THE IMPACT OF BIG DATA ON FINANCIAL STATEMENT AUDITING

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Fauve Vanbutsele

Student number: 01407701

Supervisor: Prof. dr. Ignace De Beelde
Commissioner: Gerrit Sarens

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Confidentiality Agreement

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Name student: Fauve Vanbutsele

Signature:
Acknowledgment

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<tr>
<td>ACL</td>
<td>Audit Command Language</td>
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<tr>
<td>AICPA</td>
<td>American Institute of Certified Public Accountants</td>
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<td>BD</td>
<td>Big Data</td>
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<td>BDA</td>
<td>Big Data Analytics</td>
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<td>CA</td>
<td>Continuous Auditing</td>
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<td>CAAT</td>
<td>Computer Assisted Audit Techniques</td>
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<td>DA</td>
<td>Data Analytics</td>
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<td>EC</td>
<td>European Commission</td>
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<td>EDA</td>
<td>Exploratory Data Analysis</td>
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<td>ERP</td>
<td>Enterprise Resource Planning</td>
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<td>FD</td>
<td>Financial Data</td>
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<td>FRS</td>
<td>Financial Reporting Standard</td>
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<td>FSA</td>
<td>Financial Statement Auditing</td>
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<td>GDPR</td>
<td>General Data Protection Regulation</td>
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<td>GITC</td>
<td>General Information Technology Controls</td>
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<tr>
<td>IAASB</td>
<td>International Auditing and Assurance Standards Board</td>
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<tr>
<td>IBM</td>
<td>International Business Machines</td>
</tr>
<tr>
<td>IBR</td>
<td>Instituut van de Bedrijfsrevisoren</td>
</tr>
<tr>
<td>IDEA</td>
<td>Interactive Data Extraction and Analysis</td>
</tr>
<tr>
<td>IFAC</td>
<td>International Federation of Accountants</td>
</tr>
<tr>
<td>IFRS</td>
<td>International Financial Reporting Standards</td>
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<tr>
<td>IIA</td>
<td>Institute of Internal Auditors</td>
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<tr>
<td>IoT</td>
<td>Internet of Things</td>
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<tr>
<td>IPE</td>
<td>Information Produced/Provided by the Entity</td>
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<td>ISA</td>
<td>International Standards on Auditing</td>
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<td>IT</td>
<td>Information Technology</td>
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<td>NFD</td>
<td>Non-Financial Data</td>
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<tr>
<td>PCAOB</td>
<td>Public Company Accounting Oversight Board</td>
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<tr>
<td>SAP</td>
<td>Systems Applications Products</td>
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<td>SAS</td>
<td>Statistical Analysis System</td>
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1 Introduction

1.1 Background on Financial Statement Auditing

Financial statement auditing (FSA) concerns the examination of an organization’s financial statements by an independent auditor. FSA is carried out once a year. Auditors form an opinion about the fair presentation of annual accounts and related disclosures (De Beelde, 2008). The purpose of FSA is to add credibility to the reported financial statements and to the performance of a business (Bragg, 2017). FSA has been in place for a very long time but it has to keep adapting to its changing environment. Figure 1 by Trumpener & Marissen (2017) illustrates the transition from historical audit to the way auditors perform an audit nowadays. At the very beginning, auditors performed manual audits based on very small samples. This evolved, due to emerging technologies such as computer systems, into a more automated audit with larger sample sizes. The future audit, with a scope of 100% of the population, pattern recognition and data analysis of outliers and anomalies, is of today not unimaginable anymore. Auditors are currently integrating these methods into their daily audit procedures. The present environment in which audit firms are operating is one of continuously increasing amounts of available data. Big Data (BD) is a part of this pile of information and will push auditors even further out their comfort zones of traditional audit methods. This challenge resulted into the subject of this master’s dissertation.

Figure 1: The Evolution of Audit (Trumpener et al, 2017)
1.2 Purpose & Research Questions

The purpose of this master's dissertation is to add valuable insights on the evolution of the audit profession, which is currently operating in a Big Data environment. The aim of this research is to examine the different impacts of Big Data (BD) on Financial Statement Auditing (FSA). Therefore, two research questions have been put forward:

I. What are the changes that might be observed in the audit profession due to the rise of Big Data?

II. How is the Belgian auditing profession preparing for these changes?

The first research question will be solved by looking into previous research on how BD is shaping the audit profession these days. By doing this thorough literature review, a conclusion on the different changes can be made. The second research question focuses on FSA solely in Belgium. This matter will be examined by setting up a qualitative research. Interviews will be conducted from Big Four companies and other assurance companies on how they are incorporating BD into their audit procedures. Both findings of the literature review and qualitative research will be put together in order to draw a final conclusion.

This 1st section presented some background on FSA and the purpose of the dissertation, demonstrating the process of answering the research questions. Section 2 describes several main concepts within the audit in order to get a better understanding of the subjects discussed later on. The third section consists of a literature review. Herein two reasons to implement BD in FSA are explained along with six different changes in the audit profession due to the rise of BD. Section 4 describes the research design and methodology used to conduct the qualitative research. Section 5 presents the results and discusses how the Belgian audit profession is handling these six changes. A conclusion on both the literature review and qualitative research is discussed in section 6.
2 Conceptual Framework

Traditional accounting data is not BD and neither is Data Analytics (DA). As BD, DA and Big Data Analytics (BDA) are frequently used in this dissertation, a clear distinction is necessary. This section covers the difference between auditing around, through and with the computer as an introduction to the use of technology within the audit. Additionally, an unambiguous definition of BD and BDA is given, as there are many different interpretations possible.

2.1 Auditing Around – Through – With the Computer

The technological evolution not only had an impact on the way entities operate but also on the way in which auditors control these businesses. Computers became more important within the audit profession as they evolved slowly but certainly from a secondary tool to an indispensable device.

At the beginning, when computers were starting to get more generally used within businesses, auditing around the computer was a fact. Back then an audit was carried out by traditional manual procedures, completely ignoring automated equipment (Byrnes et al, 2012). Felix Kaufman (1961) in Byrnes et al (2012) even projected the computer as a black box in his book Electronic Data Processing and Auditing. In this book he explains that auditors used computers only for physical inputs and outputs. They were never interested in how the processes within these automated systems occurred. Later on, auditing through the computer was introduced. This meant using the computer more actively in testing both controls and transactions.

Finally, auditing with the computer is the current way of working. Auditors utilize 100% of automated devices to evaluate processes, computer software and hardware (Byrnes et al, 2012). This method requires access to external databases to obtain information about the audited company. These external databases consist of data with different structures, stored on numerous different places. In the past, there was no connection between databases, which made it very difficult to obtain the correct information. Fortunately, in 1990, the development of enterprise research planning (ERP) systems was introduced. This system was able to combine many different databases into one large integrated warehouse (Rashid, Hossain, & Patrick, 2002). As these warehouses grew bigger, new types of data originated and new data techniques became more sophisticated but also more efficient. All these advancements eventually evolved into what we now call BD (Alles, & Gray, 2016).
2.2 Big Data

BD is a very extensive concept with various definitions. However, most frequently BD is defined using its characteristics known as the “Four V’s”: Volume, Velocity, Variety and Veracity (IBM, 2014). See Appendix 2.1 for an illustration. Volume refers to the large amount of data included in a BD set. Velocity measures the frequency of data availability and the speed in data change. Variety reflects the different data forms that are collected by entities, such as textual data, quantitative data but also videos, images, etc. For example, to provide a complete record of sales activity a company can combine sales calls to customers with revenue numbers. Thereby, the auditor will have to analyze this integrated data in order to fully understand the income statement. Another similar example is the combination of inventory data with surveillance videos, which the auditor needs to use effectively as additional audit evidence (Tang & Karim, 2017). See Appendix 2.2 for more examples of different data types and their use within the audit profession. Finally, veracity relates to the integrity of data. In other words, the quality and relevance of data can change overtime. This can become a huge problem to auditors as their work is based upon the correctness of data (Gepp, Linnenleucke, O’Neill, & Smith, 2018).

The variety of BD can be further divided into three features. First of all, whereas auditors are used to work with structured data, BD mostly consists of unstructured data. See Appendix 2.3 for a visual example. Second, BD can either be financial data (FD) (e.g., income statement, bank transactions) or non-financial data (NFD) (e.g., e-mail, web searches) (IIA, 2017). Finally, this data can be generated from within an organization (e.g., transaction data, customer complaint data) or from external sources (e.g., economic data, social media). Figure 2 (IIA, 2017) illustrates some examples of BD sources, which might be unstructured and non-financial.

Figure 2: Examples of Big Data Sources (IIA, 2017)
BD goes far beyond general data. To resume, general data mostly consists of financial, structured and internal generated data while BD includes both FD and NFD, structured and unstructured data as also data obtained from inside as outside an organization (Alles et al, 2016). Nevertheless, BD cannot be confused with information. Data in itself does not have any value, aside from the cost of storing and maintaining it, unless it has been put into context or has been associated with other aspects that are relevant to the context (Kiewert, Hirt, & Nikolic, 2014). Thus, data in different contexts will lead to different insights and therefore to different types of value. Even though BD will add a great value to the audit of today, it cannot be achieved without “matching hardware and software, including storage devices, data design and programming software, and analytical tools” (Tang et al, 2017). Storage devices (ERP systems) and data design (Four V’s) have already been explained above. The next paragraph will focus on analytics.

2.3 Big Data Analytics

Although Data Analytics (DA) and Big Data Analytics (BDA) are used interchangeably, their two separate definitions are shown below. DA is defined by IBR (2018) as follows:

“Data analytics is the process of examining data sets in order to draw conclusions about the information they contain, increasingly with the aid of specialized systems and software.”

According to Cao, Chychyla, & Stewart (2015) BDA can be defined as follows:

“Big Data Analytics is the process of inspecting, cleaning, transforming, and modeling Big Data to discover and communicate useful information and patterns, suggest conclusions, and support decision making.”

