significant currency devaluation or highly inflationary economies.
- Operations exposed to volatile markets, for example, futures trading.
- Operations that are subject to a high degree of complex regulation.
- Going concern and liquidity issues including loss of significant customers.
- Constraints on the availability of capital and credit.
- Changes in the industry in which the entity operates.
- Changes in the supply chain.
- Developing or offering new products or services, or moving into new lines of business.
- Expanding into new locations.
- Changes in the entity such as large acquisitions or reorganisations or other unusual events.
- Entities or business segments likely to be sold.
- The existence of complex alliances and joint ventures.
- Use of off balance sheet finance, special-purpose entities, and other complex financing arrangements.
- Significant transactions with related parties.
- Lack of personnel with appropriate accounting and financial reporting skills.
- Changes in key personnel including departure of key executives.
- Deficiencies in internal control, especially those not addressed by management.
- Incentives for management and employees to engage in fraudulent financial reporting.
- Inconsistencies between the entity’s IT strategy and its business strategies.
- Changes in the IT environment.
- Installation of significant new IT systems related to financial reporting.
- Inquiries into the entity’s operations or financial results by regulatory or government bodies.
- Past misstatements, history of errors or a significant amount of adjustments at period end.
• Significant amount of non-routine or non-systematic transactions including intercompany transactions and large revenue transactions at period end.
• Transactions that are recorded based on management’s intent, for example, debt refinancing, assets to be sold and classification of marketable securities.
• Application of new accounting pronouncements.
• Accounting measurements that involve complex processes.
• Events or transactions that involve significant measurement uncertainty, including accounting estimates, and related disclosures.
• Omission, or obscuring, of significant information in disclosures.
• Pending litigation and contingent liabilities, for example, sales warranties, financial guarantees and environmental remediation.

Source: IFAC, 2018c, pp.332-333
APPENDIX 7: AUDIT PROCEDURES SUITABLE FOR DATA ANALYTICS

Source: Following Langhein et al, 2018, p. 414
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APPENDIX 9: INTERVIEW GUIDE

Initial questions:
➢ No names will be mentioned, the interview is anonymous.
➢ Is it ok if I record the interview to make it easier to transcribe it afterwards? (The record will be deleted after the transcription)
➢ What position do you have within the firm?
➢ How many years of experience do you have in your job?

Key questions

Use of BD & DA In Audit and Risk Assessment
1. What are the main reasons why you use Big Data and Data Analytics in External Audit and Risk Assessment?
2. How has it affected your working methods/audit/audit quality?
3. Which are the top 3 advantages of using Big Data and Data Analytics in Audit and Risk Assessment more specifically compared to traditional procedures?
4. If you would have to divide the introduction and implementation of Big Data and Data Analytics into 5 stages, which would it be?

Data Analytics
5. Which types of Data Analytics do you use? Are there any differences/similarities according to the client’s industry?

Data
6. What types of Big Data do you use? (internal or external; structured, unstructured, semi-structured) Are there any differences/similarities according to the client’s industry?
7. What are the data sources? Do you treat the data differently depending on the data source?
8. Part of the data you use is provided by the client. What is the extent of responsibility of the client and the auditor? What is the role each one has to play and what does it involve? What are the advantages? Are there any differences regarding the client’s industry?

Risks:
9. Which risks can be identified through the use of Big Data and Data Analytics?

Limitations/Problems/Barriers/Issues
10. Which are for you the 3 main barriers for using Big Data and Data Analytics in external audit?
11. Are there other possibilities to use Big Data and Data Analytics in the Risk Assessment phase that you are not using in your company? What are the reasons why you are not using them?

12. How do you cope with problems regarding data quality, integrity, complexity, size etc.?

13. What ethical issues do you encounter when using Big Data and Data Analytics? How do you cope with those issues?

**Future prospects**

14. How do you see the future use of Big Data and Data Analytics in the field of risk assessment and audit, in your company but also outside of it?

**Concluding questions**

➢ Is there something you would like to add? Something I have missed?
➢ Is it possible to contact you later if additional information is needed?
APPENDIX 10: DETAILED QUESTIONS

Initial questions:

➢ No names will be mentioned, the interview is anonymous.
➢ Is it ok if I record the interview to make it easier to transcribe it afterwards? (The record will be deleted after the transcription)
➢ What position do you have within the firm?
➢ How many years of experience do you have in your job?

Key questions

Use of BD & DA In Audit and Risk Assessment

1. What are the main reasons why you use Big Data and Data Analytics in External Audit and Risk Assessment? Do you feel pressure from the client, the industry, public, regulator or standard setter… to become more digital?

2. How has it affected your working methods?
   ➢ Have you noticed any simplifications or difficulties due to the use of Big Data and Data Analytics?
   ➢ Are there any specific parts of your job that is most affected by Big Data and Data Analytics (more than others)?
   ➢ How has it influenced the External Audit and the audit quality?

3. Which are the top 3 advantages of using Big Data and Data Analytics in Audit and Risk Assessment more specifically compared to traditional procedures?

4. If you would have to divide the introduction and implementation of Big Data and Data Analytics into 5 stages, which would it be? (+Description)

Data Analytics

5. Which types of Data Analytics do you use? (descriptive, diagnostic, predictive, prescriptive) (SQL Analytics, Business Analytics, Visual Analytics, Big Data Analytics, Cognitive Analytics)

6. Are there any differences/similarities according to the client’s industry?

Data

7. What types of Big Data do you use? (internal or external; structured, unstructured, semi-structured) Are there any differences/similarities according to the client’s industry?
8. Could you give examples of non-financial data?
9. What are your data sources (client or third-party)? Do you treat the data differently depending on the data source?
10. Is it or would it be, in your opinion, possible to use Big Data from social media such as Twitter or Facebook, in Risk Assessment?
   ➢ Which information do you think could be derived from it?
   ➢ Which advantage could this information have for the external auditor/risk assessment?
11. Is the data collection, selection, cleaning, etc. done in your company or have you outsourced one or all of this data preparation & pre-processing steps?
   ➢ Will there be outsourcing of one or some those steps in the future?
   ➢ What are the advantages/disadvantages compared to internal treating?
   ➤ How do you use Big Data and Data Analytics in Audit and the Risk Assessment phase in your company? Which tools and techniques do you use?
   ➤ A high/medium percentage of the data you receive comes from the client. What is the extent of responsibility of the client and the auditor? What is the role each one has to play and what does it involve? Advantages? Differences regarding the client’s industry?
   ➤ If the client has not yet implemented the necessary technology so you can use your Big Data and Data Analytics tools, do you encourage your client to do so? Why? How?

