The Impact of Intelligent Systems on Management Accounting

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ABSTRACT

In today's competitive and changing business environment, the concern about technologies and intelligent systems has gained more notoriety. However, companies still have many tasks performed by humans; in the medium-term, intelligent systems will become more present in companies and will perform tasks that are currently done by humans much more efficiently. There is a need for companies to adapt and to start thinking about combining human and intelligent systems capabilities. This research was focused specifically in the management accounting profession, as these professionals spend a lot of time collecting and organizing data, doing repetitive tasks that can be easily and quickly accomplished by intelligent systems. This research studied the impact that artificial intelligence, big data, and internet of things can have in this profession.

KEYWORDS

Artificial Intelligence, Big Data, Internet of Things, Management Accounting

1. INTRODUCTION

In an era of increasing digitalisation of services, it has become necessary for companies to adapt and change to meet demands, as well as integrate the new emerging technologies in their structure and study their impact across the company. The intense competition that companies face and the challenge of staying differentiated and be competitive in nowadays market has led organizations to start to realize the importance that emerging technologies have for the success of a company. Artificial Intelligence (AI), Big Data and Internet of things (IoT) are three intelligent systems increasingly used by companies. The integration of this technologies in organizations structures remains to be very relevant because it will impact the way people work, deal with information, and is set to soon invade the businesses world (Quan & Sanderson, 2018).

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The impact of these 3 intelligent systems on management accounting is very pertinent to study, as management accountant's role involves processing huge amounts of information and then communicating it to managers. Then, managers use accounting information to make important decisions. Therefore, study ways to simplify the daily tasks of management accountants will have a big impact in the speed and quality of the decision, which will allow the development and application of effective managerial decisions which will serve as a fundamental prerequisite for a company's competitiveness in the nowadays market (Nicoleta, 2019; Rybicka, 2018; Zahid & Vagif, 2020).

This research has as its main objective to analyse and study the impact of Big Data, AI and IoT on management accounting, by answering to four research questions: (i) How does IoT impact management accounting? (ii) How can Big Data and AI improve management accountants' processes? (iii) What is the possibility of implementing AI, for decision making, in management accounting? (iv) What will be the shifts in management accounting profession with the massive introduction of intelligent systems into day-to-day tasks?

The structure of this paper is as follow: Section 1 presents the literature review about intelligent systems and management accounting; Section 2 includes the methodology; Section 3 contains the presentation and discussion of the results; and Section 4 presents the final conclusions, limitations, and suggestions for future research.

2. LITERATURE REVIEW

2.1. Intelligent Systems

2.1.1. Artificial Intelligence

AI is distinct from previous generations of information technology in that it can learn and update using data. The input for the learning is data, which can include text, audio, and video and can be contextual or non-contextual. The ability to learn from various types of data and learn from a massive amount of data and update thoughts or actions is what makes us consider a machine to be intelligent (Floridi, 2019; Huang et al., 2019). The methods by which AI learns from data are various computational methods, with machine learning and deep learning being especially important methods, the output of the learning is AI performance (Lewis & Denning, 2018). Huang *et al.* (2019) state that AI converts data into performance in three qualitatively different ways, which they refer as AI intelligences. Some AI systems are mechanically intelligent, designed to perform repetitive tasks for consistent results; some AI systems are thinking-intelligent, designed to learn and adapt from data autonomously and some future AI systems may become feeling intelligent, designed to interact with people and respond appropriately to human emotions ("Big Data Business Landscape In The Age Of Infonomics," 2021). In the last period, AI has rapidly developed improved thinking capability. This industry transformation is called Industry 4.0 takes production to another dimension of performance, flexibility, and mobility. The idea of Industry 4.0 emphasizes the role of integration of complex physical machines and devices with sensors and network software used for controlling, planning and forecasting, ensuring better results (Grabowska, 2020; Hermann et al., 2016; Richins et al., 2017).

2.1.2. Internet of Things

Kevin Ashton proposed the definition of IoT in 1999, he defined it as "uniquely identifiable interoperable connected objects with radio-frequency identification (RFID) technology" (S. Li et al., 2015). More recently as proposed by Rouse *et al.* (2019), IoT is viewed as "a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction" (*IoT Agenda 2019*, n.d.). The essence of IoT is really not in devices but rather in data gathering, processing and analyzing (Rybicka, 2018). The unique features of IoT include extreme heterogeneity, large scale data, variety, unstructured feature, noise, high redundancy

massive number of devices, and unpredictable dynamics partially due to human interaction (F. Li et al., 2020). The increase adoption and improvement of IoT is possible due to the rapid development of enabling technologies such as big data analytics, cloud computing, AI, control systems and wireless sensor networks (Goyal et al., 2020; F. Li et al., 2020; S. Li et al., 2015; Mohanta et al., 2020). IoT and AI combine can improve the analysis of the system, operational efficiency, save unnecessary expenses (Aboltins et al., 2020), detect possible mishap and failures in advance and improve the accuracy rate (Mohanta et al., 2020).

2.1.3. Big Data

The concept of big data has been defined in 2001 when analyst Doug Laney defined the increase of data with a 3Vs model, which considers the volume, velocity, and variety of data (Félix & Thomas, 2004). A few years later, experts have also identified other aspects that are crucial for companies to keep in mind if they want to make the most of their data. Since Laney's original work, another two concepts have been added, veracity and value. Veracity, refers to the "trustworthiness" of data, the quality of it such as correctness, consistency, trust, security and reliability (O'Leary, 2015; Rowe, 2016; Younas, 2019). Value refers to the different types of benefits that can be derived from processing and analyzing big data (Younas, 2019). S Big data now is defined as "a large volume of complex, structured, semi-structured and unstructured data that are generated in a large size and that arrive (in a system) at a higher speed so that it can be analyzed for better decision making and strategic organization and business moves" (*What Is BIG DATA? Introduction, Types, Characteristics & Example*, n.d.; Younas, 2019). Big data are generated from an increasing plurality of sources including web, mobile transactions, IoT, enterprise resources planning (ERP) systems[1], publicly available data, cloud platforms, private data, user-generated content, social media as well as purposefully generated content through sensor networks or business transactions (Choi et al., 2018; George et al., 2014). Nowadays, there are a range of specialized techniques for analyzing Big Data, businesses typically use one of three computational models to deal with large data sets: data mining, ANN, and machine learning (Grable & Lyons, 2018).

2.1.4. Intelligent Systems and Management Accounting

The definition of management accounting stated by Institute of Management Accountants (2019) is the following: "Management accounting is a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy" (Rybicka, 2018)(Rybicka, 2018). The main role of management accounting can be defined as an integrated system of cost and income accounting, rationing, planning, control and analysis, which provides information for operational management decisions and coordination of possible problems of the future development of the company (Zahid & Vagif, 2020).

According to accountancy specialists, traditional costing and measurement systems are almost incompatible with the use of these emerging technologies (Haenlein & Kaplan, 2019). These methods lead to obtain late and unhelpful information, they are characterized at some extent as ineffective, leaving the place for modern calculation systems to suit the current requirements (Bhimani, 2020; Nicoleta, 2019). Therefore, management accounting will be disrupted by new technologies, like big data, AI, blockchain[2], machine learning and robotics process automation (Lawson, 2019). Management accounting transformation is needed, an adaptation to the realities and exigencies of the present, the modification of the tools, processes and work methods in order to respond to the current economy (Nicoleta, 2019).

IoT and Big Data systems, combined with the use of intelligent algorithms, can significantly helping companies in several dimensions: time saving, helping firms cut costs, intelligent decision making, strategic business moves, helping in customer relationships, allowing managers to detect problems within a business structure and ultimately can enhance production efficiency and

competitiveness and has the potential to revolutionize the structure of an organization (Chen et al., 2014; Ghasemaghaei & Calic, 2020; Grable & Lyons, 2018; McAfee & Brynjolfsson, 2012; O'Leary, 2015; Rybicka, 2018).

When access to information is instantaneous, alternatives can be evaluated on the moment, actions can test, and alternatives can be compared in parallel. Intelligent systems have the potential to completely change management accounting functions. It will impact management accounting controls, information and decision making, not only in the way decisions are made, but also in terms of processes and competences. This will reshape the managerial process placed on more traditional information (Bhimani, 2020; Rybicka, 2018).

By using big data analytics, management accountants can broaden their controlling and monitoring techniques providing the power to identify areas of improvement and some opportunities (Bhimani, 2020; Richins et al., 2017; Rybicka, 2018). There are various opportunities for management accounting such as: integration of new data channels, include unstructured data, automatic generation of data, cost and time optimization, real-time data, improvement of operational and strategic planning, as well as improvement of decision support for highest level on managers (Rybicka, 2018). On the other hand, there are some challenges for management accountants such as: overload of information and data veracity, changing cost structure, take wrong decisions much more quickly than before and lack of resources (insufficient people with knowledge in this area) (Gärtner & Hiebl, 2018; Quattrone, 2016). Moreover, the digital revolution has challenge transparency, unveiling data that were not presupposed to be made transparent (Quattrone, 2016). Despite this challenges, big data offers a new opportunity for management accountants to play an active role in data creation and decision support (Rikhardsson & Yigitbasioglu, 2018; Rybicka, 2018).

In recent years, the convergence of AI and Big Data in the management accounting area is acquiring popularity (Pilipczuk, 2020). Big data and AI bring opportunities for better decision-making (Comaniciu, 2020; Elliot et al., 2020). Continuous progress in AI and machine learning, coupled with a growing ability to analyze Big Data will change task structures within the accounting profession, and this will provide opportunities for accountants to leverage their current skills in conjunction with newly acquired ones (Richins et al., 2017).

Technology is transforming the role of management accountants at an unprecedented speed (IMA, 2019). These new technologies will have a major impact on cost management and decision making (Rybicka, 2018). Intelligent systems revolution will lead to the automation of the more repetitive tasks, allowing accountants to focus their attention on opportunities to provide value to their company (Richins et al., 2017). The deep integration of this emerging technologies will introduced giant changes, such as reengineering accounting procedures (change cost management and decision-making process), reducing information errors and distortions, improving efficiency and consequently promoting the transformation of accounting career structures (Rybicka, 2018; Zhang et al., 2020).

