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Impact of Intelligent Systems on Management Accounting

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Master in Business Administration

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BUSINESS
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Department of Marketing, Strategy, Operation and General Management

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Dedications and acknowledgements

The conclusion of this dissertation is a milestone that ended up arriving with some struggle, but that's what makes it great to achieve. I have several people to be thankful to: first I would like to thank Professor Dr. Renato Lopes da Costa and Professor Dr. Rui Alexandre Henriques Gonçalves, for all the availability and shared knowledge indispensable for this accomplishment.

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Resumo

Contemporaneamente falando, a procura pela tecnologia é recorrente e inevitável. A aplicação da mesma tem resultados positivos em praticamente todas as áreas que se possa imaginar. No espectro empresarial, pela sua competitividade e constante procura de superação para atingir vantagem competitiva sobre o mercado, a necessidade de implementação de tecnologia e sistemas inteligentes é quase uma obrigatoriedade. A contabilidade de gestão é uma área que tem um potencial de aplicação de sistemas inteligentes vasta, sendo que ainda utiliza muito trabalho manual, tem uma grande necessidade analítica com enfase na tomada de decisões, e tem processos que podem ser melhorados e otimizados. Nesta investigação, foi feita uma análise da aplicação e implementação de Inteligência Artificial e Internet das Coisas na área de contabilidade de gestão. Após a investigação e análise feitas, foi possível concluir que os profissionais entrevistados corroboram que a aplicação de sistemas inteligentes tem enormes potenciais para a melhoria dos resultados, otimização dos processos e consequente vantagem competitiva sobre a concorrência. Apesar de haver concordância geral acerca dos benefícios referidos, é importante assinalar que houve referências de forma generalizada à necessidade de um forte investimento na formação e recursos humanos que entendam o potencial destas tecnologias, permitindo haver confiança no processo e, dessa forma, ser possível obter um resultado ótimo. Apesar das salvaguardas, e em forma de abordagem final, não houve dúvidas relativamente ao potencial da aplicação destes sistemas em Contabilidade de Gestão.

Palavras-chave: Sistemas inteligentes, Inteligência Artificial, Internet das Coisas, Contabilidade Gestão.

Abstract

Contemporarily speaking, the demand for technology is recurrent and inevitable. Its application has positive results in virtually every imaginable area. In the business spectrum, due to its competitiveness and constant search for improvement in order to achieve a competitive advantage over the market, the need to implement technology and intelligent systems is almost mandatory. Management accounting is an area that has a vast potential for the application of intelligent systems, and it still uses a lot of manual work, has a great analytical need with an emphasis on decision making, and has processes that can be improved and optimized. In this investigation, an analysis was made of the application and implementation of Artificial Intelligence and Internet of Things in the area of management accounting. After the investigation and analysis, it was possible to conclude that the professionals interviewed corroborate that the application of intelligent systems has enormous potential for improving results, optimizing processes and consequent competitive advantage over the competition. Although there is general agreement on the benefits mentioned, it is important to point out that there were general references to the need for a strong investment in training and human resources that understand the potential of these technologies, allowing for confidence in the process and, in this way, being possible to obtain an optimum result. Despite the safeguards, and in the form of a final approach, there were no doubts regarding the potential of the application of these systems in management accounting.

Keywords: Intelligent Systems, Artificial Intelligence, Internet of Things, Management Accounting.

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Glossary

AI – Artificial Intelligence

IoT – Internet of Things

ANN – Artificial Neural Networks

ERP – Enterprise Resources Planning

IMA – Institute of Management Accountants

ISCTE – Instituto Superior de Ciências do Trabalho e da Empresa

PLS – Partial Least Squares

IS – Intelligent Systems

IT – Information Technology

EASHW – European Agency for Safety and Health at Work

COGS – Costs Of Goods Sold

1 Introduction

Despite intelligent systems and concepts like Artificial Intelligence (AI) dating back to 1950's, it wasn't until 1980's that some breakthroughs were made in the management accounting area, also in auditing, taxation, financial accounting, management accounting and personal financial planning. Our lives are changing due to technological innovations. Businesses are pursuing to find new opportunities of raising profitability and return on capital ratio, whether through revenue increase, cost reduction or new sources of value creation. (Stancheva, 2018)

Management accounting is directly related with the outputs of businesses, whether regarding to cost accounting or any other subjects of management accounting. Therefore, investing in technology that might empower this topic can turn into potential profit. As stated by (Stancheva, 2018) *"Accounting profession is on its way to make a great change of the role it plays in the organization and the functions it currently performs. The proponents of artificial intelligence revolution view this development as a step-ahead and embrace the challenges of the future".*

In fact, accountants can benefit from the intelligent systems as by using their capabilities they will be able to solve three broad problems (ICAEW, 2017):

- support decision-making by providing better and cheaper data;
- provide more profound analysis of data and give new insights on business;
- focus on more valuable tasks after freeing up working time due to intelligent systems applications.