Both definitions are largely the same. The only difference is that BDA integrates BD, while DA only examines general data. In the remainder of this dissertation, BDA will be used to cover both concepts to facilitate the reading. BDA is used within the audit to examine transactions, balances and disclosures, which underlie the financial statements and related management assertions. It enables auditors to analyze larger quantities, detect fraud more easily and execute higher quality audits by providing stronger fact-based audit opinions (Earley, 2015; EY, s.d.). In general, BDA creates an opportunity to add more value to an audit and thus increases the credibility of auditors (IBR, 2018). Specific Big Data analytical tools will be explained in section 3.2 when the changes in the collection of evidence are being examined.
An advantage of using BDA instead of current analytical methods is the decrease in false positives (Cao et al, 2015). A false positive is a test result, which indicates that a particular condition or attribute is present when it is really not. Sometimes identifying anomalies and exceptions generates into a large amount of false positives, which are impossible to examine all. Using BDA can dramatically reduce these false positives by identifying anomalies more accurately and by applying a system of prioritization (Krahel & Titera, 2015; Yoon, Hoogduin, & Zhang, 2015). A disadvantage of BDA is “the “black box” nature of the way in which analytics work with algorithms or rules used to transform data and produce visualizations or reports” (Ramlukan, 2015). Therefore, professional skepticism is of great importance when assessing the reasonableness of an entity's estimated value and its disclosures (IAASB, 2016).

Figure 3 (Alles, & Gray, 2016) illustrates how the concepts of BD and BDA can be integrated in FSA. At this point in time, the audit profession is operating in the environment illustrated in cell A: using traditional data analytical techniques such as Excel, ACL, IDEA, etc. to analyze traditional accounting and financial information. On the one hand, the audit profession is starting to shift from cell A to cell B due to the rise of new technologies. Auditors are stepping aside from the sampling approach and are starting to carry out audits on 100% of the population by using BDA. On the other hand, moving from cell A to cell C does not go as smooth as the previous shift. In cell C auditors should start using NFD, aside from FD. In other words, incorporating BD into their audit procedures. Moving into cell D would be both incorporating BD and BDA as part of the audit and is therefore the most optimal usage of new technologies. However, this shift will require substantial changes in many different aspects of an audit.
3 Literature Review

Previous research on the impact of BD on the audit profession is discussed in this section. First of all, reasons to implement BD in FSA are put forward. Subsequently, the changes in the collection of evidence are clarified followed by the changes of several basic concepts within the audit. Next, the frequency of an audit is put into question. Section 3.5 focuses on the changes in the cost structure of an audit followed by section 3.6, which examines the changes in the competencies of the auditor. Finally, changes in standards are debated and a summary of the main findings is provided.

3.1 Reasons to implement Big Data in Financial Statement Auditing

Organizations are implementing BD to obtain more valuable insights on their processes. Internal auditors are moving along with this and are using BDA to deliver deeper and faster services (Kiewert et al, 2014). There are two reasons for external auditors to do the same: external pressure and opportunities (Alles, 2015; Appelbaum, 2016).

3.1.1 External Pressure

The first reason is pressure from the outside, which auditors cannot ignore. As the rise of ERP systems determined the way businesses were run and records kept, auditing around the computer was not an option anymore and auditing through the computer became a fact (Alles, 2015). Therefore, if ERP systems can persuade the audit profession to adopt IT-based audits, the same could apply to BD (Tang et al, 2017). To keep up with organizations of today, auditors will have to deliver more insights, quality and value to the users of financial statements (Ramlukan, 2015). In order to do this, auditors will have to implement BD and BDA into their own audit procedures.

3.1.2 Opportunities

Aside from external pressure, auditors realize that BD and BDA can create many opportunities. As Alles et al (2016) state: “If auditors are to find value in it, Big Data and related analytics must lead to more efficient, effective and/or higher-quality audits”. More efficiency can be translated into various outcomes. First of all, the probability of misstatements can be reduced because auditors are able to analyze evidence, at the financial statement level, more thoroughly (Srivastava & Shafer, 1992 in Yoon et al, 2015). Conference call transcripts and text analysis of company disclosures can add to this reduction (Larcker & Zakolyukina, 2012 in Yoon et al, 2015). Furthermore, as mentioned before, using BDA optimizes the detection of important anomalies and reduces false positives. This can lead to a more efficient audit (Cao et al, 2015).
The next specific example of Brown-Liburd, Issa, & Lombardi (2015) illustrates that efficiency and effectiveness can be added to the audit engagements by using BD and BDA:

“The analysis of cash transactions to ensure compliance with money laundering regulations is an example of a high-risk area where auditors can use Big Data Analytics to focus on suspicious transactions. In this scenario the general rule is that any payment exceeding a specified amount requires special approval. To avoid the need to go through the process of obtaining this approval, some users may resort to keeping the amount of the transaction just below the threshold, or dividing the amount into multiple transactions, a phenomenon known as “split payments.” While such transactions may not violate any internal controls, frequent occurrences may necessitate further investigations to ensure the legitimacy of these transactions. This scenario illustrates that by uncovering patterns that would remain otherwise unknown, Data Analytics used to extract information from larger volumes of data can help auditors identify high-risk areas where they should focus their investigative efforts”.

Implementing BD in the audit profession does not only maximize the effectiveness of the audit procedures but also the human element (IBR, 2018). Due to the increased automation within the audit process, auditors are able to focus more on fundamental audit procedures and on more complex and risk areas. Additionally, there will be more spare time for the auditor to focus on the judgmental aspects of an analysis. Auditors will create a better dialogue with clients and obtain more insights on other aspects of a client’s business (Ramlukan, 2015).

3.2 Changes in the Collection of Evidence

It does not really matter for which of the two reasons auditors are implementing BD and BDA into their audit procedures. It will have an influence on the collection of audit evidence either way. On the one hand, auditors will meet challenges on dealing with information in a BD environment. They will have to ensure that their judgments and decisions are still based on qualitative information that is relevant and trustworthy (Brown-Liburd & Vasarhelyi, 2015). On the other hand, technological challenges will rise and innovative tools will be invented to handle new types of data. These new technologies will make it possible to perform full population examinations and will have an effect on the different audit phases. Both challenges will be discussed consecutively in this section.
3.2.1 Challenges on Dealing with Information in a Big Data Environment

BD goes from structured to unstructured, financial to non-financial data and from data obtained from inside an organization as from external sources (Alles et al, 2016). This means that auditors will operate in a whole new environment, facing several new challenges. One of these new challenges is dealing with external data. Due to the rise of BDA it has become fairly easy to extract data from outside an organization. This external data delivers many new insights, but its relevance and reliability is questionable. The IAASB (2016) states that auditors may not assume the completeness and accurateness of data obtained from third parties. Previously, in the era of paper-based audit evidence, these externally obtained sources were considered highly reliable. However, due to the rise of BD and the evolution of auditing with the computer this reliability has been put into question as well as the veracity and origin of data (Appelbaum, 2016; Appelbaum, Kogan, & Vasarhelyi, 2017). Therefore, auditors will have to make sure that, when they access external data, the next requirements are met (IAASB, 2016):

1. Obtained audit evidence is accurate and complete
2. Information required is sufficiently precise and detailed for the auditor’s purpose

Another challenge concerning using external data is the safeguarding of data provenance (Appelbaum, 2016; IIA, 2017). It has become extremely difficult to ensure that data has not been altered. Appelbaum (2016) suggest that digital signatures might be a solution to this problem but this method has not yet been implemented in any organization so far. Blockchain is another example of an emerging technology that tries to secure data provenance (Kostič, & Tang, 2017). See appendix 3.1 for an illustration on the blockchain technology. Additionally, BD and ERP systems have given auditors the opportunity to obtain more information than was previously possible. However, auditors must realize that the analysis of obtained data that is not relevant, altered and thus not reliable, can have negative consequences on the audit quality (IAASB, 2016).

Whether it is external or internal data, auditors still need to collect, extract, and process useful information from data warehouses. This will bring new challenges to the surface and will result in complications relating to the acquisition of data, information overload, information relevance, pattern recognition and privacy and security issues.
Acquisition

External data, as explained above, is subjected to different pitfalls. However, this data is not that difficult to obtain. Accessing internally generated data might be a lot more challenging because some entities do not allow auditors to extract information from their data warehouses (Earley, 2015). Additionally, companies invest significantly in approval processes and technology safeguards to secure their data (Ramlukan, 2015). This prohibits the ability to obtain companies’ data efficiently, cost-effectively and in an acceptable time span. Furthermore, a shift from collecting only general ledger to also sub-ledger information, such as procurement-cycle data, has occurred (Ramlukan, 2015). This shift makes it even more difficult to extract data and to process the whole lot of information. However, when entities do allow data extraction, information overload will become a second challenge.

Information overload

BDA makes it possible to extract large volumes of data. Although this might generate into a lot of new opportunities, it can be very overwhelming to analyze and process such a tremendous amount of information (Issa & Kogan, 2014 in Brown-Liburd et al, 2015). This information overload will hinder the ability of auditors to follow up on every error that has uncovered (Krahel et al, 2015) and will also hinder the determination of probability that fraud has occurred (Appelbaum et al, 2017).

Pattern recognition

The increased volume of information gives an auditor the opportunity to search for disturbing patterns that would have stayed undetectable with smaller data sets or samples (Alles, 2013 in, Brown-Liburd et al, 2015). Such disturbing patterns can be found by using data analytical tools. Chronodating, duplicates and Benford’s law are several examples of disturbing patterns (Dekroon & Karp, 2013). However, auditors might encounter some difficulties to distinguish important from unimportant patterns. The underlying reason might be the incapability of the auditors towards patterns because they have always audited structured and financial data. Additionally, this unfamiliarity can lead to identifying large numbers of meaningless patterns. This will result in spending too much crucial time on investigating irrelevant or/and inefficient information (Brown-Liburd et al, 2015; Rose, Rose, Sanderson, & Thibodeau, 2017).
Information relevance
Auditors are used to collect only financial and structured data when forming an opinion on the financial statements of an entity. They are unaccustomed to collect non-financial or unstructured data. Therefore, the possibility exists that they are unable to separate relevant from irrelevant data (e.g., patterns), regardless whether it concerns internal or external data (Brown-Liburd et al, 2015).

Security and privacy
Due to the fact that data has become largely available, concerns about security and privacy of this information have risen (Cao et al, 2015). Auditors will have to make sure to maintain the security of their client-related data and to avoid breaches of confidentiality (Alles et al, 2016). Customer complaints, proprietary information shared in a supply chain, customer or employee personal identification data and health care records are some examples of such delicate information that needs to be protected (Alles et al, 2016). Additionally, some jurisdictional laws and regulations might prohibit certain data from leaving the jurisdiction form of an entity (IAASB, 2016). This can cause problems when the auditor needs to transfer data to a location (database) outside the jurisdiction of the entity. A solution given by Dai and Vasarhelyi (2016) in Kostić et al (2017) is the creation of strict policies to keep data secure and private. They suggest encrypting sensitive information before putting it forward to other networks and using secure channels when communicating the information. Additionally, they suggest hiring professionals who can install attack detection software and evaluate the security and privacy risk over time.