2.1.5. Challenges in Management Accounting Field to Adopt Intelligent Systems.

There's a huge space for the application of Intelligent Systems in the management systems. There are several reasons why it can be difficult to apply intelligent systems, such as machine learning and artificial intelligence, to management accounting ("Big Data Business Landscape In The Age Of Infonomics," 2021)

1. **Complexity of Data:** Management accounting involves complex data, such as financial statements, budgets, and forecasts. These data are often unstructured and may require human interpretation to understand the nuances.
2. **Lack of Data:** In some cases, management accounting data may be scarce or incomplete. This can make it difficult for intelligent systems to learn and make accurate predictions.

3. **Subjectivity:** Management accounting is often based on subjective judgments and estimates, such as the determination of inventory values or the allocation of overhead costs. These subjective factors can be difficult for intelligent systems to incorporate into their analyses.

4. **Regulatory Compliance:** Management accounting is subject to various regulatory requirements and standards, such as Generally Accepted Accounting Principles (GAAP) and International Financial Reporting Standards (IFRS). It can be challenging for intelligent systems to ensure compliance with these standards.

5. **Resistance to Change:** There may be resistance to implementing intelligent systems in management accounting due to concerns about job displacement or the loss of expertise.

6. Despite these challenges, intelligent systems have the potential to greatly enhance management accounting by providing more accurate and timely insights into financial performance, forecasting, and decision-making. As technology continues to advance and data becomes more readily available, we can expect to see increasing adoption of intelligent systems in management accounting (Quan & Sanderson, 2018).

3. METHODOLOGY

3.1. Research Model

This research is an exploratory research, and was conducted from a non-probabilistic sample for convenience[3], constituted according to the availability and accessibility of the elements addressed (Vilelas, 2009). In this case the data collection was through the application of questionnaires to accounting professionals and semi-structured interviews to intelligent systems professionals, from different nationally and internationally companies.

In the first phase, the online questionnaire was posted on LinkedIn, mentioning the objectives of it and with a Link in order to give access to the online questionnaire. In addition, professors, form ISCTE, with experience in the area of management accounting and asked for help with networking and dissemination of the questionnaire to colleagues and professionals in the field. The questionnaire was developed based on the literature review. It was constructed using the Google Forms[4] application associated with a Link to make possible its access through the internet before its application was validated by specialists. The questionnaire was voluntary and anonymous and was completed online. A total of 131 complete questionnaires were received. Data collection occurred between January 1st and 30th.

In a second phase, 18 interviews were conducted to experts in intelligent systems to understand their point of view about this theme and what benefits could these intelligent systems bring to management accountants daily tasks. The interviews were done online, through zoom platform, and took place between February 1st and 26th 2021. They were recorded, in audio support, for later transcription and analysis of content. They had an average duration of 20 minutes and were transcribed chronologically, in Word document format, with fidelity to the speech. 18 interviews were carried out because the answers given were already being repeated, thus reaching a loop. This value guarantees a certain degree of reliability according to (Vilelas, 2009), as it fit the parameters recognized by the author as acceptable, varying between 15 to 20 interviews.

In the Table 1 can be observed the relationship between objectives, research questions, questionnaire/ interview questions, data analysis technique and literature review which allows a succinct understanding of the origins of the present study. In the first column, it is possible to observe what the study objective is, in the second column which are the research questions, all of them originated from the literature review. The third column presents the question that were made in the questionnaire or in the interview with the purpose of collecting data to answer to the respective research question. The fourth column presents the data analysis technique used for each research question. Finally, the fifth column aims to indicate which authors gave rise to the respective research questions.

Table 1. Relationship between, objectives, research questions, data analysis technique and literature review

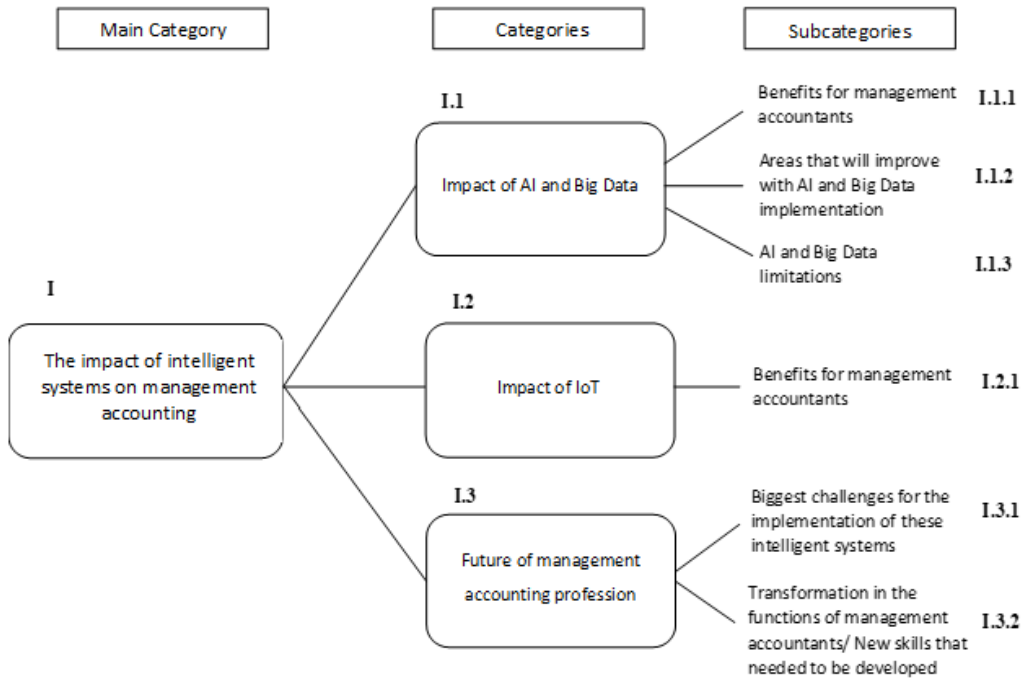| Objective	Research Questions	Questionnaire/ Interview	Data Analysis Technique	Literature Review
OBJ - Examine the impact of 3 intelligent systems on management accounting	*(Q1).* How does IoT impact management accounting? ..	*Management accountants* Questionnaire (12; 13; 13.1; 13.2; 14; 14.1)	*Management accountants* Descriptive analysis	Brous et al. (2020); S. Li et al. (2015); Pauget & Dammak (2019); (Wortmann & Flüchter, 2015)
		Intelligent systems (IS) professionals Interview (5)	*IS professionals* Content analysis from MaxQDA system	
	(Q2). How can Big Data and AI improve management accountants' processes?	*Management accountants* Questionnaire (1; 2; 2.1; 4; 5; 9; 10; 10.1; 11)	*Management accountants* Descriptive analysis	(Comaniciu, 2020); Richins et al. (2017); Rikhardsson & Yigitbasioglu (2018); Rybicka (2018); (Bhimani, 2020); Warren et al. (2015); Quattrone (2016), Zhang et al. (2020); Cubric (2020); Shrestha et al. (2019); Bolander (2019); Burrell (2016)
		IS professionals Interview (1; 2; 3)	*IS professionals* Content analysis from MaxQDA system	
	(Q3). What is the possibility of implementing AI, for decision making, in management accounting?	*Management accountants* Questionnaire (2.2; 3; 6; 8)	Smart-PLS	(Shrestha et al., 2019))(Pilipczuk, 2020); (Bitkina et al., 2020); (Siau, K., and Wang, 2018); (Petkov, 2020); (Güngör, 2020)
	(Q4). What will be the shifts in management accounting profession with the massive introduction of intelligent systems into day-to-day tasks?	*Management accountants* Questionnaire (7; 16; 17; 17.1; 18; 19)	*Management accountants* Descriptive analysis	(Lawson, 2019; Ratnatunga, 2016; Rybicka, 2018); (*How Artificial Intelligence Will Impact Accounting Industry?*, n.d.; Huang et al., 2019; Pilipczuk, 2020; Richins et al., 2017); (Bhimani, 2020); Nicoleta (2019); Sulaiman et al. (2015); Gärtner & Hiebl (2018); Cubric (2020); Dwivedi et al. (2019); Haenlein & Kaplan (2019); Robles Carrillo (2020); Quattrone (2016); (Comaniciu, 2020); Shrestha et al. (2019); Bolander (2019)
		IS professionals Interview (4; 6; 6.1; 7)	*IS professionals* Content analysis from MaxQDA system	

Source: Self-elaborated

3.2. Qualitative Methodology

In terms of the qualitative methodology used, this resulted from the analysis of the interviews that were carried out in the research question number 1, 2 and 4, seeking to measure the phenomenon under study. In terms of the qualitative analysis technique used to analyze the data from the interviews was used the (MAXQDA 2020) (Software, 2019). Through MAXQDA it was possible to classify relevant information from the various interviews carried out and then categorized according to the coding below Figure 1. Through the MAXQDA system, a word search was also carried out to make a general analysis of all the answers given to certain categories in order to be able later to present the results in graphs with the responses given by each interviewee. This allows to have an overview of answers most pointed out by the intelligent systems (IS) professionals for each of the categories.

Figure 1. Categorization and codification of the interview "corpus" for qualitative analysis
Source: Self-elaborated

3.3. Quantitative Methodology

In terms of quantitative methodology, it was used to carry out the treatment of collected data from the online questionnaires. In terms of quantitative was use in all research questions descriptive statistical analysis, using the exposure of the results obtained through tables and charts with a set of techniques and rules that summarized the information collected from the questionnaires. In the third research question was also applied analytical statistics in order to test the model (Figure 2).

To answer to the third research question, the dependent variable which corresponds to the probability of adopting AI, for decision making, in management accounting was measure using three independent variables: the value of AI for management accountants, the challenges in AI implementation and the level of trust in AI by these professionals to be possible AI implementation. These items were measured using a non-comparative evaluation scale, which allowed to evaluate each statement using a five- item scale, where 1 corresponds to very low and 5 corresponds to very high. Figure 2 presented the relationship between these five variables.

To validate the third research question, its purpose to evaluate the validity of the four hypotheses, which are appropriately presented bellow and are consequently theoretically framed in order to address its academic validity and relevance.

H1: The value of AI for management accountants positively relates with the probability of adopting AI, for decision making, in management accounting.

H2: The level of level of trust in information provided by an intelligent system positively relates with the value that AI have for management accountants.

H3: The level of trust in information provided by an intelligent system positively relates with the probability of implementing AI in management accounting.