Risks:

12. Which risks can be identified through the use of Big Data and Data Analytics? Which is the most probable to be identified through Big Data and Data Analytics?
13. Does the use of Big Data and Data Analytics allow predictive risk analysis?
14. Is continuous risk identification/assessment possible? Is there/would there be additional value?

Limitations/Problems/Barriers/Issues

15. Which are for you the 3 main barriers for using Big Data and Data Analytics in the external audit?
16. Are there other possibilities to use Big Data and Data Analytics in the Risk Assessment phase that you are not using in your company? What are the reasons why you are not using them? (Legal reasons, standards, costs, lack of competence, etc.)

17. Have you encountered any problems or limitations when using Big Data? (data quality, size, complexity, etc.)
   ➢ How do you ensure good quality and integrity of the data you receive?

18. What barriers existed or still exist for the introduction of Big Data and Data Analysis techniques in the External Audit industry and Risk Assessment more specifically?
   Are the standards really such a hurdle for the introduction of new technologies in the field of External Audit?

19. What ethical issues do you encounter when using Big Data and Data Analytics? How do you cope with those issues? (independence, data security, confidentiality, etc.)

20. Do you encounter problems when asking the clients for data? Are the clients willing to provide you with the necessary data?

21. Have you encountered other limitations or issues?

**Future prospects**

22. How do you see the future use of Big Data and Data Analytics in the field of risk assessment and audit, in your company but also outside of it?
   ➢ Will there be any changes in the near future?
   ➢ What needs to be done to enable it and by who?

23. How can further introduction of Big Data and Data Analytics influence the audit quality?
   ➢ Does it influence the time and/or budget spent on Risk Assessment?

24. Do you see a future of continuous auditing?

**Concluding questions**

➢ Do you encounter any other differences in the different client industry? Some industries are much more technology developed than others?
➢ Is there something you would like to add? Something I have missed?
➢ Is it possible to contact you later if additional information is needed?
APPENDIX 11: INTERVIEW TRANSCRIPTIONS

Due to the number and length of the interviews, only the summaries will be appended here. For the complete transcription, please contact me via e-mail (natascha.heck@student.uliege.be).

Interview 1, Interviewee M1

Big Data is not really used in external audit because it refers to a large amount of data. Data Analytics in external audit is mainly used to identify outliers and atypical transactions. However, it is not used a lot in risk assessment because it requires data and the data is difficult to receive. The interviewee also adds that their clients are mainly small and medium companies (SME) and few publicly traded companies but no bank or insurance company. The interviewee thinks that Data Analytics is more used in the banking or insurance sector. In the industrial or commercial industry, the analysis is based on data external to the client’s accounting.

More and more Data Analytics tools are being developed. A market-based solution is Caseware Analytics IDEA, which allows to make analysis based on historical accounting details. The auditors will look at the volume of the transactions to see if some months are abnormally high or low. Moreover, if the client’s server log can be extracted, the auditor can verify who has done which transactions and when. This can be used for the Journal Entry Testing. Moreover, the client has an internal control system, which is reviewed by the auditors. The information technology general controls are tested to identify who has access to which feature and if this is authorised. The newest version of IDEA contains a dashboard where the statistical quality of the data is shown. This allows to identify anomalies. These analyses can also be done for data which is not directly linked to the client’s accounting but for example data from the cash register software. Furthermore, the related parties and related companies can be analysed. The cash flow and accounting are checked to verify there is no conflict of interest. To do these analyses, the data needs to be available which is often not the case and thus a hurdle. Furthermore, the data availability depends also on the client’s software and the solutions which are built-in. ERP systems as for example SAP and AX, facilitate data analytics as they can provide the necessary data. The auditors need to be able to use the data and make the link with the business process. The auditor also needs to know which data is relevant for the analyses he wants to do. However, the availability of the data has no impact on the client’s acceptance.

The client’s level of digitalization is not necessarily sector related. What makes the difference is the number of transactions. The retail sector, banking sector and insurance sector have
typically a higher volume of accounting data. Hence, the higher the volume of accounting data, the higher the positive impact of Data Analytics on audit.

Before using Data Analytics, the external auditor first needs to understand the client’s business, his system and where the data can be found. Next, he needs to verify the quality of the data and make sure there are no missing data. The next step is the data extraction, which depends on the client’s software. Finally, the auditors import the data in their Data Analytics tool(s).

In the interviewees audit cabinet, the external auditor’s do not rely on benchmarking data to identify and evaluate risks. Nevertheless, as the accounting needs to be published in Belgium, the necessary information is available and it could thus be done in future. However, the interviewee does not see added value to do so. This is because the valuation rules and calculations of ratios can differ from one company to another.

They do use data which is not directly linked to the client’s accounting but from the client’s in-house software where the auditor can see who has done what and when. This allows to evaluate whether the transactions have been done by authorised people.

In external audit they use mostly quantitative data and numbers.

What is important in risk assessment are the management assertions: Completeness, Existence, Valuation, Obligation & Rights, Presentation, et Accuracy. Each time there is a business process, the auditor needs to see how to cover the assertions. To gain assurance on accuracy for example, the auditor performs recalculations to see if these match their expectations. They compare data from different databases and recalculate it. The auditors also forecast potential risks, if an employee has access to certain feature it is considered as a potential risk. Then, the client’s internal control system needs to be investigated. Data Analytics in risk assessment is used to identify suspicious or irregular transactions, where there can be a risk of error or fraud. Furthermore, Data Analytics allows to do gap analysis detection and to identify duplicates. This can be done in IDEA.