3.2.2 Technological changes
Challenges on dealing with information in a BD environment demands for changes in the way auditors perform an audit. Therefore, the technology within the audit procedures needs to be adapted (Yoon et al, 2015). In this section, technological changes will be outlined into three different categories. First of all, BD analytical tools will be discussed. Additionally, BDA made it possible to expand the audit scope from a small part of the population, known as sample based auditing, to the entire population (Byrnes et al, 2012; IAASB, 2016; Ramlukan, 2015). The aspect of examining 100% of the population is explained in the second part of this section. Finally, the effect of BD and BDA on the different phases of the audit process will be covered in the third part.
3.2.2.1 Big Data Analytical Tools

Audit has evolved from auditing around and through to with the computer. Dai & Vasarhelyi (2016) divided this evolution into four generations. Figure 4 (Dai et al, 2016) illustrates these four audit generations along with the different tools that were used in each particular generation.

Most audit firms use internal generated tools or commercially available software (Bagga & Singh, 2011). The basic commercially available programs are Excel, ACL, IDEA and Regression Software (IBR, 2018). ACL and IDEA are part of Computer Assisted Audit Techniques (CAAT) software. CAAT can be simply defined as: “All the techniques and aids which allow an auditor to access and view system data or the operation of software, using the computer itself” (Simon, 2014). CAAT consist of features specifically designed for auditors (Dekroon et al, 2013). These general features together with their corresponding benefits can be consulted in Table 1 below.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Read only</td>
<td>Does not modify source data</td>
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<tr>
<td>Audit log</td>
<td>All commands are traceable and repeatable</td>
</tr>
<tr>
<td>Scripting</td>
<td>For automated or repetitive audits</td>
</tr>
<tr>
<td>Powerful Data Connection</td>
<td>Can access almost any data, even text-based reports and flat files</td>
</tr>
</tbody>
</table>

Table 1: Features of CAAT (Dekroon et al, 2013)

Excel and CAAT software positions the current auditor in the generation of Audit 2.0 according to Figure 4. However, CAAT are involving significantly into BDA (Trumpener et al, 2017). BD analytical tools can import nearly limitless amounts of data and analyze both structured and unstructured data to identify patterns of behaviors, trends and potential transaction anomalies (Brown-Liburd et al, 2015; Cao et al 2015). These technological advanced tools can be classified in the generation of audit 3.0. Data mining is one of these tools. It is defined as “employing a variety of techniques to search through large amounts of data to identify unknown patterns or relationships, extract decision rules, or construct predictive models” (Gray &
Debreceny 2013 in Brown-Liburd et al, 2015). This technique helps auditors analyze external data when assessing business risk, fraud risk, internal controls, going concern, etc. (Brown-Liburd et al, 2015). The main characteristics of data mining but also Excel, Interactive Data Extraction and Analysis (IDEA), Audit Command Language (ACL) and Statistical Analysis System (SAS) can be consulted in Table 2.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excel</td>
<td>- Ability to handle considerable volumes of data</td>
</tr>
<tr>
<td></td>
<td>- Available on every desktop</td>
</tr>
<tr>
<td></td>
<td>- Familiar user interface</td>
</tr>
<tr>
<td></td>
<td>- Affordable and compatible</td>
</tr>
<tr>
<td></td>
<td>- Powerful features (e.g., subtotals, lookups, pivots, etc.)</td>
</tr>
<tr>
<td></td>
<td>(Shah, 2004)</td>
</tr>
<tr>
<td>IDEA</td>
<td>- Analyzes large amounts of data</td>
</tr>
<tr>
<td></td>
<td>- User-friendly interface (little technical skill required)</td>
</tr>
<tr>
<td></td>
<td>- High speed of processing large amounts of transactions</td>
</tr>
<tr>
<td></td>
<td>- Detects and handles fraud easily</td>
</tr>
<tr>
<td></td>
<td>(Bagga &amp; Singh, 2001)</td>
</tr>
<tr>
<td>ACL</td>
<td>- Data is locked down as read-only</td>
</tr>
<tr>
<td></td>
<td>- Commands are auditor-friendly</td>
</tr>
<tr>
<td></td>
<td>- Automatically records all of the commands that are run and the results of the</td>
</tr>
<tr>
<td></td>
<td>procedures in its log</td>
</tr>
<tr>
<td></td>
<td>- Makes use of Writing Scripts (Batch feature)</td>
</tr>
<tr>
<td></td>
<td>(Dugas, s.d.)</td>
</tr>
<tr>
<td>SAS</td>
<td>- Analyzes any kind and size of data</td>
</tr>
<tr>
<td></td>
<td>- Readily understands results with a wealth of graphs</td>
</tr>
<tr>
<td></td>
<td>- Applies the latest statistical techniques</td>
</tr>
<tr>
<td></td>
<td>- Uses proven and validated methods</td>
</tr>
<tr>
<td></td>
<td>(SAS, 2017)</td>
</tr>
<tr>
<td>Data Mining</td>
<td>- Automatically discovers useful information even from complex data sets</td>
</tr>
<tr>
<td></td>
<td>- Automatically discovers unknown patterns</td>
</tr>
<tr>
<td></td>
<td>- Handles large amounts of data</td>
</tr>
<tr>
<td></td>
<td>- Relatively high cost</td>
</tr>
<tr>
<td></td>
<td>- Technical skills required</td>
</tr>
<tr>
<td></td>
<td>(Bagga &amp; Singh, 2011)</td>
</tr>
</tbody>
</table>

Table 2: Analytical Tools and their Corresponding Characteristics
Although these tools are commonly used in analyzing BD, auditors will have to make sure that there are certain controls and processes in place. This to ensure that the tool is working properly and that the changes performed on the tool are done in a controlled manner (IAASB, 2016). Finally, audit 3.0 is assumed to evolve into audit 4.0 or semi- and progressive automation of audit, according to Figure 4. By then auditors will use sensors, GPS systems, Internet of Things (IoT), etc. to carry out an audit.

3.2.2.2 Full Population Examination

Nowadays, the audit profession consists of a backward looking approach with only one annual inspection. Cangemi (2010) in Byrnes et al (2012) argues that this way of working has become totally outdated because of the advances in business technologies (CAAT). These CAAT software packages made it possible to analyze full populations (Wang and Cuthbertson, 2015 in Appelbaum et al, 2017). Analyzing entire sets of data results in audit evidence with a higher quality and more relevant business insights. It also tends to give more confidence to the audit profession (EY, s.d.; Ramlukan, 2015). However, analyzing entire populations can also have negative impacts on the audit procedures. For example, when a full population examination is executed with the aim of finding anomalies and outliers, it is possible that a huge number of false positives are detected. This overload of false positives can discourage auditors to perform such an analysis in the first place (AICPA, 2015). Nonetheless, analyzing an entire population does not mean that auditors are able to provide 100% assurance on the statement of financial records. Auditors will continue on giving a reasonable level of assurance (Earley, 2015; IAASB, 2016). Additionally, as previously mentioned, professional skepticism becomes even more important because auditors should not solely rely on the outcomes of these full population examinations.

3.2.2.3 Impact on the Different Audit Phases

New analytical tools have been invented to be up to date with the current audit evolution and made it possible to carry out full population examinations. In addition to these two major technological changes, BD and BDA have had an impact on the different phases of the audit (EY, s.d.; IAASB, 2016). The general audit process to obtain audit evidence is divided into four phases, namely risk assessment, analytical procedures (including tests of controls), substantive procedures and a conclusion. These audit procedures to obtain audit evidence are illustrated in Figure 5 (IAASB, 2016).
BDA effects all phases within the audit process. However, the use of analytics is different throughout the different phases (Appelbaum et al, 2017). For the risk assessment phase, BDA is exploratory. “Exploratory data analysis (EDA) is an approach to analyzing data sets to summarize their main characteristics, often with visual methods” (IBR, 2018). An EDA should help the auditor to understand the business environment of the entity, its transactions and events. It should also help the auditor to determine risk areas particular to the audit and design further audit procedures (Appelbaum et al, 2017; Cao et al, 2015; IBR, 2018). BDA when used in the other audit phases is more structured, mathematical and analytical (Appelbaum, 2016; IBR, 2018).

![Data Analytics](image)

*Figure 5: Audit Procedures to obtain Audit Evidence (IAASB, 2016)*

### 3.3 Changes of Basic Concepts

BD does not only affect the collection of evidence but also questions different audit concepts that are inherent to the audit profession. As Brown-Liburd & Vasarhelyi (2015) state clearly: “An entire new, different set of evidence is evolving (...). It will however present pressure to reconsider traditional concepts in the audit such as materiality, independence, and method of judgment”. In this paragraph we will take a deeper look at these three traditional concepts, as they will need some significant reconsiderations.
3.3.1 Materiality

The purpose of an audit is to make sure that the financial statements are a fair and accurate representation of a company’s activities. This should enhance the confidence of external stakeholders in the financial statements (ISA 200). The concept of materiality was introduced to help the auditor determine which information is most important. Materiality is defined by IFAC (2009) as follows:

"Materiality is the amount by which the Financial Statements must change in order to change the decisions made by users of the Financial Statements" (ISA 320).

It may become necessary to redefine this concept due to the occurred changes in volume of transactions (e.g., full population examination), the type of usage (e.g., BD) and the probability of outcome (AICPA, 2015). Materiality reduces the scope of audit work as it only looks into those amounts that are of material matter to the stakeholders (Pompeu & Alves, 2014). However, due to the rise of BD every account can be inspected for anomalies and fraud and therefore the distinction between what is material and what is not will slowly become unnecessary (AICPA, 2015).

3.3.2 Independence

Another basic concept that might by affected by BD and BDA is the independence of the auditor. This concept is stated, according to the IFAC (2009) as follows:

“The independence of the auditor (...) 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 skepticism” (ISA 200).