Figure 2. Shows the conceptual model
Source: Self-elaborated
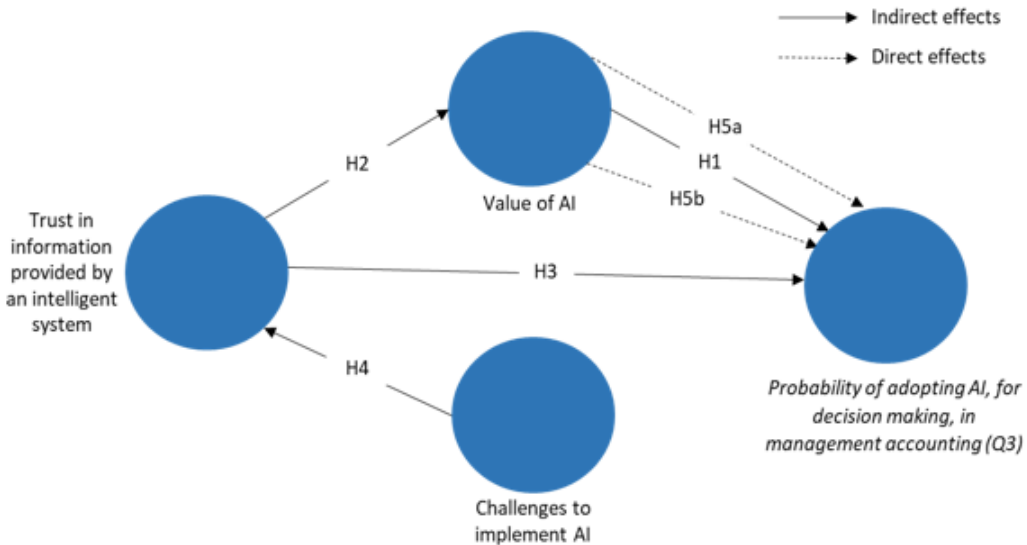
H4: The challenges in AI implementation negatively relates with the level of confidence in AI by management accountants.
H5a: The value of AI for management accountants mediates the relation between level of level of trust in information provided by an intelligent system and the probability of adopting AI, for decision making, in management accounting.
H5b: The value of AI for management accountants and the level of level of trust in information provided by an intelligent system mediates the relation between the challenges in AI implementation and the probability of adopting AI, for decision making, in management accounting.

To test the conceptual model above was used partial least squares (PLS), which is a variance-based structural equation modelling technique, by means of SmartPLS 3 software (Ringle et al., 2015).

3.4. Sample Characterization

Before analyzing the results, the sample was characterized. In terms of the questionnaire, 131 professionals participated in the survey, 55% of whom were female and 45% of whom were male. Regarding the age of the inquiries 6% were between 18 and 24 years old, 50% were between 25 and 34 years old, 16% were between 35 and 44 years old, 23% were between 45 and 54 years old and 5% were between 55 and 64 years old. Regarding qualifications, it appears that 10% have secondary education, 58% have bachelor´s degree, 21% have master's degree and 11% have a PhD. Finally, regarding the respondents' profession, 73% were accounting professionals[5], 15% were higher education professors in the management accounting area and 12% have other professions.

In terms of the interviews, 18 interviews were carried out, from these 18 interviewees 83% were male and 17% were female. Most of the respondents were from Portugal (15) and the remaining were from Brazil. In terms of age, 11% were between 25 and 34 years old, 5% were between 35 and 44 years old, 56% were between 45 and 54 years old, 22% were between 55 and 64 years old, and 6% were older than 65. Most of the respondents have a PhD (72%), 22% have master's degree and 6% have bachelor's degree. Regarding the profession 68% were higher education professors in the

Figure 3. Number of professionals that are aware of the concept IoT
Source: Self-elaborated
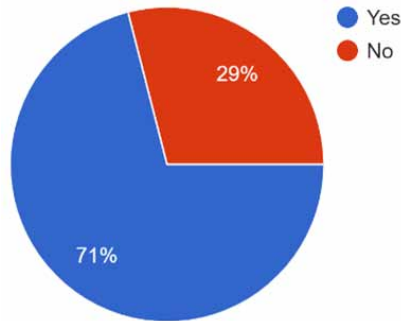
IT department, 17% were system analyst, 5% were engineer, 5% were IT project manager and the remaining 5% were CEO of a company.

4. PRESENTATION AND DISCUSSION OF RESULTS

4.1. The Impact of IoT on Management Accounting

With the objective of verifying how IoT impact management accounting, first was evaluated the answers from the 131 respondents in the questionnaire.

According to the reading of the Figures 3 and 4, it can be seen that 71% of the inquiries are aware of the concept of IoT but only 21.4% are currently using this intelligent system in their daily tasks. According with the Figure 5, from the participants that are not yet using IoT in any daily task, more than a half of them, more precisely 62,2%, planned to implement it in the future. However, the implementation of this intelligent system was more considered only in the medium term.

According to the Figure 6, 55.7% of the participants consider that integrating IoT in their daily work could have several advantages, only 9.2% consider that IoT doesn´t bring any advantages to management accountant's profession. According to the Figure 7, the three advantages of IoT that are considered as more substantial to management accounting for the inquiries are: use of real-time data to improve budget accuracy, use of real-time data for cost planning and forecasting and increase capacity for monitor the overall business processes.

Figure 4. Number of professionals that are already using IoT in their work
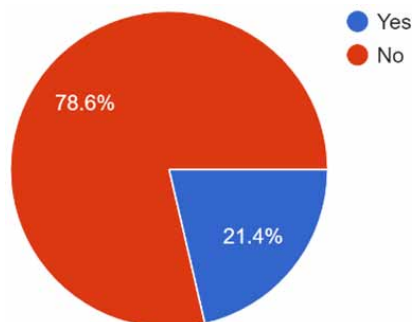*Source: Self-elaborated*

Figure 5. Number of professionals that don´t use IoT yet but are planning to implement IoT
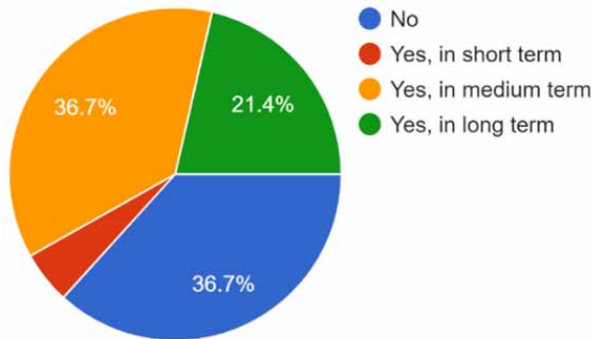*Source: Self-elaborated*

Figure 6. Number of professionals that consider that IoT could bring advantages for their work
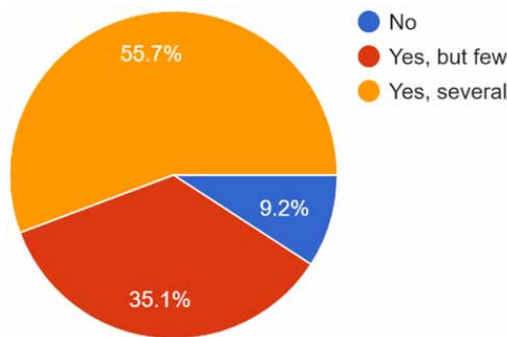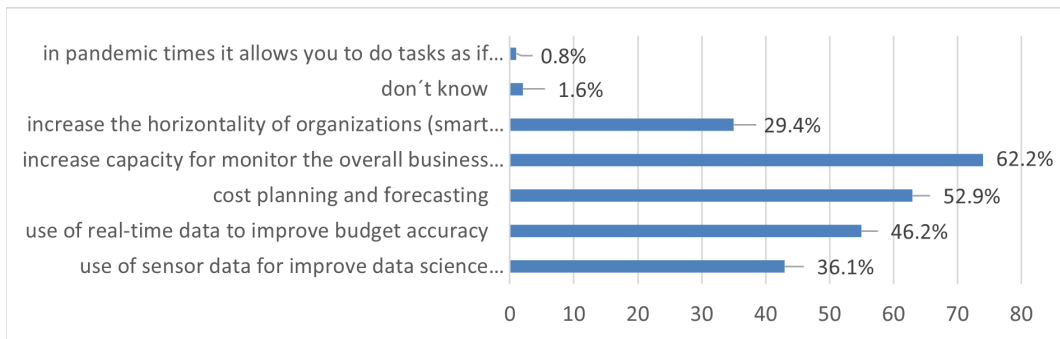*Source: Self-elaborated*

Figure 7. Benefits of IoT
Source: Self-elaborated

To have more relevant information related to this research question, a set of interviews with intelligent systems professionals was also carried out to complement the answers given in the questionnaires. By doing this is possible to match the views and knowledge of both. Bellow was evaluated the answers given by the 18 interviewees to the following questions: Do you agree that

IoT bring several benefits to management accounting? To what extent can IoT help management accounting professionals in their daily tasks?

Based on this assumption, does IoT bring benefits to management accounting, a global analysis of the responses of all interviewees was made (Figure 8).

According to the reading of Figure 8 and the Table 2 of the content analysis, 50% of the respondents agree that the IoT brings benefits to management accounting, the other 50% agree that IoT bring advantages but they are not sure if this technology has benefits specifically to management accounting, which is not in line with the answers given by the inquiries in the questionnaire, where 90.8% considered that IoT bring benefits to management accounting.