The main problem with the new technologies is the availability of the data. If the data is not available, the test cannot be performed. The data quality depends on the data integrity and who can access the data and manipulate it.

The main barriers to implement Big Data and Data Analytics are: (1) data availability; (2) data relevance; (3) understanding the data; and (4) skills and knowledge to use the tools correctly. According to M1, the ISAs give guidance but will not prohibit to use certain techniques or tools.
Ethical problems concern the GDPR legislation and the data security. The influence on external audit depends on the analysis the auditor does. But many information can be anonymised. For M1, the future of the audit will evolve more in the direction of process mining and identifying transactions that deviate from the norm. Therefore, it is necessary that the auditors apply critical thinking which information is relevant. This is also related to the auditor’s understanding of the client and his experience. 100% testing will be possible, Data Analytics will for example allow to electronically and automatically test if every order is signed by the customer. The limitation of Data Analytics is management override because it cannot be identified through analysing the data.
Interview 2, Interviewee P1

The audit firm uses the external software CaseWare Analytics IDEA, which is more powerful and more dynamic than Excel. This software allows to do a battery of tests as for example the journal entry testing. The software identifies the outliers and then the auditor can verify them. Furthermore, it can also allow to verify whether the people who have posted the transactions where authorised to do so. In risk assessment, it is used to identify trends and perform comparisons with previous year figures. Sub-populations by month or geographical sector can be done to identify anomalies. However, not everyone uses Data Analytics as it requires some time to get the data, to know how to use it and what to look for.

The main advantages of using Big Data and Data Analytics are: (1) the completeness of what is being tested; (2) saves time; and (3) supports documentation. A disadvantage if that it can be time consuming to rework the data if it is provided in a different format or if the data acquisition has been divided into multiple extractions.

Differences between the client’s industry can be identified. The retail and distribution sector are more suitable for Data Analytics. The health sector is more restrictive.

It can be problematic to receive the data from the client as it needs to be requested in advance. Afterwards, the data integrity needs to be verified as missing data can have a lit of consequences on the results of the analyses. Many clients in the small and medium owned family business do not necessarily have the accounting system to provide the data. Then traditional methods need be applied. Some bigger clients produce some kind of management reports where they analyse the full general ledger. The auditors can use this in their risk assessment.

Diagnostic Analytics is used to verify the completeness of the data. The audit firm is doing Predictive Analytics for sales forecast. Furthermore, in risk assessment, it can be used at the interim audit to forecast the year end result and to identify already some indicators of risk.

The data they collect is mainly structured. Non-accounting data is most useful in the hotel sector. Benchmarking can also be used, but in Belgium, the problem is that some industries do not replicate themselves. Hence, it is difficult to compare the data. However, if they manage to do benchmarking, it can be very useful. Nevertheless, it is very time consuming to be done by the auditors themselves. Therefore, they only do it when they know that is going to be beneficial or if the management based his assumptions on it.
The client has only the responsibility to deliver the data. The audit company offers training to its employees mainly focused on how to treat the information they received.

The main barrier for implementing Big Data and Data Analytics is the auditor’s mindset. The ISAs are also seen as a barrier. The auditors have difficulties justifying how they set their expectations. The documentation requires them to base themselves on the data and the traditional methods still lead to more audit evidence. They fear that the regulator will say that they are not doing enough testing because they are just analysing the data and testing the outliers. The new approach is more judgmental than substantive. According to P1, the ISAs need to change in the future.

The main ethical problems, the auditor encounters are due to confidentiality, especially with the GDPR legislation. However, the auditors are bound by professional secrecy and all the information will stay in the audit file and not be shared with anyone outside the audit team.

To implement Big Data and Data Analytics, the audit company first needs to ensure to get the data from the client. Next, they need to know which data they need; therefore, a correct understanding of the client’s business and information system is crucial. The third step consists in analysing the data integrity and accuracy. Furthermore, it is determined which analyses are performed depending on which kind of report is necessary. Finally, after the analysis, the conclusions are retrieved.

In future, the usage of Big Data and Data Analytics in external audit will increase. Therefore, first a change in mindset needs to happen. The usage of the new technologies leads to more sophisticated audit which provides more comfort and reliance. Therefore, it needs to be performed properly and documented properly. In P1’s personal opinion, this leads to enhanced audit quality. However, he thinks that the audit industry’s opinion is mitigated.

They are trying to change the way audit is done right now. For the time being, most of the audit work is concentrated at year end. In the future it will evolve more to the continuous way but therefore, the standards need to change. Furthermore, the auditor’s mindset needs to change. The way audit is done at the moment will remain for some more years before it changes. Data Analytics tools will also evolve because there exist many different ERP systems at the client side, which do not all provide structured data. Hence, tools which are flexible and can handle unstructured data are needed.
Interview 3, Interviewee D1

The audit company uses a risk-based approach. Data analytics enables them to identify risk areas by identifying outliers and exceptions. Furthermore, it makes the identification of trends easier, allows to regroup the relevant information in subpopulations. The reasonings that can be derived from this are more relevant. The audit firm is only in the pilot phase, but other firms of the group have projects on benchmarking. The audit group is developing tools at the global level and implementing it progressively in the local audit firms. Data Analytics becomes more relevant when they have larger amounts of data. Hence, in bigger countries, they have the critical mass to perform the benchmarking.

The audit firm is still in the pilot but they have identified potential of using Data Analytics tools. First of all, the sampling becomes more relevant, because the larger populations can be tested in a shorter amount of time. A typical example where Data Analytics is applied is the Journal Entry Testing, which can then be done much faster and in a more efficient way. Transactions that have been posted automatically by the accounting system can be identified immediately and do not need to be tested if the internal control system works properly. Furthermore, Data Analytics also makes it easier to identify the risky areas. Sub-populations can be created and links and correlations can be identified. Hence, the audit approach can be adapted to the client.