The independence of the auditor might be in danger due to several reasons. First of all, knowing too much about a client can raise concerns about the ability of an auditor to form an uninfluenced audit opinion (Tang et al, 2017). Therefore, whether an auditor will remain its objectivity becomes questionable. Secondly, because of the many features of BDA, auditors may detect things that their clients did not know about or were not even thinking of. When auditors share these insights with their clients they will have to make sure not to step in and make decisions for them (Woodie, 2016). Finally, auditors will use more non-financial information. Therefore, auditors must be careful not to wander from auditing their clients to simply providing non-audit evidence (Earley, 2015).
3.3.3 Causation

Although these two concepts above will need some reconsideration, the biggest challenge will be the shift from causation to correlation. The fact that auditors are now able to analyze entire datasets and that they are using messy instead of 100% clear data, makes it necessary to interpret data from a different point of view (Cao et al, 2015). This interpretation of data resulted in a paradigm shift from causation to correlation. This shift can be explained as moving away from understanding the fundamental causes to simply identifying and making use of associations (Cao et al, 2015). The change from causation to correlation can add to the concern of increase in false positives according to Alles et al (2016). They state that because of the absence of knowledge about the use of BDA, auditors will fall too easily into simplistic and inaccurate interpretations of misleading correlations. In their opinion auditors will not search for disconfirming data when they have come up with a quick explanation for e.g., an outlier or anomaly. This point of view is totally in contrast with the opinion of Cao et al (2015). They argue that using BDA will decrease false positives instead of increase because of the auditor’s ability to identify anomalies more accurately. Moreover, auditors will apply a system of prioritization to examine the large amount of false positives. The two different opinions can result into the following conclusion: BDA can lead to a decrease in false positives but auditors will have to be careful not to give too much weight to a result that already supports their beliefs (Alles et al, 2016).

3.4 Changes in Timing

Because businesses and auditors are integrating BD and BDA into their daily activities, changes are occurring in timing of the audit. BDA gives auditors the opportunity to examine large databases consisting of different types of data. However, they also make it possible to shift from traditional, once a year, auditing to continuous auditing (CA). One of the motivations for CA is that traditional audits are only performed annually and their data will therefore be obtained long after economic events are recorded (AICPA, 2015). The current definition of CA stated by the AICPA (2015) is as follows:

“A continuous audit is a methodology that enables independent auditors to provide written assurance on a subject matter, for which an entity’s management is responsible, using a series of auditor’s reports issued virtually simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter.”
Up to now, internal auditors are more likely to perform CA because it is more important for them to detect potential problems as soon as possible. In this way they can act immediately and therefore enhance the internal control system of their organization (AICPA, 2015). There are also several advantages for external auditors to apply CA. First of all, this technique alerts an auditor from the moment a potential problem occurs (Krahel et al, 2015). It gives the auditor more time to respond and enables the ability to directly integrate this potential problem into further audit planning. CA thereby enhances audit quality and client service. Secondly, because of the continuous base of CA, the workload can be spread throughout the year (AICPA, 2015). Finally, there are fewer chances that deviations expand into larger levels of error and misstatement. This advantage is possible because of the fast detection of potential material deviations (Krahel et al, 2015).

Although there are many advantages in adapting CA, it is not feasible for every organization to shift from annual auditing to CA as the usefulness of data for each company is limited by its quality, quantity and accessibility (Warren, Moffitt, & Byrnes, 2015). The reason for this limitation is due to several factors many organizations cannot overcome: the lack of data (quantity), irrelevance or data from questionable sources (quality) or insufficient expertise in extracting information (accessibility) (Warren et al, 2015). Additionally, CA also creates several gaps and challenges when linking databases in a CA system (Zhang, Yang, & Appelbaum, 2015). The gap in data consistency is one of them because there are many different data sources, which can conflict easily with each other regarding the content for example. Also data identification will become more difficult as BD is unstructured and non-financial. Lastly, data aggregation will need excessive computing resources, which might not be present at this moment. Nonetheless, the need arises in switching over to CA due to the changing BD environment. However, auditors seem to adapt very slowly to technological changes. While auditors are now obtaining data from ERP systems and using BDA, other innovations such as CA are still very far away from becoming a standard (Alles, 2015).

**3.5 Changes in the Cost Structure**

Retrieving BD and making use of BDA will have significant impacts on the cost structure of the audit profession. However, opinions regarding the direction of the cost component, an increase or decrease, are divided. Tang et al (2017) believe that the use of BDA can make audit assignments more cost-efficient. For example, considering the planning work involved, BD enables auditors to perform full population audits on a more cost-effective manner in comparison to sample-based audits. Additionally, audit firms might charge lower fees because of more cost-efficient audits (Kostic et al, 2017). Thereby it becomes cheaper for their clients,
who will be able to purchase more advisory services from the firm. In that way auditors will add value beyond the audit assignment (Kostic et al, 2017).

Although the reduced cost due to analytical procedures might seem an advantage, Appelbaum et al (2017) argue that regulators see the obtained evidence as less reliable compared to the more costly detailed collected evidence. Furthermore, acquiring compatible software that can handle both volume and analysis efficiently will be unavoidable costly according to Whithouse (2014). She even states that using these expensive BD applications could harm the audit quality. In addition, if auditors are not able to acquire sufficient knowledge on BD and BDA, the cost of hiring more data scientists and BD analysts can be very high (Brown-Liburd et al, 2015). This problem will be discussed in more detail in the next section. Although BDA seems very promising and is able to improve the effectiveness and efficiency of an audit, auditors will need to make sure that it outweighs the cost aspect of developing tools and hiring people who carry out the analytics (Alles et al, 2016).

3.6 Changes in the Competencies of the Auditor

The new BD environment is also changing the audit profession when it comes to the appropriate competencies. Performing BDA requires a whole new skill set, which has not been included in the current education of an auditor. There are three competencies that are of important value to a future auditor. First of all, auditors will need to increase their IT knowledge so that they are able to apply BDA effectively (Earley, 2015; IAASB, 2016). To this day audit teams lack sufficient knowledge to extract data, in the required data form, from entities' systems (FRS, 2017). Additionally, they lack the ability to use BDA tools properly. If this major need for change is neglected, firms will begin expanding advisory services to attract data scientists with BDA skills. This shift in focus from auditing to advisory services can have an impact on the audit quality (Earley, 2015). This opinion is in contrast with the argument of added value beyond the audit assignment from Kostic et al, 2017. Secondly, a transformation has occurred from the focus of BDA to the recognition of patterns within large databases (Setty and Bakhshi 2013 in Brown-Liburd et al, 2015). Auditors weren’t subjected to pattern recognition and evaluation of anomalies during their accounting education. Instead, this is currently acquired through many years of working experience (Earley, 2015). However, these high-level skills have become of huge value and should be taught from the start. Finally, auditors need to put fewer hours into processing a client’s data thanks to BDA. This creates extra time that can be used for more cognitively complex tasks, such as in-depth regression analysis or other kinds of predictive statistical work (Krahel et al, 2015). Therefore, these skills will also need to be taught at the start of an auditor's career.
As many extra requirements originated in this BD environment, the education of auditors needs to be reformed and skills such as pattern recognition, critical thinking and training in analytical procedures should be equally encouraged (Earley, 2015). A white paper by PwC in 2015 enumerates the extra courses that should make the knowledge of an auditor up to date. These courses are about: programming, structured and unstructured databases, multivariate and inferential statistics and data visualization tools. Although changes in the competencies of the auditor seem naturally, it will not happen overnight. In addition, as the IAASB (2016) states: “From the most experienced to the least experienced auditor, and from the largest accounting firms to the smallest, changing the auditor’s mindset to gathering audit evidence from the use of Data Analytics compared to traditional techniques will require time and investment in training”. Only with an adequate training will auditors be able to take full advantage of the benefits of BD and BDA (Byrnes et al 2012).

3.7 Changes of Standards

Just like the competencies of the auditor are in need of change, so is the regulation of the audit. The current attitude of the regulator towards BD and BDA is far of from the attitude of the auditor. According to ISA 200 “an auditor must obtain appropriate audit evidence . . . to reduce audit risk to an acceptably low level (…)”. There is no indication about what this appropriate audit evidence exactly means. Standards therefore do not restrict the auditor to use BD as additional audit evidence (Alles, 2015). Krahel & Titera (2015) even say that audit standards treat the availability of more continuous, automated and population-level techniques as a hopefully avoided contingency. Although there are no real constraints in using BD as audit evidence, the standards do not inform auditors about the possibilities of BD and BDA. They do not push auditors to explore their freedom and to go outside their comfort zone of traditional auditing (Alles, 2015; Appelbaum et al, 2017; IAASB, 2016). Standards should make practitioners more aware of BD, BDA and CA. Make them understand its concepts and applications and identify the extra-generated value. They can do this by issuing guidance or white papers on various relevant topics. According to the AICPA (2015) auditors will hereby embrace these initiatives more likely. Additionally, if audit standards would be modified to include BD, the audit could become more standardized and effective (Krahel et al, 2015).

New standards on several fundamental changes are unnecessary because most subjects are already included in current standards. These subjects just need some adjustments (AICPA, 2015). For example, AS 2305: Substantive Analytical Procedures (PCAOB, 2010) could be altered to include the use of BD analytical techniques. Additionally, AS 2315: Audit Sampling (PCAOB, 2016) should include full population examination opportunities (Krahel et al, 2015).
Furthermore, as previously discussed, the competencies of future auditors will require a huge change in skill set. The need for these skills can be updated in SA 1010: Training and Proficiency of the Independent Auditor (PCAOB, 2002). This standard has not been updated since 1972 and does not go beyond mentioning “adequate technical training and proficiency”, which is both vague and subjective (Krahel et al, 2015; Tang et al, 2017).

The gap between these standards and the current BD environment creates uncertainty concerning the relevance and applicability of analytics as audit evidence (Ramlukan, 2015). New standards need to be created because of this. One of them could be a specific data standard, which makes sure that data can be accessed in a standard format. This new standard should also provide auditors with formal methods of evidence aggregation (Vasarhelyi et al, 2015; Withouse, 2014). This can encourage entities, to apply BD and BDA, who are now holding back because of several facts. Every audit firm has to design its own program, have to obtain client files and figure out how the entity is organized. They also have to program the analytics (Baskin in Withouse, 2014). Although it might seem obvious that standards should change and new ones should be created in order to support BD and BDA within the audit, the pace at which it is changing is very slow. This could have caused the impact of BD on FSA to move slower than was originally expected (Kostic et al, 2017). However, according to IBR (2018), the International Auditing and Assurance Standards Board (IAASB) is currently considering integrating BDA into the international standards on auditing (ISA). Nonetheless, it does not only depend on the standards to introduce BD and BDA into the audit profession; also the willingness of auditors to adapt to this new BD environment is crucial (Vasarhelyi, Kogan, & Tuttle, 2015).