Based on the results from the questionnaire and the interview, it´s possible to answer to the research question – *How does IoT impact management accounting?* – The majority of the questionnaire and interview answers are in line with what was stated by the authors Brous *et al.* (2020) and S. Li *et al.*

Table 2. Content analysis – Benefits of IoT to management accounting

Content Analysis - Interviews			
Interviewee	**Text**	**Categories**	**Subcategories**
IS professional 2	I would say that yes, the fact that we have the arrival of data and treatment of that data and incorporation of that data in the existing knowledge in real time, when it is possible, which is not yet at this moment, will help a lot in that planning, or re-planning, in the decisions that are increasingly not taken to have an impact in a month or a year and are increasingly taken to have an impact in the next moment.	**I.2**	**I.2.1**
IS professional 3	I do not see directly that IoT will bring great advantages to management accounting. I think that IoT will bring concrete advantages to management, what I mean by this, I mean that the IoT in its various aspects allows to monitor in real time everything that is happening, essentially.	**I.2**	**I.2.1**
IS professional 4	It is a system that is automated, the data comes from the sensors and can be stored and quickly used and can be arriving all the time, it depends on the timeliness of the generation of this data by these sensors of what you want to collect and that can really impact because the data arrives faster and consequently being there can be processed faster.	**I.2**	**I.2.1**
IS professional 12	If we have a series of sensors that are communicating with a computer that makes certain decisions or provides information for decision making, I think this can be extremely useful, so I think so.	**I.2**	**I.2.1**

Source: Self-elaborated

Figure 8. Answers of interviewees (intelligent systems professionals) about the benefits of IoT for management accounting
Source: Self-elaborated
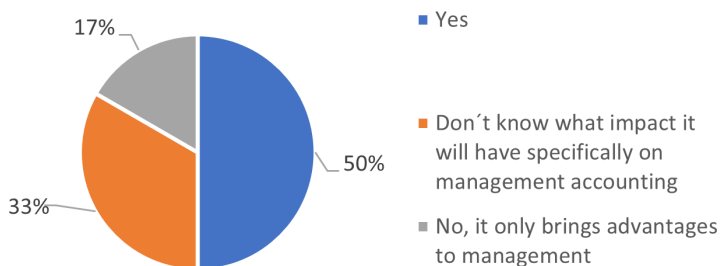
(2015), as it allows us to conclude that IoT will have a positive impact resulting from the availability of information that is automatically collected and share immediately over a network. Consequently, most of the results are also according with what was stated by Wortmann & Flüchter (2015) as the majority of respondents agree that IoT technologies will create additional value. The results are also in line with what was advocated by the authors Pauget & Dammak (2019) due to the fact that the respondents focus the advantage of IoT increase the capacity for monitor the overall business processes. However, none of these authors spoke about the direct impact of IoT in management accounting.

The answers given by the 90.8% of respondents in the questionnaire go beyond what was stated by these authors by affirm that this technology has a direct and positive effect specifically in their work as they considered that the use of real-time data will allow them to improve budget accuracy, cost planning and forecasting and increase capacity for monitor the overall business processes.

In the interviews 50% of the IS professionals also affirm that IoT bring benefits to management accounting, focusing the use of real-time data as the main advantage for management accounting professionals, some considered that IoT can have a positive impact in monitor everything in real-time, planning and in the decision-making process as management accountants can count with more data arriving much faster and consequently being there can be processed and used immediately. However, the other 50% agree that IoT bring advantages but they are not sure if this technology will impact management accounting profession.

4.2. The Impact of Big Data and AI in the Improvement of Management Accountants' Processes

With the objective of verifying how Big Data and AI impact management accounting, first was evaluated the answers from the 131 respondents in the questionnaire.

According to the reading of the Figures 9 and 10, it can be seen that 74.8% of the inquiries are aware of the concepts of AI and Big Data but only 25.2% are currently using at least one of these intelligent systems in their daily tasks. When asked in what task(s) they were using an intelligent system the answers were diverse but there was one that was referred with higher frequency, which was "Product allocation expenses, employee costs and forecasting".

According to the Figure 11, multiple and different areas were focused, with most participants agreeing that AI and Big Data will have an impact in several areas of management accounting. The answer with higher percentage was reporting and control, followed by cost management (change of costing and measurement systems).

According to the Figure 12, 99.2% of the participants agree that combine human and intelligent system-based decision making will bring advantages to management accounting processes. According to the Figure 13, it is possible to mention that all participants except 1 saw benefits in the

Figure 9. Number of professionals that are aware of the concepts Big Data and AI
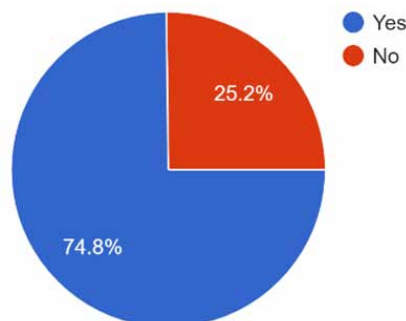*Source: Self-elaborated*

Figure 10. Number of professionals that are already using at least one of these intelligent systems in their work
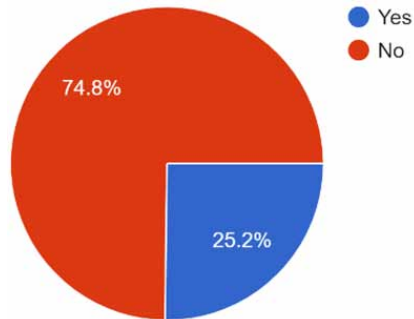*Source: Self-elaborated*

Figure 11. Areas where big data and AI have the greatest impact on management accounting
Source: Self-elaborated
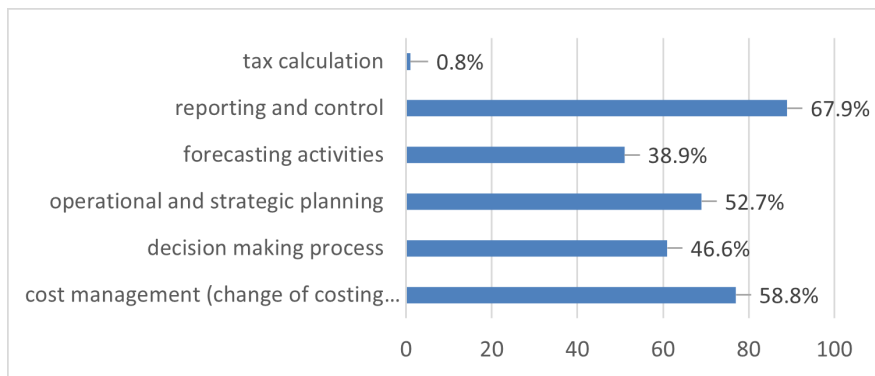
Figure 12. Number of professionals that consider that combining human and intelligent system-based decision making have advantages
Source: Self-elaborated
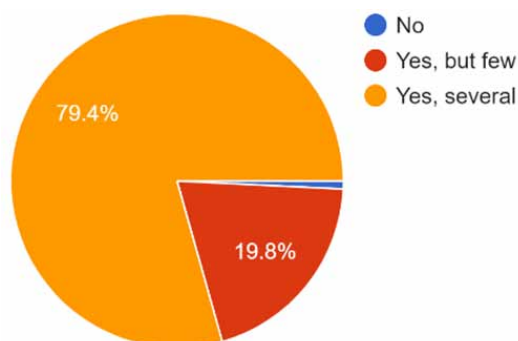
implementation of these intelligent systems. The benefits that more than a half of the 131 participants expect to have with the implementation of these technologies are cost and time optimization, reduction in human error, intelligent decision making (fast, accurate, repeatable) and increase in efficiency.

Figure 13. Benefits of big data and AI
Source: Self-elaborated

This is not in completely agreement with what was mentioned by Warren *et al.* (2015), and Rybicka (2018) that considered that the access to new data channels through Big Data will bring huge benefits to these professionals, only 27,5% of the inquiries agree with this.

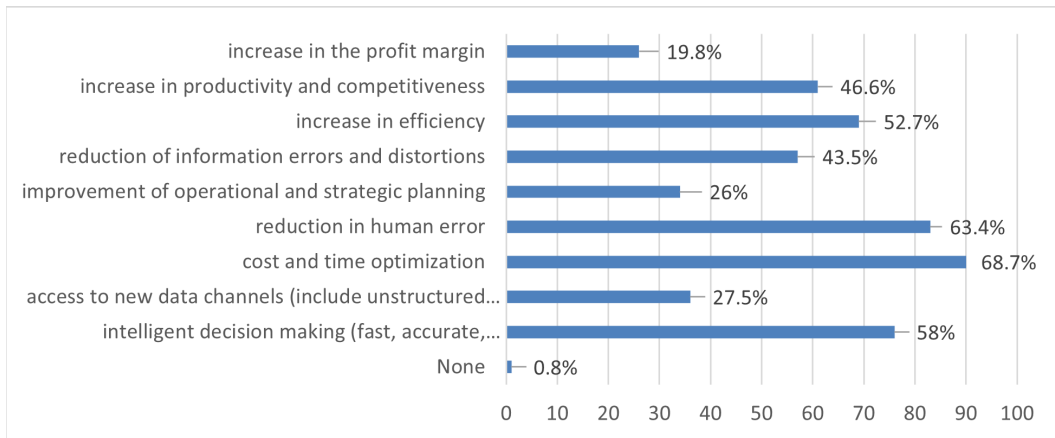A high percentage of the inquiries agree with Rybicka (2018) that stated the following opportunities to management accountants: improvement of decision-making process, improvement of operational and strategic planning and cost and time optimization. Zhang *et al.* (2020) also mentioned the advantages of reducing information errors and distortions, better decisions and improving efficiency, which is in line with what was advocated by a large percentage of the respondents.

On the other hand, according to the Figure 14, 89.3% of the participants considered that in certain situations we can have advantages of not fully delegate the decision making to an intelligent system. The two main reasons appointed for this is the lack of interpretability of these systems and the fact that intelligent systems have difficulties at solving problems that are not very clearly delimited and well-structured.

In order to have more relevant information related to this research question, a set of interviews with professionals of intelligent systems was also carried out to complement the answers given in the questionnaires. By doing this is possible to match the views and knowledge of both. Bellow was evaluated the answers given by the 18 interviewees to the following questions: To what extent can

Figure 14. Number of professionals that consider that in certain situations not fully delegate decision making to an intelligent system is the best option
Source: Self-elaborated
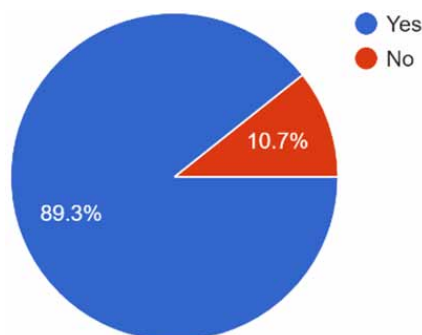
AI and Big Data help management accounting professionals in their daily tasks? In what areas do you think that AI and Big Data systems will have the greatest impact on management accounting?

Based on this assumption, can AI and Big Data help management accounting professionals in their daily tasks, a global analysis of the responses of all interviewees was made (Figure 15).