Having the above mentioned in mind, what (ICAEW, 2017) says regarding the importance and opportunity of applying intelligent systems, and perceiving a potential in new technologies applied to management accounting, combined with my interest in accounting – since I have a solid professional background in the field – this study identified the following objective: Analyse the potential implementation of intelligent systems in a management accounting role.

Three specific research questions were targeted to deepen the knowledge and better understand this topic:

1. Are there benefits on decision making by implementing intelligent systems?
2. Is there potential of using Artificial Intelligence and IoT in management accounting?
3. Which are the Barriers that might be in the implementation of intelligent systems?

Regarding the Research Methodology, a literature review has been made to make sure that the chosen methods, approach, and theory have solid foundations. Once the approach and methods were validated a sample of accountants was interviewed, each one representing a different company and therefore a different scenario.

The data collection was conducted through interviews to each company's accountant representative. The goal was to understand how accountants in the different scenarios perceived the potential of implementing intelligent systems in management accounting, if they experience challenges by using technology in accounting role, whether there was agreement on the hypothesis of the benefits, and if there were perceived barriers they might expect in their pre and post-implementation.

As contributions, it is expected that this research deepens the knowledge on the benefits of implementing intelligent systems in management accounting through decision-making, gather information from professionals that have a clear view on what areas of management accounting they perceive as having potential to develop through new technologies, and raise awareness on possible barriers and limitations that can/should be considered for future implementations.

This study will be structured in the following chapters: Chapter 1 - Offers a literature review about Intelligent Systems (AI and IoT), Management Accounting and Intelligent Systems applied to Management Accounting; Chapter 2 – Shows the methodology and data collection; Chapter 3 – Describes the results and discussion; Chapter 4 -Conclusion, suggestions for future research and limitations.

2 Literature review

With the intent to present the problem identified in this study, it was fundamental to have literature review to get a deeper understanding of what has been developed so far, main findings, limitations when approaching Intelligent Systems in Management Accounting scenarios.

2.1 Intelligent Systems

AI dates back and can be traced to early 1940s, but it wasn't until 1956 that the term AI was settled in a project named Dartmouth Summer Research Project, this one was driven by Marvin Minsky and John McCarthy. The purpose of this summit was to gather researchers that could build machines able to simulate as close as possible to human intelligence. This was the birthplace of the renowned ELIZA computer program, a natural language processing tool able to simulate conversations with a pattern matching script combined with a substitution methodology that gave the users the idea of an understanding. (Haenlein & Kaplan, 2019)

AI is a multidisciplinary technology and there are a lot of definitions of it. I chose a small but quite explaining one, given by (Hassabis, 2017) as "science of turning machines into intelligence". When referring to intelligence, it is to be understood that machines will be capable of running cognitive functions of a human brain. We can therefore suggest artificial intelligence as a computer system that replicates human attitudes made of concepts, methodologies and techniques that leads to a demonstration of a similar intelligent behaviour.

According to the European Agency for Safety and Health at Work (EASHW), there are two different kinds of Artificial Intelligence: Weak AI and Strong AI. We may say that Weak AI is a bit limited in the range of appliances like text/image recognition, expert systems, and chess computers. On the other hand, the Strong AI can exhibit behaviours like a human being and thinks relentlessly (Kaivo, 2015). The appliance of robots is already in use in many cases, even for our safety and health, for example to do repetitive tasks there are robots performing and even outperforming humans. Of course,

there is a barrier that we should not cross. Robots are not to replace human beings, but to help us do tasks that we were not meant to do in the first place, dealing with radioactive materials would be a good example in this case.

What distinguishes AI from previous information technologies is its ability to learn and most of all update using data. There are several AI technologies, divided in three groups, Mechanical Intelligence, Thinking Intelligence and Feeling intelligence. "*Some AI systems are mechanically intelligent, designed to perform repetitive tasks for consistent and reliable performance; 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 empathetically with people"* (Huang, 2019) (Shrestha, 2019). At the moment the most used group of AI is the mechanical AI. Thinking Intelligent AI and Feeling Intelligent AI are expanding in research expectations even though Feeling Intelligence is considered to be the most difficult to achieve and polish.

Table 1 Mechanical, Thinking and Feeling tasks

Mechanical	Thinking	Feeling
1. Getting information	1. Monitor processes, materials,or surroundings	1. Communicating with supervisors, peers, orsubordinates
2. Inspecting equipment,structures, or material	2. Identifying objects, actions,and events	2. Communicating with personsoutside organization
3. Scheduling work andactivities	3. Estimating the quantifiable characteristics of products,events, or information	3. Establishing and maintaininginterpersonal relationships
4. Performing general physicalactivities	4. Processing information	4. Assisting and caring for others
5. Handling and movingobjects	5. Evaluating information to determine compliance withstandards	5. Selling or influencing others
6. Controlling machines andprocesses	6. Analyzing data orinformation	6. Resolving conflicts and negotiating with others
7. Operating vehicles, mechanized devices, orequipment	7. Organizing, planning, andprioritizing work	7. Performing for or workingdirectly with the public
8. Repairing and maintainingmechanical equipment	8. Interacting with computers	8. Coordinating the work andactivities of others
9. Repairing and maintainingelectronic equipment	9. Drafting, laying out, and specifying technical devices,parts, and equipment	9. Developing and buildingteams
10. Documenting/recordinginformation	10. Monitoring and controllingresources	10.Training and teaching others
11. Performing administrativeactivities	11. Judging the qualities of things,services, or people	11. Guiding, directing, and motivating subordinates
	12. Making decisions and solvingproblems	12. Coaching and developingothers
	13.Thinking creatively	13. Staffing organizational units
	14. Updating and using relevantknowledge	
	15. Developing objectives andstrategies	
	16. Interpreting the meaning ofinformation for others	
	17. Provide consultation andadvice to others	