3.8 Summary

BD and BDA are transforming the traditional way of auditing. Various aspects of the audit, from tools and timing to competencies and standards, are facing new challenges. Audit firms will need to make modifications to their traditional audit procedures. However, not all auditors are enthusiastic about leaving their comfort zones and exploring new methods. The next part of this master’s dissertation will therefore investigate the attitude of Belgian audit firms towards to rise of BD within the audit profession. A qualitative research will be carried out by taking semi-structured interviews. The complete research design can be consulted in the next section. To have a clear view on the changes that have emerged from the literature review, a summary is given on the next two pages.
<table>
<thead>
<tr>
<th><strong>Major Changes</strong></th>
<th><strong>Characteristics</strong></th>
</tr>
</thead>
</table>
| **Collection of Evidence** | **Challenges on Dealing with Information in a BD Environment**  
- Relevance and reliability of external/internal data  
- Safeguarding data provenance  
- Acquisition of data  
- Information overload  
- Pattern recognition  
- Information relevance  
- Privacy and security issues  

**Technological Changes**  
- New innovative analytical tools: ACL, IDEA, SAS and Data Mining  
- Full population examination  
- BDA in all phases of the audit process |
| **Basic Concepts** | - Reduction of materiality  
- Impairment of the auditor’s independence  
- Shift in method of judgment: from causation to correlation |
| **Timing of the Audit** | **Continuous Auditing**  
- Enhances audit quality and client service  
- Possibility to spread the workload throughout the year  
- Fewer chances for deviations to expand into larger levels of error  
- Not feasible for all entities due to limitations in data quality, quantity and accessibility  
- Gaps when linking databases in a CA system  
- CA very far away from becoming a standard |
| **Cost Structure** | **Decrease in Cost Structure**  
- BDA (full population examination) makes audit assignments more cost-efficient and effective  
- Charging lower audit fees results in clients buying more advisory services: added value beyond traditional audit  

**Increase in Cost Structure**  
- Compatible software is unavoidably costly  
- Extra cost of hiring data scientists and BD analysts |
### Major Changes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Competencies of the Auditor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Required IT knowledge, especially on data extraction and BDA</td>
</tr>
<tr>
<td></td>
<td>- Ability to recognize relevant patterns</td>
</tr>
<tr>
<td></td>
<td>- Critical thinking</td>
</tr>
<tr>
<td></td>
<td>- Education of future auditors need to be reformed</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Standards do not restrict the use of BD and BDA</td>
</tr>
<tr>
<td></td>
<td>- Standards should inform auditors about the possibilities of BD and BDA</td>
</tr>
<tr>
<td></td>
<td>- Need to give out more guidance</td>
</tr>
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<td></td>
<td>- Fundamental standards need adjustments</td>
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<td></td>
<td>- A new specific standard on BDA should be in place</td>
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<td></td>
<td>- Willingness of the auditor remains crucial</td>
</tr>
</tbody>
</table>

Table 3: Summary of the Changes within the Audit Profession due to BD
4 Research Design

4.1 Research Questions

The first research question “What are the changes that might be observed in the audit profession due to the rise of Big Data?” has been answered by investigating previous research on the impact of BD and BDA on FSA. The literature review revealed six major changes: changes in the collection of evidence, basic concepts, timing of the audit, the cost structure, competencies of the auditor and standards. The next part of this dissertation will focus on how the Belgian auditing profession is adapting to and taking advantage of BD and BDA. Hence the second research question: “How is the Belgian auditing profession preparing for these changes?” To investigate the impact on the Belgian auditing profession, a qualitative research will be implemented and depth interviews of several assurance companies will be conducted. The setup of this research will be discussed in the following paragraphs.

4.2 Methodology

4.2.1 Selection of Companies

To investigate the impact of BD and BDA on the Belgian auditing profession, three companies were asked to participate. Two companies pertain the “Big Four”, namely EY and KPMG. Hereby, 50 percent of the four largest international professional services networks is covered. The selection of EY and KPMG and not Deloitte and/or PwC was a deliberate choice. EY and KPMG have published more information on integrating BD and BDA into their audit procedures than the other two companies. This enables a clearer comparison between the theory and what is genuinely used in practice. The third interrogated company is Mazars Bedrijfsrevisoren. Incorporating this organization in the qualitative research will add to a more realistic view on how the Belgian auditing profession, and not only the largest assurance companies, is dealing with BD and BDA.

The interviewees all possess an extensive knowledge about the subject of BD and BDA. However, they were also able to provide answers from the point of view of a general auditor and his activities. The first interviewee is Mr. W, a director within the audit department of EY Diegem. He has 13 years of experience within the audit profession. Besides this position, he is responsible for the Digital Audit Department in Belgium. This department is in charge of inventing new tools in order to handle all sorts of data. It also designs methodologies so that these tools match the required ISA. Digital Audit also covers robotization and other innovative projects, such as process mining and blockchain. The second and third interviewee both work at Mazars Ghent. Mrs. X is partner within Mazars Advisory Services. She is responsible for the Governance, Risk and Internal Control Department in which BD plays a crucial role and has 20
years of experience. Mrs. Y is Director within the Audit Department of Mazars Bedrijfsrevisoren Ghent and has 15 years of experience within the audit profession. The last person who partook in this research is Mr. Z. He is a manager within the audit department of KPMG Ghent. Additionally, he is a member, or “champion” as they call it at KPMG, of the Data & Analytics Team within the audit department. Mr. Z has seven years of experience in the audit field. A summary of the general information on the interviewees can be consulted in Table 4 below.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Company</th>
<th>Position</th>
<th>Division</th>
<th># Years of experience in Audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>EY</td>
<td>Director</td>
<td>Audit Department</td>
<td>13 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Responsible</td>
<td>Digital Audit</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Mazars Bedrijfsrevisoren</td>
<td>Partner</td>
<td>Advisory Services</td>
<td>20 years</td>
</tr>
<tr>
<td>Y</td>
<td>Mazars Bedrijfsrevisoren</td>
<td>Director</td>
<td>Audit Department</td>
<td>15 years</td>
</tr>
<tr>
<td>Z</td>
<td>KPMG</td>
<td>Manager</td>
<td>Audit Department</td>
<td>7 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Champion”</td>
<td>Data &amp; Analytics Team</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: General Information on the Interviewees

In addition, it should be mentioned that the information communicated during the interviews reflects the opinion of the interviewees and cannot always be extended to the point of view of the entire Belgian company.

4.2.2 Method of Interrogation

Semi-structured interviews were used to carry out a qualitative research. This type of interrogation is a combination between a structured and unstructured interview. A pre-made questionnaire is used to guide the interview so that the main topics are covered. Nonetheless, the interviewer gives the interviewee the change to elaborate and explain some deeper underlying insights (Alsaawi, 2014). The intention of this in-depth interview is to bring underlying
motivations and attitudes of the respondents to the surface regarding the use of BD and BDA within the audit profession (De Pelsmacker & Van Kenhove, 2015).

To ensure the quality of the interview, attention was paid to the following issues. First of all, the content of the interview was mastered so that the answers to the questions asked could be interpreted correctly. Secondly, the following guidelines were taken into account when drafting the questions and while taking the interview (Hannes & Bruneel, 2011):

- Ask clear, to the point questions
- Ask neutral questions first, thereafter more difficult questions
- Search for clarification and completeness in the answers
- Pay attention to non-verbal aspects of the respondent, e.g., not understanding a question
- Give the respondent time to think

To give the interview a concrete form, an interview guide was set up. The six main changes that resulted from the literature review were translated into eight challenges for the Belgian audit profession. The interview guide categories can be consulted in Table 5 below.

<table>
<thead>
<tr>
<th>1. Big Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Technology</td>
</tr>
<tr>
<td>3. Basic Concepts</td>
</tr>
<tr>
<td>4. Frequency of the Audit</td>
</tr>
<tr>
<td>5. Cost Aspect</td>
</tr>
<tr>
<td>6. Competencies of the Auditor</td>
</tr>
<tr>
<td>7. Standards</td>
</tr>
<tr>
<td>8. Other Challenges observed by the Professional</td>
</tr>
</tbody>
</table>

Table 5: Interview Guide Categories

The purpose of the research was clarified at the beginning of the interview. Some general questions concerning their position and experience in the field were asked, followed by the outline of the interview. The interview guide can be consulted in Appendix 4.1.
4.2.3 Structure of Interrogation

The interviewees were contacted by email to be informed of the subject of this master’s dissertation and were asked to participate in the research. When they agreed on cooperating, a date was set and the topic list was send to them at the latest of one week prior to the interview date. The topic list was drawn up in English. However, the interviewees were left the choice of answering the questions in either English or Dutch. All interviews were eventually conducted in Dutch. Used concepts in the questionnaire, such as continuous auditing, were explained in advance to avoid misinterpretations. All three interviews were conducted at the office where the interviewee worked most of his/her time. At the beginning of each interview, permission was asked to record the interview. By recording the interview, all information acquired is stored so no repeated questions had to be asked. The record could also be replayed to ensure a more thorough analysis (Alsaawi, 2014). Additionally, their permission was asked to make the information communicated during the interview public. Although delicate information was revealed and innovative tools were explained, all this information was made anonymous within the dissertation. Therefore, permission was given to consult and/or reproduce the content of this Master’s Dissertation, provided that the source is referenced. All three interviewees were asked the same questions to retain the comparability between the acquired information. In Table 6, a detailed interview schedule can be consulted about the date, place and length of the different interviews.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Company</th>
<th>Date</th>
<th>Location</th>
<th>Length (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>EY</td>
<td>02/05/2018</td>
<td>Diegem</td>
<td>72</td>
</tr>
<tr>
<td>X</td>
<td>Mazars Bedrijfsrevisoren</td>
<td>04/05/2018</td>
<td>Ghent</td>
<td>80</td>
</tr>
<tr>
<td>Y</td>
<td>KPMG</td>
<td>08/05/2018</td>
<td>Ghent</td>
<td>106</td>
</tr>
</tbody>
</table>

Table 6: Detailed Interview Schedules

4.2.4 Report of Interrogation

As outlined above, the questionnaire has been drawn up into eight different challenges, based on the findings of previous research. The interviews have been recorded and transcribed in its original language to increase the reliability of the collected data and to allow a deeper analysis of the interviewee’s response (Alsaawi, 2014). The transcribed interviews could not be attached to this master’s dissertation due to confidentiality requirements.
5 Qualitative Research: Results & Discussion

The results of the qualitative research will be presented below, divided into eight categories based upon the interview guide. The information retrieved from the semi-structured interviews was used to delineate a global view of the Belgian auditing profession, which is currently dealing with several challenges due to the rise of BD.