According to the reading of Figure 15 and the Table 3 of the content analysis, most interviewees agree that AI and Big Data help management accounting professionals in their daily tasks, which is in line with the answers given by the respondents in the questionnaire. Regarding the concrete advantages of AI and Big Data, the benefits that were appointed by more IS professionals are the increase efficiency and productivity derived from automation (32%), followed by the reduction

Table 3. Content analysis – Impact of AI and big data on management accounting

Content Analysis - Interviews			
Interviewee	**Text**	**Categories**	**Subcategories**
IS professional 1	Automation in the identification and extraction of explicit or implicit data (data mining) about relevant information, optimization of the management of large databases, (…) automation in making decisions derived from large volumes of data. Therefore, AI and Big Data can help in actions or procedures which impose the need to equip machines with the knowledge and behavior of human specialists.	**I.1**	**I.1.1**
IS professional 2	Automated systems will greatly facilitate the daily task and will even free up part of the time of those who are working on these tasks and activities to a much more important dimension, which is the dimension of decision making.	**I.1**	**I.1.1**
IS professional 3	Very objectively, I think beside helping, human resources in these areas will be highly replaced.	**I.1**	**I.1.1**
IS professional 5	In a faster and more accurate decision-making process, I think it makes perfect sense and also in reducing human error. I believe that an intelligent system can adapt to the circumstances and try to diagnose a possible problem, and it may possibly minimize human error and perhaps facilitate the filling of things a little bit because it may have the capacity for suggestion, the capacity for validation.	**I.1**	**I.1.1**
IS professional 10	Time and costs optimization because there may be some automatic part for allocating expenses to certain items, there may be some automation. (…) The reduction of human error also by the same reason, by a kind of decision support in which some good candidates for these expenses were pre-selected by the automatic system.	**I.1**	**I.1.1**
IS professional 10	In forecasting it is more or less easy to understand that yes, because one of the things that these algorithms do, data science, data mining, machine learning is essentially forecasting, that is based on data from the past be able to predict what will be the future output for the standard, for the similar example that has never been seen before.	**I.1**	**I.1.2**
IS professional 14	All kinds of functions will be affected by AI without any doubt. So, the reporting part, the procurement part, all this will be affected. Reporting is increasingly interconnected with data mining for the presentation of data.	**I.1**	**I.1.2**
IS professional 16	The more data we have and the more detailed and deeper we can go to be able to determine what is the cause of what is happening to us, the more efficient our work will be, this is what Big Data brings.	**I.1**	**I.1.1**
IS professional 17	Through AI we have data to be able to make a better, more documented, and more informed decision.	**I.1**	**I.1.1**

Source: Self-elaborated

Figure 15. Answers of respondents (intelligent systems professionals) about the benefits of AI and big data for management accounting

Source: Self-elaborated
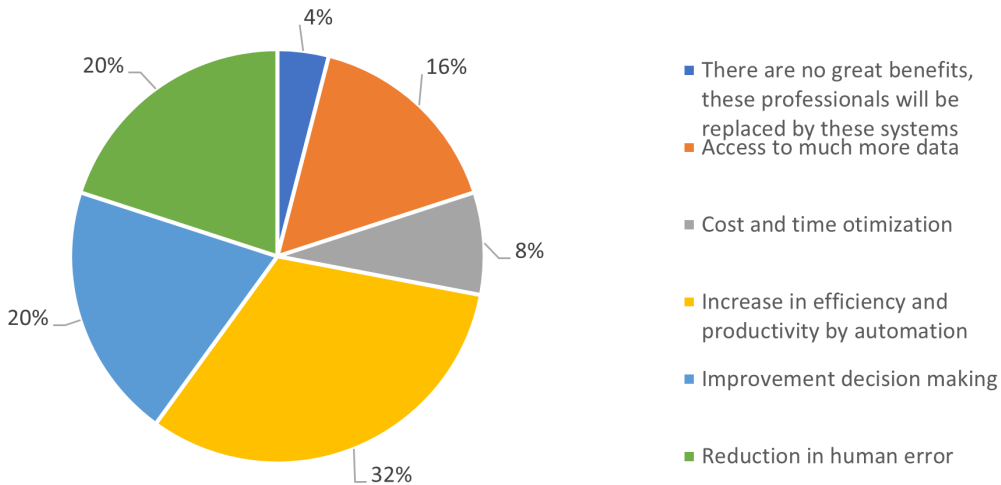
in human error (20%) and the improvements that these IS can bring to decision making (20%) all these advantages are in agreement with Zhang *et al.* (2020) and the last one is also in agreement with Rybicka (2018). Comparing to the answers given in the questionnaire they are similar, they simply do not consider the advantages in the same order of importance, as in the questionnaire was considered as the more important advantage cost and time optimization and in the interviews only two IS professionals appointed this advantage.

Regarding the areas where AI and Big Data systems will have the greatest impact on management accounting, the IS professionals didn´t have a lot of knowledge about it, a few of them mentioned forecasting, reporting, and strategic and operational management. Although this question was not answered by all IS professionals, the answers that I got are in line with the answers given in the questionnaire, as they considered that the area that will be more affected is reporting and control.

Based on the results from the questionnaire and the interview, it´s possible to answer to the research question – *Can Big Data and AI improve management accountants' processes?* **–** The results are in agreement with what was stated by the authors Bhimani (2020), Rybicka (2018) and Richins *et al.* (2017), it allows us to conclude that the huge volumes of data combined with AI technologies will create value for these professional's work, as 99.2% of the inquiries in the questionnaire and 96% of the interviewees stated that AI and Big Data improve and bring benefits to management accounting.

Part of the results are also in line with what was advocated by the authors Bhimani (2020), Rikhardsson & Yigitbasioglu (2018), Rybicka (2018), Elliot *et al.* (2020) and Richins *et al.* (2017) due to the fact that 20% of IS professionals and 58% of the professionals that answer to the questionnaire mentioned that these systems will have a positive impact in the decision-making process. Although Cubric (2020) and Shrestha *et al.* (2019) didn´t mentioned specifically management accounting in their studies, it is possible to said that the results are also in agreement with these authors as they stated that by using AI is possible to reduce human error and have faster and high-quality decisions.

To explore deeply the impact of intelligent systems on management accounting bellow was evaluated the answers given by the interviewees to the subsequent question: Do you think that we can have advantages in certain cases of not fully delegating decision-making to an intelligent system? Why?

Based on this assumption, can we have advantages in certain cases of not fully delegating decision-making to an intelligent system, a global analysis of the responses of all respondents was made (Figure 16).

According to the reading of Figure 16 and the Table 4 of the content analysis, despite agreeing on the question before that AI and Big Data help and improve management accountants' processes, 83% of the IS professionals agree that we have advantages in certain cases of not fully delegating decision-making to an intelligent system, which was in line with 89.3% of the questionnaire´s answers.

These results complement the answer to the research question above that even though it has been stated that AI and Big Data contribute to the improvement of management accounting processes, it is important to not fully delegate all the tasks to an intelligent system, is still very important the management accountant professional. These results are in agreement with what was referred by Bolander (2019) and Shrestha *et al.* (2019), as the majority of IS professionals considered that we potentially lose something by fully automation through AI because human intelligence and machine intelligence have different strengths and weaknesses, so they think that the best path to follow is combine human and AI intelligences in order to explore the advantages of each. The majority of IS professionals appointed that the lack of explainability and transparency by these intelligent systems is a big problem that still don´t have a solution, which is also in agreement with the authors Bolander (2019), Burrell (2016) and Shrestha *et al.* (2019).

Table 4. Content analysis – Advantages of not fully delegate decision-making to an intelligent system

Content Analysis - Interviews			
Interviewee	**Text**	**Categories**	**Subcategories**
IS professional 1	Eventually, yes. When there is no prior knowledge of what the behavior is, a human specialist must proceed, or when there are subjective factors that are not formalized or even in situations that require emotions. . . . Neural networks have difficulty in presenting the explanations for the inference that were performed…it is extremely important to justify the decision making.	**I.1**	**I.1.3**
IS professional 2	I totally agree. . . . There will always be some need for now, at least, and in the medium term, before being able to fully automate this decision making. . . . It also does not progress more quickly, precisely because of the lack of explainability that exists in the most complex systems, not all, some are dominable, but those that are really showing better performance, in forecasting, planning are still a bit obscure.	**I.1**	**I.1.3**
IS professional 3	In the case of accounting, I think it will be much more perfect than the human in 99% of situations.	**I.1**	**I.1.3**
IS professional 10	Only when the error rate is very low in the tests that were made to that model and simultaneously the error is quite easy to correct and go back without having a very significant impact, only then we can let the system do a few things alone without a direct and immediate supervision, I think that beside this we should not let the system make too many decisions alone.	**I.1**	**I.1.3**
IS professional 14	The path that seems to me to be more mature is in decision support systems. . . . I am not saying that in the future will not be almost everything through expert system, that is, automatic decisions, but the path that seems to me that makes the most sense is decision support system, that is, there is support and then the end user decides.	**I.1**	**I.1.3**

Source: Self-elaborated

Figure 16. Answers of respondents (intelligent systems professionals) about not fully delegate decision-making to an intelligent system
Source: Self-elaborated
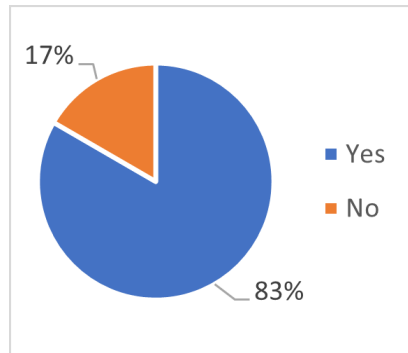
4.3. Probability of Implementing AI, for Decision Making, in Management Accounting

To test the conceptual model and assess the probability of implementing AI in management accounting was used the SmartPLS 3 software (Ringle et al., 2015). To answer to this research question was evaluated the answers of 98 respondents in the questionnaire to four questions (2.2; 3; 6; 8). This analysis was carried out with 98 respondents and not with the total sample because it aims to assess the probability of adopting AI, so only respondents who currently do not use AI in their daily tasks were considered. Of the 131 inquiries who answer to the questionnaire, 33 who are already using AI were excluded, so the sample that will be considered to answer to this research question is composed by 98 respondents.

In first place was applied descriptive statistic (Table 5) where was evaluated the mean, median, maximum, minimum and standard deviation. As can be seen all variables have high mean values and all of them have a median of 4, which is a high value. The variable with the highest mean was the "Value of AI for management accounting", the average of responses was slightly above 4, which means that these professionals see great value in AI.

Then was assessed and evaluated the model reliability and validity. To evaluate the quality of the measurement model, was examined the individual indicators of reliability, convergent validity, internal consistency reliability, and discriminant validity (Hair et al., 2017). In this particular case, there was only one question in the questionnaire for each item, thus this automatically provides evidence for the individual indicator reliability and internal consistency reliability (Hair et al., 2017). For the same reason the average variance extracted (AVE) for all constructs are equal to 1 and so exceeded the threshold of 0.50 (Bagozzi & Yi, 1988).