The advantages of using Big Data and Data Analytics in audit are: (1) relevance of the samples; (2) enhanced risk identification; and (3) identification of seasonality, cycles and business lines. The risk identification is more adapted to the client and the specific circumstances.

The successful implementation of the new technologies requires first, that the auditors are trained to use the tools and understand how they work. Next, they need to be trained to become data literate. This means to be able to interpret the data and draw conclusions. This is something which can be challenging. The next step is to demonstrate that the tool works and to show the benefits of it through examples. The final step is to “roll out”, which means to apply the tools on more clients. Hence, the critical success factors of the implementation are: (1) data literacy and (2) overcome the initial resistance to change.

The auditors are treating accounting data, historical data. This is the major difference to operational companies. Hence, the auditors do not use Data Analytics in the same way as their
clients. The auditors use a mix of different types of Data Analytics. First of all, Descriptive Analytics is used to summarise raw data in an easily readable form and to summarise transactions and events in patterns so that exceptions and outliers can be identified. Diagnostic Analytics is used to understand what has happened and why these outliers exist. Finally, Predictive Analytics is used less but it depends on the nature of the work and the client. It is used less because they do not have yet the necessary data as they are just in the second year of implementing the new technologies. The auditors, predict sales or transactions of a company based on historic trends. Non-accounting data is analysed to determine how it is reflected in the accounting. The major differences concerning the clients is the predictability of transactions. The hotel sector is very predictable but other sectors are more volatile and depend on many factors. The sales of mineral trader depend on various factors as he can have many different clients in different industries. Data Analytics also allows to visualise data which makes the data more relevant and understandable. It also allows the auditor to go deeper in his investigation. The visualisations can also be used to explain their audit approach to the client. It allows to explain why the auditors are investigating and focussing on certain transactions. This can be a big advantage when asking some additional information, they client may have other reports which are more adapted and then it saves time. Nevertheless, the auditors need to verify the data integrity and quality.

The audit firm analyses mainly structured data coming from the client’s accounting system. They also use non-accounting data, but then it is more complicated to verify their integrity. Hence, the differences concerning the clients are not industry-related but depend on the operating systems used by the client.

They have projects in other countries of the group where they are doing benchmarking on anonymised data of the different clients. The data is stored on a centralised server. These countries can anonymise and compare the data because they have a high number of clients because the country is bigger. However, there is the clause of confidentiality and the concept of Chinese Wall which does not allow to share information outside of the audit team.

The client is responsible to deliver the data but the auditor needs to test its quality and integrity. The client also has to confirm that he delivered all the data and that he did not manipulate it; however, the auditor still needs to test it. There is always a risk that there is an issue with the integrity of the data and the auditor does not identify these issues. Planning and an open mind is essential to be able to use data analytics so that issues are identified early enough. The audit
firm has a project to develop an artificial intelligent tool which will be implemented in the client’s system to immediately extract the necessary data. This would reduce the risk to receive manipulated data. Nevertheless, there will be problems coming from the client side because they will fear a security breach.

Auditors are currently using data analytics mainly for risk assessment because they can instantly extract and filter information based on some unusual criteria. Outliers and exceptions can be identified and the auditor can focus on these items rather than running a random sample. Furthermore, trends and exceptions can be identified and investigated more easily.

The main barriers of implementing the new technologies are: (1) resistance to changes; (2) expectations of quick wins; and (3) data literacy. There are other possibilities of using Big Data and Data Analytics but which cannot be used because of the ISAs. The standard setters are aware of the potential of the new technologies but D1 thinks that they do not have the courage yet to change something.

There are no fundamental ethical problems in audit, because they are treating few personal data. They are only using non-accounting data to examine their impact on the accounting. According to D1, the GDPR legislation has not a lot of impact on audit because it concerns personal information.

Big Data and Data Analytics have a lot of potential, but as long as the standard setter and regulator do not react to it, there will not be any major changes in the audit industry. The usage is still limited, as long as the standards do not change, D1 feels like they cannot use Data Analytics for audit assurance. Data Analytics is not a revolution but an evolution, it is a way of doing this more effectively than before and allows to target what should be tested. The next step should be to use Artificial Intelligence combined with Data Analytics to make audit a continuous process. Human intervention will always be necessary because the tools can only do what a human tells them to do.
Interview 4, Interviewees SM 1 & S 1

They use Big Data and Data Analytics because of its relevance and not because of external pressure. Furthermore, they need to get all the information from the client and there is a large amount of transactions. For them, it is not possible to do audit without Big Data because of the high number of transactions and because the industry has digitized. Moreover, they add that the regulators are only noticing the trends and thus following them.

The technological advance has helped the audit process and improved the data quality. Additionally, using Big Data allows to transfer information.

The top three advantages for SM 1 and S1 are: (1) The trends and the different perspectives it allows to have; (2) The possibility to spend less time on substantive procedures; and (3) Big Data forces the client to have sufficient internal control.

Flexible types of Data Analytics are used and adapted according to the client’s need. The tools are developed internally and external tools are also used. The choice of the technique or tool depends also on the manager who knows its pertinence. The most common way to use Big Data and Data Analytics in the external audit is in the JET test. Furthermore, Data Analytics is used to visualize the results and use it in working papers. Nevertheless, the information needs to be used wisely and a good understanding of the entity and its business is essential.

More digitalised industries they name are telecom, banks and insurance. Retail sector is an example of a less digitalised industry. However, the sector is not the only difference. It also depends on the client’s willingness to provide the data and the technological development of the accounting department.

The data structure depends on the client’s system. Client and third-party data are used. Third-party data is preferred. The auditor needs reliable information he can rely on.

The perfect client would have the GITC. Then, it has to be checked who has the capability to change data or manipulate it and see if there is compliance. Next, the ideal client would verify data consistence and integrity and reconcile it before giving it to the auditor.

In reality however, the client of gives information which does not match. It is the client’s responsibility to give matching and integer data to the auditor, but the auditor often needs to remind him. The client is also responsible for deleting the lines and information which are not
useful for the auditor. The data provided and data quality depend on the client. It is useful for the auditors to add management letter points with recommendations how data should be extracted or the data format.