Source: (Huang, 2019)

AI technology learns from existing data through several computational methods, there are two that usually come up as the most important ones: machine learning and deep learning (a machine learning technique). (Lewis & Denning, 2018) Even though these two sub-fields are a reference to AI, there are more computational methods also relevant to be considered, such as ANN (Artificial Neural Networks), Cognitive Computing, Natural Language Processing and Computer Vision.

The term Internet of Things first appeared and was proposed by a British technologist named Kevin Ashton in the year of 1991. Since then, and especially in the last few years, it has been gaining momentum. According to (Vermesan, 2013), Internet of things (IoT) is a generalized presence of a large variety and series of objects connected to the internet, wired or not (wireless), that link up and therefore are capable to share information and create new kinds of services and applications, or even outperform current types or services.

Internet of things is a next generation technology trend that can (and will) impact a wide range of businesses as it grants extended benefits for every possible object that connects to the internet. The benefits range from advanced connection between those devices, the information gathered from anyplace on the internet, systems and kinds of services that go far beyond of what a machine or series of machines could do only by their function and appliance by itself. (Jan Holler, 2014) (SAS–IoT, 2020).

As (Tripathy & Anuradha, 2018) mentions "*Equipment's are becoming more digitized and more connected, establishing networks between machines, humans, and the Internet, leading to the creation of new ecosystems that enable higher productivity, better energy efficiency, and higher profitability."*. This technological perk enhances our production and efficiency even without the need of human intervention to make decisions.

The goal of the Internet of Things (IoT) is to upgrade and develop a different lifestyle for humanity, where objects are connected and are put to it best use according to our interests and demands. (Pattar, Buyya, Iyengar, & Patnaik, 2019). Although IoT is a next generation trend, we can already find it almost everywhere, for example (SAS–IoT, 2020) Applications: Apps, intelligent houses, healthcare, transports, industry, manufacturing, agriculture…

2.2 Management Accounting

The main goal of management accounting is to provide useful information to people in the organization, usually to managers to help them make better decisions. It measures, reports, and analyses financial and non-financial information in a way that will help the company improve its efficiency in their current operations. This information is used to develop and implement the right strategy for that certain period, to coordinate product design, production, and marketing decision, and for last to control and evaluate the performance of the strategy and the company as a whole. (Bhimani, 2020)

The expected functions of management accounting are to allocate costs between costs of goods sold (COGS) and inventories for profit reporting, provide information for continuous improvement and therefore positively influence managers to be make good calls and decisions. A good example is to discontinue a certain product based on information gathered, or to set prices for products and services. (Bhimani, 2020)

Management accountants give insights regarding financial or non-financial information to managers. The purpose of a management accountant is to provide intel so that the best outcomes of the organization can be achieved. By pursuing the three steps – the strategy formulation, then the implementation and lastly the monitoring or controlling – management accountants will be able to identify key competitive factors, apply appropriate measures and then inform the company. Afterwards, managers use the intel provided to trace the best plan to formulate and implement the best fit strategy for the situation. (Nicoleta, 2019)

2.3 Intelligent Systems on Management Accounting

Intelligent Systems have been adding great value to the business spectrum. There is no doubt that the appearance of big data, for example, has had a great impact on management accounting controls and information for decision making as it is reshaping the reliance that once was met in more traditional and conventional information models. As (Bhimani, 2020) explains "*There is now increased recognition that corporate strategy, organisational arrangements and information systems structures defy*

conventional ties traditionally seen to have connected them as greater appeal is made to big data-based analyses and insights".

Accountants as (ICAEW, 2017) refers, will benefit from intelligent systems to help them solve major issues like better decision-making through cheaper and better data, upgraded analysis so new insights or pattens might be presented, or even the availability of free time to spend on different tasks that now can be done because of the time freeing leaded by the use of intelligent systems.

In management accounting tasks conducted by AI results in almost instantaneous outputs. This means better improvements in the timeliness of information and productivity. For accuracy purposes, if AI is well developed or programmed, applies its principles as they come up, the information can be accurately and more consistently prepared (Petkov, 2020).