The discriminant validity was assessed using two approaches. First, was used the Fornell and Larcker criterion. This criterion implies that the square root of AVE, exposed on the diagonal with bold values in (Table 6) is larger than its biggest correlation with any construct (Fornell & Larcker, 1981). Table 6 shows that this criterion is verified for all constructs. Second, was used the heterotrait-monotrait ratio (HTMT) criterion, this provides additional evidence of discriminant validity (Hair et al., 2017; Henseler et al., 2015). As Table 6 shows, in this particular case, as there was only one question in the questionnaire for each item, HTMT ratios are equal to the correlation between construct below. More important to this is verified that all HTMT ratios are below the more conservative threshold value of 0.85 (Hair et al., 2017; Henseler et al., 2015).

The structural model was calculated with the sign, magnitude, and significance of the structural path coefficients, the magnitude of R^2 value for the dependent value as a measure of the model's

Table 5. Mean, median, maximum, minimum, and standard deviation of the five variables in study

	Variable	Mean	Median	Min	Max	Standard Deviation
(1) Probability of adopting AI	Dependent	3.63	4	1	5	0.95
(2) Value of AI	Independent	4.16	4	2	5	0.80
(3) Challenges to implement AI	Independent	3.76	4	2	5	0.73
(4) Trust in information provided by an intelligent system	Independent	3.81	4	1	5	0.74

Source: Self-elaborated

Table 6. Composite reliability, average variance extracted, correlations, and discriminant validity checks

Latent Variables	α	CR	AVE	1	2	3	4
(1) Probability of adopting AI	1.000	1.000	1.000	**1.000**	0.638	0.297	0.465
(2) Value of AI	1.000	1.000	1.000	0.638	**1.000**	0.294	0.535
(3) Challenges to implement AI	1.000	1.000	1.000	0.297	0.294	**1.000**	0.272
(4) Trust in information provided by an intelligent system	1.000	1.000	1.000	0.465	0.535	0.272	**1.000**

Note: α -Cronbach Alpha; CR -Composite reliability; AVE -Average variance extracted. Bolded numbers are the square roots of AVE. Below the diagonal elements are the correlations between the constructs. Above the diagonal elements are the HTMT ratios. (Source: Self-elaborated)

predictive accuracy (Hair et al., 2017). Before analyzing the structural model was assessed the collinearity (Hair et al., 2017). For the same reason that was mentioned above, the VIF values were all 1.00, which was below the indicative critical value of 5 providing evidence for no collinearity (Hair et al., 2017). The coefficient of the determination R^2 for the dependent variable "probability of adopting AI" was 42.9% (Figure 15), this value far exceeds the threshold value of 10% (Falk & Miller, 1992). In Figure 17 it is also possible to observe the SmartPLS model with all the direct and indirect relations between the four constructs.

The results in the Table 7 demonstrate that the value that inquiries see in AI has a significantly positive effect on the probability of adopting AI for decision making (β=0.545, $p<0.05$), which provides support for H1. The level of trust that the inquiries have on information provided by an intelligent system has a significantly positive relation with the value perceived of AI (β=0.535, $p<0.05$) and the probability of adopting AI (β=0.174, $p<0.05$), which supports H2 and H3, respectively. The level of challenges to implement AI has a significantly positive effect on trust that the inquiries have in information provided by an intelligent system (β=0.272, $p<0.05$), which proves that the relation between these two variables is positive and not negative, as speculated in H4. Thus, although there is a significantly relation, hypothesis H4 is not supported.

To test the mediation hypotheses was used a bootstrapping procedure to test the significance of the specific indirect effects via the mediator (Preacher & Hayes, 2008). Table 8 presents the results of the mediation effects. The indirect effects of trust in information provided by an intelligent system on the probability of adopting AI for decision making via the mediator of value perceived of AI is significant with (β=0.000; $p>0.05$). This result supports the mediation hypothesis H5a. The indirect effects of challenges to implement AI on the probability of adopting AI via the mediator of trust in information provided by an intelligent system and value perceived of AI is significant with (β=0.046; $p>0.05$). This result supports the mediation hypothesis H5b.

Based on these results, it´s possible to answer to the research question – *What is the possibility of implementing AI, for decision making, in management accounting?* – According to these results
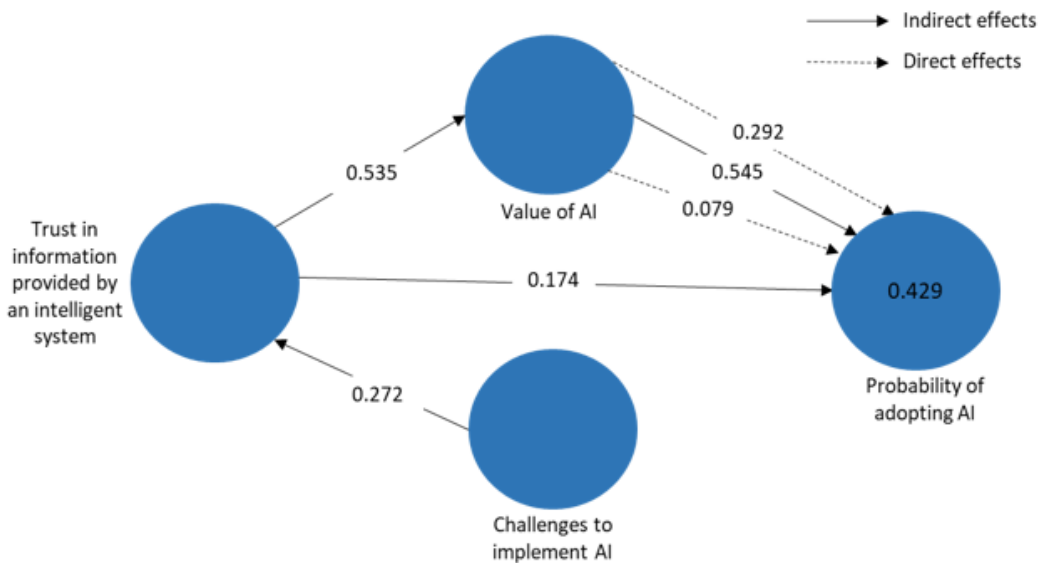
Figure 17. SmartPLS model
Source: Self-elaborated

Table 7. Structural model assessment

Path	Path Coefficient	Standard Errors	t Statistics	p Values
Value of AI -> Probability of adopting AI	0.545	0.085	6.444	0.000
Trust in information provided by an intelligent system -> Value of AI	0.535	0.074	7.199	0.000
Trust in information provided by an intelligent system -> Probability of adopting AI	0.174	0.084	2.079	0.038
Challenges to implement AI -> Trust in information provided by an intelligent system	0.272	0.112	2.439	0.015

Source: Self-elaborated

Table 8. Bootstrap results for indirect effects

Indirect Effect	Estimate	Standard Errors	t Statistics	p Values
Trust in information provided by an intelligent system -> Value of AI -> Probability of adopting AI	0.292	0.061	4.791	0.000
Challenges to implement AI -> Trust in information provided by an intelligent system -> Value of AI -> Probability of adopting AI	0.079	0.040	2.000	0.046

Source: Self-elaborated

in order to successfully apply the framework developed by Shrestha *et al.* (2019) in the management accounting area, to be able to combine human and algorithmic decision making and exploit the advantages of each, is very important that these professionals could see the value and advantages of the AI system and trust in the information provided by it. According to Güngör (2020) the perceived

value creation with AI is seen predominantly for shareholders and customers not by employees and society, the results of this study go against this author by affirm that all the respondents that answer to this questionnaire, including employees, saw value on AI. Although there are no studies about the perceived value of AI on management accounting the results are in line with Petkov (2020) and Shrestha et al. (2019) as AI brings value to human capabilities, however these studies does not make a correlation between the increase in value perceived and the probability of adopting AI.

Additional to this is possible to affirm that the higher the trust in the information provided by an intelligent system the higher is the value perceived by these professionals and consequently the higher is the likelihood of companies implementing AI in the decision-making process. Although there are no studies about this in the management accounting area, this is in line with what (Siau, K., and Wang, 2018) stated in their study by affirm that trust is crucial in the development and acceptance of AI. Bitkina *et al.* (2020) study also support this view by proving that the perceived performance of AI grows along with the perceived trust.

Based on the results it is also possible to state that the challenges in AI implementation are not an obstacle to its implementation, as was expected, they are, on the contrary, a driver for the trust in AI systems to be higher, consequently, the perceived value of AI will be higher, and therefore the probability of adopting AI will be higher. These results are not according with Bitkina *et al.* (2020) study, that demonstrates that the growth on the task complexity, which can be considered as challenges, undermines the perceived trust and perceived performance of AI.

4.4. The Shifts in Management Accounting Profession With the Massive Introduction of Intelligent Systems Into Day-to-Day Tasks

With the purpose of verifying what shifts can occur in management accounting with the introduction of intelligent systems, first was evaluated the answers from the 131 respondents in the questionnaire.

According with the Figure 18, most of the inquiries considered that management accountants will need to develop medium knowledge in data science, data management, IT and intelligent systems. An improvement and update in management accountants' skills is considered necessary by the majority of the participants.

According with the Figure 17, most of the inquiries agree with the six domains but some of them only agree with some. From the ones that only agree with some only 20 inquiries (15,3%) answer that the domain of Technology and Analytics is not needed to protect management accountants' careers in the future.