Continuous risk identification and assessment is needed. The auditors are always identifying new risks.

The main barriers identified by SM1 and S1 are: (1) data quality; (2) data relevance; and (3) client’s system. The ISAs are not seen as a barrier because they are vain. They are not aware of any text passages in ISA which prohibit the usage of Big Data and Data Analytics in external audit.

Confidentiality is the major ethical issue when applying Big Data and Data Analytics in audit.

The auditors encounter problems when asking the clients for data. The clients are not always willing to provide the data. This depends on the client’s willingness and ability.

In future, Data Analytics will be more and more visual and also more used. There will be more flows of information and data. The audit approach will become more drilled down and thus more detailed. The interviewees disagreed when those changes will happen and whether the people are willing to invest in accounting. Nevertheless, they are willing to invest in reporting according to SM1.

Both interviewees agreed there will be legal limitations concerning the implementation of the auditor’s program into the client’s system. This is due to data security and leaks. They do not think that the clients will agree to mitigate the risk of the audit company in addition to their own risks.

Finally, the interviewees add that, in their opinion, the audit profession will never be fully automated as their still needs to be some human components and professional judgment.
Interview 5, Interviewee P2

The impact on the quality of the audit of Big Data and Data Analytics depends on the size of the companies involved. They are convinced that it will enhance the audit quality but it is not fully implemented. They cannot say yet of there are efficiency gains that exist or will exist. The impact on the audit quality cannot be quantified yet because the audit staff still needs to be trained. Furthermore, the audit budget is fixed in the contracts. Hence, if the auditors have to rely on specialists for the development of the new techniques, additional fees can occur. The impact on the efficiency is still questionable. For the time being, it considered more as an investment and cost instead as a benefit. It is an opportunity that exist and will certainly turn into growth but it is still too early to say.

The audit company has worldwide shared service centres to take advantage of the time difference. They can send him information and ask them to treat it and the next morning they get back to work it will be done. However, this requires good communication and understanding what data they have and which output is wanted.

At the moment, the auditors risk to do the work twice, because if one process does not work as expected, they have to start again in another way. However, this how things are done at the moment because they have to adapt to the market.

There are a lot of transactions in the financial sector. Also, the pharmaceutical and automotive sector has millions of transactions. However, it is not really sector-related. All sectors will impacted but each at different degrees. The precursors are obviously the financial sector and large multinationals. The clients are becoming more digitalised and therefore the auditors need to keep pace. The technological evolution has evolved on in a flash the last two or three years.

The main advantages of using Big Data and Data Analytics in audit are: (1) larger population; (2) better trained auditors; (3) higher efficiency in the future.

The disadvantages are: (1) weaker client relationship; (2) cost; and (3) loss of teamwork.

The responsibility of the client has not changed, it is just another way of using the data. What has also changed is the reliability the auditor gives to the data they receive and which was used in the audit to lead to an opinion. It the source of the data is inaccurate; the resulting conclusions
will also be wrong. Hence, they need to analyse the key reports. P2 thinks that today, even the costumers are not yet organised well enough to provide reliable data.

The ISAs are not perceived as a barrier to the new technologies. The ISAs are a general framework. It is more a question of methodology and not the substance. The substance of the ISA is not going to change, the auditors will always have to deliver an opinion on the financial statements. Changing the way, the sampling is done is more cosmetic.

In the future, the typology of the employees will evolve. They will need more and more skills and be more experienced. The audit company is already doing trainings and eLearning in this field, but the university courses might also adapt to the changes. The main objective of the audit will remain the same but the way of proceeding will change. The auditors depend on their customers and those are evolving. Hence, if the audit companies do not adapt, they will not have any customers anymore. When they are going to defend and offer, they need to distinguish from their competitors. They have to show the client his added value from their audit approach.
Interview 6, Interviewee D2

The audit group has a competency centre where they have developed a Big Data tool. This tool is used to treat the client’s data that cannot be treated in Excel. The competency centre sends a list to the client’s computer scientists saying which data they need and in which format. The extraction and the analysis are then automated and the local auditors receive the reports they have requested.

Only a certain number of hours of the competency centre’s tool is allocated to the Belgian audit company. Hence, it needs to be well organised to be used efficiently. The auditor’s need to know beforehand when exactly they will receive the data and when the final result is required to be able to plan their mission.

Regarding risk identification, the auditors fill in a standardised questionnaire. The risks are then identified automatically according to their answers. Nevertheless, they still need to apply professional judgement to determine if these are real risks.

The top three advantages of using Big Data and Data Analytics in audit are: (1) assurance; (2) identify outliers and anomalies; (3) increased reliability of the accounts; (4) added value for the client; and (5) save time.

The usage of Big Data and Data Analytics also has an influence on the audit methodology: they look now at the total population and then identify the risks. The audit company has also a tool to see if the controls in SAP are working correctly. Then less substantive testing is required and the sample size for the substantive procedures can be reduced.

The auditors can also test all the opening operations automatically which is helpful regarding the risk of management override. Before, they had to do it manually. Hence, they risked to miss some or could not make the link between different accounts; it also took more time. The usage of Big Data and Data Analytics increases the reliability of the audit work.

The auditors can focus on the risky areas which allows to increase the efficiency and to have an overview of the whole population. It also increases the audit quality.

Before applying Data Analytics, the data needs to have the right format. It can sometimes be time consuming to put the data in the correct format. They are also using a tool to perform visualisations, distributions, variations, correlations, etc. This leads to better documentation.
why something has been considered as risky or why certain transactions have been investigated. These visualisations can also be used to show their results to the client or make presentations.

Regarding benchmarking, it is not done by the auditors themselves but the consulting departments does so based on statistical data. They then send newsletter with the industries’ trends. Nevertheless, it can be difficult to compare data.