IoT infrastructure is interlinked in three layers: sensing, network and application layer. The sensing layer is the ability to gather information in real time. The network layer sends the information gathered from the sensing layer to the data processing centre. The network layer aims to link databases, operating systems and applications, it comprises of storage on demand and various other tools for computing and data analysis. Through IoT, when data is uploaded to the cloud it can be processed by different tools and applications, the application layer is able to use the information gathered in order to do tasks of the daily routine. (J. Wu, 2019) (SAS–IoT, 2020)

As (Cubric, 2020) affirmed, there will be many challenges to be considered when applying AI systems such as ethical or even legal objections. The following is stated by (Cubric, 2020) "*While the drivers for the AI adoption in these areas are mainly economic, the barriers are related to the technical aspects (e.g. availability of data, reusability of models) as well as the social considerations such as, increased dependence on non-humans, job security, lack of knowledge, safety, trust and lack of multiple stakeholders perspectives*." . This gives us a good perception that despite the importance of upgraded and enhanced outcomes, there are several barriers to be considered.

(Güngör, 2020) conducted a survey to business professionals where the aim was to understand the perceived value creation and risks of adding AI. On a scale of 1 to 10,

the perceived value to the shareholders was 7.39, and for customers was 7.15, but when it referred to employees or the society the results of the study were negative.

Studies were developed in order to prove that the overload of data and its veracity, lack human resource with knowledge in intelligent systems, the changing costs related to the implementation and the possibility of false decisions are considered as main challenges to be faced. (Gärtner, 2018)

3 Methodology

3.1 Research model

In order to get the best possible answer to the proposed study objectives above presented, the qualitative method was the chosen approach. This said, the data collected through semi-structured interviews to professionals was compiled and scrutinized so we can better comprehend the impact of Intelligent Systems on Management Accounting in Portugal.

The semi-structured interview technique used was developed on a more or less structured basis of questions, always considering bullet points to guide the interview but at the same time leaving room to an open and stimulating conversation so it be comfortable for interviewees to make suggestions and point out hypothesis regarding the subjects discussed. (Goundar, 2012) (Vilelas, 2009)

Every method of analyses has its advantages and disadvantages. Considering the advantages, the flexibility amplitude is surely a plus, long side with its little formalization. This way, spontaneous information, deeper perspectives and understandings are to be achieved on the topics discussed, accomplishing from the observation, collection and analysis "in loco" of the scientific facts. Regarding the disadvantages, synthesizing data collection and trying to make comparisons may be troubling because of the heterogeneity of responses and its wide variety. It can be difficult to delimit boundaries in answers in the way of properly compare them in a fair manner. (Goundar, 2012) (Vilelas, 2009)

Seven interviews were conducted to professionals of management accounting to comprehend their perspective on the advantages and disadvantages of implementing intelligent systems in their management accounting role. The interviews were performed online, recorded with audio support and were conducted by Zoom meetings. They lasted no longer than 25 minutes each. Word support was used to accurately transcribe the speech. Only seven interviews were carried out because the answers given were already being repeated, thus reaching a loop.

Table 2 Relationship between Objectives, Research Questions and Literature Review.

Objective	Research Questions	Literature Review
Analyse the impact of implementing intelligent systems in management accounting	Q1 - Are there benefits on decision making by implementing intelligent systems?	(ICAEW, 2017) (Huang, 2019) (Bhimani, 2020) (Petkov, 2020)
	Q2 - Is there potential of using Artificial Intelligence and IoT in management accounting?	(ICAEW, 2017) (Stancheva, 2018) (Bhimani, 2020) (Petkov, 2020)
	Q3 - Which are the Barriers that might be in the implementation of intelligent systems?	(Cubric, 2020) (Gärtner, 2018) (Güngör, 2020)

Source: Author

3.2 Sample characterization

A characterization of the sample was performed before analysing the data collection. From the 7 interviews, 57% were males and 43% were females.

Every interviewee was Portuguese since the scope of the study was the Portuguese markets only. 57% of the sample has a degree, 29% has a master and 14% has a doctorate degree.

Figure 1 Sample by Gender

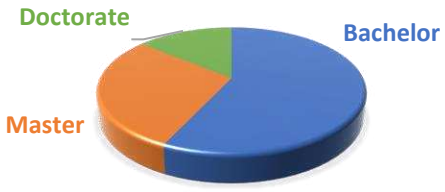

Figure 2 Sample by Academic Degree

Source: Author

Other aspect of the sample that was considered was the type of role that the interviewees play in their companies. 71% performs a technical role and the other 29% perform directive roles.

The last characteristic of the sample that was considered was the number of years of relevant experience in the field. 57% of the professionals have 5+ years of experience, 29% have between 2-5 and lastly 14% had at least 1-2 years.

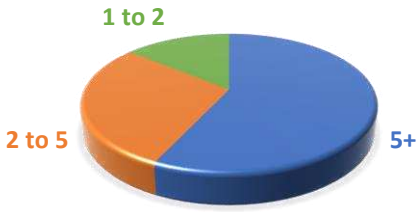

Figure 3 Sample by type of role performed *Figure 4 Sample by relevant experience.*

Source: Author

4 Obtained results and discussion

As mentioned previously, the analyses of this study were at first based on a literature review and after on a non-partial interpretation of the answers given by the interviewees through the semi-structured interviews.