Figure 18. Skills that needed to be developed with the introduction of intelligent systems rate from 1 to 4
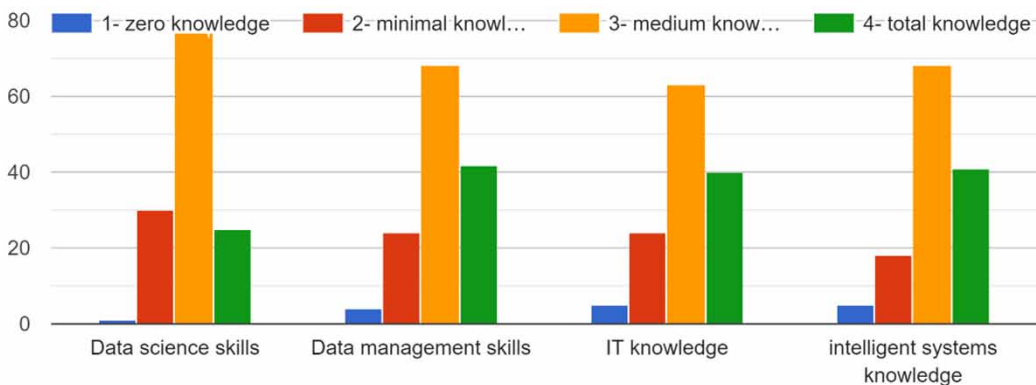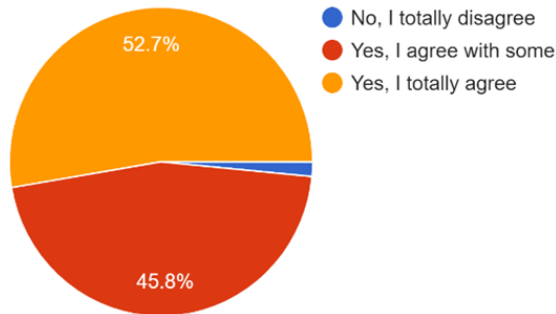*Source: Self-elaborated*

Figure 19. Number of professionals that agree with the six domains of competencies needed by management accountants to protect their careers in the future suggested by the updated Management Accounting Competency Framework 2019

Source: Self-elaborated

According to the reading of the figures 20 and 21, it can be seen that 77.1% of the inquiries considered that the certification process in the accounting area should now include intelligent systems. Additionally, 93.1% of the participants think that there will be pressure in the future for the integration of intelligent systems in management accounting profession.

Figure 20. Number of professionals that consider that the certification process in the accounting area should now include intelligent systems
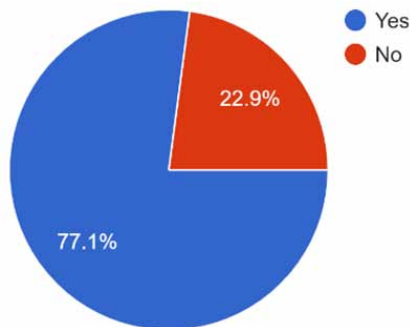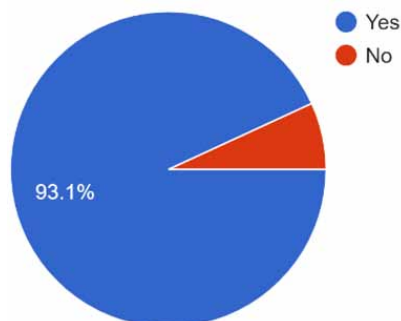
Source: Self-elaborated

Figure 21. Number of professionals that consider that will be pressure in the future for the integration of intelligent systems in management accounting profession

Source: Self-elaborated

According to the answers that were given to the present questionnaire most of the management accountants that answer to it considered that a change must occur in order to remain competitive in the future and protect their careers. The implementation of intelligent systems will help a lot in this by having a very positive impact in many aspects. According to the Figure 22, the biggest challenge for the implementation of these intelligent systems is the resistance to change.

To have more relevant information related to this research question, a set of interviews with professionals of intelligent systems was also carried out to complement the answers given in the questionnaires. By doing this is possible to match the views and knowledge of both. Bellow was evaluated the answers given by the 18 interviewees to the subsequent questions: Do you think that there will be a major transformation in the functions of management accounting professionals with the introduction of intelligent systems? What are the main transformations that will occur? What new skills need to be developed by these professionals?

Based on this assumption, about the transformation in the functions of management accounting professionals with the introduction of intelligent systems, a global analysis of the responses of all respondents was made (Figure 23).

According to the reading of Figure 23 and the Table 9 of the content analysis, 89% of the respondents agree that intelligent systems will introduce big changes in the management accounting profession. The respondents focused "…the rapid elimination or replacement of human intelligence or human work by machine work in everything that is routine...", the importance of the soft skills and the importance of upskilling and focus on more intellectually stimulating jobs.

Based on the results from the questionnaire and the interview, it´s possible to answer to the research question – *What will be the shifts in management accounting profession with the massive introduction of intelligent systems into day-to-day tasks?* **–** The results are in accordance with what was mentioned by Lawson (2019), Richins *et al.* (2017), Sulaiman *et al.* (2015), Bhimani (2020) and Rybicka (2018) that referred that these emerging technologies have the potential to replace many of the more repetitive and manual tasks, allowing accountants to focus on opportunities that delivered higher value. The results are also according to Richins *et al.* (2017) and Nicoleta (2019), this can be seen by what was stated by an IS professional in the interview "…they can help in the construction of these machines and have a relevant role in the construction of these machines...".

Most of the professionals that answer to the questionnaire and some IS professionals considered also the importance of include now data science, intelligent systems and IT skills in their knowledge, this is in line with what was stated by Pilipczuk (2020), that mentioned that the future management accountants will need to develop high cognitive, like IT and management skills.

Figure 22. The biggest challenges for the implementation of these intelligent systems
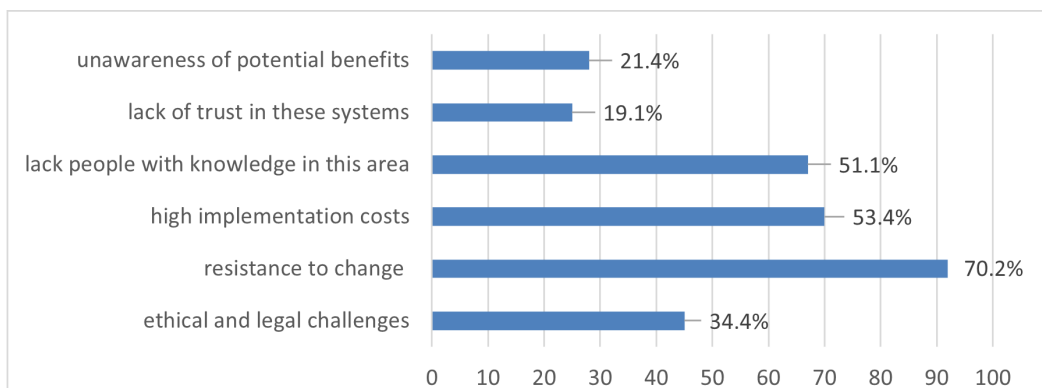*Source: Self-elaborated*

Table 9. Content analysis – Transformations in the functions and competencies of management accountants with the introduction of intelligent systems

Content Analysis - Interviews			
Interviewee	**Text**	**Categories**	**Subcategories**
IS professional 1	Probably yes. Automation of tasks that can be performed by machines equipped with AI and Big Data techniques. They needed to have knowledge of techniques for using computer systems with Big Data and AI.	**I.3**	**I.3.2**
IS professional 3	What I see in general terms and this applies in particular to accounting is the rapid elimination or replacement of human intelligence or human work by machine work in everything that is routine. What is beginning to be realized is that perhaps the work of an accountant has to evolve into work that, in the end, in collaboration with the machine, can work on other aspects. What I think and see is that these professionals have to take advantage of IS to migrate to a higher level in the value chain, that is, intelligence at the service of added value. I think that these professionals will have to do the upskilling of more static tools and will have to evolve to more analytical and eventually more emotional functions, the relationship part, the internal negotiation part within organizations, the ability to deal with all elements of different cultures and different positions within the organization is basically what will make people stand out in the future because the routine things the machine and the computer will do much better and faster than the human. And it is in this aspect in the components of soft skills that people have to evolve in order to be able to keep themselves in organizations and where the machine will hardly enter.	**I.3**	**I.3.2**
IS professional 6	I think there is no need for specific knowledge, it has to be a tool implemented for day-to-day life, so the tool has to adapt to the processes and not the other way around.	**I.3**	**I.3.2**
IS professional 8	I would say no. Being something that helps, in spite of being an IS the part that is missing is another type of intelligence that has to be in people, and that they already have, if they are management accounting specialists, they already have all the capacities for that, they will only be provided with tools that give them much more information in decision making. So, I think that you don't have to change anything, in practice they will have better tools to do what they already do.	**I.3**	**I.3.2**
IS professional 12	I think it can have a really big impact, in fact. Accountants as specialists in their field can in fact make an important contribution to the development of these IS, instead of them feeling that they are being overtaken by machines they can help in the construction of these machines and have a relevant role in the construction of these machines, which makes them focus on more intellectually stimulating jobs and less on routine tasks.	**I.3**	**I.3.2**
IS professional 17	The very big impact will be, above all, that people have to be aware of what data science is, how to get from a set of statistics and data, how to extract information from here that has added value to their work.	**I.3**	**I.3.2**

In order to explore deeply the transformations and challenges of the introduction of intelligent systems on management accounting bellow was evaluated the answers given by the interviewees to the next question: What are the biggest challenges for the implementation of these intelligent systems in management accounting?

Based on this assumption, about the biggest challenges for the implementation of these intelligent systems in this profession, a global analysis of the responses of all interviewees was made (Figure 24).

According to the reading of Figure 24 and the Table 10 of the content analysis, the respondents mentioned several challenges for the implementation of these intelligent systems in management accounting, the challenge that was appointed for more interviewees was the lack of intelligent systems

Figure 23. Answers of interviewees (intelligent systems professionals) about if there will be a major transformation in the functions of management accountants with the introduction of intelligent systems
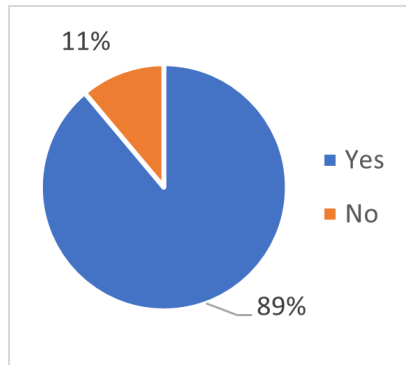
Source: Self-elaborated

Table 10. Content analysis – Biggest challenges for the implementation of intelligent systems in management accounting