It is the client’s responsibility to provide the data. The first year of implementation it was difficult but now they do not encounter many problems anymore. The data extraction does not take more time but has moved from financial to IT. Moreover, there is more data.

Regarding risk assessment, they were seeing the hole population as at risk. Now, they can better determine whether a transaction is risky or not. They can divide the population into sub-populations. Big Data and Data Analytics allow to target the risky transactions. More work is done during risk assessment and less afterwards. The distribution of the workload has changed.

The main barriers for the implementation are: (1) client’s willingness to give access to data; (2) computer scientists’ competencies; and (3) auditor’s skills. The ISAs are not seen as barrier.

It is important to adapt the tools used to the client’s needs. The tools are not always more efficient and are sometimes to complicated to be used on some clients. As long as the reasoning is well documented and clear and any other auditor would come to the same conclusion it is ok. Furthermore, the reasoning needs to be detailed by fact, figures and graphs. Data Analytics and Big Data allow to do so.

The usage of Big Data and Data Analytics does not necessarily save time. For larger client’s yes, but the workload is also distributed differently. If the implementation took place some years ago for a specific client then time spent on this client can be saved. However, the aim is not to reduce the workload but above all to increase the assurance.

Data quality always depends on the data extraction. Certain tools require certain data formats. If this is not possible, more traditional methods need to be used.

Differences between the clients exist mainly due to their size, but also the client’s sector plays a role. Sectors where there are many transactions are for example telecommunication and electricity. It also depends on the clients’ number of customers.

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In future, it could be possible that SAP will develop a audit feature implemented in their systems at the client side. This could then be treated just as information received from external experts. However, SAP’s auditors will need to test their tool and provide the necessary certificates.
Interview 7, Interviewees M2 & S2

M2 and S2 are risk manager in a Big Four company in Luxembourg. They assist the financial auditors in IT and help the financial auditors in Data Analytics.

Whether or not they receive Big Data depends on the client. They have encountered Big Data especially in the banking and insurance sector. Then, the auditors need powerful tools to process it. However, they use the same procedure no matter if the amount of data. The only difference is that there are more transactions but the procedures are the same.

One common application of Data Analytics is the journal entry testing. Furthermore, it used for recalculations, to see if they match the client’s calculation. In risk assessment, they forecast for example the revenue and compare it with the client information to identify patterns and outliers.

Data Analytics has improved a lot in the last years: It allows more analyses, better visibility on the risks and to focus on the risky areas. Before, when using samples, they could only test a smaller number of items, which reduced the chance to find exceptions. Now, they can get more accurate results. The client’s expectations have also changed. They expect the auditors to find errors and to get more assurance on their financial statements. Focusing on the risky areas, allows to spend more time on the things that matter. Nevertheless, what is analysed depends also on the materiality. Both interviewees agreed that the data quality has improved since. The auditor’s work is also more efficient and provides added value for the client.

The three main advantages they identified are: (1) test entire populations; (2) focus on the risky areas; and (3) improved quality of audit evidence and audit work.

What is important for a successful implementation of the new technologies is that the auditors understand how Data Analytics works, how to extract data in a correct format and how to use the tools. Therefore, they need training. Also, to understand which output they want and how to get it.

The audit firm uses several tools which are developed internally in the audit group. These tools allow among others visualisation. The tools allow the auditors to be more agile and responsive to the analytics’ results. Nevertheless, the auditors can only analyse what has happened during this financial year. Predictions are not done except in risk assessment to forecast the year end result. Benchmarking data provided by the global group level is also used.
Most of the time structured data is collected because of the client’s system. It is also easier to analyse. However, there exist some projects on global level to transform unstructured data into a structured format.

Mainly client’s data is analysed but also data from the client’s external environment as third-parties or the correspondent bank. The auditors often rely more on third-party data.

It is the client’s responsibility to keep the records available in their system and to protect the data. The client’s need to know his system and how to extract the data, but the auditor needs to tell him what he needs and in which format. There exist tools on global level to extract data immediately from the client but most of the time the client extracts the data himself and transfers it to the auditor. The bank and fund industry are more mature in this topic. The telecommunication industry is more mature regarding data collection and data storage. However, it also depends on the client’s size, IT system, how the data is stored etc.

The difficulties identified with Big Data and Data Analytics are: (1) data collection; (2) data integrity; (3) data security; and (4) data privacy.

There exist three methods to ensure data quality and integrity: (1) reconcile data with other reliable information; (2) assist the client while data extraction; (3) test the client’s internal control system.

Ethical problems they encounter concern data privacy and security. The data needs to be stored in a safe and secure place and cannot be disclosed to anyone outside the audit team.

They think that Big Data and Data Analytics will be used more and more in future and the usage will become more dynamic. They see a future of continuous auditing where the audit programs are introduced in the client’s system. Thanks to this, immediately after a transaction has been registered, the system immediately says if it is an exception or in the norm. Nevertheless, there will be a lot of discussions with the client. In the end the clients will also see the added value: less time spent on data extraction, more data transparency, etc. The interviewees think that the regulator should then establish norms which will then encourage or force the client to allow this continuous auditing.

This kind of tools are already in development and somehow the auditors are all using Data Analytics but for sure the future will be continuous auditing.

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Interview 8, Interviewee P3

The audit firms apply a risk-based approach in accordance with the ISAs. The identify and assess the risk of fraud and error. Therefore, the usage of Big Data and Data Analytics is crucial. They differentiate between general and specific risk assessment. During the general risk assessment, they investigate among others the company’s governance. Therefore, they access a blacklist of an international database, containing information of managing directors which have already gone bankrupt, committed fraud, or money laundering, to decide whether they are going to accept a client. They use a database with paid access, but of course there are also public databases which are free of charge. The databases with payable access are often more powerful and contain more information. After the client has been accepted, the next phase is to understand the client’s business, environment, and related risks. Data Analytics is used to understand the client’s IT systems. There exist many different information systems and often companies have more than just one. Then it is important to analyse how they communicate with each other. Next, there is the specific risk assessment per section they will audit. Larger clients offering different products or services have different revenues, hence this is Big Data. To fully understand the client’s business, the auditor’s need to understand the income source and the information source to make a correct risk assessment. The usage of Big Data and Data Analytics makes the process more visible and more understandable. Furthermore, homogenous groups and subpopulations can be identified. Hence, to perform qualitative audit, it is necessary to use Big Data and Data Analytics. They can now perform exception-based audit instead of sampling. Furthermore, Data Analytics can be applied to test the segregation of duties.