The results of this study will be presented by answering the proposed research questions by the following order: (1) Is there benefits on decision making by implementing intelligent systems? (2) Is there potential of using Artificial Intelligence and IoT in management accounting? (3) Which are the Barriers that might be in the implementation of intelligent systems?

The following outputs, organized through three categories, are described in tables and sustained with quotes given by the interviewees in order to prevent biased results and therefore more reliable with the persons points of view. In order to respect the interviewees confidentiality and they're respective companies, names are not going to be mentioned. Interviewees are to be represented by "Participant" followed by ordinal numbers directly related by the order by which they're interviews were performed.

4.1 Implementation of intelligent systems for decision making

Q1 - Are there benefits on decision making by implementing intelligent systems?

The first research question aims to understand, to begin with, if there is perceived potential on Management Accounting professionals whether implementing intelligent systems positively influence decision making or not, and secondly if agreed, on what grounds they sustain their vision.

Table 3 Intelligent Systems on decision making

Category		Sub-category	N
Implementation of intelligent systems to influence decision making.	Does not influence	Non appliable	0
	Influences	Less manual work	3
		Faster/timely access to information	6
		Faster decisions	4
		Ability to predict/anticipate trends	3
		More conscious/grounded decisions	4

Source: Author

By analysing Table 3, we can infer that every interviewee (N=7) agreed that implementing Intelligent systems has a positive impact on decision making in the business spectrum.

The most mentioned topic as a positive outcome of the implementation of Intelligent Systems was the faster/timely access to information (N=6). As Participant 1 refers that "*it still takes too much time gathering information manually in order to take a supported decision, I believe that if with Intelligent Systems technologies we could benefit from real-time information, good decisions could be a lot faster to take and with accurate information."* It can be observed that this quote also supports other positive outcomes, such as less manual word and faster decisions.

Even though it wasn't one of the most mentioned positive outcomes (N=3), the ability to predict and/or anticipate trends was strongly highlighted by Participant 7, *"I believe AI can be a real asset when it comes to predict and anticipate situations, after all it teaches itself from previous data and learns from situations. Despite my believes that it all can be done by humans, the fact that we can use it has a tool without even spend time analysing data to do that job seems very useful."*

Having in consideration the results presented in table 3, we may infer that the interviewees had no doubt regarding the positive impact of intelligent systems like Artificial Intelligence and Internet of Things have on decision making. This vision is supported by (Stancheva, 2018) when he refers that there is a positive path through new technologies like intelligent systems to make management accounting thrive in the future. Also (ICAEW, 2017) gives his feedback in accordance with the interviewees by saying that intelligent systems will resolve a big problem of management accounting, when referring to decision-making.

When (Petkov, 2020) talks about the time saved in tasks and the ability to have instantaneous outputs for decision making supports the view of the general agreement of the interviewees when considering that the fast access to quality data will lead to better and faster decision-making. Thus, trust in the process of data generated through IS reliance will be emphasised.

4.2 Potential of using Artificial Intelligence and IoT in management accounting

Q2 - Is there potential of using Artificial Intelligence and IoT in management accounting?

The aim of this research question is to comprehend if the application of intelligent systems like Artificial Intelligence and IoT can have a positive impact in the management accounting profession and therefore on the tasks performed by these professionals. In order to better understand and properly separate the benefits from these distinct intelligent systems, this subject is analysed separately. First IoT will be presented and discussed and after Artificial Intelligence.

For the purpose of this research question, there was no objection regarding the perceived potential of both intelligent systems, as every interviewee (N=7) agreed, that in their perspective, there can be great outcomes by implementing this kind of technology in the management accounting field.

Table 4 Benefits of implementing IoT in management accounting

Category	Sub-category	N
Potential of the implementation of IoT in management accounting.	Real time access to information	7
	Intimate necessity by sourcing data to AI	4
	Multiple sources of information converging	3
	Possible connection with supply chain	1
	Enhancing decision-making	5
	Optimum results by cutting costs	4
	Better data management	3

Source: Author

We can infer, by observing Table 4, that the most highlighted topic was the real time access to information (N=7), yet this topic can evolve to different types of scenarios like the enhanced decision-making, because real time access to information will potentially lead to better decision-making, considering most of the times the time factor has a big role in decision-making process. Participant 5 supports this perspective by saying "*Communication and processing of information in real time will make better decisions to be made since time management is essential when we talk about management accounting*.".

Participant 4's perspective is to be highlighted since it refers to almost every sub-category that was mentioned in the interviews with interesting logic supporting his view as follows "*More information and better data management - management accounting absorbs information from all departments of the company, and the possibility of having access to data in real time is one way - for example, it is possible to have access to data from a production line and understand where they can be optimized; greater control over product inputs and outputs can allow unnecessary cost reductions.".*

Participant 2 raised a topic that no other participant did, I consider this opinion interesting as it is completely different from the others. He refers the that "*I find*

interesting that everyone focuses on the obvious, like time management, or fast access to information, but wouldn't it be interesting to escalate the type of information we can get… For example, almost every business has supply chain, I say why not try to find a way of using IoT directly from the supply chain to predict better decisions? I know there are barriers, either legal and ethical to be crossed, but wouldn't it be beneficial for either the companies or for the supply chain itself?"