5.1 Big Data

BD as described by most authors (Alles et al, 2016) incorporates non-financial (NFD), unstructured and external data aside from all traditional data forms. However, Belgian audit firms do not interpret BD entirely by these characteristics. They portray BD mainly as a tremendous volume of available information. Belgian auditors are challenged to transform all this data into a relevant and reliable source of information. So far Belgian auditors used financial, structured and internal generated data or in other words, all available information from within a client’s ERP system. Nonetheless, most Belgian audit firms already incorporate NFD into their audit procedures. External and unstructured data are less popular but not unknown to some auditors. Several Belgian audit firms are retrieving bank statement directly from a bank instead from their client and are therefore obtaining external data. Unstructured data remains the most difficult source of information to integrate yet could be very interesting to carry out fraud assessments. Each Belgian audit firm also has a separate department that focuses on BD. The knowledge of these departments will have to be converted to auditors in the future. However, it will become a challenge for the Belgian auditing profession to reconcile these two separate worlds of IT and traditional audit. In the remainder of this qualitative research the term BD will portray the tremendous volume of general data along with non-financial data due to the fact that Belgian auditors do not yet use unstructured and external data.

In general, the use of BD is similar between all interviewed parties. However, each of them has a totally different approach when it comes to data extraction. Some audit firms carry out the extraction themselves. This is done by using an internal generated tool that downloads information from a client’s laptop. Others install a read-only tool on the client’s system. Extracting data directly from a client’s server is the most optimal method because the risk of data alternation is the lowest. However, this is not always possible due to complex ERP systems or clients who are unwilling to cooperate. In that case some audit firms reach out to a client’s IT department to request a copy of the appropriate information. Others use an online platform. This platform allows clients to leave a copy of the requested data. However, providing a copy involves more risks. Therefore, auditors have to make sure that the retrieved information, both internally and externally, is accurate, complete and most of all reliable (IAASB,
Information Produced by the Entity (IPE) is the most common form of information used by Belgian auditors. “IPE refers to any information created by the entity using IT applications, end-user computing tools (e.g., Microsoft Access, Excel), or other means, including manually prepared information” (EY, 2016). This internal data is checked by reconciling the retrieved information with a trial balance or by reviewing and verifying source documents. Relying on the number of hits of a certain external Internet source could be a control system for external generated data. However, this method is not in place yet in Belgium.

Collecting, extracting, and processing useful information from data warehouses in a BD environment creates new challenges, such as information overload, pattern recognition (Brown-Liburd et al, 2015) and privacy and security issues (Cao et al, 2015). Generated tools can already help the auditor in reducing information overload by only selecting data that is important to the Belgian auditor. However, according to Belgian audit firms, difficulty lies with the client when there are no tools available. Most of the time clients do not know how to extract correct data from their databases. Some Belgian auditors state that from that moment a quadrangular relationship arises. (1) Auditors are in need for certain information. (2) Data specialists within the audit firm have to translate this information into specific data and sources. (3) This request is reported to the CFO of the audited firm. This person is purely financially oriented and will therefore (4) communicate the required information to the IT department of its company. Only from that moment auditors receive the information they initially needed. A lot can go wrong during this process, which makes the information overload a serious challenge. Additionally, information overload gives the auditor the opportunity to see everything within an organization. Some Belgian audit firms think that this can be a risk when an auditor was not able to analyze all the information. The underlying reason is that later on a crucial problem may rises. At that moment the auditor will have to justify why he did not investigate certain matters more into detail. Another challenge concerns pattern recognition. Belgian auditors state that pattern recognition causes problems when it is implemented on all data available. If data is selected, pattern recognition will be very easily effectuated. However, the interpretation of these patterns is a different story. Experience and professional judgment are therefore more important than ever. Additionally, more false positives arise from analyzing entire data sets (Cao et al, 2015; Alles & Gray, 2016). It requires experienced auditors to interpret them in a correct way.

Furthermore, the Belgian auditing profession is aware of the many privacy and security challenges due to the rise of BD. Auditors know more about their clients than they used to. In order to guarantee a client’s privacy, some Belgian audit firms carry out a method of privacy by design. Privacy by design means that auditors only request certain information that does not violate the privacy of employees. Every audit firm also has a duty of confidentiality (ISA 200).
Whether it’s about ordinary data or BD, this obligation cannot be neglected. Additionally, General Data Protection Regulation (GDPR), which has been applied from 25 May 2018, should help to decrease privacy issues (EC, 2018). BD that is available on the Internet is public and thus not covered as a privacy issue. Finally, to protect a client’s data from third parties Belgian audit firms have secure servers.

5.2 Technology

5.2.1 Big Data Analytical Tools

New technologies need to be invented to handle BD. Each Belgian audit firm that was interviewed stated that they use internally produced tools. These tools ensure that auditors can distinguish themselves in terms of services from their competitors. Therefore, names and specific features of these tools are not discussed in this dissertation. Nonetheless, some general findings can be brought forward. Belgian audit firms commonly use commercially available software such as Excel, IDEA and ACL in addition to their internal tools. Auditors can analyze entire processes and test these by using the three-way-matching method. Additionally, auditors can fully check the General Information Technology Controls (GITC) with the help of BDA. GITC consists of information on who can change prices or bank account numbers, what checks are performed when adding a new module in SAP, etc. BDA is also able to schematize the complete ledger and can identify which account combinations are unexpected or exceptional. Some of these data analyses are rather complex and are carried out by data experts. Documentation on the different analyses executed is a crucial aspect in making BDA a reliable extra value within the auditing profession.

5.2.2 Full Population Examination

Thanks to new innovative tools, it became possible for auditors to carry out full population examinations instead of small sample based audits (Appelbaum et al., 2017). Belgian audit firms are now analyzing 100% of an organization’s processes, most importantly the sales process. By using BDA, auditors are getting more and better insights in the figures of an organization and in the organization itself. It becomes possible to perform an audit in a more detailed way, to better identify risks and to display information in a more structured way. Additionally, there are fewer manual or human errors due to the automation. Extra value for the client is created because BDA ensures that a statement can be made about the entire population instead of only a small sample. However, to assure the reliability of data, BDA needs to be complied with methodology and external regulations.
Belgian auditors are not completely abandoning sample-based audits. In their opinion, samples are still necessary for certain procedures within the audit process. As EY states on 2 May 2018: “We are auditing the virtual world when using BDA, whereas the purpose of our profession is to audit the real world. The link between these two worlds is the reliability of data and for this we still need sampling.” One example of sample based auditing is sending out confirmations to an organization’s clients and suppliers. Confirmations are a form of external evidence that is situated on a higher level than IPE. Samples are therefore sufficient enough in this case. Besides confirmations, the analysis of exceptions that emerge from analyzing the entire process is also subjected to sampling. In that case, the source documents of the selected exceptions will be verified. Professional judgment will thus always be a task for the auditor despite the possibilities of BDA.

BDA is not possible for every organization. Some entities cannot deliver the required data. Additionally, it can happen that different databases of a client are not linked with each other, which makes it very difficult to apply BDA. Full population examination has three major challenges to overcome. The biggest of them all is the tenacious mentality of the traditional auditors towards BDA and full population examination. They are unwilling to change their ways of auditing. Second, information overload has become an even bigger challenge due to the ability of covering 100% of the population. Finally, auditors cannot rely on BDA blindly as professional judgment remains necessary throughout every audit. BDA does not only changes the way auditors work but also has in impact on the client. Although some Belgian audit firms state that the workload for clients to deliver data will not increase, others express the distrust of clients. In their opinion, clients are not used to deliver data or answer questions that were never asked before and therefore they will not easily cooperate.

5.2.3 Impact on the Audit Phases
Belgian auditors believe that BDA has an impact on all the phases within an audit process. In the first phase, risk assessment, auditors are able to obtain more data thanks to BDA. During the analytical procedures and test of controls, auditors are able to record everything and track exceptions much faster because they own all logs of each transaction. At last, the substantive procedures are changing completely due to the possibility of full population examination. In addition, BDA will not have an effect on the time spent on an audit. However, financial auditors and data experts will have to work more closely together to fully execute BDA.
5.3 Basic Concepts

5.3.1 Materiality
There is no need in changing materiality despite the rise of BD and BDA according to Belgian audit firms. They even state that materiality becomes more important these days. The underlying reason is that BDA causes information overload. Applying the concept of materiality can reduce the large number of exceptions that need to be verified. If materiality is abolished, auditors will drown in all the workload that BDA produces. Materiality will remain a threshold of what is important for shareholders and other users of financial statements. The rise of BD and BDA will not change this fundamental principle. On top of this, the purpose of an auditor remains to report on the true and fair view of the financial statements and not on the accuracy of the annual accounts. The principle of an auditor continues providing reasonable assurance.

5.3.2 Independence
There are two kinds of independence: independence in appearance and in mind (ISA 200). First, independence in appearance is how the public interprets an auditor’s independence. Second, independence in mind reflects the attitude of an auditor to act independently. The duty of an auditor will always be to act for the public and general interest. Therefore, the independence of an auditor does not depend on BD and BDA according to Belgian auditors. Additionally, an auditor can never possess too much information about a client. However, seeing everything that is going wrong within an organization can be challenging. Auditors will have to make sure not to intervene because otherwise they will control their own-implemented procedures.

5.3.3 Causation
Cao et al (2015) state that auditors will have to interpret data from another point of view due to new data characteristics and the use of BDA. This different interpretation will result in a paradigm shift from causation to correlation. Belgian auditors argue that causation will not transfer into correlation but both will be applied in combination with each other. BDA makes it possible to cover 100% of the population but auditors are not auditing the full 100%. They use correlations to create insights on a certain process and its procedures. Afterwards auditors use causation to verify certain unexpected patterns or exceptions that resulted from the correlation analysis. They will look into source documents and will ask for underlying explanations. In addition, causation is still very important to verify the quality of a client’s data. BDA analyzes all data that is available in a client’s ERP system. However, auditors will need to know how this data was entered into the ERP system. As long as they do not verify the accuracy and reliability of this data, BDA is useless.
5.4 Frequency of the Audit

Belgian auditors are able to extract information more easily because of BDA. This makes it possible to extract data more than once a year. It also will not take auditors extra time to do this. So in theory CA has great potential. However, it is not that simple in practice. It’s easier for internal auditors because they are already directly connected with the finance department of their organization. The implementation of CA is therefore mainly dependent on the method that is in place to obtain data from a client. While some Belgian audit firms are using an online platform, others have already invented a software program that is installed on their client’s system. For the latter, CA is within close reach because they can extract information directly from their client. Nonetheless, most Belgian audit firms do not own such a tool and are even skeptical about the fact of being connected with a client 24/7. Some of them argue that CA will make an auditor become part of a client’s organization. At that moment, auditors will feel the urge to intervene when they see that the company is having troubles, which will affect their independence. In addition, some Belgian auditors consider it too much of a risk to link their tool with a client’s system. They are afraid that the tool will shut it down. However, it is not all up to the auditors. Clients must also want to participate. Some might be very enthusiastic and will cooperate immediately, while others will keep their distance. Aside from the willingness of the clients, CA is not feasible for every organization (Warren et al, 2015). The organization must posses a solid ERP system such as SAP, Microsoft 365 or Navision to make CA possible. Many small and medium enterprises do not own one of these systems. Switching to another ERP system is very expensive which will make these enterprises no candidates for CA in the near future. Although CA has become a common topic within the auditing profession, Belgian audit firms do not or rarely carry out FSA more than once a year.