The usage of the new technologies is necessary for all audit phases, they auditors cannot do without it, at least the larger audit firms. Nevertheless, it also requires high investments to develop the tools, hardware, etc.

Large entities and multinationals operate worldwide, to understand their business and risks, benchmarking is necessary. Therefore, Big Data is also needed, they will compare the client’s performance against the competitors. The data used is mainly public, because their clients are listed on stock exchange and therefore the accounts are published.

Robotics combined with Big Data and Data Analytics is also used. For example, they verify all the publications on a client in the “Moniteur Belge”. The robot does an automatic search and analysis.
Even the smallest start-ups are becoming more digitalised. The audit firm has to differentiate themselves from their competitors in the request for proposal. The client wants to know which Big Data and Data Analytics tools they use. It is an essential element for the client as it provides added value. The audit firm is aware that the usage of the new technologies is essential to cover the risk. They also demonstrate their results to the clients; hence they are also more interested. However, the data extraction can sometimes be difficult and some clients do not like to share their data. Some audit firms include in their general terms and conditions that the client has to give them access to all the data, otherwise they do not accept the client. P3 thinks that it will evolve more and more in this direction because the auditors need the data to do their analysis. A client who does not want to provide the data can be an indicator that he wants to hide something.

Big Data and Data analytics allow to save time and to be more efficient. It also increases the relevance of the audit work and therefore the audit quality. The auditor can still make human mistakes in risk assessment due to the application of professional judgement, but of the risk assessment is correct, the auditors are certain to identify all the errors. There is still room for improvement, as the audit firm is just implementing the technologies and not yet completely used to it.

The main advantages identified by P3 are: (1) large population (100%); and (2) flexibility.

Different steps are necessary for successful implementation of the new technologies: (1) awareness; (2) investment and development of hardware and software; and (3) training. The interviewees add that human intervention will always be necessary because of professional judgement.

The main barriers to apply the new techniques are, according to P3: (1) mindset; and (2) investment. The ISAs are not seen as a barrier but more as a recommendation to use Big Data and Data Analytics. The standards have to evolve as the environment is becoming more technological but is still too early. for the small audit firms. The high investment is even more problematic for the smaller audit firms. A possible solution is to build associations to access the technologies and data. They smaller audit firms do not have the financial capacity to invest and therefore it requires an evolution in the sector.
The problems regarding data quality and integrity are mainly due to the client’s information system. Especially, the less known systems are problematic. The only ethical issue P3 identifies concerns the data confidentiality and the privacy of the people which needs to be secured.
Interview 9, Interviewee SM2:

SM2 works in the Digital and Innovation Department of a mid-tier audit company in Belgium. He has projects with clients concerning the implementation of ERP systems and projects on the concept of big data. He works in this company since last year and before he worked as a freelancer for ERP systems. He also works together with the audit department on technology and innovation. They started to implement Big Data and Data Analytics techniques this year.

The company does not feel pressure from the client but see the advantages of using it and the enhanced audit quality: In traditional audit, the auditors do only spot checks or small samples. Data Analytics and Big Data allow to test the full population, this increases the quantity and quality of insight.

The usage of the new technologies has not resulted in time savings yet, because they just started implementing them. Nevertheless, they are convinced it will, once they have determined a way of working.

The top three advantages the interviewee identified are: (1) Enhanced audit quality, (2) Speed, and (3) Cost efficiency.

The company is aware of the importance of the technologies. As it is a new way of working, the auditors need to be trained. Moreover, they need appropriate tools which are developed and tested by the informaticians but need to be useable for the auditors. External tools and techniques are used, but they also develop them internally.

The critical success factors are: (1) Inspire the auditors, (2) Convince the clients of their new way of auditing, and (3) Build a template for Data Analytics.

The audit company is analysing mostly structured data but also sometimes unstructured data. The structure depends on the client’s ERP system. There exist many different systems, hence the template they build needs to be agile.

The audit firm uses at the moment mainly descriptive analytics but also analytics to find correlations and determine if those are causal or not.

He does not see differences regarding the client’s industry in the techniques used. However, sectors which are less digitized are the construction sector, because they do not have a lot of
experience in Big Data. Sectors which are more digitized are for example the banking and insurance sector.

The auditors are not yet using benchmarking. However, it is considered as a future possibility.

Continuous auditing has a lot of advantages, the auditors can for example react faster.

SM2 considers it possible, that the audit program will be included in the client’s system in future. However, he adds that it might not be the case for all clients. There will also be problems regarding data security and the clients are still very reluctant to share their data.

Whether data is extracted by the client or the auditor depends on the client’s choice. At the moment, the client is mainly extracting the data himself.

There can also be problems regarding data quality. Missing parts of data can lead to wrong conclusions. The audit firm uses a template to ensure data integrity.

The main barriers to implement Big Data and Data Analytics in audit are: (1) Clients’ reluctance to deliver the data and his data protection system, (2) auditor’s mindset and training, and (3) data quality.

They ISAs are not seen as barrier because SM2 believes they will be adapted to the new way of working.

The only ethical problem identified is GDPR, when receiving records with the name of the people.

In future, more companies will use Big Data and Data Analytics. There is a lot possible s for example continuous auditing, benchmarking, and the application of predictive analytics in external audit. Furthermore, the clients will also see the added value. In the beginning it will cost a lot and it will take time before generating advantages.
The usage of client’s data is nothing new, but what is new are the more powerful tools. For some processes, the audit company is just in the beginning of implementation, the maturity is not equal in all areas.