The necessity of IoT to source data to AI is also an interesting view since they seem to compliment each other for better outcomes. As Participant 7 refers "*I believe that one of the principal benefits from implementing IoT is to source data to AI, since AI naturally learns from data, and if data is provided to AI systems in real time with precise data it would be a cherry on top a cake.*".

This last perspective directly forwards us to the potential of implementing Artificial Intelligence systems in management accounting, as follows in Table 5.

Table 5 Implementation of Artificial Intelligence in management accounting.

Category	Sub-category	N
Potential of the implementation of Artificial Intelligence in management accounting.	Input analyses and classification tool	2
	Processes automation	7
	Less manual work means less risk	5
	Problem identification	5
	Problem solving	4
	Prediction of patterns	3
	Efficiency and reliability of data	3

Source: Author

By analysing table 5, it can be observed that every interviewee (N=7) agreed on process automation being a major benefit through the implementation of AI in management accounting. Participant 1 revealed that "*the automation of processes is a big step into management accounting, considering that this profession is filled with small tasks that will be challenged by automation processes through AI, it might be tough and costly to implement, but once it's running it will be worth it in the long run.".* Also mentioning possible handicaps to the implementation.

Together with other participants, participant 3 enhances the emphasis on the identification and solving of problems, *"Automated information processing identifying problematic sectors and suggesting improvements that optimize production via Artificial Intelligence.".*

Participant 7 sees the big picture until the final decision making with his perception on the implementation of AI by saying "*Analysis of inputs from assembly lines, for example, in a more general concept. A tool for analysing and classifying the inputs and, in this way, making connections to better adapt the work and even decisions.".*

By analysing table 4 and 5 we may infer that there is consensus by management accounting professionals of the perceived added of implementing AI and IoT in management accounting. The points raised by the interviewees, regarding the impact of IoT on management accounting, are on full agreement by what was said by (J. Wu, 2019) (SAS–IoT, 2020) when referring to the quality source of data and real time access to information leading to potential upgraded outputs. Also was pointed out that the fact of sourcing data for better decision-making and even for other intelligent systems like AI was essential, this aligns with the vision of (ICAEW, 2017) in the previous research question.

Regarding the appliance of artificial intelligence, there was unanimity when concerning the automation of processes, this topic develops to several others like the less needed amount of work and therefore less risk, which indicates higher efficiency and reliability of the data generated. These topics are supported by (Bhimani, 2020) (Tripathy & Anuradha, 2018) as they emphasise the importance that AI may have regarding the processes automation, and importance of data quality and reliability.

(Huang, 2019) supports the view of the interviewees when sharing his opinion regarding the utility of AI when considered has a tool that can analyse, treat and learn

from previous and real time data in order to predict patterns or give outputs that can be used by managers for decision-making.

A point was raised by a participant that was not found in the literature review, which was the possibility of engaging IoT in the supply chain, that way being able to predict scenarios that both parties can benefit.

4.3 Barriers that might be in the implementation of intelligent systems.

Q3 - Which are the barriers that might be in the implementation of intelligent systems?

The last research question gives emphasis to the possible challenges that are expected to be faced when considering implementing intelligent systems in the management accounting profession. In order to have a better understanding of the situation, this topic is divided in two. To begin with, a query on the challenges expected before implementing, (pre-implementation) and after, the challenges to be considered after the implementation (post-implementation).

Table 6 Expected challenges on pre-implementation of Intelligent Systems

Category	Sub-category	N
Challenges on pre-implementation of intelligent systems in management accounting	Perceived potential of implementation	3
	Resistance to change	7
	Fear of technology automation (jobs at stake)	3
	Implementation costs	6
	Data migration errors	2

Source: Author

By taking table 6's data into consideration, it can be observed that every interviewee agreed that "resistance to change" was predominant before taking the decision of implementing intelligent systems in management accounting. As participant

2 said *"Change is always difficult, change takes you to a place where you are not comfortable. If we are talking about people's jobs it has a special emphasis, because their pay check is at stake. There must be an adaptation of the current work and some persons are just not up to put up the extra effort needed, either because they think they are not capable of, or they just don't want to take the effort."*

Other topic that had almost full agreement (N=6) was that the implementation cost is to be considered. Participant 1 talks about the cost implementation combined with the perceived potential, saying *"... usually when you invest in new technology, it means that your company is stable, or at least means that you have available money to invest. If there isn't a strong belief that intelligent systems will turn into potential profit for the company, the decision might be not to invest because of the implementation costs and the control costs that are to be expected in the future."*

One aspect that was only pointed out by two participants (N=2) was the expected errors that might happen when beginning the migration of data to the new intelligent systems. Participant 4 refers to it as the following *"... if the migration of the data is not properly parameterized it is to be expected a huge amount of workload, slowing the implementation and preventing the systems to run on the expected due date..."*

Table 7 Expected challenges in post-implementation of intelligent systems.