5.5 The Cost Aspect

BDA makes it possible to carry out full population examinations and to analyze tremendous data warehouses. This evolution will eventually affect the cost structure of an audit firm. Developing Big Data analytical tools is very expensive according to Belgian audit firms. However, the audit procedures will be much more efficient once these tools are in place. As a result, auditors will carry out the same audit in fewer hours. The fixed cost of developing analytical tools will have to be weighed with the variable personnel costs. Auditors will have to decide if they want to charge an additional fee to their clients or not. This is a difficult decision because the Belgian auditing profession is already undergoing a price war and prices have dropt significantly the past ten years. The financial crisis is probably the biggest cause of this. However, some Belgian auditors are in favor to charge their clients an extra fee. Their new cost structure might transfer from Hour x Price = Amount to Hour x Price = Amount + Technological Aspect = Total Amount.
Nonetheless, similar to CA, the attitude of the clients towards BDA will have to be considered as well. Some clients will recognize the extra value of BDA and will not mind to pay extra, while others want to get rid of the auditor as soon as possible every year. It also depends on how far auditors want to go with BDA. It cannot become a summation of using the traditional way and BDA during an audit. Auditors must find a balance between these two in order to carry out an audit with the same audit fee of today. The first year it will be a considerable investment to introduce BDA as a standard in audit procedures. However, in the following years, these costs will be compensated by benefiting fully from BDA. The Belgian audit firms realize that they have to go with the flow of BD and BDA otherwise they will get behind and will not be able to compete with their rivals anymore.

5.6 Competencies of the Auditor

Competencies of the auditor are at stake due to new types of data and new technologies according to Belgian audit firms. In this new BD environment, IT knowledge becomes an important part of an auditor’s skill set. This knowledge is currently located at the IT department. Although examples such as insight on system configuration and data extraction will always be part of this department, auditors of the future need to become technology savvy. Belgian auditors should not be able to look behind the tools but they need to acknowledge that there is a system behind the figures. They should not be afraid to handle new applications and software. In addition, auditors of today need a good understanding of Excel and the operation of an ERP system. They need to recognize the difference between a server and a database, a number and a field, etc. However, Belgian auditors state that economic knowledge such as accounting, company law, IFRS and consolidation will always overrule IT know-how. Nonetheless, the Belgian auditing profession is in need of people with an analytical mindset. Auditing is about using common sense and not just checking things off a list. Some auditors state that competencies such as interpreting data, pattern recognition and handling information overload is something to learn on the job and not something to be taught beforehand. “With the rise of CA it might also become continuous learning” (EY, 2 May 2018). Others believe that these skills should already be taught at universities. Therefore, the education of auditors will need to be transformed.

Belgian auditors believe that secondary and higher education needs to incorporate more IT and computer skills. Courses should be linked together instead of treated as separate subjects. Hereby, students will acquire analytical skills. Belgian auditors believe that this mindset should apply to all careers and not only audit. In addition, more practical knowledge needs to be introduced. Unfortunately, where there must be something more (IT), there also must be
something less (other courses). Belgian audit firms also generate internal training for new auditors. Some state that by then it is already too late for graduate students to pick up analytical knowledge. Others state that internal training will help graduate students to become aware of BDA. However, the approach of this training will change due to higher expectations of clients. In general, the ideal auditor is a combined profile between three careers: a civil engineer, who possesses analytical skills; a business engineer, who possesses IT skills; and a student business economics, who possesses business and economical skills (Mazars, 4 May 2018).

5.7 Standards

The Belgian auditing profession is experiencing a major challenge in certain parts of the traditional audit procedures. The regulator plays a certain role in this interest. However, the opinions about the attitude of the regulator are divided between Belgian audit firms. Some state that the attitude of the regulator towards BDA has shifted from being reluctant to favorable. Others expect the regulator to promote and even demand the use of BDA. However, in their opinion the regulator is not doing this and they feel that he even tends to go back to the traditional way of auditing. Finally, there are some auditors who believe that it’s all up to the audit firm to take initiative. They are leaving the regulator aside. Auditors themselves need to create methodologies on top of ISA to comply with the demands of a BD environment. Although the opinions about the role of the regulator vary, Belgian auditors do agree on the outdated aspect of the standards. Standards need to be adjusted to the BD environment. According to the Belgian audit profession, standards on sampling (ISA 530) should include the possibility of full population examination. In addition, the standard on training and proficiency of the auditor (AS 1010) should be adjusted to incorporate IT knowledge and analytical skills. At this moment, the IAASB is modifying two standards namely ISA 500 (Audit Evidence) and ISA 315 (Risk Assessment) to the use of BDA (IBR, 2018).

Although changing the standards is a requirement, auditors should not forget that standards must remain something general. In addition, not all organizations will be able to fully rely on BDA. Therefore, some Belgian auditors demand for a new standard, which is solely about BDA and its applications. They state that ISA should also give an auditor more guidance and should provide extra brochures or practical guides. The modification of certain standards could also change the attitude of auditors towards BDA. While some Belgian auditors continue to defend their point of view that it’s all up to the auditor to take initiative, others are sure that the modified ISA will encourage and even obligate auditors to use BDA. If not, a quality difference will rise because of the fact that one audit firm might use small samples while the other is covering
100% of the population. This could result in other conclusions while both audits will be ISA compliant.

5.8 Other Challenges observed by the Professional
The biggest extra challenge that came forward from the interviews was time. Change needs time. BDA is currently not applicable for all organization and this will not change from one day to the next. However, auditors are obligated to go along with the trend of BD and BDA. Otherwise they will fall behind and never recover again.

5.9 Summary
The Belgian auditing profession is facing many challenges due to the rise of BD. Audit firms are trying to come up with remedies to handle new types and volumes of data. On the next two pages, Table 7 will provide a summary of these eight main challenges within the auditing profession and the attitude of the Belgian auditors towards these challenges.
<table>
<thead>
<tr>
<th>Major Challenges</th>
<th>Belgian Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Big Data</strong></td>
<td>- BD is defined as a tremendous amount of available data</td>
</tr>
<tr>
<td></td>
<td>- Data = Information Produced by the Enterprise</td>
</tr>
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<td></td>
<td>- Traditional data + NFD (but hardly unstructured and external data)</td>
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<tr>
<td></td>
<td>- Extraction: direct (less risk) or copies (more risk)</td>
</tr>
<tr>
<td></td>
<td>- Information overload due to incapability of clients to deliver data</td>
</tr>
<tr>
<td></td>
<td>- Pattern recognition and data interpretation</td>
</tr>
<tr>
<td></td>
<td>- Privacy by design + standard policies + GDPR</td>
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<tr>
<td></td>
<td>- Data stored on secure servers</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td><strong>Big Data Analytical Tools</strong></td>
</tr>
<tr>
<td></td>
<td>- Internal generated tools + commercially available software</td>
</tr>
<tr>
<td></td>
<td>- Analyze entire processes + more thorough analysis</td>
</tr>
<tr>
<td></td>
<td>- Knowledge about BDA is located at the IT department</td>
</tr>
<tr>
<td></td>
<td>- Documentation is essential</td>
</tr>
<tr>
<td><strong>Full Population Examination</strong></td>
<td>- Cover 100% of the population</td>
</tr>
<tr>
<td></td>
<td>- Performed on business processes (e.g., sales process)</td>
</tr>
<tr>
<td></td>
<td>- Sampling still used within several parts of the audit process</td>
</tr>
<tr>
<td></td>
<td>- Limitations from the client: software and mentality</td>
</tr>
<tr>
<td></td>
<td>- Information overload has become a bigger issue because of this</td>
</tr>
<tr>
<td></td>
<td>- Professional judgment becomes more important</td>
</tr>
<tr>
<td><strong>Audit Phases</strong></td>
<td>- Impact on all phases</td>
</tr>
<tr>
<td></td>
<td>- Requirement to work together with experts</td>
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<tr>
<td></td>
<td>- No difference in time use compared to sample based auditing</td>
</tr>
<tr>
<td><strong>Basic Concepts</strong></td>
<td><strong>Materiality</strong></td>
</tr>
<tr>
<td></td>
<td>- Remains necessary due to information overload</td>
</tr>
<tr>
<td></td>
<td>- Purpose of the FSA is reasonable assurance</td>
</tr>
<tr>
<td></td>
<td>- True and fair view versus correctness of financial statements</td>
</tr>
<tr>
<td><strong>Independence</strong></td>
<td>- Depends on the mindset of the auditor</td>
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<tr>
<td></td>
<td>- Auditors can never have too much information about a client</td>
</tr>
<tr>
<td></td>
<td>- Danger of intervening in a client’s organization</td>
</tr>
<tr>
<td>Major Challenges</td>
<td>Belgian Attitude</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **Basic Concepts**  | **Causation**  
- No shift but combination of both  
- Correlation: obtain insights on processes  
- Causation: verifying unexpected patterns and exceptions  
- Important to verify data that has been inserted in an ERP system |
| **Frequency of the Audit** | **Continuous Auditing**  
- Possible in theory  
- Already used by internal auditors  
- Depends on the method in place to extract data  
- Different audit opinions on being directly connected to a client  
- Requirement: ERP system that can handle CA  
- Willingness of clients needed to cooperate  
- Hardly applied in Belgium |
| **Cost Aspect**      | - Developing BD analytical tools is very expensive  
- The result of using BDA is a more efficient audit  
- The two aspects above need balancing  
- Different attitudes of clients towards extra audit fee  
- Cost depends on how far auditors go in using BDA |
| **Competencies of the Auditor** | - Economic knowledge is most important  
- Analytical mindset and basic knowledge on ERP systems and Excel  
- Data interpretation, recognizing patterns and dealing with information overload is learned on the job  
- Education: more IT, analytical skills and practical knowledge  
- Internal training needs to be modified |
| **Standards**        | - Different opinion on the role of the regulator  
- Standards on sampling, proficiency of the auditor, audit evidence and risk assessment need alternation  
- New standard solely on BDA  
- More guidance + brochures  
- Standards will encourage/obligate auditors to use BDA otherwise quality differences will rise  
- Initiative stays with the auditor to implement BDA |
| **Other Challenges** | - Time                                                                                                                                 |