The usage of Big Data in risk analysis is, according to P4, still relatively limited because it is used more in the audit tests as such. The audit firm is using an external software called Caseware Analytics IDEA, which allows among others to reperform data processing as for example the recalculation of depreciation. Therefore, they need the necessary data. Before, it was already possible but was more complicated and time consuming. Now, the power of the tools clearly makes it possible to democratise the use of Big Data.

The client’s pressure is rather related to the effectiveness of the audit and in fact mainly associated with the audit cost. Hence, the pressure is more on the audit fees. One way to work more efficiently, reduce the cost and respond to the competitive pressure, is the usage of Big Data. First of all, because of all the reprocessing and recalculation techniques which allow to verify whether the processing in the accounts is correct. This is for the substantive work, where the audit company is already more advanced. The second reason why Big Data allows to be more efficient is because of process mining. Process mining allows to validate whether the internal control environment works as described and works properly. These two techniques require to have access to all the data and to treat the whole population. One of the challenges of Big Data is that if both techniques, reprocessing and process mining, is done on the same population, in reality the work is done twice. According to the ISAs, the auditors have to do both, test the internal control system and test or implement substantive procedures. Moreover, the ISAs are based on a risk-based approach. The auditors do not need to test everything, but with Big Data this becomes possible. Hence, Big Data leads to do work which goes far beyond what the standards require. Furthermore, there is pressure on the fees and Big Data requires high investments to develop the tools and train the auditors. Finally, the client’s environment also needs to be suitable for the implementation of Big Data.

The usage of the technologies allows to be more efficient and it saves time for the auditor who has to execute the work. However, it does not reduce the time related to the developments of the tools. Hence, the definition of the audit cost nowadays is becoming less appropriate. For the time being, the audit cost is calculated according an hourly rate, depending on the team
composition. In the future, however, the process will become more automated and require less direct human intervention. The question is then if the audit fees should include the costs for the development of the software and tools and the training costs. Furthermore, the audit firms are subject to an increasing number of rules, particularly concerning independency. P4 fears that this could lead to complete separation of the audit firm, doing only audit tasks and the other departments. In this case, the investments would increase even more.

The audit firm uses external tools but also develops tools themselves. The difficulty is that the tools also allow to document the auditors work, the conclusion and the traceability. The audit quality can only be increased if the procedures are designed effectively and are performed appropriately.

The main advantages of using Big Data and Data Analytics are: (1) increased efficiency; and (2) ability to test larger populations.

The implementation if the new technologies is a complex process which is linked to the development of the software and the digitalisation in general. It is continuous and iterative process which is also linked to the ability of the software to extract data immediately from the client.

Ethical issues are linked to the new GDPR legislation. Here, one of the difficulties is to raise awareness and ensure to have all the data the auditors need but not more and not less. Furthermore, the audit companies need to have security systems to ensure the security of data processing.

Benchmarking can be done with the data provided by the client. However, it is not the auditor’s mission to perform benchmarking. Comparing data from different clients is not possible because of confidentiality rules. Anonymising the data is a possibility but not an easy task. If the data is not anonymised enough, it’s origin can be reconstructed. If the data is too anonymised, it can become unusable. The strength of the data is to be able to connect it, if this is not possible, it loses all its interest.

The auditors analyse mainly historical data. However, Predictive Analytics can still be done in some cases as for example substantive analytical procedures. These procedures are performed to understand trends and developments and see if the client’s data is in line with what their expectations. This can be done for example for margins. However, when the auditor receives
all the data at year end to reperform the calculations, the necessity of the predictions is questioned. Business Intelligence tools are used for visualisations, but P4 feels that the audit company is not yet advanced enough. Therefore, they will investigate the client’s dashboard and KPI’s to determine if they can be relevant for their audit.

The audit firm is using mainly structured data. They have projects to use non-client, unstructured data in risk identification and risk assessment. They are doing so because the feel like the real risk is not the one that is known and can be measured but the one that is not known yet.

The differences between the clients are linked to their maturity and their organisation. It is not really sector-related, even if there are some sectors, like hospitals or banks, where the data is more critical than for others. Some operational systems are more computerised but this is linked to the importance of the continuity of the operations.

The auditors have to verify the data quality and integrity. Big Data and Data Analytics is used less in risk assessment as this will always require human intervention through professional judgement. The risk analysis is linked to the understanding of the client’s business which, according to P4 cannot be automated. However, artificial intelligence could be used to monitor social networks and press articles and then identify risks related to the client’s business.

At the moment, the auditors are certifying the account, but the clients are expecting more. The expect the auditors to communicate in a detailed way the results of his audit procedures and event those that do not result in certification problems.

Barriers for the implementation of the new technologies are: (1) the complex client environment and (2) cost linked to the development of the tools.

According to P4, not much will change in the near future, but new tools will arrive on the market and the technological maturity will increase. In the longer term, the nature of the audit will change. For the time being, the accounts are certified once per year, In the future, the frequency will increase until arriving at a continuous system.

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EXECUTIVE SUMMARY
The aim of this research is to determine how the application of Big Data and Data Analytics techniques influences the external audit. The impact on the working methods and the audit quality is discussed. Furthermore, the technological maturity of the Belgian and Luxembourgish audit industry is analysed. Therefore, the following research questions are asked: How do Big Data and Data Analytics influence the audit working method? What is the impact of Big Data and Data Analytics on the audit quality? How is the audit risk identification and assessment phase influenced? Which audit risks can be identified? Which tools and techniques do the Belgian and Luxembourgish auditors use and where do they stand? In order to answer the research question, scientific articles were analysed in the context of the literature review. Subsequently, a case study was carried out. Interviews with experts in Belgium and Luxembourg were conducted. The results of the research show that there is high potential to use these technologies in audit. Nevertheless, it is also connected with initial investments and a certain agreement of the clients. There is high potential to enhance the auditor’s effectiveness and efficiency, but the complete impact cannot yet be analysed. The audit quality can be enhanced when qualitative analyses generates audit evidence based on high quality data. The Belgian and Luxembourgish audit industries have just started implementing the technologies.