Category	Sub-category	N
Challenges on post-implementation of intelligent systems in management accounting.	Expected training costs to optimum outcomes of usage	6
	Make people perceive the added value	3
	Create trust on generated data	4
	Communication error between the IS and the software	6
	Undetected errors might lead to wrong data	5

Source: Author

Together with "expected training costs", the most emphasised point by the interviewees was the "communication error between intelligent systems and the software". This point is related some other points like "undetected errors might lead to

wrong data" thus it can also lead to create mistrust and discordance in the usage of intelligent systems. Like participant 4 says *"... for intelligent systems to be properly implemented, the systems must be correctly parameterized so there are no communication errors between the IS and the software in use. If there is full trust in the data created, and there are no validation process of the data that is being created, it can lead to wrong generated data and therefore future problems to be solved."*

An interesting topic that should be highlighted is the "perception of the added value" that participant 3 points out in his interview as *"Considering that the implementation of intelligent systems is successful, and AI is running and automating processes, when it generates data useful for analyses or even if it generates suggestions, it is supposed that that outcomes are to be taken into consideration and persons taking the decisions rely on it. Otherwise, if you don't perceive the value of the intelligent tool and if you can't trust it, why even bother implementing it?".*

According to the reading and analyses of Table 6 and 7 we can observe that the most highlighted barrier was the resistance to change and the implementation costs, as (Gärtner, 2018) refers, also the training must be a focus, in order to run the intelligent systems to its optimum potential. The perceived quality of the data, and directly related to it, the reliance on it to turn it into outputs is also highlighted and supported by (Cubric, 2020) (Gärtner, 2018).

5 Conclusion

Contemporarily speaking, new technologies are constantly changing, and the market is adapting in real time. Companies are seeking for ways to exceed and gain competitive leverage over the market, so the aim of this study was to analyse the impact of implementing intelligent systems in management accounting. There are big challenges in management accounting that can be surpassed by implementing intelligent systems as emphasised by (ICAEW, 2017) and (Stancheva, 2018). After taking into consideration the literature review and the research conducted by interviews, we may infer that the results corroborate with the expectations, and in fact, new technologies like AI and IoT can help to surpass big challenges in management accounting.

In the first research question the aim was to understand the perceived importance of intelligent systems on decision-making and, if so, to identify on which grounds it could benefit management accountants and managers in decision-making. Both in literature review and in the conducted interviews it was clear that one supports the other, regarding the potential benefits of the implementation. Full agreement was achieved that it has positive impact on decision-making and topics were structured so it's easier to understand how it can be beneficial, as it was the objective of this research question.

In the second research question, the focus was to comprehend how intelligent systems like artificial intelligence and internet of things could enhance management accounting. After focusing on analysing the subject through the literature review and scrutinising the interviews, there was general agreement that artificial intelligence and internet of things can have major impacts regarding the management accounting profession, it was specially emphasized that task automation, leads to time saving and less manual work. That way, if intelligent systems are properly parameterized and configured, risk of error lowers and quality data is created with less effort. The topic of the reliance on the data created was also highlighted so there can be optimum outputs by using intelligent systems as a tool.

The potential barriers/challenges to be expected in the implementation of intelligent systems on management accounting was the third research question, it was divided in before and after implementation. The most highlighted topics were the resistance to change and implementation costs, there was general agreement on this topic and it turns

out that as referred in literature review and by some interviewees, it intensifies if there is not enough perceived value of the implementation, because, if it is clear for everyone that the outcomes will potentially surpass the implementation costs, the reliance on the process will overcome implementation fears and consequent costs. Regarding the post-implementation, it was highlighted by interviewees and corroborated by literature that people are the main focus of the whole process, as it is almost mandatory that training is performed properly, so the process can run smoothly, with the less error migration possible and therefore achieve quality data to ultimately rely on it for good analyses and consequential outputs.

By analysing all the interviews and literature review, it was clear that there are expected barriers to be crossed, like the resistance to change, the cost of the implementation of intelligent systems or even the necessary training, but it was unanimous that even though every interviewee agree that barriers exist, before and after its implementation, the outcomes of the implementation are positive in their perspective and there is full agreement regarding the worth of implementing intelligent systems in management accounting as it can be a serious tool go get leverage over this ferocious competitive market.

On the writing of this study, there were some limitations as expected. When gathering articles and papers to put up a consistent literature review it was a struggle to find data that clearly stated on what grounds IoT and AI could enhance the daily tasks of an account manager, at least not in the depth that was expected.

The fact that we are experiencing a pandemic era, forced the interviews to be conducted online, via zoom, and not in person as would be desirable. Another limitation of this study was the number of interviews performed. The size of the sample wasn't the expected as it was difficult to find management accounting professionals with the will to contribute to the academy. The last limitation is that as this subject and new technologies are constantly changing, the conclusions and outputs generated in this study, in a certain period of time, can fairly be outdated without reasonable endeavour.