Content Analysis - Interviews			
Interviewee	**Text**	**Categories**	**Subcategories**
IS professional 2	Resistance to change. . . . The other part is that we are creating mechanisms that often use samples to do planning or decision making, the data that we are providing to those mechanisms, are the algorithms to form the automatic mechanisms may not be completely exempt and, so it is true that we still need to have some way to validate the equity and fairness of the results that are being provided to us and finally the legal norms.	**I.3**	**I.3.1**
IS professional 3	I think that this will be overcome by the conjuncture of the market's needs, that is, by nature it wants to be as efficient as possible, it will force these systems to emerge almost by force of law. And, therefore, this will delegate to the background if they want or not want if they are adverse to the change or not, in the end they will be overcome.	**I.3**	**I.3.1**
IS professional 4	The professionals who are going to implement this have to understand what are the needs and then have to adapt the algorithms to those needs, that is one of the reasons. Resistance to change also exists everywhere when changes are needed. Intelligent systems are in the IT area to be applied to management accounting, so it´s necessary time to communicate for them to realize what they can do with this type of tools.	**I.3**	**I.3.1**
IS professional 5	The biggest difficulty is to make a system that takes advantage of current AI technologies apply it to the area of management or accounting.	**I.3**	**I.3.1**
IS professional 7	I think that the ethical part is going to be a challenge and the resistance to change will always exist, what you have to realize is that there are advantages to changing to a system that helps us, this is very important, technology exists to help humans, it is not the technology by itself.	**I.3**	**I.3.1**
IS professional 9	There is a big problem that is the following, often the data that is used by this system learn and is distorted in a certain sense, there is a set of news about the use of AI algorithms that have learned for example to discriminate racially or based on other criteria. Another problem is that the access to these data often raises ethical problems.	**I.3**	**I.3.1**
IS professional 15	It is the lack of knowledge versus the lack of data quality.	**I.3**	**I.3.1**

Figure 24. Answers of respondents (intelligent systems professionals) about the biggest challenges for the implementation of these intelligent systems in this profession
Source: Self-elaborated
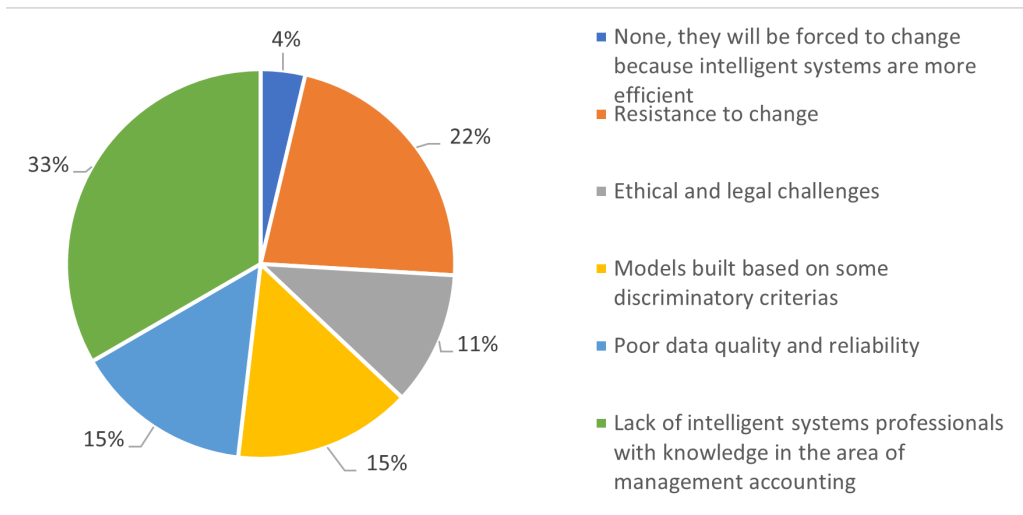
professionals with knowledge in the area of management accounting (33%), in the questionnaires 51,1% of the inquiries also mentioned this.

To complement the answer to the research question above is also important to look at the challenges that exist and will need to be addressed in order to implement intelligent systems in the management accounting area. The answers given in the questionnaires and in the interviews are in line with Gärtner & Hiebl (2018) and Quattrone (2016) as they referred that the lack of people with knowledge in this area will be a huge challenge. However, the majority of the inquiries in the questionnaire mentioned the resistance to change as the main challenge which is not mentioned directly by none of the authors in the literature review.

Some IS professionals also mentioned the data quality and reliability which was also referred by Gärtner & Hiebl (2018) and Quattrone (2016). These two authors also mentioned in their studies the overload of information, changing cost structure and the possibility of faster false decisions as main challenges, these challenges were not referred in the interviews and in the questionnaires.

15% of IS professionals are also in agreement with the authors Richins *et al.* (2017), Elliot *et al.* (2020) Bolander (2019) and Shrestha *et al.* (2019) that stated that inaccuracies or biases that can be present in the huge amount of data can be a challenge in the management accounting area. Although Cubric (2020) focused their study on the management and business area it is possible to said that the results are also in agreement with this author that stated that the main barriers for AI implementation are: dependence on non-humans, job security fears, lack of knowledge and understanding of potential benefits and lack of trust. All these challenges were appointed in the questionnaires, in the interviews were only mentioned the resistance to change and the lack of people with knowledge in this area.

The answers from 34,4% of the inquiries in the survey and 11% of IS professionals in the interview are also in line with what was advocated by Cubric (2020), Dwivedi *et al.* (2019), Haenlein & Kaplan (2019) and Robles Carrillo (2020), as they appointed the ethical and legal challenges in the implementation of AI in an organization. Cubric (2020), Dwivedi *et al.* (2019) and Robles Carrillo (2020) also focused the economic barriers that were appointed by 53,4% of the participants in the questionnaire but were not mentioned in the interviews.

5. CONCLUSION

In the digital era where we are now more and more intelligent systems are implemented to help and improve several tasks. The present research had as main objective to understand how intelligent systems and management accounting are related and how the first can be used for the benefit of the second. As management accounting is a profession that involves very repetitive tasks and structured procedures that could be easily optimize by an intelligent system. After the analysis of the literature review, as well as the answers to the research questions, it was possible to take some final considerations that, in a way, allow to deepen the study of the proposed theme. Through the questionnaires and interviews that were applied, it is possible to observe that intelligent systems will have a huge impact in the management accounting area. Intelligent systems can offer added value to these professionals in many tasks and procedures that are part of their daily work.

As it was possible to observe throughout the analysis of data and discussion of the results of the first research question, although accountants and the IS professionals agree that IoT could bring benefits mainly through the possibility of use real-time data, which are in line with what was stated by Brous et al. (2020) and S. Li et al. (2015), 50% of the IS professionals are not sure that these benefits will affect directly this profession, 17% even claim that the advantages are in the management area only not in management accounting. On the opposite 90.8% of the accountants stated that IoT will brings benefits directly to their daily tasks. Therefore, based on these results, was not clear that IoT will impact management accounting.

Through the analysis of the results of the second research question most accountants and experts in IS agree that Big Data and AI have the capability to create additional value in management accountants' processes, which is according to Bhimani (2020), Rybicka (2018) and Richins et al. (2017). When asked about the more important benefits IS professionals appointed the increase efficiency and productivity derived from automation as main advantage, accountants appointed the cost and time optimization. These two advantages end up being complementary to each other because higher efficiency and productivity at work, will lead to a better use of time and in the long run to an optimization of costs.

Despite all the benefits the majority of the questionnaire and interview inquiries affirm that they won´t fully delegate all the tasks to an intelligent system due to the lack of explainability that exists in the systems that show better performances, as was stated in the interviews these systems are still a bit obscure and is extremely important to be able to justify the decision that is taken. The path that was more appointed was a complementary work between the human and the machine.

In the third research question was only collected data through the questionnaires applied to accountants. By analyze the model that was built it is possible to state that the trust that management accountants have in the information provided by an intelligent system positively influences the value that these professionals see in AI and has also a direct impact in the probability of adopting AI. The value that accountants see in AI has also a direct influence in the probability of implementing AI. Moreover, the indirect link that exists between trust and the probability of adopting AI reinforces the importance of the value perceived of AI.

Furthermore, the indirect link between challenges to implement AI and the probability of adopting AI reinforces the importance of the trust in information provided by an intelligent system and the value that management accountants see in AI. Thus, on the opposite of what was expected challenges in AI implementation are not an obstacle, but a driver for the trust in the AI systems to be better. Based on these results is possible to affirm that value and trust are direct drivers for AI implementation, so it´s necessary to create trust by demonstrating the value of this systems to management accountants. By doing this successfully management accountants will be open to this technology and will embrace it easily in their daily tasks.

By evaluating the results from the fourth research question it is possible to state that these technologies will transform the management accounting profession, these results are in line with

was referred by Lawson (2019), Richins et al. (2017), Sulaiman et al. (2015), Bhimani (2020) and Rybicka (2018). Most of the accountants and some IS professionals considered important to start to include now data science, intelligent systems and IT knowledge as new necessary skills for this profession. By updating their existing skills, these professionals will be able to adapt and become more valuable for the company because they will have all the necessary skills to work together with these emerging technologies that are the future.

However, to implement these technologies it is necessary to face many challenges, the main one that is mentioned by IS professionals was the lack of intelligent systems professionals with knowledge in the area of management accounting, accountants referred as the biggest challenge the resistance to change. However, as was observe in the results of the third research question, where the sample taken into account were only the accountants that currently do not use AI in their daily tasks, the resistance to change was not considered a real barrier if it could be successfully prove to accountants that they can trust in the information provided by an intelligent system, on the other hand this can be difficult to demonstrate due to the lack of transparency of these systems.

As this research has shown, despite the benefits and the growing implementation of these emerging technologies in multiple areas and professions, in the management accounting area is still in the very beginning. There is still a long way to go for most management accountants start working together with these technologies and carry out tasks of greater value and relevance for the companies in which they operate. But this is certainly the future because these technologies, mainly AI and Big Data, as was proved by the results of this investigation, have the power to greatly improve productivity and efficient, which is a necessary requirement for companies to remain competitive in the market.

This study contains, due to the exclusive focus on the Portuguese and Brazilian market, it is not recommended to extrapolate its findings to a general population. As a suggestion for future research, it would be interesting to extend the study to other countries. In this way, it would be possible to understand whether people's opinions regarding the topics covered follow the same line of thought across different countries and cultures.

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ENDNOTES

[1]   ERP systems is the integrated management of main business processes, often in real time and mediated by software and technology. ERP software integrates the various functions of the organization into one complete system to streamline processes and information across the entire organization.

[2]   Blockchain technology is a digital record of transactions, a distributed ledger technology that allows data to be stored globally on thousands of servers, while letting anyone on the network see everyone else's entries in near real-time.

[3]   This occurs when participation is voluntary, or the elements of the sample are chosen for the sake of convenience. Therefore, this sample is not representative of the population, so the results of this investigation will have to be read with great caution to be able to generalize to the population in general.

[4]   Google Forms - Application associated with the WEB organizer that allows access to quick response files that are accessible and confidential to the user.

[5]   As accounting professionals, I considered accountants and management accountants, since in a small / medium-sized company it is the typical accountant who also perform the management accounting functions within their functions.

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