Table 7: Summary of the Results from the Qualitative Research
6 Conclusion

This dissertation investigated the changes that might be observed in the audit profession due to the rise of BD. In addition, the attitude of the Belgian auditing profession towards these changes was examined. The literature review revealed six major changes, namely changes in: collection of evidence, basic concepts, timing of the audit, cost structure, competencies of the auditor and standards. These changes were translated into eight different challenges for the Belgian auditing profession. Verifying the relevance and reliability of new types of information is one of them. Belgian audit firms are recognizing the problem of data acquisition, information overload, pattern recognition and privacy and security issues. In order to deal with these challenges they developed different tools to extract data themselves, they pre-select data, apply privacy by design and use secure servers. In addition, they started to develop analytical tools with which they can carry out full population examinations. Although this has generated more value for their clients, several limitations such as incompatible software make it impossible for certain organizations to use BDA. In addition, some organizations are not convinced when it comes to BDA and full population examination. All audit phases will be affected by the use of BDA. Nonetheless sampling will still be used to conduct certain parts of the audit process such as sending out confirmations. All these modifications are a first step towards CA. Although research (AICPA, 2015; Krahel et al, 2015) has revealed that CA enhances audit quality and client services, many Belgian audit firms are hardly conducting an audit more than once a year. In addition, Belgian auditors have different opinions about being directly connected to a client. BD analytical tools will also have to be in line with audit regulations. ISA is becoming outdated and need several adjustments. Standards on sampling (ISA 530), proficiency of the auditor (AS 1010), audit evidence (ISA 500) and risk assessment (ISA 350) are some examples. A new specific BD standard and practical guides should also be put forward. Nevertheless initiative will stay with the auditor to implement BDA. Auditors will also have to extend their knowledge on IT, analytics and recognition of patterns. Reshaping the education system can be of help in realizing this. In addition, internal training needs to be modified due to higher expectations of clients. While authors (Cao et al, 2015; Brown-Liburd et al, 2015) state that basic concepts, such as materiality, independence and causation will be at stake, Belgian auditors do not agree. They believe that materiality and causation will become more important than ever, while their independence will not be harmed. Finally, the cost structure of an audit will experience a major transformation. The cost of an audit can evolve in two directions. It can increase because of the expensive developing cost of analytical tools or it can decrease because analytical tools will make an audit more efficient. Belgian auditors believe that both will eventually balance each other out. To conclude, the Belgian auditing profession realizes that it has to go along with the trend of BD and BDA. However, “change needs time and patience is a virtue” (EY, 2 May 2018).
7 Limitations and Further Research

This master’s dissertation on the impact of BD on FSA is subject to certain limitations. First of all, the scope of this study can be criticized. Only three companies were selected to participate in the research. Nonetheless, all of them possessed sufficient knowledge about BD and BDA and the impact of BD on the general auditor. However, due to temporal limitations, follow-up interviews with the interviewees and interviews with additional audit companies were not possible. Secondly, data collected through the interview process can be biased because the questions were subject to the interpretation of individual interviewees. Therefore, a general view of the Belgian audit profession was not always feasible.

Further research should be conducted to investigate the impact of different events such as GDPR and modified standards on the use of BD and BDA in the audit profession. Additionally, other changes may rise due to time and evolution of BD and BDA. This could also represent an opportunity for further research.
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Appendix 2.1: The Four V’s of Big Data (Source: IBM, 2012)

**The FOUR V’s of Big Data**

- **Volume**: Scale of Data
  - 40 Zettabytes by 2020, an increase of 300 times from 2009
  - 6 billion people have cell phones
  - 2.5 quintillion bytes of data are created each day
  - Most companies in the U.S. have at least 100 terabytes of data stored
  - The New York Stock Exchange captures 1 TB of trade information during each trading session
  - Modern cars have close to 100 sensors that monitor items such as fuel level and tire pressure

- **Velocity**: Analysis of Streaming Data
  - By 2015, it is projected there will be 18.9 billion network connections
  - Almost 2.5 connections per person on earth

- **Variety**: Different Forms of Data
  - Over 400 million tweets are sent daily by about 200 million monthly active users
  - As of 2011, the global size of data in healthcare was estimated to be 150 exabytes
  - 30 billion pieces of content are shared on Facebook every month

- **Veracity**: Uncertainty of Data
  - 1 in 3 business leaders don’t trust the information they use to make decisions
  - 27% of respondents in one survey were unsure of how much of their data was inaccurate

**Sources**: McKinsey Global Institute, Twitter, Cisco, Gartner, EMC, SAS, IBM, WEFTEC, QPS
## Appendix 2.2: Illustrative Uses of Extended Audit Evidence (Source: Vasarhelyi, Kogan & Tuttle, 2015)

<table>
<thead>
<tr>
<th>Data</th>
<th>Use 1</th>
<th>Use 2</th>
<th>Use 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security videos</td>
<td>Confirm receipts and exit of materials</td>
<td>Confirm shipping costs</td>
<td>Observe/deter fraud</td>
</tr>
<tr>
<td>News videos</td>
<td>Help in marketing</td>
<td>Warn of management or employees activities</td>
<td>Observe/deter fraud</td>
</tr>
<tr>
<td>Social networks</td>
<td>Evaluate consumer satisfaction and product defects</td>
<td>Support clients with technical problems and confirm technical support costs</td>
<td>Observe/deter fraud</td>
</tr>
<tr>
<td>RFID</td>
<td>Confirm inventory</td>
<td>Confirm/measure shipping</td>
<td>Link to price databases and estimate cost of goods sold</td>
</tr>
<tr>
<td>Web hits</td>
<td>Predict purchases</td>
<td>Predict revenue</td>
<td>Predict sales, cost of sales, geographic sales, product mix</td>
</tr>
<tr>
<td>Inbound mobile calls</td>
<td>Predict service costs</td>
<td>Monitor employees and estimate employee costs</td>
<td>Observe/deter fraud</td>
</tr>
</tbody>
</table>
Appendix 2.3: Examples of Structured and Unstructured Data (Source: IIA, 2017)
Appendix 3.1: An Illustration of the Blockchain Technology (Source: PwC, 2017)

A look at
blockchain technology

What is it?
The blockchain is a decentralized ledger of all transactions across a peer-to-peer network. Using this technology, participants can confirm transactions without the need for a central certifying authority. Potential applications include fund transfers, settling trades, voting, and many other uses.

How it works:

Someone requests a transaction.
The transaction is complete.
The new block is then added to the existing blockchain, in a way that is permanent and unalterable.

Benefits

- Increased transparency
- Accurate tracking
- Permanent ledger
- Cost reduction

Unknowns

-Complex technology
- Regulatory implications
- Implementation challenges
- Competing platforms

Cryptocurrency

- Has no inherent value in that it is not redeemable for another commodity, such as gold.
- Has no physical form and exists only in the network.

Potential applications

Automotive
Consumers could use the blockchain to manage fractional ownership in autonomous cars.

Financial services
Faster, cheaper settlements could shave billions of dollars from transaction costs while improving transparency.

Voting
Using a blockchain code, constituents could cast votes via smartphone, tablet or computer, resulting in immediately verifiable results.

Healthcare
Patients’ encrypted health information could be shared with multiple providers without the risk of privacy breaches.

Validation
The network of nodes validates the transaction and the user’s status using known algorithms.

A verified transaction can involve cryptocurrencies, contracts, records, or other information.

Once verified, the transaction is combined with other transactions to create a new block of data for the ledger.
Appendix 4.1: Interview Guide

Interview Guide: The Impact of Big Data on Financial Statement Auditing

Main Topic:
The impact of Big Data on Financial Statement Auditing

Research Questions:

III. What are the changes that might be observed in the audit profession due to the rise of Big Data?

IV. How is the Belgian auditing profession preparing for these changes?

Interview Guide – Categories

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Interview Guide

1. Big Data

   I. Does Big Data play a role in your daily work? If yes, how? Does this differ from the use of Big Data by an ‘average’ auditor?

   II. Which types of Big Data (financial, non-financial; structured, unstructured; internal, external data) do you use when performing an audit?

   III. Do you check the reliability/veracity of external data (obtained from outside the audited organization)? If so, how?

   IV. How are you obtaining data from your clients?

   V. What is your experience regarding processing information in a Big Data environment? (E.g. pattern recognition, information relevance, ambiguity, etc.)

   VI. Do you think there are any security or privacy issues concerning the use of Big Data?
2. Technology

I. Do you think Big Data Analytics are important for your work? If so, why and how?
II. What is your opinion towards providing audit evidence based on a small sample size?
III. Technology made it possible to carry out full population examinations. How do you think full population examination, compared to sample sized auditing, will affect the reliability and quality of the audit?
IV. Does your organization actually apply the full population examination method?
V. What are the downsides of auditing the entire database?
VI. In addition to being able to examine entire populations are there other major changes in the planning and approach of an audit?

3. Basic Concepts

I. Do you think that the concept of materiality becomes irrelevant because every detail of the organization can be examined with Data Analytics nowadays?
II. Will your independence be affected by e.g. starting to provide non-audit evidence or knowing too much about your client?
III. Due to the fact of analyzing tremendous sets of data, there has occurred a shift from causation to correlation. This means moving away from understanding the fundamental causes to simply identifying and making use of associations. What is your view on this matter? Have you experienced this firsthand?

4. Frequency of the Audit

I. Continuous auditing stated by Zhang, Yang, & Appelbaum (2015) is “providing assurance simultaneously with, or a short period of time after, the occurrence of events”. What is your view on this subject?
II. Does the audited company need specific characteristics to make it possible performing a continuous audit? If yes, what are these characteristics and do you have any clients who posses them?
III. How would you extract information on such a continuous basis? Is the client’s database continuously linked with yours or are they providing a copy of their database?
IV. Is or will this technique be effectively used in your company?
5. Cost Aspect

I. Do you think executing full population audits is more expensive than sample based auditing? Why?
II. Will the cost of buying compatible expensive software outreach the added value delivered by Big Data?

6. Competencies of the Auditor

I. How important are IT skills in your profession?
II. What is your opinion towards the education of future auditors today?
III. Which new skill set is required to perform an audit in this Big Data environment?

7. Standards

I. Where do you see the role of the regulator in this interest?
II. In your opinion, are standards becoming outdated in this emerging Big Data environment? If yes, how would you solve this issue?
III. Do you think modifying the standards will encourage auditors to use more Big Data (Analytics)?

8. Are there any challenges that have not been mentioned yet during this interview but which are of important value?