In order to get a better and deepened understanding of this subject, it would be interesting to interview intelligent systems professionals so we can get the perspective of the implementation in management accounting from both parties and understand if there is agreement on each other's outputs.

Also, it can be interesting for future research to target companies with the artificial intelligence and internet of things implemented and conduct a study to understand if the challenges expected in this study, regarding the intelligent systems implementation, were experienced. If so, which were the rules of engagement to surpass those challenges, and if not, why weren't experienced. Considering that IS are being increasingly implemented, it would be interesting to create information to overcome difficulties in the business spectrum.

Bibliography

Bhimani, A. (2020). Digital data and management accounting: why we need to rethink research methods. *Journal of Management Control*.

Cubric, M. (2020). Drivers, barriers and social considerations for AI adoption in business and management: A tertiary study. *Technology in society*.

Gärtner. (2018). Issues with Big Data. In Q. M. Strauss. *The Routledge Companion to Accounting Information Systems*, https://doi.org/10.4324/9781315647210.

Goundar, S. (2012). Research methodology and research questions. *Research Methodology and Research method.*

Güngör, H. (2020). Creating Value with Artificial Intelligence: A Multi-stakeholder Perspective. *Journal of Creating Value*.

Haenlein, M., & Kaplan. (2019). A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. *California Management Review*.

Hassabis, D. (2017). Neuroscience-Inspired Artificial Intelligence. *Neuron*.

Huang, M.-H. R. (2019). The Feeling Economy: Managing in the Next Generation of Artificial Intelligence (AI). . *California Management Review*.

ICAEW. (2017). Big data and analytics – What's new? 8.

J. Wu, F. X. (2019). Application of Internet of Things and Blockchain Technologies to Improve Accounting Information Quality. *IEEE Access*, doi: 10.1109/ACCESS.2019.2930637.

Jan Holler, V. T. (2014). From Machine-To-Machine to the Internet of Things: Introduction to a New Age of Intelligence.

Lewis, T., & Denning, P. (2018). The profession of IT learning machine learning. *Communications of the ACM*, 24-27. Retrieved from http://doi.org/10.1145/3286868

Nicoleta. (2019). Journal of Academic Research in Economics Management Accounting : the Boundary between tradicional and modern.

Pattar, Buyya, Iyengar, & Patnaik. (2019). Social Internet of Things (SIoT): Foundations, thrust areas, systematic review and future directions. https://doi.org/10.1016/j.comcom.2019.03.009.

Petkov, R. (2020). Artificial intelligence (Ai) and the accounting function—a revisit and a new perspective for developing framework. *Journal of Emerging Technologies in Accounting*, https://doi.org/10.2308/jeta-52648.

SAS–IoT. (2020). *Internet of Things (IOT).* https://www.sas.com/en_us/insights/big-data/internet-of-things.html.

Shrestha, Y. R.-M. (2019). Organizational Decision-Making Structures in the Age of Artificial Intelligence. *California Management Review*.

Stancheva, E. (2018). How artificial intelligence is challenging accounting profession. *Researsh Gate*.

Tripathy, B., & Anuradha, J. (2018). Internet of Things (IoT): Technologies, Applications, Challenges and Solutions. *CRC Press*.

Vermesan, O. a. (2013). Internet of Things—Converging Technologies for Smart Environments and Integrated Ecosystems. *River Publishers*.

Vilelas, J. (2009). Investigação : O processo de Construção do Conhecimento.

ANNEXES

ANEXO A – INTERVIEW SCRIPT

Nome:
Idade:

QUESTÕES GENÉRICAS

1) Qual o seu nível de formação académica?

2) Exerce funções de contabilidade há quantos anos?

3) Exerce na qualidade de técnico ou direção?

4) Qual o seu grau académico?

QUESTÕES ESPECÍFICAS

1) Nas suas tarefas de contabilista de gestão, considera que novas tecnologias ajudam a realizar mais eficientemente o trabalho?

2) A sua empresa tem sistema de contabilidade de gestão ou subcontratam?

3) Quais os principais desafios em usar tecnologia em contabilidade?

4) Considera que os sistemas inteligentes podem melhorar as tarefas do dia a dia na interação entre o user e o sistema?

5) Com a utilização de Sistemas Inteligentes em funcionalidades/tarefas do sistema e para tomadas de decisão, acha que as mesmas poderiam ser mais rápidas e eficientes?

6) Conhece bem os conceitos de Inteligência Artificial e de Internet of Things?

7) Consegue visualizar Internet of Things a ser aplicado numa plataforma de contabilidade de gestão para ser mais eficiente?

8) De que forma vê IoT a ser aplicado em contabilidade de gestão?

9) Consegue visualizar Inteligência Artificial a ser aplicada numa plataforma de contabilidade de gestão para ser mais eficiente?

10) De que forma vê Inteligência Artificial a ser aplicado em contabilidade de gestão?

11) Na sua opinião, que barreiras poderão existir na pre-implementação de sistemas inteligentes no espectro empresarial?

12) Na sua opinião, que barreiras poderão existir na pós-implementação de sistemas inteligentes no espectro empresarial?